Emerging Markets for Geothermal Energy in the Western United States: An Industry Perspective on Project Initiation within Current Market Trends

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Introduction

Energy needs in the Western United States have increased the demand for geothermal projects throughout the region, creating an opportunity for the geothermal industry to expand its reach into a broader marketplace. By year-end 2007, only six U.S. states had active geothermal power plants with capacities ranging from 225 kW to over 100 MW (compared to 34 states with wind projects in that range).[1] Only two states (California and Nevada) had more than one geothermal field producing power at that time, and only three states (California, Hawaii and Nevada) utilized geothermal power for more than a negligible share of their energy portfolio.

This paper discusses how the changing power market is encouraging geothermal development throughout the Western U.S. and highlights three "emerging" states where geothermal development has strong promise in the near- and long-term future.

What is the State of the Geothermal Power Market in the U.S?

A cursory look at geothermal resource development in the U.S. indicates that development opportunities are limited to California, Nevada, and the volcanic Hawaiian Islands. Indeed, California continues to lead the world in installed capacity for geothermal power, while Nevada leads the U.S. in geothermal power generation per capita. Together with Hawaii and its geothermal operations on the Big Island, these three states together represented 98 percent of all U.S. geothermal installed capacity by year-end 2007 (California and Nevada represented 96 percent of total capacity).[2]

However, that doesn't mean that 98 percent of the U.S. geothermal resource base is situated in these three states. In fact, the Western Governor's Association (WGA), in their Geothermal Taskforce Report (released in January 2006) concluded that only 70 percent of the near-term and 63 percent of the long-term identified geothermal resource potential exists in California, Hawaii and Nevada.[3] Geothermal-active regions extend into all 13 Western U.S. States, and development of geothermal power is feasible in all of them. Yet, far more geothermal exploration and resource characterization has been performed in California and Nevada, while other states contain entire regions with questions as to their full potential for geothermal power development.

Three P's and an R

Besides the quality of the geothermal resources, there are important market forces driving the demand for geothermal power projects. Among the most prominent are the three P's and an R: Population, Pollution, Power prices and Reliance on energy imports.

Sometimes, these are interrelated. For example, California's large population has impacted its power prices; and its utilities cannot produce nearly enough fossil fuel resources and hydro-electric resources in-state to satisfy demand. California's air quality has suffered from multiple factors, including population, that have caused its energy policies to encourage geothermal power and other clean energy developments.

Hawaii does not have a population or pollution problem like California; however their reliance on energy imports, particularly petroleum, has been a clear driver for geothermal power development.

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[1]Source – American Wind Energy Association: http://www.awea.org/projects/

[2]Source – Geothermal Energy Association: "Update on US Geothermal Power Production and Development", January 16, 2008

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

In Nevada, there are multiple concerns. Nevada has experienced the most rapid population growth of any U.S. state in the past two decades. This has exacerbated concerns over air quality in the Las Vegas basin as well as the availability of water. Yet, perhaps the most significant driver for Nevada to seek alternative power sources is its reliance on energy imports. Nevada's production of oil and natural gas is negligible, and its coal-fired power plants import all their coal from out-of-state.

Going forward, it appears that these market forces will continue to drive the demand for geothermal development in California, Hawaii and Nevada. However, power markets in other Western States are following similar trends. In most cases, the inexpensive electricity prices enjoyed by ratepayers in these states are based on their access to existing power generators, such as operating hydro-electric dams constructed many years ago, large-scale nuclear power plants constructed during the 1970s and 1980s, and operating coal-fired power plants with existing infrastructure. Acquiring new electric power in states like Idaho, Oregon and Utah is no longer a bargain. New fossil-fueled generators require substantially more capital costs to build, and importing fuel from out of state has becoming exceedingly expensive. States which do produce fossil fuels like oil, gas and coal are using more of those fossil fuels in-state, and exporting less to other markets. The increase in pollution, caused by urbanization and sprawl in cities like Boise and Salt Lake City, has created an additional incentive by government, citizens and utilities to switch to cleaner sources of energy; especially base-load renewable energy sources like geothermal power that sustain grid stability.

Three Emerging States

Idaho, Oregon and Utah all contain considerable potential for geothermal power development, and all of them have had a geothermal power plant within their borders. Yet, by year-end 2007, only two of these three states were producing power from geothermal resources, with a total capacity of approximately 50 MW. However, an effort towards new development in these states has increased over recent years, breaking through old barriers, and providing momentum for future development.

Idaho – WGA Near-Term Potential: 855 MW

Market Summary

Admitted into the Union in 1890, residents of Idaho's capital city of Boise began using geothermal resources for district heating in 1892. While there are numerous direct-use geothermal facilities in the state, Idaho has only one geothermal power plant.

The completion of this plant, located in the Raft River Valley, is considered a remarkable achievement given that Idaho customers paid the lowest electricity prices in the nation in 2006, 38 percent as much as the average ratepayers in California and 51 percent as much as the average ratepayers in Nevada.[4]

However, this era of low-cost energy appears to be nearing its end. Idaho's population has been growing consistently faster than average U.S. growth since 2000, now at roughly 1.5 million. While hydro-electric power plants represent the majority of in-state generation, the state's largest utility, Idaho Power, relies on out-of-state coal-fired generation for a significant amount of its electric load.[5]

With limited prospects for expanding the use of hydro-electric power, Idaho utilities must now examine more expensive options. There are no coal-fired facilities located in Idaho, and the state government recently placed a moratorium on coal-fired plants constructed in-state. Idaho has no coal mining operations in the state, nor do they have producing oil and gas wells.[6]

Geothermal Resource

Idaho's geothermal resource may represent a bright spot on the state's energy horizon. Regions of known geothermal potential extend over more than half of the state. While some of the most attractive geothermal resource areas in Idaho are remote, a number of promising prospects are actually located relatively close to population and/or existing transmission infrastructure. The Snake River Plain, which stretches from the Oregon border in Washington County to Idaho Falls, is a key region with geothermal activity, and is home to roughly half the state's population.

The Raft River geothermal facility is located in the northern extension of the Basin and Range Province, an area with abundant faults, fractures and inherent high crustal heat flows, extending primarily in the southeast and south-central part of the state.

Figure 1. Boiling Springs steam vent, Idaho. Photo by Josh Laughtland of idahohotsprings.com: Used by permission.

Another area of potential is located northeast of Boise, in the mostly unexplored Idaho Batholith region (see photo). The Idaho Batholith is a large mountainous area stretching 15,400 square miles from the Boise National Forest to the Bitterroot Mountains.

[4]Source – Energy Information Agency: http://www.eia.doe.gov/cneaf/electricity/epa/fig7p4.html

[5]Sources: U.S. Census Bureau: http://quickfacts.census.gov/qfd/states/16000.html & Idaho Power Company, 2006 Integrated Resource Plan: http://www.idahopower.com/pdfs/energycenter/irp/2006/2006_IRP.pdf (Page 13)

[6]Source – Energy Information Agency: http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=ID

This area contains numerous thermal springs with temperatures as high as 199°F (93°C) at the surface.

Challenges and Opportunities

A primary challenge for geothermal development in Idaho is resource characterization. Although Idaho is considered to have significant geothermal power potential, many of the sites exhibiting the most promise haven't been adequately explored. Many of these areas of interest are on federal land. 64 percent of Idaho's land is managed by the federal government (69 percent of the mineral acreage).[7] While resource areas in the Snake River Plain generally contain a mix of private and Bureau of Land Management (BLM) land, resource areas in the Basin and Range contain significant tracts of BLM land and some U.S. Forest Service land. Nearly all the resource areas in the Idaho Batholith region are located on Forest Service land.

Without a track record of geothermal development and exploration in the state, these federal agencies have limited experience with leasing and permitting. Many of these lands do not include geothermal power development in their management plans. The uncertainty of the leasing and permitting process on federal lands in Idaho has thus far frustrated developers efforts to commit exploration teams to the state.

Despite these challenges, the prospects for geothermal development in Idaho appear to be improving. Although the state lacks a Renewable Portfolio Standard (RPS) or any significant tax benefits for geothermal power projects, Idaho policymakers have increased focus on how to benefit the industry, now that there is an operating geothermal plant in the state. In June 2007, the Idaho BLM held a geothermal lease sale which covered more than 8900 acres of land and generated more than $5.7 million.[8] The frequency and success of future lease sales will be affected by the Programmatic Environmental Impact Statement (PEIS), a joint effort by the BLM and the Forest Service to analyze and expedite the leasing of BLM-and Forest Service-administered lands with high potential for renewable geothermal resources in 12 states, including Idaho.

Oregon – WGA Near-Term Potential: 380 MW

Market Summary

Oregon's geologic setting is ideal for geothermal power development. Nearly three-quarters of the state hosts regions of known geothermal activity. Yet, despite this geologic advantage, the state lacks an operating geothermal power plant.

Perhaps one reason for Oregon's lack of geothermal development has been its ability to rely on low-cost hydro-electric power. In 2006, Oregon customers paid 51 percent as much as the average ratepayers in California and 68 percent as much as the average ratepayers in Nevada.[9]

Oregon also benefits from the infrastructure developed along the Pacific Intertie, designed to take power from throughout the West into the Pacific Northwest and California markets. Besides hydro-electric power, natural gas is the major energy source generated in Oregon. There is only one utility-scale coal-fired facility in Oregon. The continued reliance of Oregon utilities on gas-fired plants is limited by Oregon's minimal natural gas production in-state.[10]

Oregon's population has been rising faster than the U.S. average since 2000, at 3.7 million by the end of 2006. Helping to accommodate load growth without increasing fossil fuel consumption, Oregon utilities have greatly expanded their use of wind power, which doubled from 438 MW by year-end 2006 to 885 MW by year-end 2007, and passed the 1,000 MW mark in early 2008.[11]

Geothermal Resource

Like its neighbors in California and Washington State, Oregon sits in the "Pacific Ring of Fire" with active volcanoes of the Cascade Range running north-south through the west-central part of the State. Geothermal power development potential also exists in parts of the High Lava Plains and the Oregon Plateau of central Oregon, the Basin and Range Province in southeastern Oregon, and the western edge of the Snake River Plain in northeastern Oregon. There are numerous geothermal direct-use facilities in these areas used for a variety of applications.

The most substantial exploration of Oregon's geothermal resources was performed during the 1970s and early 1980s. While a number of potential geothermal prospects were identified during this time, there were challenges to development that kept companies from moving forward. The highest temperature sites were located primarily in the Cascades. Though some exploration in Eastern Oregon demonstrated resources suitable for binary power plants, the technology was not a commercially viable option until the mid-1980s.

Challenges and Opportunities

Thus far challenges to development of Oregon's geothermal resources have been great enough to prevent a utility-scale power plant. Geothermal leasing in the Cascades continues to generate public concerns over energy development within the vicinity of pristine national forests and natural landmarks. Geothermal development in Eastern Oregon has been limited by remoteness from load and transmission access as well as development restrictions in certain areas, such as the Alvord Desert.

Federal lands make up roughly 53 percent of the surface acreage and 55 percent of the mineral acreage in Oregon. 23 percent of Oregon lands are managed by the BLM and 23 percent are managed by the Forest Service. The Forest Service land areas are predominately in the Cascades and northeastern Oregon. BLM

[7] Total tribal and federal mineral acreage in Idaho: Bureau of Land Management (BLM) (2002): Mineral and Surface Acres Administered by the Bureau of Land Management: http://www.blm.gov/natacq/pls02/pls1-3_02.pdf

[8] Source – U.S. Bureau of Land Management (BLM), 6/21/2007: http://www.blm.gov/id/st/en/info/newsroom/2007/06/idaho_blm_geothermal.html

[9] Source – Energy Information Agency: http://www.eia.doe.gov/cneaf/electricity/epa/fig7p4.html

[10] There were only 14 producing natural gas wells in Oregon in 2006. Source – Energy Information Agency: http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=OR

[11] U.S. Census: http://quickfacts.census.gov/qfd/states/41000.html & American Wind Energy Association: http://www.awea.org/projects/

land areas are predominately in the Basin and Range covering much of the southeastern quarter of Oregon.[12]

Arguably some of the challenges to geothermal development in Oregon may have been overcome if not for the low cost of power for Oregon during the time of primary exploration. Oregon residents have also lacked major exposure to pollution which has strongly motivated development of renewable energy projects in California. Presently, new geothermal power development efforts in Oregon are promising and it is likely that when the state's first utility-scale geothermal power plant is completed, it will ignite renewed interest. Areas currently unavailable for leasing may be reconsidered.

More recently, state policy has focused on promoting non-hydro renewable technologies, including geothermal. This includes the implementation of an RPS and increasing the existing Business Energy Tax Credit (BETC) in 2007.[13]

Utah – WGA Near-Term Potential: 230 MW

Market Summary

Both Utah and Nevada installed geothermal power plants for the first time in 1984, but Nevada continued its development while Utah stalled. Unlike Nevada, Utah is a net-exporter of electric power and produces more fossil fuels than it imports. In 2006, Utah ranked 12th in crude oil production and coal production, while producing more than 1.87 percent of domestic dry natural gas. In fact, Utah's natural gas production has increased in recent years to the highest levels in history. Oil production has increased since the start of the decade, although it is well below average levels of production during the 1980s and 1990s.[14]

At present, Utah is almost completely reliant on fossil fuels for electricity generation. In 2006, 72.9 percent of the electric power generated in Utah was produced from coal. Natural gas provided another 21.9 percent. Meanwhile, Utah's population growth has been more than double the U.S. average, growing by more than 400,000 people in the past seven years (now over 2.6 million).[15]

While Utah customers paid electricity prices well below the national average in 2006 (47 percent as much as the average ratepayers in California and 62 percent as much as the average ratepayers in Nevada) it is facing increasing energy constraints trying to meet population growth and inhibit pollution along the Wasatch Front.[16]

Geothermal Resource

Geothermal power remains an attractive option in Utah. Utah's first geothermal power plant at Roosevelt Hot Springs is still running, and was expanded in 2007 by PacifiCorp using an 11 MW bottoming cycle unit manufactured by Ormat. Cove Fort, the only other geothermal field in Utah to have had an operating geothermal power plant, is now under re-development. Developers are attempting projects at a few other sites as well.

It is no surprise that these development efforts have been renewed. Utah's geology is conducive to geothermal systems, particularly in the Basin and Range province in Western Utah, the Transition Zone in central Utah, and the Wasatch Fault Zone in northern Utah.

Challenges and Opportunities

Unlike Nevada, deep exploration drilling in Utah's geothermal target areas has been minimal. Resource characterization remains an important step to understanding the full potential in this region.

Ultimately, capturing Utah's geothermal potential will hinge on access to resources on federal lands, primarily the BLM. Roughly two-thirds of Utah's land and mineral acreage is managed by the federal government with 43 percent of the land managed by the BLM.[17] Leasing and permitting on these lands remain uncertain. The Utah BLM is accepting nominations for geothermal exploration. They plan to hold a BLM lease sale for these lands in November of 2008. Until then, opportunities for exploration drilling on prospective geothermal resources on federal lands in Utah will remain stagnant.

Overall, Utah is very promising for new development. Unlike Idaho, federal land agencies have more experience with leasing and permitting for energy and minerals, due to the surge in federal oil and gas leases over the past several years. In June 2007, the Utah BLM held a geothermal lease sale which covered more than 6,000 acres of land at Cove Fort and generated nearly $3.7 million.[18] The success of this lease sale demonstrates the value for geothermal resources as a leasable commodity and may encourage future sales. In addition, state policy has begun to address renewable energy more aggressively. In the spring of 2008, Utah established an RPS target of 20 percent by 2025. This policy, while not a requirement, sets an agenda for low-carbon technologies, and complements a state renewable energy production tax credit of 0.35¢/kWh established in 2007.[19]

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[12]Wildland Firefighters (11/13/2007): http://www.wildlandfire.com/docs/2007/western-states-data-public-land.htm & Bureau of Land Management (BLM): http://www.blm.gov/natacq/pls02/pls1-3_02.pdf

[13]The BETC was expanded in 2007 to cover 50% of tax liability for renewable energy projects including "costs directly related to the project, including equipment cost, engineering and design fees, materials, supplies and installation costs. Loan fees and permit costs also may be claimed." The credit currently has a maximum credit of $10 million filed over five years. Source: Database of State Incentives for Renewable Energy (DSIRE): http://www.dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=OR&RE=1&EE=1

[14]Source – Energy Information Agency: http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=UT; Utah oil production history: http://tonto.eia.doe.gov/dnav/pet/hist/mcrfput1m.htm; Utah natural gas production history: http://tonto.eia.doe.gov/dnav/ng/hist/n9050ut2a.htm

[15]U.S. Census: http://quickfacts.census.gov/qfd/states/49000.html & The Southwest Energy Efficiency Project (SWEEP): http://www.swenergy.org/factsheets/UT-factsheet.pdf

[16]Source – Energy Information Agency: http://www.eia.doe.gov/cneaf/electricity/epa/fig7p4.html

[17]Wildland Firefighters (11/13/2007): http://www.wildlandfire.com/docs/2007/western-states-data-public-land.htm & Bureau of Land Management (BLM): http://www.blm.gov/natacq/pls02/pls1-3_02.pdf

[18]Source – U.S. Bureau of Land Management (BLM), 6/21/2007: http://www.blm.gov/id/st/en/info/newsroom/2007/06/idaho_blm_geothermal.html

[19]Source: Database of State Incentives for Renewable Energy (DSIRE): http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=UT01F&state=UT&CurrentPageID=1&RE=1&EE=1

What About the Other Western States?

Alaska – WGA Near-Term Potential: 25 MW

Much of Alaska's southern coastal region is part of the Pacific Ring of Fire, and has many volcanoes and hot springs. As a major oil and gas producer, Alaska's economy is greatly affected by fossil fuel prices. In-state consumption of these fuels reduces imports and exacerbates the depletion of producing fields, particularly gas fields in the Cook Inlet. As a result, geothermal can be a useful alternative if it can be developed and sent to market. To date, geothermal development has been limited in Alaska to a few direct heating facilities and a small geothermal power plant serving the Chena Hot Springs resort, 60 miles northeast of Fairbanks.

There are essentially two power markets in Alaska. The first is the Railbelt, serving Anchorage, Fairbanks and the surrounding communities. The second is all of the small cooperatives and village utilities serving rural Alaska. The Railbelt serves the majority of Alaska's population, and its power rates are comparable to California or Nevada. Rural communities, on the other hand, pay exorbitant prices for electricity, obtaining their power mostly through diesel generators using fuel shipped into ports.

Geothermal projects serving the Railbelt face large infrastructure costs, incompatible with the existing market economics. Geothermal projects in rural areas face the challenge of serving small populations which do not need more than a few megawatts. Still, the fact that Alaska has a substantial geothermal resource base has encouraged state policymakers to pursue innovative ways to use them to offset fossil fuel consumption in both remote areas and the Railbelt.

Southwestern States: Arizona and New Mexico – 20 MW WGA Near-Term Potential for Arizona, 80 MW WGA Near-Term Potential for New Mexico

The Southwestern states of Arizona and New Mexico are both intriguing markets for geothermal power development. Both have an RPS, and supportive policy environments for renewable energy. Both states are experiencing rising energy prices and a growing concern over their reliance on fossil fuels.

In 2006, New Mexico ranked 6th in crude oil production, 13th in coal production and produced 8.5 percent of domestic dry natural gas. Fossil fuel production in Arizona, on the other hand, is negligible with the exception of coal production, which ranked 16th in 2006 (still one-third the production of New Mexico). Both states, however, generate roughly 90 percent of their electric power from fossil fuel sources.[20]

The potential for geothermal power development is more evident in New Mexico than in Arizona. New Mexico's geology contains a mix of volcanic and tectonically active regions. This includes the Basin and Range Province and the Rio Grande Rift areas in south central and southwestern New Mexico as well as the Valles Caldera, in north central New Mexico where temperatures as high as 647.6°F (342°C) were measured at its western rim. Development of the Valles Caldera stalled due to a myriad of complications during the late-1970s and early 1980s and most of the resource area is now part of a National Preserve, with restrictions on development.[21]

In Arizona, geothermal exploration has been minimal. A few locations have shown promise, such as hot spring areas in the Southeastern part of the state and the San Francisco Volcanic Field northeast of Flagstaff.

Exploration in both states is complicated by the "blind" nature characterizing some of their primary resource areas. "Blind" geothermal resources are those which lack obvious surface anomalies like fumaroles and hot springs. These are especially prevalent in the southern Basin and Range in Arizona and New Mexico. Several areas like these have been explored in this region, where geochemical studies indicated temperatures ranging from 212°F to 347°F (100°C to 175°C). Advanced exploration techniques, including remote sensing and other surface technologies, provide an opportunity to study this region in depth through more efficient means than on-the-ground field surveys. As with other Western states, the inability to acquire geothermal leases on federal lands has impeded further exploration and development of these prospective areas.

Washington State – WGA Near-Term Potential: 50 MW

Like Oregon, Washington State is heavily reliant on hydroelectric sources for its electric power supply, and its power prices are similar to Oregon. While the state contains significant geothermal anomalies within the Cascade Range, most of these prospect areas are located in the immediate vicinity of Cascade volcanoes. As a result, there is trepidation in pursuing development in these areas. Groups within the state have suggested consideration of deep geothermal and Engineered Geothermal Systems (EGS) targets to take advantage of resources outside of federal lands in agricultural areas in need of economic development. Meanwhile, development in the Cascades remains a possibility, albeit one that needs a great deal of outreach and environmental mitigation to accomplish.

Rocky Mountain States: Colorado, Montana and Wyoming – 20 MW WGA Near-Term Potential for Colorado, No Estimate for Montana and Wyoming

Although the geology differs from the Northern Rockies in Montana and Wyoming to the high Rockies in Colorado, they share natural resource similarities. All three states are large producers of oil, natural gas and coal. All three primarily rely on coal for electricity. All three have a strong wind portfolio, with 1.5 GW installed between them by year-end 2007. Colorado and Montana have RPS policies in place, and their largest utilities are on track to meet their 2010 goals, primarily through existing

[20]Sources – Energy Information Agency: http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=AZ & http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=NM

[21]Sources: Goff, Fraser. "Geothermal Potential of Valles Caldera, New Mexico". GHC Bulletin, Geo-heat Center, Oregon Institute of Technology (OIT), December 2002: http://geoheat.oit.edu/bulletin/bull23-4/art3.pdf & New Mexico Energy, Minerals and Natural Resources Department (EMNRD). *Strategic Plan for New Mexico Geothermal Resources Development*. Prepared by James C. Witcher 8/31/2004: http://www.emnrd.state.nm.us/emnrd/ecmd/Geothermal/documents/NMGeothermalStrategicPlan.pdf

wind installations. Of these three states, Colorado has the highest population and energy prices. Unlike Montana and Wyoming, electricity generation in Colorado only slightly exceeds in-state electricity consumption.

Geothermal exploration has been limited in these states to mostly shallow drilling and surface exploration, although a few sites indicate promise for intermediate-temperature resources that could be used to produce electric power. Colorado has several potential areas, particularly in the Southwest and Central Rocky Mountains. In Montana and Wyoming, geothermal exploration is restricted within Yellowstone National Park and its vicinity. However, Montana has several potential areas in the southwestern part of the state that are located far outside Yellowstone.

In each of these states, geothermal exploration on federal lands is complicated by a lack of regulatory authority for leasing, particularly for resources on or involving Forest Service lands. This needs to be addressed in order for developers to move forward with exploration on the most promising geothermal areas in these states.

In 2008, Ormat Technologies partnered with the U.S. Department of Energy to test a 200 kW binary unit at the Rocky Mountain Oilfield Testing Center (RMOTC) west of Casper, Wyoming using fluid with temperatures less than 190°F (88°C). A similar project has been pursued in Eastern Montana, yet remains in the pre-development stage. Ultimately, these projects may help lay the groundwork for future projects, both conventional hydrothermal and applications like EGS.

Because each of these states generate significant revenue from fossil fuel production, the potential for carbon legislation and other factors has caused state policymakers to promote diversification of energy resource development to hedge against an indefinite reliance on fossil fuels for their economic sustainability.

Conclusion

Clearly, market forces like population, pollution, power prices and reliance on energy imports have altered the landscape of Western power markets and created a window of opportunity for private industry to deploy renewable technologies on a commercial level. The wind industry has already taken advantage of this, installing over 18 GW of electric generating capacity in the U.S. this decade, with over 6.5 GW in the Western U.S. alone.

With support of clean energy technologies at its strongest in many years, and utilities in need of base-load renewable energy capacity, the geothermal industry now has an opportunity to become a viable energy source in these markets. For this reason, it is imperative that there is government support for research and tax credits (such as the Federal Production Tax Credit or PTC) and it is critical that industry involvement in new projects extends into every Western state.

Furthermore, it is critical for the federal government to continue to support efforts by federal land agencies (the BLM and Forest Service in particular) to establish a clear protocol for geothermal leasing and permitting on federal lands. Such protocols, including the PEIS, can reduce projects risks caused by delays and stagnation so that developers can work with these agencies to perform necessary environmental reviews and environmental mitigation to move forward on projects within a reasonable timeframe.

Increased involvement in these states will help break through existing barriers, and open the door for advances in conventional technologies such as drilling and subsurface mapping, as well as new applications such as utilizing geothermal fluids co-produced with oil and gas fields, and EGS.