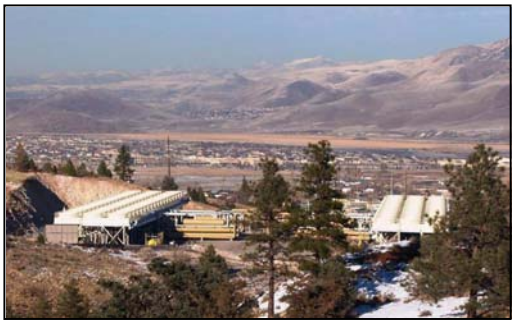
Geothermal Energy Association

U.S. Geothermal Power Production and Development Update



August 2008

209 Pennsylvania Avenue SE
Washington, D.C. 20003
www.geo-energy.org

Prepared by Kara Slack, August 7, 2008

GEOTHERMAL ENERGY ASSOCIATION

209 Pennsylvania Avenue SE, Washington, D.C. 20003 U.S.A.
Phone: (202) 454-5261 Fax: (202) 454-5265 Web Site: www.geo-energy.org

U.S. GEOTHERMAL POWER PRODUCTION AND DEVELOPMENT UPDATE: AUGUST 2008

Cover photos: (clockwise from top left) Ormat 20-MW Burdette Power Plant, Reno, Nevada (Start-up November 2005); UTC Power 225-kw Power Plant, Chena, Alaska (Start-up July 2006): Enel North America Stillwater Project 4 Unit, 47-MW Power Project (Start-up planned December 2008).

1. Installed Geothermal Capacity and Generation

The United States continues to be one of the key countries in increasing geothermal growth. According to energy data, the United States still remains the world leader in online capacity of geothermal energy, leading with 30% of the world total. As of August 2008, geothermal electric power generation is occurring in seven U.S. states: Alaska, California, Hawaii, Nevada, New Mexico, Utah, and Idaho. Other states, such as Oregon and Wyoming, are soon to be added to the list. As of August 2008, the United States has a total installed capacity of 2957.94 MW.

Table 1: **August 2008 Geothermal Power Capacity On-Line**

Alaska	California	Hawaii	Idaho	Nevada	New Mexico	Utah	**Total**
0.4 MW	2555.3 MW	35 MW	13 MW	318 MW	.24 MW	36 MW	**2957.94 MW**

1.1 State Installed Geothermal Capacity Data

Alaska
The first geothermal power plant in Alaska was installed in 2006 at Chena Hot Springs. It is a small-scale unit, using organic rankine cycle (ORC) technology to produce 200 kW from a low-temperature resource (165°F). A subsequent 200 kW unit has been installed, bringing total production to 400 kW.

California
U.S. geothermal capacity remains concentrated in California. In 2005, California's geothermal capacity exceeded that of every country in the world. In 2007, 4.5 % of California's electric energy generation came from geothermal power plants, amounting to a net-total of 13,439 GWh. This year the state welcomed the addition of another power plant, Heber South, which added 14 MW to California's online capacity. Now California has 2555.3 MW of installed capacity.*

Hawaii
Currently, one power plant operates on the big island of Hawaii. This plant, Puna Geothermal Venture, delivers an average of 25–30 MW (35 MW name-plate capacity) of firm energy on a continuous basis, supplying approximately 20% of the total electricity needs of the Big Island.

Idaho
In December 2007, construction of the first geothermal power plant in Idaho was finished, and commercial sale of the produced electricity began in January 2008. Raft River, a binary plant that uses a 300°F resource, has a nameplate production capacity of 13 MW. Currently, net electrical power output is between 10.5 and 11.5 MW. An expansion to this plant is underway, as well as several other projects in the state.

Nevada
In 2007, Nevada had 16 power plants, with a nameplate capacity of 301 MW. Together, these plants produced a net total of 1,216 GWh during the year. Another plant, Galena 3, went online in 2008. This made Nevada's nameplate capacity approximately 318 MW.

New Mexico
In July, Raser Technologies' 0.24 MW pilot installation project went online. The full project, Lightning Dock, is designed to produce 10 MW of electrical power and it is expected to go online in 2008.

Utah
There is currently one power plant in operation in Utah. Unit 1 of the Blundell Plant has a gross capacity of 25 MW and Unit 2 has a capacity of 11 MW. Utah is about to get its second power plant in late 2008, when Thermo Hot Springs is scheduled to come online. Thermo Hot Springs is on track to generate with a net capacity of 10 MW. In 2003 and 2004, Cove Fort units were shut down and are now under redevelopment.

*California had 2030.47 MW of net-capacity producing power in 2005. There is approximately 461 MW of power in California on standby (not producing power in 2005).
SOURCES: Geothermal Energy Association: http://www.geo-energy.org/information/plants.asp; California Energy Commission: http://www.energy.ca.gov/; and Nevada Commission on Mineral Resources Division of Minerals: http://minerals.state.nv.us/; BP: http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

2. New Activity

The following results identify up to 3959.7 MW of new geothermal power plant capacity under development in the United States (this includes projects in the initial development phase).* Unconfirmed projects, some of which might be developed in the next few years, increase the potential capacity to 3979.7 MW. There are 13 states with projects currently under consideration or development: Alaska, Arizona, California, Colorado, Florida, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Between confirmed and unconfirmed projects there are a total of 103 developing projects.

The projects listed for each state are categorized by the following phases:

- **Phase I:** Identifying site, secured rights to resource, initial exploration drilling
- **Phase II:** Exploratory drilling and confirmation underway; PPA not secured
- **Phase III:** Securing PPA and final permits
- **Phase IV:** Production drilling underway; facility under construction
- **Unconfirmed:** Proposed projects that may or may not have secured the rights to the resource, but some exploration has been done on the site

*Only projects in Phase 1 through Phase 4 are included in the 3959.7 MW

Please Note: GEA is reporting information that is provided to us about these projects from the developer or public sources. We do not independently verify the data provided or warrant its accuracy.

2.1. Active State Geothermal Projects

Table 2: **Active Geothermal Projects Listed By State**

Alaska: 53–100 MW

Phase 1
• Chena Hot Springs – 5 MW – Chena Hot Springs • Unalaska – 10 MW (Resource potential expected to be 50 MW) – City of Unalaska • Tongass – 20 MW (Pending Action of Volume II of the PEIS) – Bell Island Hot Springs
Phase 2
• Naknek – 18 MW (Plans to expand to 25 MW in two years) – Naknek Electric Association
Unconfirmed
• NANA Geothermal Assessment Program – Unspecified – Northwest Alaska Native Association

Arizona: 2–20 MW

Phase 1
• Clifton – 2 MW with 2 MW units added incrementally (20 MW potential resource) – Arizona Public Service
Unconfirmed
• Northern Arizona University – Unspecified – Received GRED II funding and preliminary studies completed

California: 927.6–1036.6 MW

Phase 1
• Superstition Mountains – 12–35 MW – Geothermal Program Office (GPO) of U.S. Government • Modoc – 20 MW (Pending Action of Volume II of the PEIS) – Vulcan Power • Modoc – 20 MW (Pending Action of Volume II of the PEIS) – Western Geothermal Power • San Felipe – 20–25 MW – Esmeralda Truckhaven Geothermal LLC • Juan Bautista de Anza Geothermal Project – 49.9 MW – Esmeralda Truckhaven Geothermal LLC • Fourmile Hill – 49.9 MW – Calpine Corporation • Telephone Flat – 49.9 MW – Calpine Corporation • El Centro – 50 MW (Pending Action of Volume II of the PEIS) • El Centro – 50 MW (Pending Action of Volume II of the PEIS)
Phase 2
• Casa Diablo #4 – 25 MW – Ormat Technologies, Inc. • Surprise Valley – 27 MW (38 MW by 2011) – Enel North America • Truckhaven I – 49 MW – Iceland America Energy, Inc. • North Geysers – 60 MW – Calpine Corporation • Salton Sea – 155 MW – MidAmerican, CalEnergy
Phase 3
• Unnamed Imperial Valley Project – 30–100 MW – Ormat Technologies, Inc.

• East Brawley – 50 MW – Ormat Technologies, Inc.
Phase 4
• The Geysers Field/ WGP Unit 1 Geothermal Project – 35 MW – Western GeoPower Corp. • Hudson Ranch I – 49.9 MW – CHAR, LLC • North Brawley – 50 MW – Ormat Technologies, Inc. • Northeast Side of Geysers: Bottlerock – 55 MW – U.S. Renewables Group, Riverstone
Unconfirmed
• Salton Sea – 20 MW – Sierra Geothermal Power

Colorado: 10 MW

Phase 1
• Mount Princeton Hot Springs – 10 MW – Mount Princeton Geothermal LLC

Florida: 0.2–1 MW

Phase 1
• Jay Oil Field – 200 kW (Potential for 1 MW) – Chena Hot Springs

Hawaii: 8 MW

Phase 1
• Unspecified Hawaii Project – Unspecified – Ormat Technologies, Inc.
Phase 2
• Puna – 8 MW – Expansion to Puna Plant – Ormat Technologies, Inc.

Idaho: 251–326 MW

Phase 1
• Sulphur Springs – 25–50 MW – Idatherm, LLC • Preston Area Project – 50 MW – Idatherm, LLC • China Cap – 50–100 MW – Idatherm, LLC • Magic Hot Springs – Unspecified – Ormat Technologies, Inc.
Phase 2
• Willow Springs – 100 MW – Idatherm, LLC
Phase 3
• Raft River Expansion – 26 MW – U.S. Geothermal

Nevada: 1082.5–1901.5 MW

Phase 1
• Gerlach – 5–10 MW – Sierra Geothermal Power • Hawthorne Army Ammunition Depot – 10 MW – Geothermal Program Office (GPO) of U.S. Government • Humbodlt-Toayaibe – 12 MW (Pending Action of Volume II of the PEIS) – Darrough Hot Springs, Great American Energy • Hazen – 20–30 MW – GRID LLC • Emigrant/Fish Lake Valley – 25 MW – Esmeralda Energy Company, Geo-Energy Partners

- San Emidio – 27 MW (Expansion to San Emidio plant) – U.S. Geothermal
- Gabbs Valley – 30 MW – Ormat Technologies, Inc.
- McGinness Hills – 30 MW – Ormat Technologies, Inc.
- Black Warrior – 37 MW – Nevada Geothermal Power
- New York Canyon – 27–54 MW – Vulcan Power
- Lee Allen – 48–115 MW – Vulcan Power
- Colado – 121–232 MW – Vulcan Power
- Desert Peak EGS – Unspecified – Ormat Technologies, Inc.
- Dead Horse – Unspecified – Ormat Technologies, Inc.
- Fireball Ridge – Unspecified – Ormat Technologies, Inc.
- Rock Hill – Unspecified – Ormat Technologies, Inc.
- Smith Creek – Unspecified – Ormat Technologies, Inc.
- Salt Wells – Unspecified – Sierra Geothermal Power
- Dixie Valley – Unspecified – Sierra Geothermal Power
- Sou Hills Prospect – Unspecified – Montara Energy Ventures
- Pyramid Lake – Unspecified - Pyramid Lake Paiute Tribe, Pyramid Lake Energy Project

Phase 2

- Trail Canyon No. 1 – 10 MW – Raser Technologies
- Truckee No. 1 – 10 MW – Raser Technologies
- Devils Canyon No. 1 – 10 MW – Raser Technologies
- Silver Peak – 15–40 MW – Sierra Geothermal Power
- Blue Mountain – 24 MW – Nevada Geothermal Power
- Silver State Geothermal – 25–50 MW – U.S. Renewables Group
- Reese River – 26–58 MW – Sierra Geothermal Power
- Alum – 41–90 MW – Sierra Geothermal Power
- Barren Hills – 55–117 MW – Sierra Geothermal Power
- Jersey Valley – Unspecified – Ormat Technologies, Inc.

Phase 3

- Grass Valley – 18–30 MW – Ormat Technologies, Inc.
- Buffalo Valley – 18–30 MW – Ormat Technologies, Inc.
- Pumpernickel Valley – 20–30 MW – Nevada Geothermal Power, Sierra Geothermal Power
- Hot Sulphur Springs – 32 MW (Plans to expand to 48 MW) – TG Power
- Carson Lake – 30–40 MW – Ormat Technologies, Inc., Nevada Power Company
- Aurora – 132–350 MW – Vulcan Power

Phase 4

- Salt Wells – 13 MW – Enel North America
- Rye Patch – 13 MW – Presco Energy
- Stillwater – 32 MW – Enel North America
- Blue Mountain/Faulkner I – 49.5 MW – Nevada Geothermal Power
- Salt Wells – 117–245 MW – Vulcan Power

Unconfirmed

- Howard – Unspecified – Sierra Geothermal Power
- Sulphur – Unspecified – Sierra Geothermal Power
- Wells – Unspecified – Sierra Geothermal Power

New Mexico: 10 MW

Phase 3
• Lightning Dock – 10 MW – Raser Technologies

Oregon: 297.4–322.4 MW

Phase 1
• City of Klamath Falls – 1 MW (Distributed Generation Project) – City of Klamath Falls • Geoheat Center at the Oregon Institute of Technology (OIT) – 1.2 MW – OIT • Liskey Greenhouse – 10 MW – Raser Technologies • Hood River County – 20 MW (Pending Action of Volume II of the PEIS) – Portland General Electric • Willamette – 20 MW (Pending Action of Volume II of the PEIS) – Estate of Max Millis • Hood River County – 30 MW (Pending Action of Volume II of the PEIS) – Portland General Electric • Willamette – 30 MW (Pending Action of Volume II of the PEIS) – Estate of Max Millis
Phase 2
• Neal Hot Springs – 25–30 MW – U.S. Geothermal
Phase 3
• Geoheat Center at the Oregon Institute of Technology (OIT) – 0.2 MW (Distributed Generation Project) – OIT • Crump Geyser – 40–60 MW – Nevada Geothermal Power • Newberry Geothermal – 120 MW – Davenport Power, U.S. Renewables Group, Riverstone

Utah: 244 MW

Phase 2
• Escalante Desert – 10 MW – Raser Technologies • Roosevelt Hot Springs (Blundell 3) – 35 MW – PacifiCorp • Cove Fort – 69 MW – Enel North America • Renaissance Geothermal – 100 MW – Idatherm, LLC
Phase 3
• Central Utah – 20 MW – Raser Technologies
Phase 4
• Thermo Hot Springs – 10 MW – Raser Technologies

Washington: Undefined

Phase 1
• Mt. Baker – Unspecified – Vulcan Power

Wyoming: 0.2 MW

Phase 3
• Rocky Mountain Oilfield Testing Center – 0.2 MW – U.S. DOE/ Ormat

3. Developing Project Summaries

Table 3: Developing Projects by Phase

State	Unconfirmed		Phase I		Phase II		Phase III		Phase IV	
	#	MW	#	MW	#	MW	#	MW	#	MW
Alaska	1	Unspecified	3	35–75	1	18–25				
Arizona	1	Unspecified	1	2–20						
California	1	20	9	321.7–349.7	5	316–327	2	80–150	4	189.9
Colorado			1	10						
Florida			1	0.2–1						
Hawaii			1	Unspecified	1	8				
Idaho			4	125–200	1	100	1	26		
Nevada*	3	Unspecified	21	392–612	10	216–409	6	250–528	5	224.5–352.5
New Mexico							1	10		
Oregon			7	112.2	1	25–30	3	160.2–180.2		
Utah					4	214	1	20	1	10
Washington			1	Unspecified						
Wyoming							1	0.2		
Totals	**6**	**20**	**49**	**998.1–1379.9**	**23**	**897–1113**	**15**	**546.4–914.4**	**10**	**424.4–552.4**

*Nevada has 21 projects in Phase I, but developers did not disclose projected MW values for nine projects.

Phase I: Identifying site, secured rights to resource, initial exploration drilling
Phase II: Exploratory drilling and confirmation being done; PPA not secured
Phase III: Securing PPA and final permits
Phase IV: Production drilling underway; facility under construction
Unconfirmed: Proposed projects that may or may not have secured the rights to the resource, but some exploration has been done on the site

Table 4: **Developing Projects by State**

State	Phase 1 to Phase 4	TOTAL (with unconfirmed)
Alaska	4: 53–100 MW	5: 53–100 MW
Arizona	1: 2–20 MW	2: 2–20 MW
California	20: 907.6–1016.6 MW	21: 927.6–1036.6 MW
Colorado	1: 10 MW	1: 10 MW
Florida	1: 0.2–1 MW	1: 0.2–1 MW
Hawaii	2: 8 MW	2: 8 MW
Idaho	6: 251–326 MW	6: 251–326 MW
Nevada	42: 1082.5–1901.5 MW	45: 1082.5–1901.5 MW
New Mexico	1: 10 MW	1: 10 MW
Oregon	11: 297.4–322.4 MW	11: 297.4–322.4 MW
Utah	6: 244 MW	6: 244 MW
Washington	1: Unspecified	1: Unspecified
Wyoming	1: 0.2 MW	1: 0.2 MW
Total	**97 projects 2865.9–3959.7 MW**	**103 projects 2885.9–3979.7 MW**

4. Comparison of Results from GEA Surveys: March 2006 – August 2008

Table 5: **Installed Capacity**

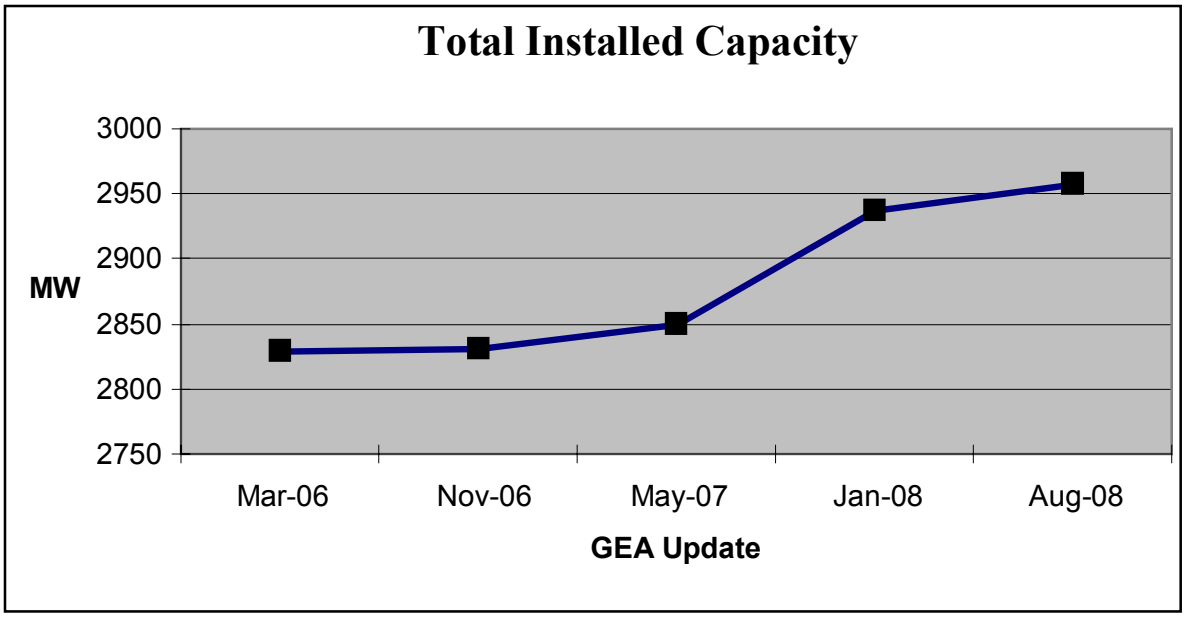


Table 6: **New Activity**

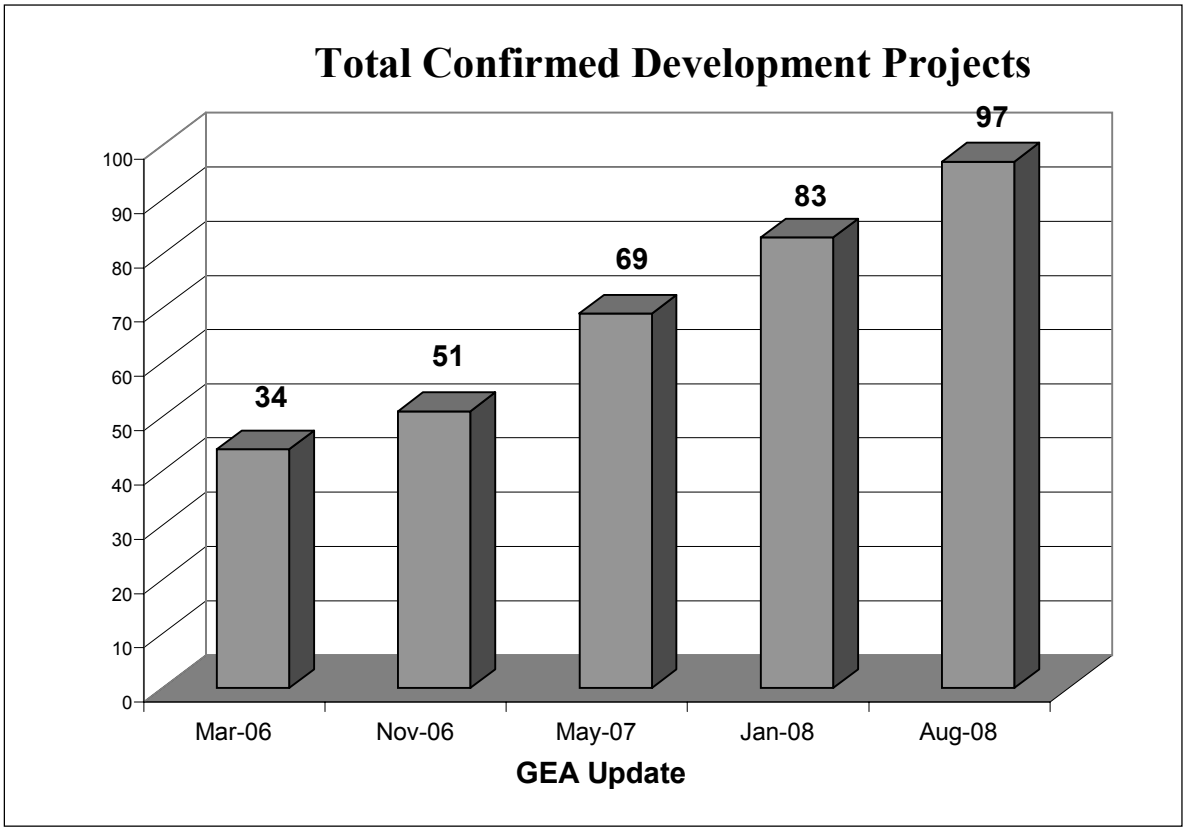
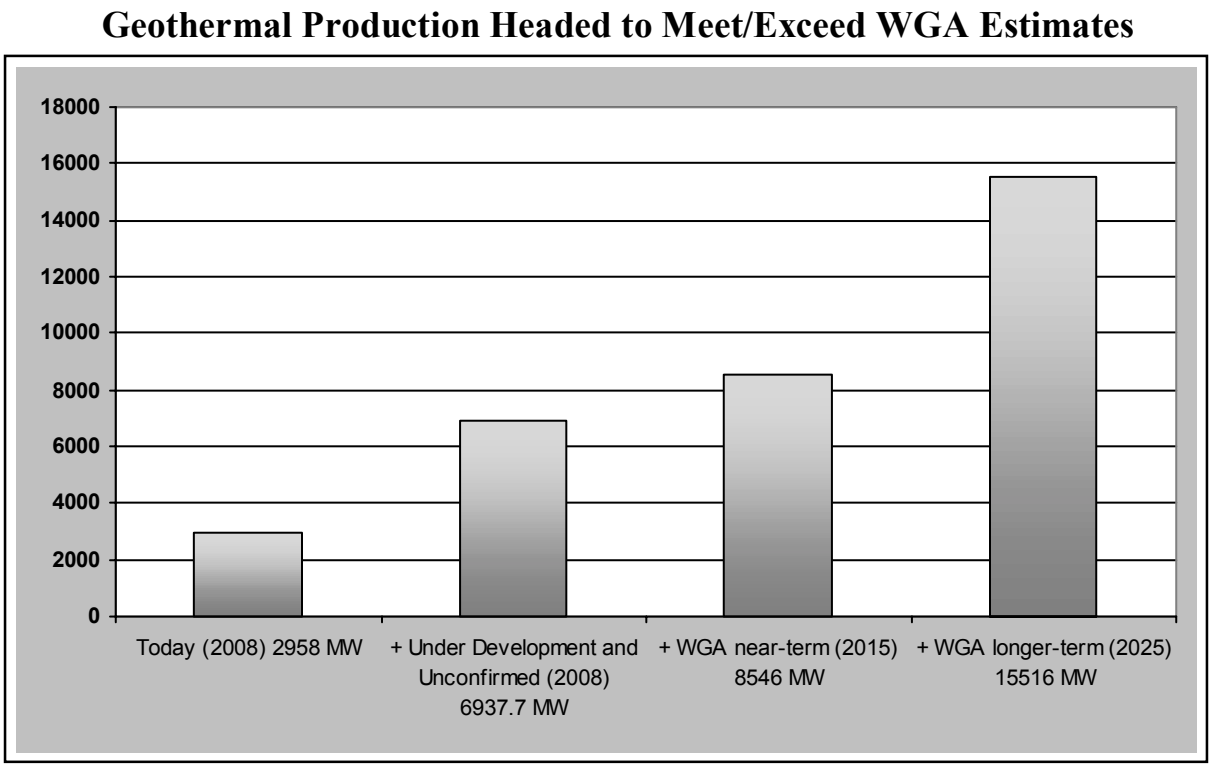


Table 7: **Geothermal Potential**



The January 2006 Geothermal Task Force Report submitted to the Western Governors Clean and Diversified Energy Initiative projected that there could be an additional 5,588 MW of geothermal power on-line by 2015 and 12,558 MW on-line by 2025. The chart above shows current MW of installed capacity, the total capacity if all projects identified in this update are completed, and the WGA estimates for 2015 and 2025 (current capacity plus estimated additional capacity. The WGA Task Force Report is available at: http://www.westgov.org/wga/initiatives/cdeac/cdeac-reports.htm#TaskForceReports)

5. Emerging Technologies

As geothermal technology progresses, resources that were once non-commercial are now being actively examined as feasible possibilities. Some of these technologies are listed below, along with two notable projects mentioned in the "New Activity" section that are applying new technologies.

5.1. Enhanced Geothermal Systems (EGS) – Often categorized under the antiquated term 'Hot Dry Rock,' EGS is thought by several experts to refer to any resource that requires artificial stimulation. This includes resources that have to be fully engineered, or ones that produce hydrothermal fluid, but sub-commercially. Regarding the latter, one expert states, 'As we go further, there might be projects that require more and more stimulation.' Although EGS technology is still young and many aspects remain unproven, several projects are currently underway. If EGS technology proves commercially successful, it is expected to allow significantly increased extension of and production from existing fields, as well as utilization of geothermal energy in previously implausible locations.

Desert Peak (Nevada): The U.S. Department of Energy has invested more than $5 million in another project that is underway to establish the first commercial project to apply an Enhanced Geothermal System in the United States. Ormat Technologies Inc. and GeothermEx Inc. are among some of the other stakeholders in the project. It is estimated that the completion of the project could add at least 5 MW to the Desert Peak Plant, showing the potential of EGS development. GeothermEx states that, "The Desert Peak resource, which currently supports 11 MW of electricity production from a conventional geothermal resource, is likely to have the potential to support 50 MW or more from an EGS development."

The Department of Energy issued a Funding Opportunity Announcement (FOA) in June 2008 for up to $90 million over a four year period to advance research, development, and demonstration of next-generation geothermal energy technology. The FOA specifically addresses the need for additional technical understanding of EGS. The Department of Energy plans to make up to 26 awards through this opportunity.

5.2. Hydrocarbon/Geothermal Co-Production – There is growing interest in producing electricity from the thermal fluid that flows from several oil & gas wells. Geothermal co-production has been predicted to be capable of providing 1000–5000 MW to the 7 states in the Texas Gulf Coast Plain alone (*McKenna et al.*, Oil & Gas Journal, September 5, 2005). Note that there is currently no geothermal electricity production in any of those states. Also, there appears to be renewed interest in production from the geo-pressured resources in Texas, Louisiana and the Gulf of Mexico.

Jay Oilfield (Florida): A demonstration project at Jay Oilfield is set to begin this year and will use thermal fluids commonly co-produced from oil and gas wells. The expected capacity of the project is 200 kW but has potential for 1 MW. If successful, a full project could follow at the Florida oilfield and provide about 5% of the field's total electrical demand. Estimates show that there are thousands of megawatts of geothermal potential in oilfields.

5.3. Geopressured Geothermal Resources – There is also new attention to the energy potential of geopressured-geothermal resources. While located in a number of states, the most significant resources are said to be located in the northern Gulf of Mexico (offshore and onshore). The USGS has estimated that in addition to thousands of megawatts of geothermal energy, these resources hold as much as 1,000 TCF of potentially recoverable gas. New technologies may allow more economical recovery of both the geothermal and gas resources. While Congress in 2007 authorized new technology demonstrations for geopressured-geothermal systems, no new projects or demonstrations have been identified for this report.

For more information on these technologies, see *The State of Geothermal Technology: Parts I & II*, recently released by the Geothermal Energy Association (for electronic copies, please visit: http://www.geo-energy.org/publications/reports.asp).

6. Tribal Land Geothermal Projects

The growing interest in geothermal energy is also recognizable in the increase in tribal land projects. Many Native American tribes are now considering the use of geothermal for their energy needs and are in varying stages of beginning geothermal projects. As noted in the "New Activity" section, the Northwest Alaska Native Association Regional Corporation of Alaska and the Pyramid Lake Paiute Tribe have projects in development.

Other tribes like the Confederated Tribes of the Warm Springs (OR), Fort Bidwell (CA), Citizen Potawatomi Nation (OK), and Winnebago (NB) are also exploring district heating and ground source heat pump possibilities.

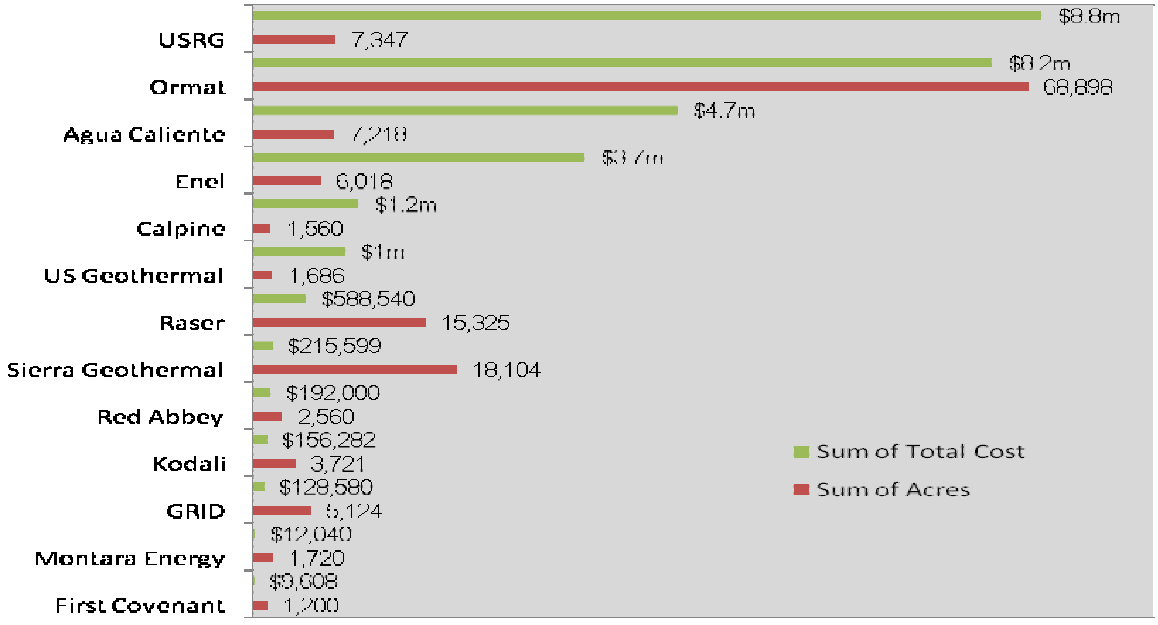
Additional areas of interest are Jemez Pueblo (NM) and Walker River (NV). Both private and governmental funds are being invested into some of these projects, most notably Fort Bidwell, which has received Department of Energy funding in the past.

For more information about some of these projects, please visit http://www.eere.energy.gov/tribalenergy/projects_technology.cfm.

7. The Bureau of Land Management Lease Sales

In 2007, the U.S. Bureau of Land Management held geothermal lease sales in Idaho/Utah and California/Nevada. This resulted in the sale of 140,484 acres of land. The BLM is planning on more sales in Nevada, Utah, California, Oregon, and Washington later this year. The following *New Energy Finance* graph shows a breakdown of the 2007 lease sales by company.

Graph 1: **BLM Lease Sales 2007**



The 2007 lease sales were largely based upon tracts of land pending competitive sale under the pre-2005 changes to the geothermal leasing law.

New sales, based upon industry expressions of interest, are just starting. On August 5, 2008, the BLM held a geothermal lease sale in Nevada, selling a total of 105, 211 acres in 35 parcels. The sale brought in a record-breaking $28.2 million. High bidders included ENEL Geothermal, LLC, Standard Steam Trust, LLC, and Magma Energy U.S. Corp. Full results of the August 5 sale are available at:

http://www.blm.gov/nv/st/en/prog/minerals/leasable_minerals/geothermal0/ggeothermal_leasing.html

The BLM has also announced a lease sale for parcels in Utah for November 2008. Coming sales are also expected in California and Oregon. Additional projects are expected to result from both the 2007 and 2008 lease sales.

8. Recent Publications

The following 2008 publications give additional information on geothermal energy and the industry:

- Geothermal Energy Association:
  The State of Geothermal Technology: Part I Subsurface Technology,
  http://www.geo-energy.org/publications/reports.asp
  The State of Geothermal Technology: Part II Surface Technology,
  http://www.geo-energy.org/publications/reports.asp

- U.S. Department of Energy:
  Geothermal Risk Mitigation Strategies Report,
  http://www1.eere.energy.gov/geothermal/pdfs/geothermal_risk_mitigation.pdf

- U.S. Department of Energy:
  An Evaluation of Enhanced Geothermal Systems Technology,
  http://www1.eere.energy.gov/geothermal/pdfs/evaluation_egs_tech_2008.pdf