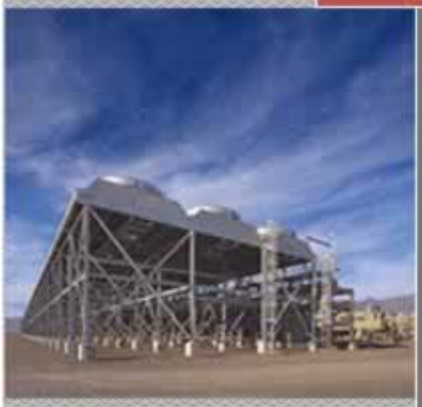
2010



# US Geothermal Power Production and Development Update

**Geothermal Energy Assocation**
Dan Jennejohn
April 2010

# 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: APRIL 2010



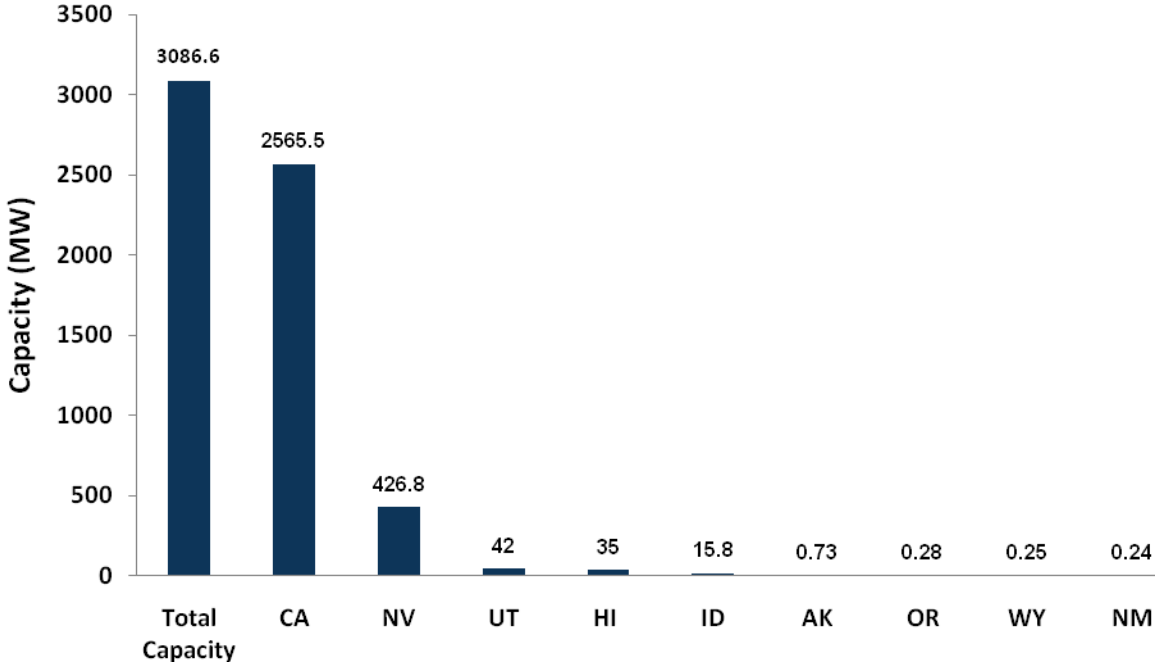
*Cover Photos courtesy of Enel NA, Raser Technologies, Ormat Technologies, and Geo-Heat Center/OIT.*

# 1. Installed Capacity and Projects in Development

## 1.1 Installed Capacity Growth

The United States currently leads the world's countries in online geothermal energy capacity and continues to be one of the principal countries to increase its geothermal growth. In 2007 geothermal energy accounted for 4% of renewable energy-based electricity consumption in the United States.[1] As of April 2010, geothermal electric power generation is occurring in nine U.S. states: Alaska, California, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, and Wyoming. Other states, such as Colorado, Louisiana, Mississippi, and Texas are soon to be added to the list. The United States has a total installed capacity of 3086.6 MW.

**Figure 1: April 2010 Geothermal Power Capacity On-Line (MW)**



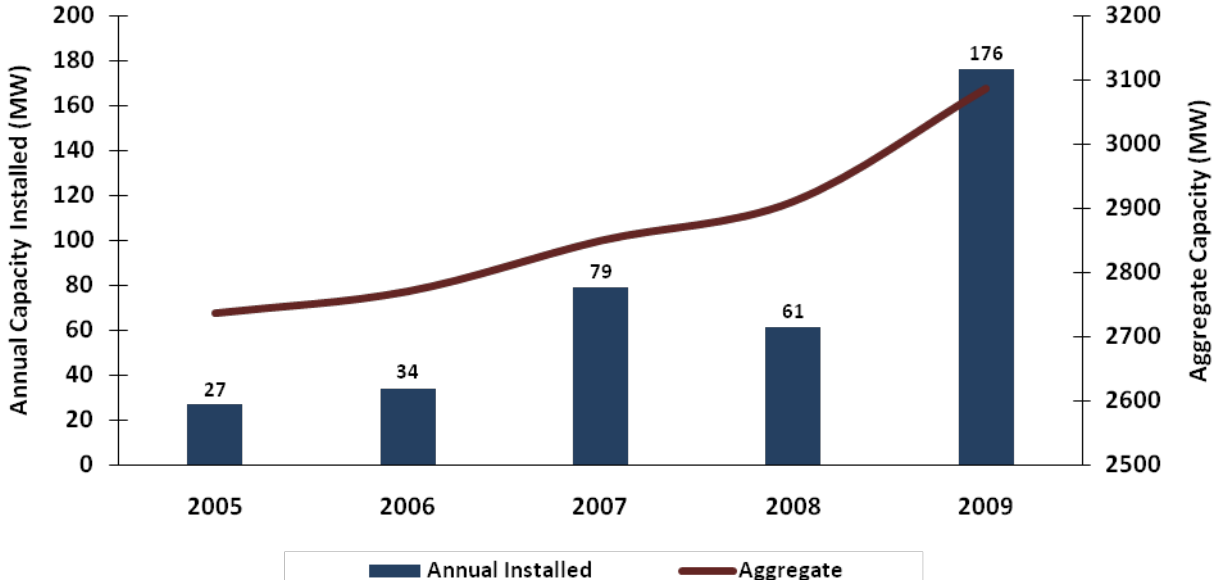

**Source: GEA**

In 2009 geothermal developers brought seven geothermal projects online, adding approximately 176 MW of renewable energy capacity in five different states. Many of these were relatively larger scale geothermal power plants. Specifically, Enel North America completed the construction of two geothermal projects in the state of Nevada for a combined total of 65 MW. Nevada Geothermal Power, Inc. completed its Blue Mountain Faulkner 1 (50 MW) power plant in Nevada in September 2009. Ormat Technologies, Inc.'s North Brawley (50 MW) power plant in California became operational in 2009. Raser Technologies, Inc.'s Thermo No. 1 or Hatch (10 MW) power plant became operational in Utah in April 2009.

[1] U.S. DOE: Geothermal Technologies Program. Geothermal Tomorrow (Sep. 2008).

A number of smaller power units were installed in 2009 as well. The Oregon Institute of Technology began generating electricity with a 0.28 MW unit at its Klamath Falls campus in Oregon in 2009. Additionally, the Rocky Mountain Oil Testing Center (RMOTC) installed and operated a 0.25 MW geothermal hydrocarbon co-production (GHCP) unit at its facilities near Casper, Wyoming in 2009. The addition of these projects to US national geothermal capacity in 2009 is the continuation of a growth trend that the industry has been undergoing since 2005.

**Figure 2: Total Installed Capacity 2005 – 2009**




**Source: GEA**

While levels of installed capacity may fluctuate on an annual basis, geothermal developers in the US continue to develop geothermal resources at an increasing rate. Concerns over climate change, energy security, as well as the recognition of geothermal energy's value as a clean, renewable, base load energy source, drive the increased development of US geothermal resources.

## 1.2 Capacity in Development

The following results identify up to 7057.26 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 7875.16 MW. There are 15 states with projects currently under consideration or development: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Louisiana, Mississippi, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming. Between confirmed and unconfirmed projects there are a total of 188 developing projects.

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

- **Phase I:** Identifying resource, secured rights to resource, pre-drilling exploration
- **Phase II:** Exploration and/or drilling permits approved, exploration drilling conducted/in progress
- **Phase III:** Securing PPA and final permits, full size wells drilled, financing secured for portion of project construction
- **Phase IV:** plant permit approved, facility in construction, production and injection drilling underway
- **Unconfirmed:** Project information obtained by GEA from publicly available sources but not verified by the project developer

*Only projects in Phase 1 through Phase 4 are included in the 7057.26 MW of capacity under development.

**Please Note: GEA is reporting project information that is provided by developers or public sources. We do not independently verify the data provided or warrant its accuracy.**

# Alaska

**Installed Capacity: 0.73 MW** **In Development: 80 MW**

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 225 kW from a low-temperature resource (165°F). Subsequent 225 and 280 kW units have been installed, bringing total capacity to 730 kW.

Currently, seven different geothermal companies, resorts, utilities, and Native American organizations are developing 80 MW of geothermal resources in Alaska for potential electricity production. Additionally, the SW Alaska Regional Geothermal Energy and Pilgrim Hot Springs projects received funding awards from the Department of Energy via the American Recovery and Reinvestment Act of 2009 (ARRA). For more details on these awards see section 2.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Akutan Geothermal Project | City of Akutan | 10 | |
| | Unalaska | City of Unalaska | 10 | |
| | Mount Spurr | Ormat | TBD | |
| **Phase 2** | | | | |
| | Chena Hot Springs II* | Chena Hot Springs | 5 | |

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | Pilgrim Hot Springs | Unaatuq LLC | 10 | **ARRA Recipient** |
| **Unconfirmed** | | | | |
| | Tongass* | Bell Island Hot Springs | 20 | |
| | SW Alaska Reg. Geo. Energy Project | Naknek Electric Assoc. | 25 | **ARRA Recipient** |

*Received GRED III funding for Phase I and II of project

# Arizona

**Installed Capacity: 0 MW** **In Development: 2 – 20 MW**

Arizona currently has one geothermal development project which remains in an unconfirmed phase of development. Additionally, the Arizona State Geological Survey (AZGS) received $15.8M dollars of ARRA funding to assist in the collection of state geological surveys into the National Geothermal Data System. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Unconfirmed** | | | | |
| | Clifton | | 2-20 | |

# California

**Installed Capacity: 2565.5 MW** **In Development: 1609.7 – 1997.7 MW**

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. California currently has approximately 2565.5 MW of installed capacity.[2]

Geothermal developers continue to actively develop the states' geothermal resources. The following table identifies 35 projects currently in development. Additionally, DOE awarded $47.4M to 22 projects in California via ARRA and FY 08 appropriations. Of these, two projects have been identified as being in development in the following table. For more information on DOE funding of geothermal projects and technologies see section 6 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Unnamed Glass Mountain | Calpine | 320 | |
| | Unnamed North Geysers | Calpine | 100 | |
| | Surprise Valley | Enel NA | 20 | |
| | NAWS China Lake So Range | Navy Geothermal Program | 5-15 | |
| | MCAS Yuma Chocolate Mountains | Navy Geothermal Program | 12-30 | |
| | NAF El Centro/Superstition Hills | Navy Geothermal Program | 5-25 | |
| | Orita 3 | Ram Power | 40-100 | |
| | New River | Ram Power | 40-50 | **ARRA Recipient** |
| | Mesquite Lake | Ram Power | 49.9 | |
| **Phase 2** | | | | |
| | Fourmile Hill-Glass Mountain | Calpine | 50 | |
| | Telephone Flat-Glass Mountain | Calpine | 50 | |
| | NAF El Centro/Superstition Mts. | Navy Geothermal Program | 12-35 | |
| | Marine Corps, Twenty-nine Palms | Navy Geothermal Program | 5-12 | |
| | Mammoth Phase II | Ormat | 25 | |
| | Wister | Ormat | 30 | **ARRA Recipient** |
| | Project CA | Oski Energy | TBD | |
| | KS | Oski Energy | 75-100 | |
| | HV | Oski Energy | 75-100 | |

[2] California Energy Commission: http://www.energy.ca.gov/

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | KN | Oski Energy | 75-100 | |
| | Orita 2 | Ram Power | 40-100 | |
| **Phase 3** | | | | |
| | Buckeye-North Geysers | Calpine | 30 | |
| | Wildhorse-North Geysers | Calpine | 30-50 | |
| | East Brawley | Ormat | 30 | |
| | Orita 1 | Ram Power | 40-100 | |
| | Black Rock 1 | CalEnergy | 53 | |
| | Black Rock 2 | CalEnergy | 53 | |
| | Black Rock 3 | CalEnergy | 53 | |
| **Phase 4** | | | | |
| | Geysers Field | Ram Power | 35 | |
| | Hudson Ranch 1 | CHAR | 49.9 | |
| **Unconfirmed** | | | | |
| | San Felipe | Esmeralda Energy | 20-25 | |
| | Bautista | Esmeralda Energy | 49.9 | |
| | Truckhaven I | Iceland America Energy | 49 | |
| | Salton Sea | Sierra Geothermal Power | 18-38 | |
| | Modoc | Vulcan | 20 | |
| | El Centro* | | 50 | |

* Pending Action of Volume II of PEIS

# Colorado

**Installed Capacity: 0 MW** **In Development: 10 MW**

In addition to having one geothermal project currently in development, DOE awarded $12.9M to 9 projects in Colorado via ARRA and FY 08 appropriations. No projects receiving DOE funding have yet been identified as being in development in Colorado. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 2** | | | | |
| | Mount Princeton Geo | Mt. Princeton Geothermal | 10 | |

## Hawaii

**Installed Capacity: 35 MW** **In Development: 8 MW**

One geothermal 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 electricity to the grid, supplying approximately 20% of the total electricity needs of the Big Island.[3]

Two additional projects are currently being developed on the island of Maui and the Big Island by Ormat Technologies. DOE awarded $4.9M in funding to the Maui project via ARRA. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

### Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Maui | Ormat | TBD | **ARRA Recipient** |
| **Phase 4** | | | | |
| | Puna | Ormat | 8 | |

## Idaho

**Installed Capacity: 15.8 MW** **In Development: 413 – 676 MW**

In January 2008 the first geothermal power plant came online in Idaho. Raft River, a binary plant that uses a 300°F resource, has a nameplate production capacity of 15.8 MW. Currently, net electrical power output is approximately 11.5 MW. An expansion to this plant, as well as 11 other projects in the state, is underway.[4]

In addition to these projects in development DOE awarded $23M to 7 projects in Idaho via ARRA and FY 08 appropriations. Projects in development receiving DOE funding are identified in the following table. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

### Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Gray Lakes | Eureka Green Systems | 100-200 | |

[3] Hawaii Department of Business, Economic Development and Tourism: http://hawaii.gov/dbedt/info/energy/renewable/geothermal
[4] Idaho Office of Energy Resources: http://www.energy.idaho.gov/

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | Thatcher/South Thatcher | Eureka Green Systems | 25-50 | |
| | Oakly/North Twin | Eureka Green Systems | 25-50 | |
| | Twin Falls/Westside | Eureka Green Systems | 25-50 | |
| | Sulfur Springs | Idatherm | 25-50 | |
| | Willow Springs | Idatherm | 100 | |
| **Phase 2** | | | | |
| | China Cap | Idatherm | 50-100 | |
| | Preston Project | Idatherm, Shoshone | 50 | |
| **Phase 3** | | | | |
| | Raft River Expansion | US Geothermal | 13-26 | ARRA Recipient |
| **Unconfirmed** | | | | |
| | Newdale | Standard Steam Trust | Unspecified | |
| | Weiser | Standard Steam Trust | Unspecified | |
| | Snake River Plain | Standard Steam Trust | Unspecified | |

# Louisiana

**Installed Capacity: 0 MW** **In Development: 5.30 MW**

Louisiana currently hosts two known developing geothermal projects. One is a planned geothermal hydrocarbon co-production (GHCP) unit at a producing gas field. Another project, which has been awarded $5M of ARRA funding from the DOE Geothermal Technologies Program, will develop geopressured resources at an oil and gas field. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Sweetlake Geopressure Project | Louisiana Geothermal | 5.25 | ARRA Recipient |
| **Phase 4** | | | | |
| | GHCP (Gas) | GCGE*, ElectraTherm | 0.05 | |

*Gulf Coast Green Energy

## Mississippi

**Installed Capacity: 0 MW** **In Development: .05 MW**

Mississippi's first developing geothermal project is a planned geothermal hydrocarbon co-production (GHCP) unit at a producing oil field.

### Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 4** | | | | |
| | GHCP (Oil) | GCGE*, ElectraTherm | 0.05 | |

*Gulf Coast Green Energy

## Nevada

**Installed Capacity: 433.4 MW** **In Development: 2120.4 – 3686.4 MW**

In 2009 three new power plants were added to Nevada's geothermal power plant portfolio. There are currently 20 operating geothermal power plants in Nevada with a total operating capacity of 433.4 MW. With more developing projects than any other state, it is expected that Nevada's installed capacity will increase significantly in the future.[5]

In addition to harboring 86 developing projects, 20 recipients in Nevada were awarded $73.6M of funding from Doe via ARRA and FY 08 appropriations. Those projects already in development that were awarded DOE funding are identified in the following table. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

### Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Beowawe | Magma | TBD | |
| | Columbus Marsh | Magma | TBD | |
| | Baltazor Hot Springs | Magma | TBD | |
| | NAS Test Ranges-Fallon | Navy Geothermal Program | 10-30 | |
| | Hawthorne Army Depot | Navy Geothermal Program | 10-30 | |
| | Black Warrior | Nevada Geothermal | 55 | **ARRA Recipient** |
| | Desert Peak EGS | Ormat | TBD | |
| | Brady EGS | Ormat | TBD | **FY 08 Recipient** |
| | Dixie Meadows | Ormat | TBD | |

[5] Nevada Commission on Mineral Resources Division of Minerals : http://minerals.state.nv.us/

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | Leach Hot Springs | Ormat | TBD | |
| | Smith Creek | Ormat | TBD | |
| | Hawthorne | Oski Energy | 25-50 | |
| | Hot Pot Geo | Oski Energy | 30-50 | **ARRA Recipient** |
| | Alligator Geo | Oski Energy | 20-40 | |
| | Clayton Valley | Ram Power | 120-200 | |
| | Delcer Butte | Ram Power | 30 | |
| | Gerlach | Sierra Geothermal Power | 7-15 | |
| | Salt Wells | Sierra Geothermal Power | 35-76 | |
| | Howard | Sierra Geothermal Power | 19-38 | |
| | Sulphur | Sierra Geothermal Power | 12-27 | |
| | Wells | Sierra Geothermal Power | 15-32 | |
| | Pearl Hot Springs | Sierra Geothermal Power | 22-45 | |
| | Dixey Valley | Sierra Geothermal Power | 14-31 | |
| | Dixey Valley North | Sierra Geothermal Power | 40-90 | |
| | Hawthorne | Sierra Geothermal Power | 10-22 | |
| | North Salt Wells | Sierra Geothermal Power | 48-101 | |
| | Spencer | Sierra Geothermal Power | 9-19 | |
| | Granite Creek | US Geothermal | TBD | |
| | Lee Allen | Vulcan | 48-115 | |
| | New York Canyon | Vulcan | 27-54 | |
| | Colado | Vulcan | 121-232 | **ARRA Recipient** |
| **Phase 2** | | | | |
| | Lee Hot Springs | Earth Power Resources | 32 | |
| | Fireball | Earth Power Resources | 32 | |
| | McCoy | Magma | 80 | **ARRA Recipient** |
| | Panther | Magma | 34 | |
| | Desert Queen | Magma | 36 | |
| | Dixie Valley | Magma | TBD | |
| | Granite Springs | Magma | TBD | |
| | North Valley | Magma | TBD | |
| | Hawthorne Army Depot SW | Navy Geothermal Program | 12-25 | |
| | Gabbs Valley | Ormat | TBD | |

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | Dead Horse | Ormat | TBD | |
| | Silver State Geo. | Oski Energy | 25-50 | |
| | Pyramid Lake | Pyramid Lake Paiute Tribe | TBD | **ARRA Recipient** |
| | San Emidio | US Geothermal | 20-25 | **ARRA Recipient** |
| | Gerlach | US Geothermal | 15-30 | |
| | Sou Hills | Montara Energy Ventures | TBD | |
| | Truckee | Raser Technologies | 20 | |
| | Trail Canyon | Raser Technologies | 20 | |
| | Alum | Sierra Geothermal Power | 33-68 | **ARRA Recipient** |
| | Silver Peak | Sierra Geothermal Power | 15-42 | **ARRA Recipient** |
| | Reese River | Sierra Geothermal Power | 26-58 | |
| | Barren Hills | Sierra Geothermal Power | 46-99 | |
| | Aurora/Green Hills | Vulcan | 132-350 | |
| **Phase 3** | | | | |
| | Darrough Ranch | Great American Energy | 21 | |
| | NAS, Fallon-Mainside | Navy Geothermal Program | 30 | |
| | Blue Mountain | Nevada Geothermal | 20-30 | |
| | Pumpernickel | Nevada Geothermal | 15-33 | |
| | Carson Lake | Ormat | 20 | |
| | McGinness Hills | Ormat | 30 | |
| | Tuscarora | Ormat | 16-40 | |
| | San Emidio Repower | US Geothermal | 8.4 | |
| | Devil's Canyon | Raser Technologies | 20 | |
| | Salt Wells | Vulcan | 117-245 | |
| | Patua Hot Springs | Vulcan | 175-378 | |
| **Phase 4** | | | | |
| | NV Co-production Project | ElectraTherm | .03 | |
| | Jersey Valley | Ormat | 15 | |
| | Soda Lake Upgrade and Expansion | Magma | 12 | **ARRA Recipient** |
| **Unconfirmed** | | | | |
| | Fish Lake Valley | Esmeralda Energy | 25 | |
| | Fish Lake II | Esmeralda Energy | 25-75 | |
| | Emigrant | Esmeralda Energy | 50 | |

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | Gabbs Valley | GeoGlobal | 5-60 | **ARRA Recipient** |
| | Humboldt-Toayaibe* | Great American Energy | 12 | |
| | Rye Patch | Presco Energy | 13 | **ARRA Recipient** |
| | Marys River | Standard Steam Trust | Unspecified | |
| | Marys River SW | Standard Steam Trust | Unspecified | |
| | Edwards Creek | Standard Steam Trust | Unspecified | |
| | Edwards Creek SW | Standard Steam Trust | Unspecified | |
| | Coyote Canyon | Terra-Gen | 62 | |
| | Dixie Meadows | Terra-Gen | 62 | |
| | New York Canyon | Terra-Gen | 62 | |
| | Buffalo Valley | Magma | TBD | |
| | Moping Hills | Magma | TBD | |
| | Quartz Mountain | Magma | TBD | |
| | Soda Lake East | Magma | TBD | |
| | Upsal Hogback | Magma | TBD | |

*Pending Action of Volume II of the PEIS

# New Mexico

**Installed Capacity: 0.24 MW** **In Development: 35 MW**

In July 2008, a 0.24 MW pilot installation project went online in New Mexico.[6] The full project, Lightning Dock, is currently expected to produce 15 MW. In addition to having two geothermal project currently in development, DOE awarded $11.1M of ARRA and FY 08 funding to 7 recipients in New Mexico to fund EGS R&D and innovative exploration technology projects. No projects receiving DOE funding have yet been identified as being in development in New Mexico. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 2** | | | | |
| | Lightning Dock II | Raser Technologies | 20 | |
| **Phase 4** | | | | |
| | Lightning Dock | Raser Technologies | 15 | |

[6] New Mexico Energy, Minerals, and Natural Resources Department: http://www.emnrd.state.nm.us/main/index.htm

# Oregon

**Installed Capacity: 0.28 MW** **In Development: 342 – 473 MW**

In August 2009, a 0.28 MW geothermal unit began producing electricity at the Oregon Institute of Technology's Klamath Falls campus. Currently, 15 known geothermal projects are in development with the potential of providing 473 MW to Oregon's electricity grid.

In addition to currently developing projects, $40M of ARRA and FY 08 appropriations funding was made available to 7 recipients in Oregon. Those projects already in development that were awarded DOE funding are identified in the following table. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | City of Klamath Falls | City of Klamath Falls | 1 | **ARRA Recipient** |
| | Glass Butte, Mahogany | Ormat | TBD | **ARRA Recipient** |
| | Glass Butte, Midnight Point | Ormat | TBD | |
| | Olene Gap | Oski Energy | 25-50 | |
| **Phase 2** | | | | |
| | Glass Buttes | Magma | TBD | |
| | Newberry | Newberry Geo Holdings | 120 | |
| | Alvord | Raser Technologies | 20-80 | |
| | Klamath Falls Plant | Raser Technologies | 15 | |
| **Phase 3** | | | | |
| | Crump Geyser | Nevada Geothermal | 40-80 | **ARRA Recipient** |
| | Geoheat Center | OIT | 1 | |
| | Neal Hot Springs | US Geothermal | 20-26 | |
| **Unconfirmed** | | | | |
| | Williamette* | Estate of Max Millis | 20 | |
| | Williamette* | Estate of Max Millis | 30 | |
| | Hood River County* | Portland General Electric | 20 | |
| | Hood River County* | Portland General Electric | 30 | |

* Pending Action of Volume II of the PEIS

## Texas

**Installed Capacity: 0 MW** **In Development: 0.4 MW**

Texas' first developing geothermal project is a planned geothermal hydrocarbon co-production (GHCP) unit. In addition to this project DOE awarded $32.4M of ARRA funding to 13 recipients in Texas for research in areas such as EGS R&D and innovative exploration technologies. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

### Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Liberty County Co-production | Universal GeoPower | 0.4 | **ARRA Recipient** |

## Utah

**Installed Capacity: 42 MW** **In Development: 628 – 883 MW**

A number of geothermal power plants operate in Utah. Unit 1 of the Blundell power plant has an installed capacity of 23 MW and Unit 2 has a capacity of 9 MW. In April 2009 the low temperature 10 MW Hatch Geothermal Power Plant in Beaver County began delivering power to Anaheim California.

In 2009 $5.7M of ARRA and FY 08 appropriations funding was made available to 7 recipients in Utah. Currently, no projects identified as already in development were awarded DOE funding. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

### Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 1** | | | | |
| | Cove Fort II | Enel NA | 20-35 | |
| | Hill Air Force Base | Navy Geothermal Program | 5-30 | |
| | Whirlwind Valley | Ormat | TBD | |
| | Drum Mountain | Ormat | TBD | |
| | Drum Mountain | Raser Technologies | 20-40 | |
| | DeArmand | Raser Technologies | 20 | |
| | Wood Ranch | Raser Technologies | 20 | |
| | Abraham | Raser Technologies | 20 | |

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| | Pavant | Raser Technologies | 20 | |
| | Thermo, Greater | Raser Technologies | 100 | |
| | Falstaff | Verdi Energy | 40 | |
| **Phase 2** | | | | |
| | Cove Fort | Enel NA | 20-65 | |
| | Thermo | Magma | 20 | |
| | Cove Fort | Oski Energy | 50-75 | |
| | Cricket | Raser Technologies | 25-50 | |
| | Thermo, Central | Raser Technologies | 70-170 | |
| **Phase 3** | | | | |
| | Renaissance | Idatherm | 100 | |
| | Thermo 3 | Raser Technologies | 26 | |
| | Thermo 4 | Raser Technologies | 26 | |
| **Phase 4** | | | | |
| | Thermo 2 | Raser Technologies | 26 | |
| **Unconfirmed** | | | | |
| | Drum Mountains | Standard Steam Trust | Unspecified | |

# Washington

**Installed Capacity: 0 MW** **In Development: TBD MW**

In 2009 $4.7M of ARRA and FY 08 appropriations funding was made available to two recipients in Washington. Currently, no projects identified as already in development were awarded DOE funding. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Unconfirmed** | | | | |
| | Mt. Baker | Vulcan | TBD | |

# Wyoming

**Installed Capacity: 0.25 MW** **In Development: 0.28 MW**

In Augsust 2008, a 0.25 MW GHCP unit was installed at the Department of Energy's Rocky Mountain Oil Test Center (RMOTC) near Casper, Wyoming. The unit was operated for approximately one year when it was shut down for maintenance. The unit has since resumed operation and RMOTC is developing another site for the installation of a 0.28 MW GHCP unit in 2010.

Additionally, in 2009 $4.5M of ARRA and FY 08 appropriations funding was made available to one recipient in Wyoming. Currently, no projects identified as already in development were awarded DOE funding. For more information on DOE funding of geothermal projects and technologies see section 2 of this report.

## Projects in Development

| Phase | Project Name | Developer | Capacity (MW) | DOE Funding |
|---|---|---|---|---|
| **Phase 4** | | | | |
| | RMOTC Co-production | RMOTC | .28 | |

# US Project Totals

**Installed Capacity: 3086 MW** **In Development: 4584 - 7875 MW**

**Figure 3: Projects in Development Totals by State**

| State | Phase 1 to Phase 4 Development | | TOTAL (with unconfirmed) | |
|---|---|---|---|---|
| | Total Projects | In Development (MW) | Total Projects | In Development (MW) |
| **Alaska** | 5 | 35 | 7 | 80 |
| **Arizona** | 0 | 0 | 1 | 2-20 |
| **California** | 29 | 1402.8-1765.8 | 35 | 1609.7-1997.7 |
| **Colorado** | 1 | 10 | 1 | 10 |
| **Hawaii** | 2 | 8 | 2 | 8 |
| **Idaho** | 9 | 413-676 | 12 | 413-676 |
| **Louisiana** | 2 | 5.3 | 2 | 5.3 |
| **Mississippi** | 1 | 0.05 | 1 | 0.05 |
| **Nevada** | 68 | 1804.43-3265.43 | 86 | 2120.43-3686.43 |
| **New Mexico** | 2 | 35 | 2 | 35 |
| **Oregon** | 11 | 242-373 | 15 | 342-473 |
| **Texas** | 1 | 0.4 | 1 | 0.4 |
| **Utah** | 20 | 628-883 | 21 | 628-883 |

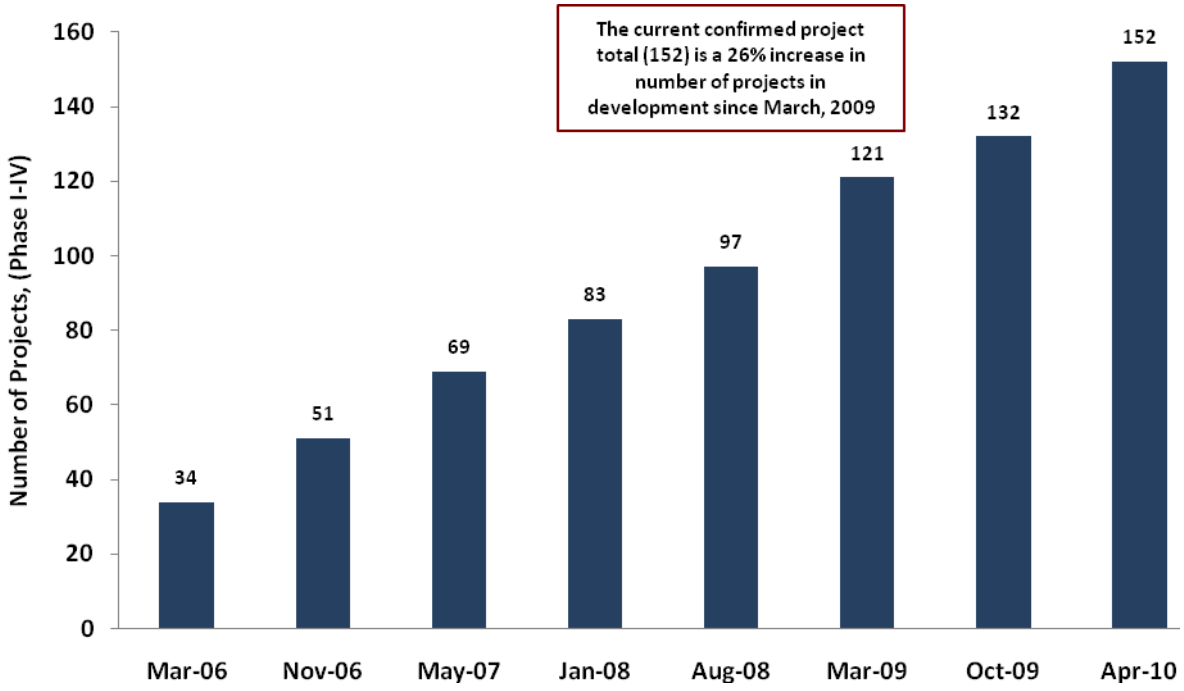
| | | | | |
|---|---|---|---|---|
| **Washington** | 0 | Unspecified | 1 | Unspecified |
| **Wyoming** | 1 | 0.28 | 1 | 0.28 |
| **Total** | **152** | **4584.26 -7057.26** | **188** | **5254.21 – 7875.16** |

**Source: GEA**

## 1.3 Project in Development Summary

Geothermal project in development information recorded in this report indicates that geothermal developers are actively developing known geothermal resources as well as seeking new resources for development. The number of projects in development has continued to increase at a steady rate since early 2006. Since March 2009 identified confirmed projects in development rose from 121 to 152 for an increase of 26 percent.

**Figure 4: Total Confirmed projects 2006-2010**



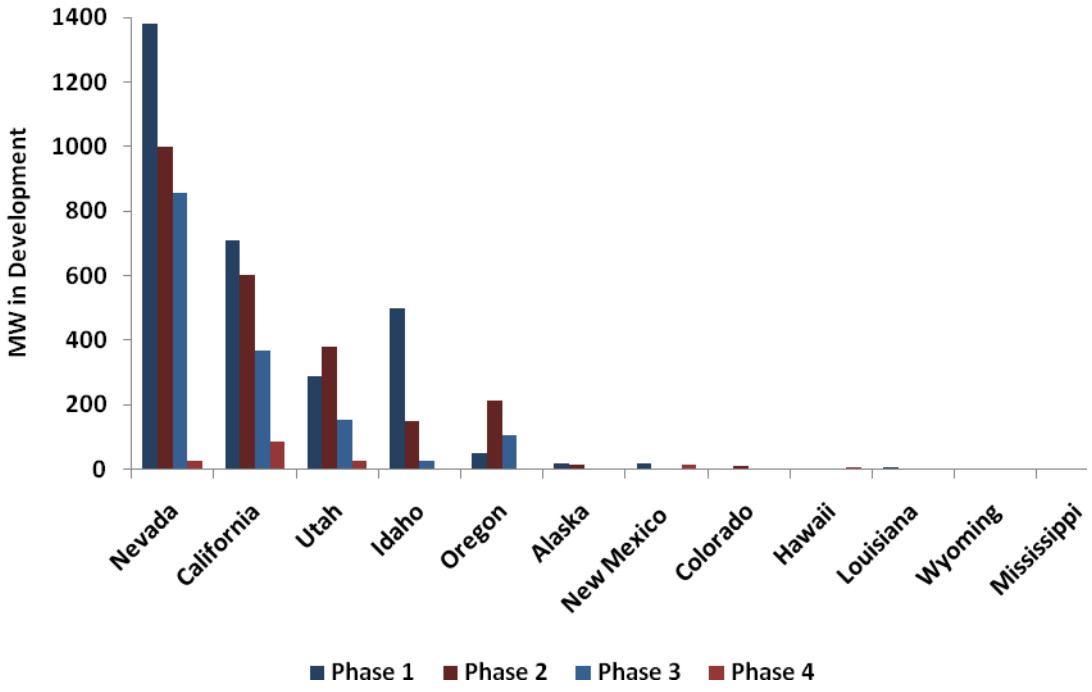

**Source: GEA**

When unconfirmed projects are accounted for the current geothermal resource in development count reaches 188 projects.

The progress of projects identified in the US Geothermal Industry Update is routinely tracked in a four-phase development system(explained in section 1.2). While there has been a general increase in the total number of projects in development over the past year, developers' reports

indicate that projects are generally progressing from early to more advanced stages of development.

**Figure 5: Developing Projects by State and Phase**




**Source: GEA**

The precise number of projects and their standing in respect to phase of development is summarized on a state-by-state basis in Figure 6.

**Figure 6: Developing Projects by Phase**

| State | Unconfirmed | | Phase I | | Phase II | | Phase III | | Phase IV | |
|---|---|---|---|---|---|---|---|---|---|---|
| | # | MW | # | MW | # | MW | # | MW | # | MW |
| Alaska | 2 | 45 | 3 | 20 | 2 | 15 | 0 | 0 | 0 | 0 |
| Arizona | 1 | 2-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| California | 6 | 206.9-231.9 | 9 | 591.9–709.9 | 11 | 437–602 | 7 | 289–369 | 2 | 84.9 |
| Colorado | 0 | 0 | 0 | 0 | 1 | 10 | 0 | 0 | 0 | 0 |
| Hawaii | 0 | 0 | 1 | TBD | 0 | 0 | 0 | 0 | 1 | 8 |
| Idaho | 3 | Unspecified | 6 | 300–500 | 2 | 100-150 | 1 | 13-26 | 0 | 0 |
| Louisiana | 0 | 0 | 1 | 5.25 | 0 | 0 | 0 | 0 | 1 | 0.05 |
| Mississippi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.05 |
| Nevada | 18 | 316–421 | 31 | 737–1382 | 23 | 578–1001 | 11 | 472.4–855.4 | 3 | 27.03 |
| New Mexico | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 | 1 | 15 |
| Oregon | 4 | 100 | 4 | 26–51 | 4 | 155–215 | 3 | 61–107 | 0 | 0 |
| Texas | 0 | 0 | 1 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Utah | 1 | Unspecified | 11 | 265–290 | 5 | 185-380 | 3 | 152 | 1 | 26 |
| Washington | 1 | Unspecified | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wyoming | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.28 |
| **Totals** | **36** | **669.9-817.9** | **67** | **1935.6-2993.6** | **49** | **1500-2393** | **25** | **987.4-1509.4** | **11** | **161.31** |

**Source: GEA**

While obstacles to the development of geothermal resources remain, a growing demand for geothermal energy fueled by state renewable portfolio standards as well as concerns regarding climate change and energy security has resulted in the increased development of US geothermal resources.

# 2. Federal Programs and Funding of Emerging Technologies

## 2.1 DOE Geothermal Technologies Program Funding and Projects

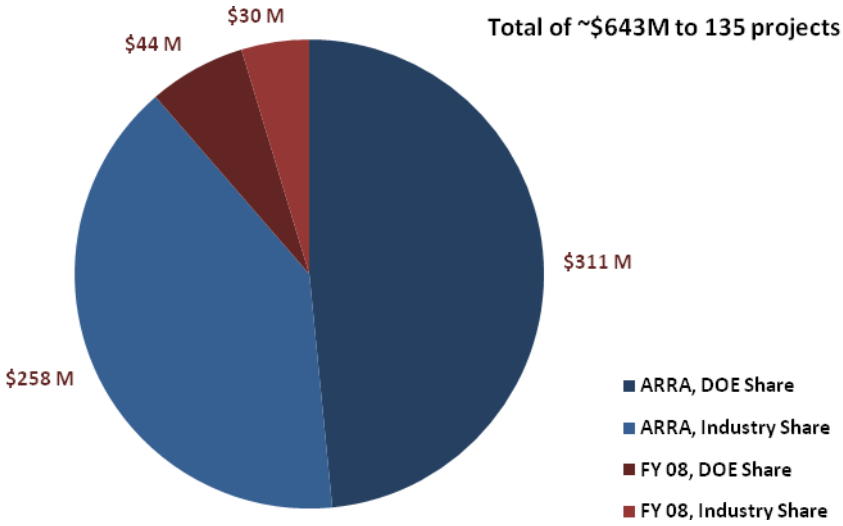
The Department of Energy (DOE) Geothermal Technologies Program (GTP) works with industry, academia, research facilities, and national laboratories to advance commercial scale applications of geothermal technologies. The GTP provides funding to institutions in these sectors to assist research, development, and demonstration efforts in the geothermal industry. Funding is primarily provided via funding opportunity announcements (FOA's).

In addition to funding provided to the geothermal industry through annual appropriations, the American Recovery and Reinvestment Act (ARRA) of 2009 provided up to $338M in new funding for implementation by the GTP over a wide range of research, development, demonstration, and deployment activities. Funding is distributed among six categories, including Innovative Exploration and Drilling Projects (up to $98.1M, 24 projects), Coproduced, Geopressured, and Low Temperature Projects (up to $20.7M, 11 projects), Enhanced Geothermal System Demonstrations (up to $51.4M, 3 projects), Enhanced Geothermal Systems Components Research and Development/Analysis (up to $81.5M, 45 projects), Geothermal Data Development, Collection, and Maintenance (up to $24.6M, 3 projects) and Ground Source Heat Pump Demonstrations (up to 61.9M, 37 projects). It is planned that 123 projects in 39 states will receive DOE ARRA funding with recipients ranging from private industry, academic institutions and tribal entities to local governments, and DOE National Laboratories. According to the DOE, the initial grant of $338M will be supplemented by an additional $353M in private and non-Federal cost-share funds.[7]

[7] US DOE: Geothermal Technologies Program. http://www.energy.gov/news2009/8233.htm (October 2009).

Currently, up to $354.7 M of federal funding from ARRA and DOE FY 08 annual appropriations has been awarded to 135 geothermal research, development, and demonstration projects in 25 states. Of this total, $311.1M has been allocated to the geothermal industry through ARRA and $43.6M has been allocated through FY 08 annual appropriations.

**Figure 7: DOE and Industry Funding under ARRA and FY 08 Appropriations**

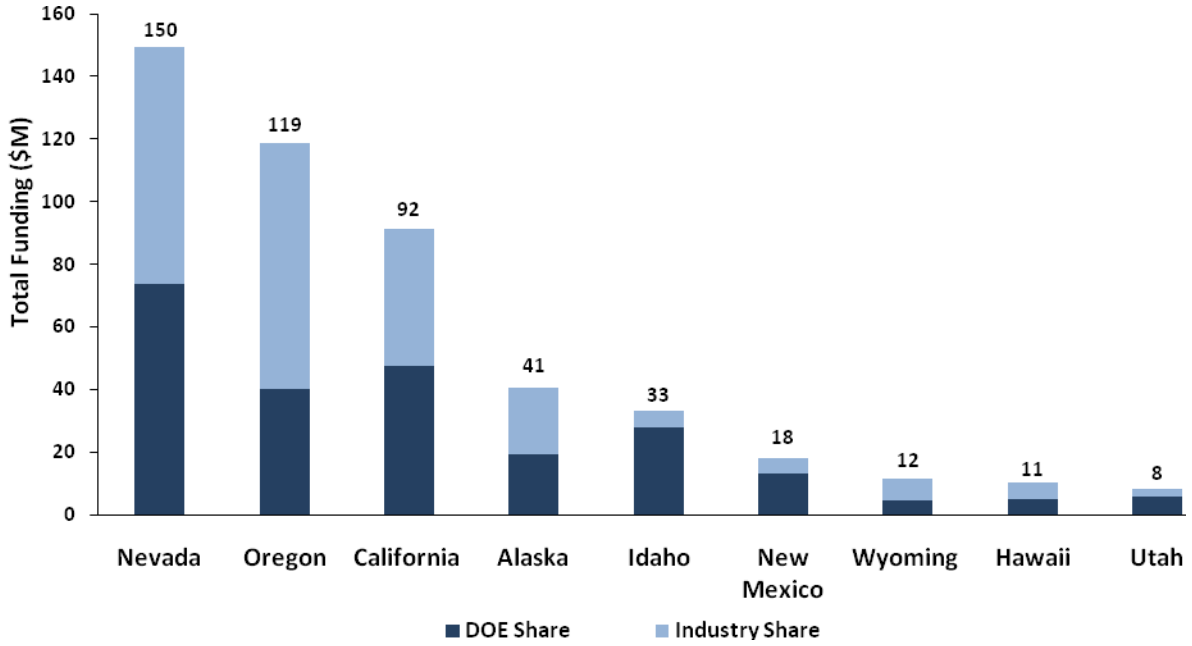



**Source: GEA, DOE**

When cost sharing among the awardees is accounted for, the amount of dollars allocated to geothermal research and development over the last year increases to approximately $642.8M.

A total of 77 projects in states with a relatively well established geothermal industry base (see Figure 8) received approximately $236.5M of federal funding via ARRA and FY 08 appropriations. The industry cost share, approximately $245.7M, provided by funding recipients in these states will bring a total of $482.2M to fund research and development activities in these regions.

**Figure 8: Funding and Cost Share in States Producing Geothermal Electricity**

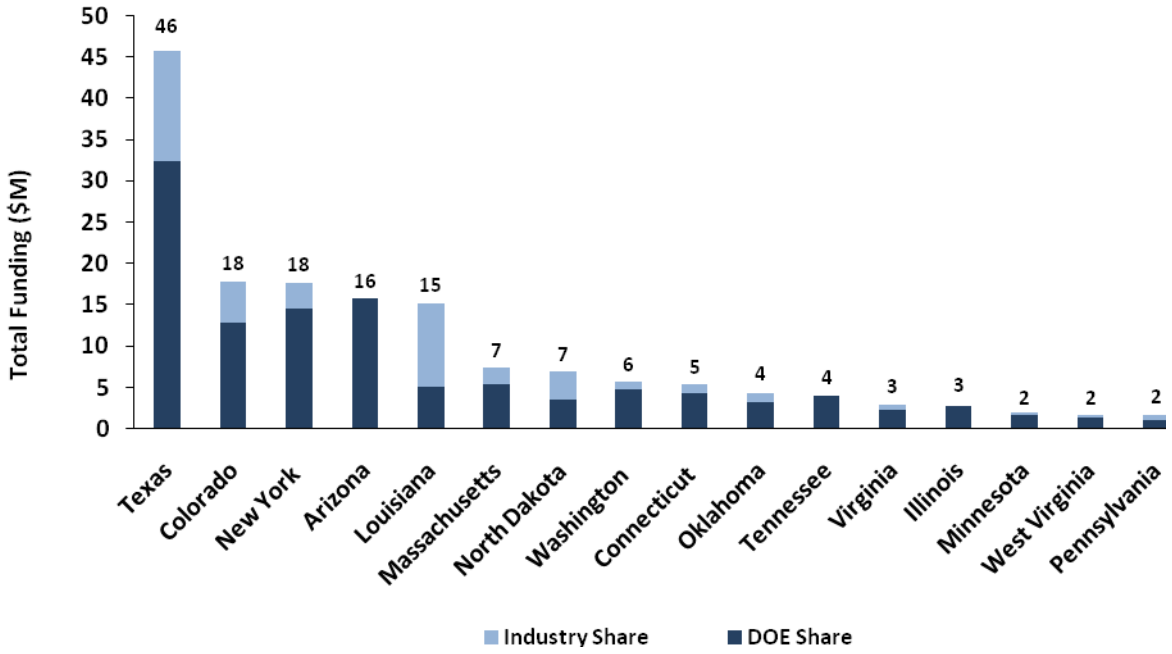



**Source: GEA, DOE**

**Note:** Funding provided to the US Geological Survey has not been included in state DOE and Industry Share totals. Funding values by state have been rounded to the million place holder.

While many of the recipients of federal funding are operating in states where the geothermal industry is established, 57 projects in states not traditionally known for harboring a geothermal industry (see Figure 9) were awarded approximately $114.5M of federal funding. With an industry cost share total of $42.4M by awardees, a total of $156.9M will fund geothermal research and development projects in states where geothermal technology deployment present new opportunities in geothermal technology development and deployment.

**Figure 9: Federal Funding and Cost Share in States with Nascent Geothermal Industries**




**Source: GEA, DOE**
**Note:** Funding provided to the US Geological Survey has not been included in state DOE and Industry Share totals. Funding values by state have been rounded to the million place holder.

The amount of Federal funding provided to the geothermal industry through ARRA is unprecedented and provides substantial incentives to encourage the continued development of domestic geothermal resources. The DOE GTP ARRA funding awards will not only facilitate new job growth but also the development and deployment of new technology as well as growth in new sectors of the geothermal industry.

## 2.2 Federal Funding of Developing Geothermal Technologies

Funding provided by the GTP through FY 08 Appropriations and ARRA is channeled to different areas of research and development within the geothermal industry. A wide range of technologies and applications are covered under new funding and projects identified fall under one of the following areas: EGS demonstration projects, new application projects[8], innovative exploration technologies, EGS R&D or analysis, the national geothermal data system (NGDS), and geothermal heat pumps. While each of these areas present unique opportunities for the

[8] New application projects include geothermal electricity generation from geothermal hydrocarbon co-production, geopressured, and low-temperature resources. DOE, EERE. *Geothermal Technologies Program Recovery Act Funding Opportunities.* June, 2009.

further development of the geothermal industry, certain focuses stand to impact the near-term development of geothermal resources.

### 2.2.1 Enhanced Geothermal Systems Projects

Enhanced Geothermal Systems (EGS) commonly refers to any resource that requires artificial stimulation and includes resources that have to be fully engineered, or ones that produce hydrothermal fluid, but sub-commercially. In certain respects EGS is still a young and not fully proven technology. However, GTP recently provided $73.5M of federal funding to EGS demonstration projects in 5 different states. In addition to funding provided by DOE the total industry cost share for these projects is $99.1M.

**Figure 10: EGS Demonstration Projects**

| Project Name | Awardee | State | DOE Funding | Cost Share | In Development |
|---|---|---|---|---|---|
| Naknek Geo Project | Naknek Electric | AK | $12,376,568 | $18,970,500 | **Unconfirmed** |
| Desert Peak EGS | Ormat | NV | $4,138,003 | $1,485,529 | **Phase 1** |
| NW Geysers EGS | Geysers Power | CA | $5,697,700 | $6,120,050 | |
| Raft River Expansion | University of Utah | ID | $8,928,999 | $3,372,789 | **Phase 3** |
| New York Canyon | TGP Development | NV | $14,006,000 | $5,668,667 | **Unconfirmed** |
| Brady EGS | Ormat | NV | $3,374,430 | $2,735,970 | **Phase 1** |
| Newberry EGS | AltaRock | OR | $24,999,430 | $60,758,496 | |
| **Total*** | | | **$73,521,130** | **$99,112,001** | |

**Source: GEA, DOE**
***Under Negotiation: Numbers Not Final as of April 2010**

As indicated in Figure 10, some of these projects have been previously tracked as “projects in development” in section 1.2 of this and previous GEA US Geothermal Industry Updates. As the geothermal industry’s knowledge of EGS technology expands from experience gained via federally supported projects, EGS technologies are expected to significantly increase extension and production from existing fields. As technology advances, EGS may also enable the eventual utilization of geothermal energy in previously implausible locations.

### 2.2.2 Innovative Exploration and Drilling Projects

The drilling of geothermal exploration and production wells constitutes one of the most expensive and risk-intensive aspects of the development of a geothermal resource. It is estimated that the construction of a geothermal steam field can constitute nearly half of the total cost of developing a geothermal resource. Industry and government are continually

developing technologies designed to improve the success rate of drilling geothermal exploration and production wells. The GTP recently provided $25.8M of funding to 6 geothermal drilling projects in 3 states. The total industry cost share for these 6 projects amounts to $30.7M.

**Figure 11: Validation of Innovative Drilling Projects**

| Project Name | Awardee | State | DOE Funding | Cost Share | In Development |
|---|---|---|---|---|---|
| McCoy | Magma | NV | $5,000,000 | $6,126,664 | **Phase 2** |
| El Paso Co. Project | El Paso County | TX | $5,000,000 | $4,812,500 | |
| Crump Geyser | Nevada Geothermal | OR | $1,764,272 | $1,764,272 | |
| Silver Peak | Sierra Geothermal | NV | $5,000,000 | $7,356,546 | **Phase 2** |
| Alum | Sierra Geothermal | NV | $5,000,000 | $7,356,546 | **Phase 2** |
| Gabbs Valley | GeoGlobal | NV | $4,040,375 | $3,302,766 | |
| **Total*** | | | **$25,804,647** | **$30,719,294** | |

**Source: GEA, DOE**
***Under Negotiation: Numbers Not Final as of April 2010**

Some projects receiving funding for geothermal drilling projects have previously been tracked as projects in development in section 1.2 of this and previous US Geothermal Industry Updates. Federal funding of these and additional projects will help to improve geothermal drilling technologies and bring additional geothermal electricity to the grid.

### 2.2.3 Geothermal Hydrocarbon Co-production (GHCP) Projects

Usable geothermal fluids are often found in oil and gas production fields as well as certain mining operations. Using low temperature binary technology the heat in "produced fluids" from oil and gas wells can be utilized to produce geothermal electricity. The Southern Methodist University Geothermal Energy Program has estimated that geothermal hydrocarbon co-production (GHCP) operations in the Texas Gulf Plains have the capability of providing 1000 – 5000 MW of power.[9]

In addition to GHCP, geopressured resources represent another opportunity for geothermal development. Geopressured resources exist where deposits of natural gas form under very high pressure. The mechanical energy from pressurized natural gas, the natural gas itself, and the heat from the co-produced geothermal brine can be utilized to provide electricity as well as two separate revenue streams. While located in a number of states, the most significant resources are said to be located in the northern Gulf of Mexico, particularly Texas and Louisiana (offshore and onshore). The USGS has estimated that in addition to thousands of megawatts of

[9] McKenna, et al, SMU, *Oil and Gas Journal*, (September 5, 2005).

geothermal energy, these resources hold as much as 1,000 TCF of potentially recoverable gas. Also, it is estimated that in Texas alone, there exists a total geopressured resource of 5,100 EJ.[10] New GHCP and geopressured geothermal projects are beginning to be developed throughout the Great Plains and southern United States. THE DOE recently provided $8.2M of ARRA funding to two GHCP projects and one geopressured project in three different states.

**Figure 12: Geothermal Hydrocarbon Co-production and Geopressured Projects**

| Project Name | Awardee | State | DOE Funding | Cost Share | In Development |
|---|---|---|---|---|---|
| North Dakota GHCP | University of ND | ND | $1,733,961 | $1,734,961 | |
| Liberty County GHCP | Universal Geopower | TX | $1,499,283 | $2,050,005 | **Phase 1** |
| Sweet Lake | Louisiana Tank | LA | $5,000,000 | $10,202,879 | |
| **Total*** | | | **$8,233,244** | **$13,987,845** | |

**Source: GEA, DOE**
***Under Negotiation: Numbers Not Final as of April 2010**

## 2.2.4 Other Federal Awardees and Technologies

While EGS, drilling, GHCP and geopressured technologies all represent sectors of geothermal development with significant potential for high impact growth, federal funding made available through ARRA and FY 08 appropriations addressed other technological and development needs in the geothermal industry. EGS R&D or analysis, innovative exploration technologies, the development of a national geothermal data system, and geothermal heat pumps also received federal funding. Certain projects that have already been identified as being in development in previous updates (in addition to those identified in sections 2.2.1, 2.2.2, and 2.2.3 of this report) have received funding awards through ARRA and/or FY 08 appropriations.

**Figure 13: Other Geothermal MW in Development Receiving Funding**

| Project Name | Awardee | State | DOE Funding | Cost Share | In Development |
|---|---|---|---|---|---|
| Pilgrim Hot Springs | University of AK | AK | $4,616,879 | $1,538,960 | **Phase 1** |
| New River | Ram Power | CA | $5,000,000 | $9,339,420 | **Phase 1** |
| Wister | Ormat | CA | $4,475,015 | $1,507,980 | **Phase 2** |
| Maui | Ormat | HI | $4,911,330 | $5,595,464 | **Phase 1** |
| Hot Pot Geo | Oski Energy | NV | $4,214,086 | $3,985,570 | **Phase 1** |
| Colado | Vulcan | NV | $3,825,973 | $4,489,760 | **Phase 1** |
| Pyramid Lake | Pyramid Pauite Tribe | NV | $4,845,534 | $0 | **Phase 2** |

[10] Texas State Energy Conservation Office, *Texas Renewable Energy Resource Assessment,* (December 2008)

| Project Name | Awardee | State | DOE Funding | Cost Share | In Development |
|---|---|---|---|---|---|
| San Emidio | US Geothermal | NV | $3,772,560 | $3,451,878 | **Phase 2** |
| Soda Lake Upgrade | Magma | NV | $5,000,000 | $9,571,873 | **Phase 4** |
| City of Klamath Falls | City of Klamath Falls | OR | $816,100 | $816,100 | **Phase 1** |
| **Total*** | | | **$41,477,477** | **$40,297,005** | |

**Source: GEA, DOE**
***Under Negotiation: Numbers Not Final as of April 2010**

Note that these projects have already been listed in section 1.2, *Geothermal Capacity in Development*, of this report. Therefore, the MW values of projects in development receiving DOE funding are not to be thought of as additional to the 7057.26 MW of geothermal capacity in development already identified. **Values for MW in development receiving DOE funding are derived from industry estimates used in section 1.2 of this report and are not provided by DOE.**

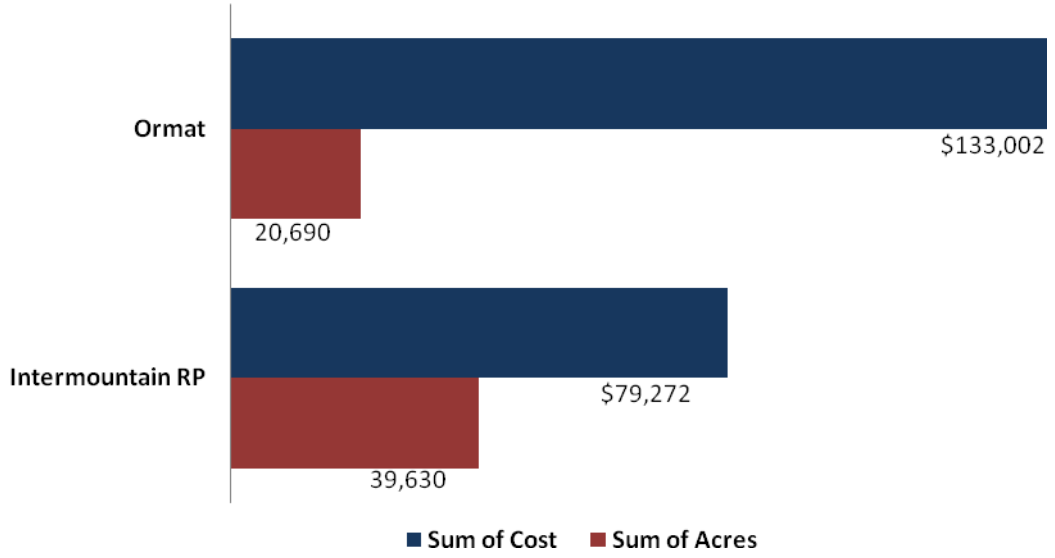
While the recipients of federal funding via ARRA were announced in October of 2009, the process by which awardees actually receive money is ongoing. Currently, awardees are in the process of performing due diligence on their proposed projects. Once the processes of final project negotiations are completed awardees will receive funding and progress on the ground will commence on a larger scale.

## 2.3 Bureau of Land Management Lease Sales

The U.S. Bureau of Land Management (BLM) held geothermal lease sales in February 2010 which resulted in the sale of 70,913 acres of land and bid revenue of approximately $233,462. In the state of Idaho 4 out of 10 lease parcels offered were sold. In the state of Utah a total of 17 lease parcels offered by the BLM were purchased.

Previously, The Energy and Policy Act of 2005 distributed 50 percent of lease sale revenue to the state, 25 percent to the county in which a lease resides, and the remaining 25 percent to the BLM for the processing of geothermal leases and geothermal use authorizations. However, the recently approved fiscal year 2010 Department of the Interior Appropriations Bill, HR 2996, stripped counties of geothermal lease sale revenue. Currently, 50 percent of revenues from geothermal lease sales are allocated to the state within which the geothermal leases reside. The other 50 percent is allocated to the federal government.[11]

**Figure 14: Utah February 2010 BLM Lease Sale Results**

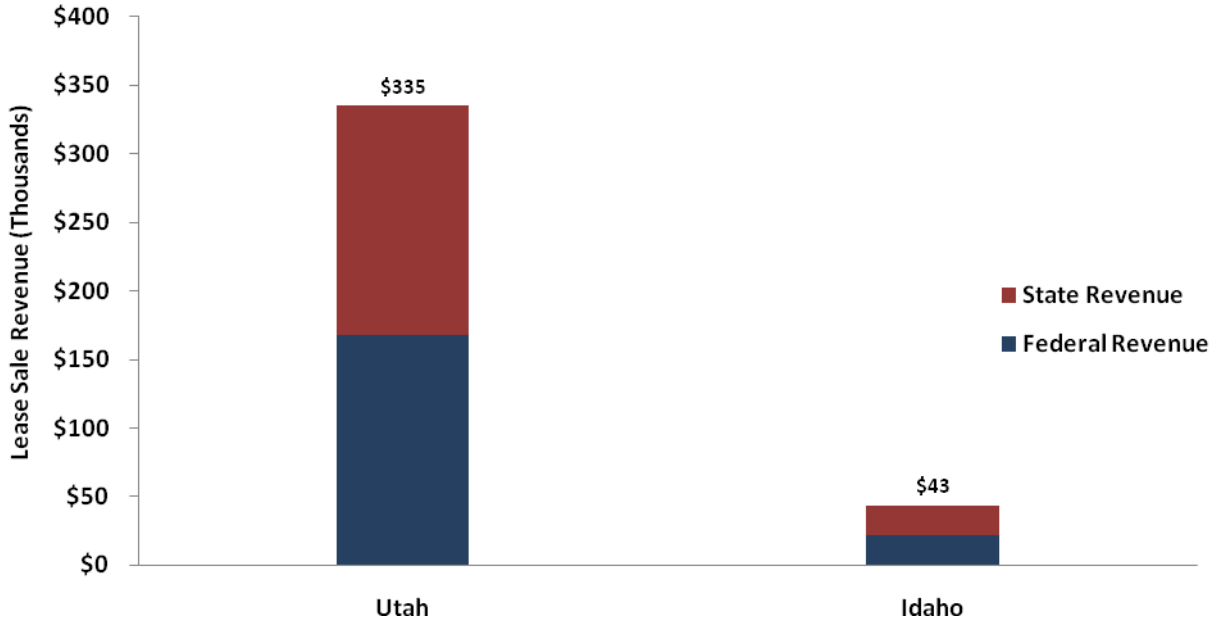



**Source: GEA, BLM**

A breakdown of the lease sale by state, total acreage sold, and total bonus bid dollar amount can be found in the table below.

[11] US Department of the Interior. http://www.govtrack.us/congress/billtext.xpd?bill=h111-2996 (October 2009).

**Figure 15: February 2010 BLM Geothermal Lease Sale State and Federal Revenue**



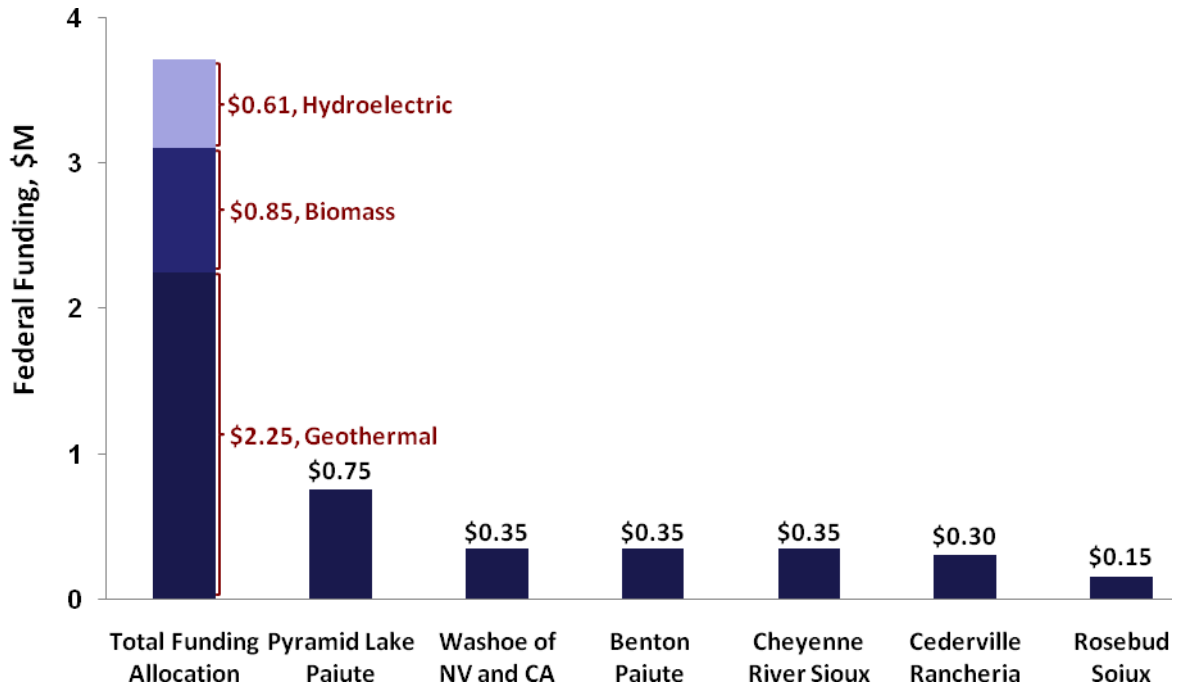

**Source: BLM, GEA**

BLM has also published an amended plan for geothermal leasing in the Western states. The plan allocates approximately 111 million acres of BLM lands and 79 million acres of National Forest System lands open for leasing. In addition to this, the plan allows pre-existing studies on specific lands to be used along with best management practices. The change will reduce the processing time of future geothermal power development. For more information on BLM's plan, please visit http://www.blm.gov/wo/st/en/info/newsroom/2008/december/NR_12_18_2008.html

## 2.4 Geothermal Development on Tribal Lands

The growing interest in the development of geothermal energy resources has also led to projects being developed on tribal lands. Many Native American tribes are now considering the use of geothermal to meet their energy needs as well as to provide jobs to local residents. The federal government has also recognized the value of geothermal energy development on tribal lands. Recently the Office of Indian Energy and Economic Development awarded $3.7M to various tribes for the development of localized renewable energy resources.

**Figure 16: Federal Funding to Tribal Lands**




**Source: GEA**

Of the $3.7M awarded to the various tribes $2.25M went to tribes planning to develop their geothermal resources, $0.85M went to biomass projects, and $0.61M went to hydroelectric projects. Of the tribes receiving awards to develop geothermal resources the Pyramid Lake Paiute tribe received the largest award of $.75M. As indicated in section 1.2 of this report, the Pyramid Lake Paiute Tribe is in the early stages of developing its geothermal resources and has also received ARRA funding for the exploration of its geothermal resources.[12]

[12] US Department of the Interior. http://www.doi.gov/news/pressreleases/2010_03_11_releaseA.cfm (March 2010).

Renewed focus on the development of geothermal and other renewable energy resources on tribal lands by tribes is indicative of their recognition of geothermal energy's value as a provider of local jobs, revenue, and clean, cost-competitive electricity.

Prepared by Dan Jennejohn, Geothermal Energy Association
April 2010

Geothermal Energy Association, 209 Pennsylvania Ave SE, Washington, DC
www.geo-energy.org