

Open-File Report

***Geothermal Power Generation in Idaho:
An Overview of
Current Developments and Future Potential***

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Geothermal Power Generation in Idaho: An Overview of Current Developments and Future Potential

Current Developments

Idaho is poised to receive its first geothermal power generation facility at Raft River in southern Cassia County (Figure 1). By the end of 2007, U.S. Geothermal Inc., plans to be operating a 13 megawatt (MW) power plant as Phase I of its Raft River Project. This site was the location of the world's first geothermal binary operation in the early 1980's when the US Department of Energy constructed a demonstration plant. The binary plant operated successfully for about eight months, but since it was not economical, the plant was shut down and much of the equipment was sold. The site was leased by Vulcan in the 1990's, but there was no additional exploration or development.

In 2002, U.S. Geothermal Inc., obtained the Raft River project and began refurbishing the site. The existing wells were cleaned and tested, geophysical surveys were run to further define the geothermal resources, new wells were drilled, financing for the project was obtained, a power purchase agreement was secured, and construction of the plant commenced. There are now nine deep production and injection wells at the site. The company currently owns or holds leases for 10.8 square miles, which may have the potential of 110 MW (U.S. Geothermal, Inc., website). In June 2007, the BLM leased four parcels (7,164 acres) in the project area, which netted a total bonus of \$4.29 million (BLM, 2007). U.S. Geothermal was the high bidder for one of the parcels, and Aqua Caliente from Colorado won the other three bids.

Future Potential

Over the last 30+ years, many publications have documented the potential for geothermal power generation prospects in Idaho. In addition to Raft River (described above), at least 24 other Idaho sites hold potential for geothermal power generation (Figure 2 and Table 1). All of these sites have had some degree of technical analyses completed on them. Some locations have exploration wells with recorded bottom hole and/or flowing temperatures, while others have geothermometer calculations and geological assessments. At least three locations currently have companies with lease holding positions. Several locations are on Federal lands, which pose some significant challenges with respect to leasing, environmental issues, and power transmission. The Bureau of Land Management and the U.S. Forest Service are currently preparing a Programmatic Environmental Impact Statement (PEIS) analyzing areas with high potential for geothermal power development. It is anticipated that Idaho will be included in the PEIS.

In 2006, the Western Governors' Association Geothermal Task Force report ranked Idaho 3rd of the 12 western states in potential for new geothermal power generation by 2015. The Task Force's report listed Idaho's near-term capacity as 855 MW. Comprising this total were six named sites (Big Creek, China Cap, Crane/Cove Creeks, Raft River,

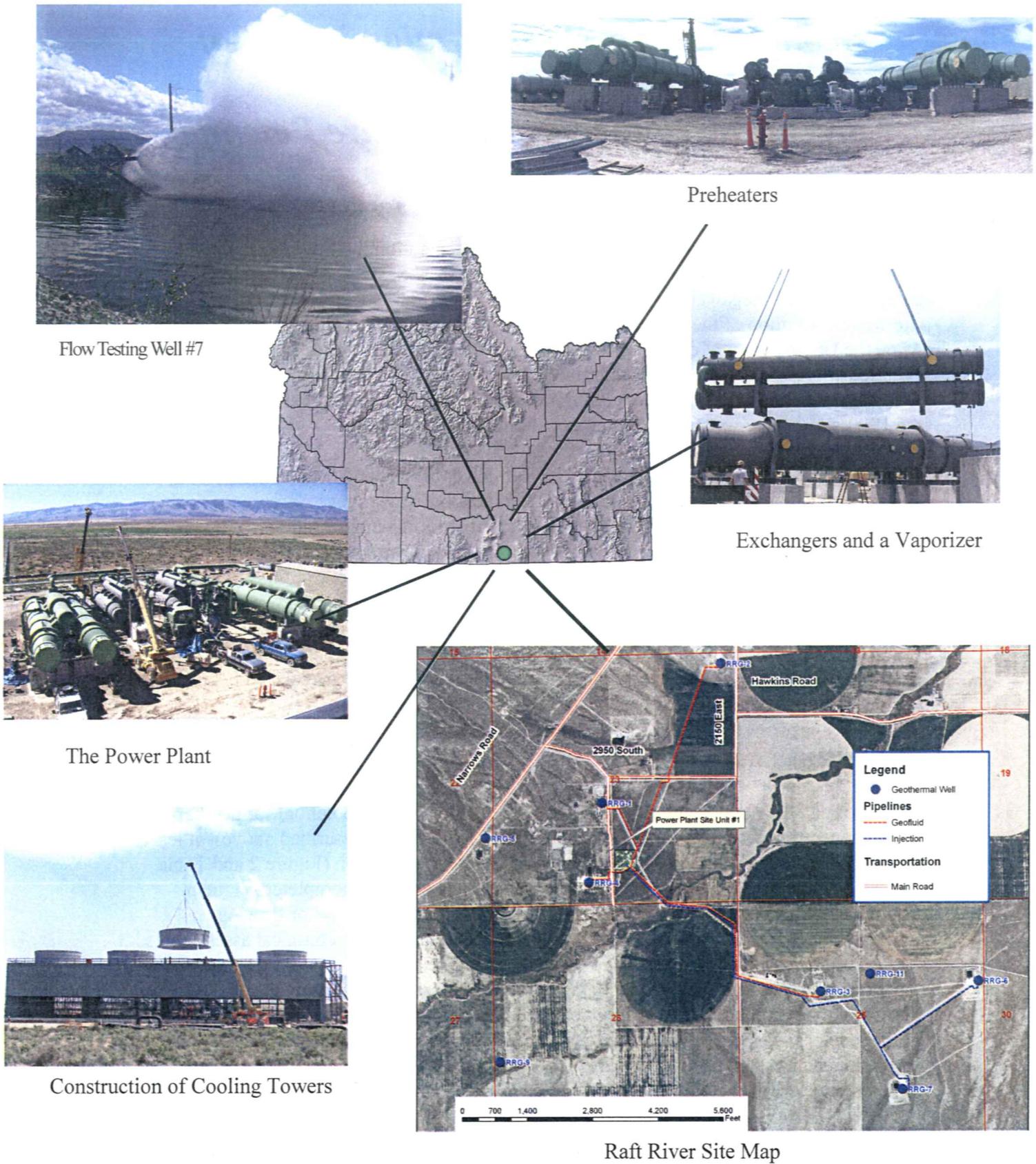


Figure 1. Developments at the Raft River location (Photographs and well site locations on the map are courtesy of U.S. Geothermal, Inc.).

Rexburg, and Willow Springs) with an estimated capacity of 305 MW, plus a general category of “Other Idaho Sites” with a capacity of 550 MW. To accomplish this ambitious development goal in the next 8 years, an aggressive exploration program and a cross-section of funding sources are needed.

Excluding Raft River, the three prospects that are currently the most advanced in development are China Cap, Crane Creek, and Willow Springs. Combined, these prospects may have a potential of 309 MW, which is enough electricity to serve the power needs of at least 160,000 homes. At Crane Creek, one parcel (1,740 acres) was sold by the BLM in June, 2007, for \$1.44 million to Aqua Caliente (BLM, 2007). Geological mapping and some geophysical studies have been accomplished at these three prospects, and the next step is the drilling of exploration wells. However, funding is difficult to obtain for the initial high-risk exploration wells. A combination of private funding and government assistance could provide the needed capital to get these projects through the exploration process and into the development stages.

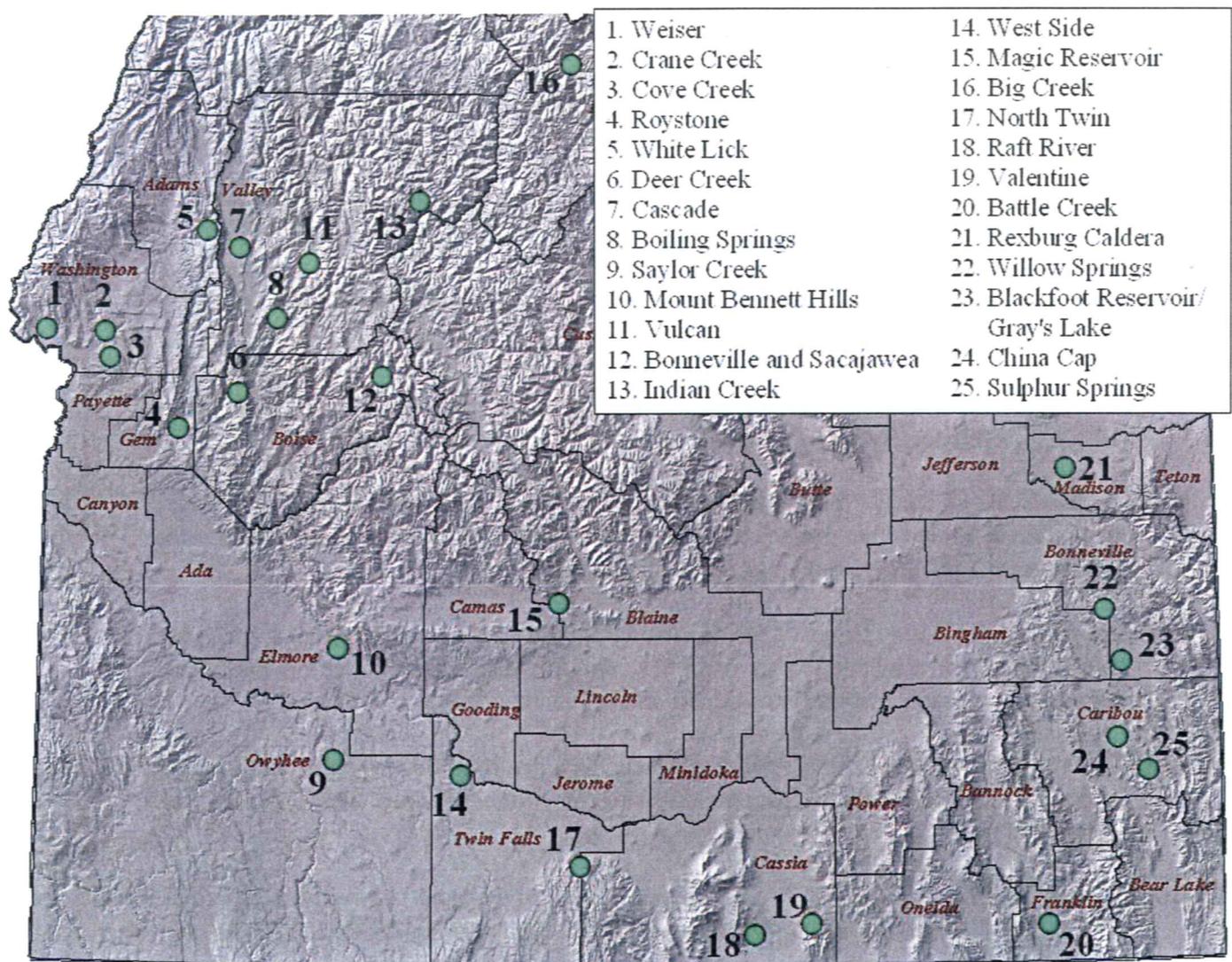


Figure 2. Locations of geothermal power development and potential.

List of Power Generation Developments and Potential Projects.

1. **Weiser.** Washington County. Surface temp = 78° C. Subsurface temp could range from 141 – 156° C. Reference: Mitchell and others (1980).
2. **Crane Creek.** Washington County. Surface temp = 92° C. Subsurface temp could range from 166 – 176° C. Reservoir estimated to be capable of 100 – 179 MW. Formerly designated as a KGRA. An exploration well drilled in 1981 to 7,998 feet found a 162.8° C bottom hole temperature, but insufficient quantities of water for a power generation facility. Geological mapping and geophysical surveys are needed to further define the resource. Capacity of the existing power line may be a barrier. One nearby parcel was leased recently by Aqua Caliente from the BLM. Reference: Bloomquist and others (1985), Brott (1976), Dansart and others (1994), Fleishmann (2006), Hoover and others (1976), McClain (1979), Mitchell and others (1980), Mitchell and others (1984), Spencer and Russell (1979), St. Marie and others (2002), Western Governors' Association Geothermal Task Force (2006), Young and Mitchell (1973), Young and Whitehead (1975).
3. **Cove Creek.** Washington County. Surface temp = 74° C. Subsurface temp could range from 152 – 172° C. References: Mitchell and others (1980), Western Governors' Association Geothermal Task Force (2006).
4. **Roystone.** Gem County. Surface temp = 54° C. Subsurface temp could range from 147 – 150° C. Reference: Mitchell and others (1980).
5. **White Lick.** Adams County. Surface temp = 65° C. Subsurface temp estimated to be 145° C. Reference: Mitchell and others (1980).
6. **Deer Creek.** Boise County. Surface temp = 80° C. Subsurface temp could range from 139 – 147° C. Reference: Mitchell and others (1980).
7. **Cascade.** Valley County. Idatherm, LLC has completed geological mapping in Valley County and believes that there is a magmatically-driven geothermal system in the area. Reference: Austin (personal communication, 2007).
8. **Boiling Springs.** Valley County. Surface temp = 85° C. Ormat Technologies, Inc., has shown interest in six Federal parcels in this area. Site has access, environmental, and power transmission barriers. Reference: Fleischmann (2006).
9. **Saylor Creek.** Owyhee County. Idatherm, LLC has identified this prospect but no details are currently available. References: Austin (personal communication, 2007), Austin and Whelan (1982).
10. **Mountain Bennett Hills.** Elmore Counties. Union Oil's Bostic 1A well was drilled to 9,616 feet and had a bottom hole temperature of 195° C. The well produced 1,000 gpm with a water temp of 132° C. In the early 1980's, the area was considered to have EGS or Hot Dry Rock potential. References: Arney, Goff, and Harding Lawson Associates (1982), Fleischmann (2006), McClain (1979).

- 11. Vulcan.** Valley County. Surface temp = 84° C. Subsurface temp could range from 135 – 150° C. McClain (1979) estimated the electrical potential to be 50 MW. Site has access, environmental, and power transmission barriers. Reference: Bloomquist and others (1985), Dansart and others (1994), McClain (1979), Young and Mitchell (1973), Mitchell and others (1980), St. Marie and others (2002).
- 12. Bonneville and Sacajawea.** Boise County. Surface temp = 85° C. Subsurface temp could range from 130 – 150° C. Site has access, environmental, and power transmission barriers. Reference: Fleischmann (2006), Mitchell and others (1980).
- 13. Indian Creek.** Valley County. Surface temp = 88° C. Subsurface temp could range from 137 – 142° C. Site has access, environmental, and power transmission barriers. Reference: Mitchell and others (1980).
- 14. West Side.** Twin Falls County. Idatherm, LLC has identified this prospect as a magmatically-driven geothermal feature, but the exact location has not been release due to leasing considerations. Reference: Austin (personal communication, 2007).
- 15. Magic Reservoir.** Blaine and Camas Counties. Surface temp = 72° C. Subsurface temp could range from 139 – 174° C. Reference: Dansart and others (1994), Mitchell and others (1980), Ross (1971), St. Marie and others (2002), Struhstacker and others (1984).
- 16. Big Creek.** Lemhi County. Surface temp = 93° C. Subsurface temp estimated to be 175° C. Reservoir estimated to be capable of 11 – 50 MW. Site has major access, environmental, and power transmission barriers. Nearby Owl Creek may also have power potential. References: Bloomquist and others (1985), Dansart and others (1994), Fleischmann (2006), McClain (1979), Mitchell and others (1980), St. Marie and others (2002), Struhstacker (1981), Western Governors' Association Geothermal Task Force (2006).
- 17. North Twin.** Twin and Cassia Counties. Idatherm, LLC has identified this prospect and believes that it is related to granitic magma and a thrust ramp. References: Austin (2005), Austin (personal communication, 2007).
- 18. Raft River.** Cassia County. Surface temp = 92° C. Subsurface temp could range from 133 – 150° C. The geothermal reservoir is a fault and fracture dominated system. U.S. Geothermal, Inc., is developing the first phase of this project, and plans to have a 13 MW binary plant in operation by the end of 2007. Additional phases are being planned with hopes that the Raft River field will have a capacity of 110 MW. McClain (1979) estimated the field to be as large as 100 MW. One nearby parcel was leased recently by U.S. Geothermal from the BLM, and three parcels were leased by Aqua Caliente. References: Allen and others (1979), Applegate and Moens (1980), Bloomquist and others (1985), Chappell and others (1978), Dansart and others (1994) Mitchell and others (1980), St. Marie and others (2002), U.S. Geothermal, Inc., webpage.
- 19 Valentine.** Cassia County. Idatherm, LLC has identified this prospect and believes that it is a associated with a magmatic heat source that is actually feeding the Raft River field a few miles to the west. Reference: Austin (personal communication, 2007).

- 20. Battle Creek.** Franklin County. Surface temp = 84° C. Subsurface temp could range from 150 – 250° C. Reference: Mitchell and others (1980).
- 21. Rexburg Caldera.** Jefferson and Madison Counties. Water from some existing wells yielded geothermometer data that indicated water temperatures in the deep reservoirs may be as high as 200° C. However, a well drilled to 3,943 feet in 1980 did not find temperatures high enough for direct use. Potential ranges from 20 MW (near-term) to 500 MW (long-term). References: Fleischmann (2006), Petty and others (1992), Western Governors' Association Geothermal Task Force (2006).
- 22. Willow Springs.** Bonneville County. Quasar's oil exploration well drilled to 13, 600 feet, and found 249° C water. Idatherm estimates capacity to be 100 MW, and is seeking funding for exploration drilling. References: Austin (personal communication, 2007), Fleischmann (2006), Western Governors' Association Geothermal Task Force (2006).
- 23. Blackfoot Reservoir/Gray's Lake.** Bonneville and Caribou Counties. In 1979, Conoco's oil exploration well drilled to 9,439 feet, and had a bottom hole temp of 190° C. References: Fleischmann (2006), Mitchell and others (1980).
- 24. China Cap.** Caribou County. Idatherm estimates capacity to be 30 MW, and is seeking funding for exploration drilling. Idatherm believes this prospect is associated with two intrusive systems. References: Austin (personal communication, 2007), Western Governors' Association Geothermal Task Force (2006).
- 25. Sulphur Springs.** Caribou County. Idatherm, LLC has identified this prospect and believes that it may be a dry steam deposit or a deposit with a steam cap. Reference: Austin (personal communication, 2007).

Table 1. Geothermal areas with power generating development and potential (in alphabetical order).

Geothermal Area	Developing Company	County	Potential Size (MW)	Potential Reservoir Temp (°C)	Technical Work Completed	References
1. Weiser	None	Washington	NA	141-156	Geothermometers	15
2. Crane Creek	Interwest? Aqua Caliente	Washington	100-179	166-176	Geothermometers, geological mapping, geophysics, exploration well to 7,998 feet.	7, 8, 9, 11, 12, 13, 14, 15, 16, 19, 21, 26, 27
3. Cove Creek	None	Washington	NA	152-172	Geothermometers	12
4. Roystone	None	Gem	NA	147-150	Geothermometers	15
5. White Lick	None	Adams	NA	145	Geothermometers	15
6. Deer Creek	None	Boise	NA	139-147	Geothermometers	15
7. Cascade	Idatherm, LLC	Valley	NA	NA	Completed but unreleased geological mapping and report by Idatherm	5
8. Boiling Springs	Ormat Technologies, Inc.	Valley	NA		None	12
9. Saylor Creek	Idatherm, LLC	Owyhee	NA	NA	Prospect was described in previous technical report.	5, 6
10. Mount Bennett Hills	None	Camas and Elmore	NA	192	Oil exploration well drilled to 9,616 feet. Potential EGS (Hot Dry Rock	3, 12, 14

Table 1. Geothermal areas with power generating development and potential (in alphabetical order).

Geothermal Area	Developing Company	County	Potential Size (MW)	Potential Reservoir Temp (°C)	Technical Work Completed	References
11. Vulcan	None	Valley	50	135-150	Geothermometers	7, 11, 14, 15, 21, 26
12. Bonneville and Sacajawea	None	Boise	NA	130-150	Geothermometers	12, 15
13. Indian Creek	None	Valley	NA	137-142	Geothermometers	15
14. West Side	Idatherm, LLC	Twin Falls	NA	NA	Unpublished geological study by Idatherm	5
15. Magic Reservoir	None	Blaine and Camas	NA	139-174	Geothermometers	11, 15, 18, 21, 23
16. Big Creek	None	Lemhi	10-50	175	Geothermometers	7, 11, 12, 14, 15, 21, 22, 25
17. North Twin	Idatherm, LLC	Twin Falls and Cassia	NA	NA	Unpublished geological study by Idatherm	4, 5
18. Raft River	U.S. Geothermal, Inc.	Cassia	50-110	133-150	Production and injection wells drilled. Geophysics. Power plant construction is nearly finished. Power purchase agreement in place	1, 2, 7, 9, 10, 15, 21, 24, 25
19. Valentine	Idatherm, LLC	Cassia	NA	NA	Unpublished geological study by Idatherm	5
20. Battle Creek	None	Franklin	NA	150-250	Geothermometers	15

Table 1. Geothermal areas with power generating development and potential (in alphabetical order).

<i>Geothermal Area</i>	<i>Developing Company</i>	<i>County</i>	<i>Potential Size (MW)</i>	<i>Potential Reservoir Temp (°C)</i>	<i>Technical Work Completed</i>	<i>References</i>
21. Rexburg Caldera	None	Jefferson and Madison	20	200	Geothermometers	12, 17, 25
22. Willow Springs	IdaTherm, LLC	Bonneville	100	249	Oil exploration well drilled to 13,600 feet. Geological mapping. Leasing accomplished.	5, 12, 25
23. Blackfoot Res./Gray's Lake	None	Bonneville and Caribou	NA	+190	Oil exploration well	12,15
24. China Cap	Idatherm, LLC	Caribou	30-100		Unpublished geological study by Idatherm. Leasing accomplished	5, 25
25. Sulphur Springs	Idatherm, LLC	Caribou	NA	NA	Unpublished geological study by Idatherm	5

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