

THE ECONOMIC, ENVIRONMENTAL, AND SOCIAL BENEFITS OF GEOTHERMAL USE IN MONTANA

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Montana has a long and rich history of utilization of its geothermal resources. Today, the documented direct uses of geothermal waters are related to tourism and recreation, spas and resorts, space heating, and greenhouse heating. The Montana Department of Environmental Quality has recently published a consumer's guide to geothermal energy in Montana (Birkby, 2012), outlining the current and potential uses and advantages of geothermal energy in the State.

Geothermal resources for direct-utilization in Montana generally occur in the western and the eastern thirds of the state. In the western third of the state, geothermal features are related to Yellowstone National Park and the Rocky Mountains, where numerous hot springs are found. In the eastern third of the state, geothermal occurrence is different, and is related to the Williston Basin – a deep sedimentary basin extending through western North and South Dakota, eastern Montana, and southern Saskatchewan known for its rich deposits of petroleum.

ECONOMIC BENEFITS

The greatest use of geothermal energy today in Montana is related to spas and resorts, and recreation and tourism. Much of the other significant direct uses of geothermal energy (eg. space heating and greenhouse heating) stem from uses at spas and resorts.

A large contributor to the economic benefit of geothermal energy in Montana is also related to its historic entrance to Yellowstone National Park - a place that has made famous the marvels of geothermal energy. The town of Gardiner in southwest Montana boasts the only year-round entrance to the Park through The Roosevelt Arch (Figure 1), which was dedicated by President Theodore Roosevelt on 24 April 1903.

According to U.S. National Park Statistics, Yellowstone National Park currently attracts about 3 million recreational visitors per year, providing an enormous contribution to the region's economy. Since Yellowstone was designated a National Park in 1872 (America's first national park), over 156 million people have visited the park as of the end of 2011.

Numerous hot springs exist to the north and northwest of Yellowstone National Park, in the western third of Montana. Birkby (1999) lists 26 hot springs in western Montana in addition to four in the eastern part of the state. Of these, many are remote and not fully developed; this report summarizes only those that currently support viable businesses.

For many centuries, Native Americans gathered at natural hot springs to absorb the healing benefits that they believed came from soaking in the warm mineral water. Hot springs

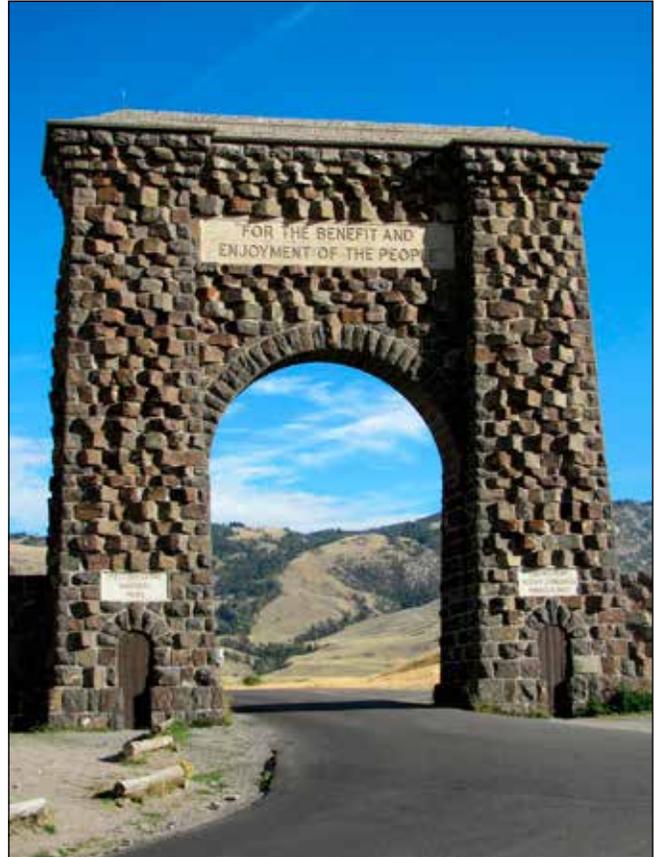


Figure 1. Historic Roosevelt Arch in Gardiner, Montana at the north entrance to Yellowstone National Park (www.gardiner-montana.com).

areas were regarded as sacred, neutral territory, and members of different tribes who encountered each other at a hot spring would put down their weapons and relax in peace. According to Jeff Birkby quoted in Martin (2012), “when John Bozeman, one of Montana’s first settlers, drove his wagon train by what would later become Hunter’s Hot Springs in 1864, one of the men with him reported seeing more than a thousand teepees of the Crow Indians camped there.”

Lewis and Clark are believed to be the first white settlers to encounter Montana’s hot springs when they camped near Lolo Hot Springs in 1805. Other explorers, trappers, and miners who passed through the state used the springs to bathe and wash clothes, and as Montana experienced a boom during the gold rush of the 1860s through the 1880s, crude bathhouses and log cabins were built near hot springs. Entrepreneurs eventually took advantage of the hot springs, particularly when the western railroad was built through Montana, and transformed the crude bathhouses into luxury resorts. These resorts often advertised miraculous medical cures to lure guests, and claimed to treat ailments of all kinds, from arthritis to liver disease.

As Montana developed and prospered, the state experienced an age of extravagant bathhouses from about 1890 to 1920. One of the most lavish was the Broadwater Hotel and Natatorium near Helena (Figure 2). According to Birkby (1999) “the palatial resort fulfilled Charles Broadwater’s ideals of elegance and refinement with Persian rugs covering the floors and French wallpaper lining the walls. After meals of up to ten courses served in the elegant dining room, guests could repose in parlors filled with Victorian furniture.”

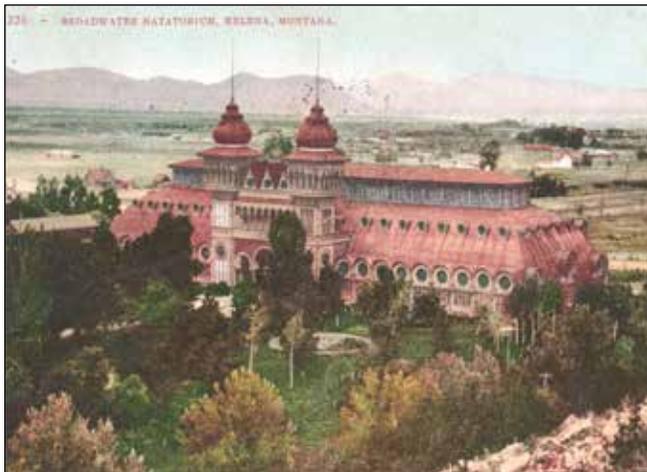


Figure 2. Broadwater Natatorium near Helena, circa 1889. (source: Birkby, 2012).

The elegant resorts of Montana entered a period of decline beginning in the 1920s due to a number of factors: population growth in the state failed to meet expectations, prohibition was enacted, and several of the resorts were irreparably damaged by fires and the historic earthquake that rocked the Helena area in 1935 (Martin, 2012).

Today, Boulder Hot Springs and Chico Hot Springs Resort, built in 1891 and 1900, respectively, are the only lavish resorts that remain from this period. There are also a number of smaller, family-owned resorts that exist, as well as springs on public land that are available for public use.

Boulder Hot Springs, having undergone major renovations since its original construction, today boasts an inn, indoor and outdoor pools, spa, and conference facilities. Chico Hot Springs, located just north of Yellowstone National Park, today offers lodges, log cabins, chalets, cottages, geothermal spring-fed pools, a mineral spa, and numerous amenities.

Bozeman Hot Springs, a small pool enjoyed only by a few in the late 1800’s, has evolved into a destination spot. Located minutes from Yellowstone National Park and Big Sky Resort, the facility features nine different pools (Figure 3) with temperatures ranging from 59 to 106°F, and both dry and wet saunas. To ensure a consistently clean facility, the indoor pools use a flow-through system so no chemicals are needed; they are drained and cleaned every night.

Fairmont Hot Springs, located off Interstate 90 between Yellowstone and Glacier National Parks claims a reputation throughout the Northwest for its pools. The facility boasts



Figure 3. Outdoor pool at Bozeman Hot Springs. (source: <http://www.bozemanhotsprings.co>)

two oversized Olympic swimming pools and two mineral soaking pools, one of each located indoors and outdoors. The pools are fed by 155°F natural hot spring water. The facility also offers a lodge, convention and events center, fitness center, and numerous amenities.

Jackson Hot Springs in the heart of the Big Hole Valley offers an approximate 10,000 sq. ft. rustic lodge and outdoor warm-water pool (approximately 30 ft x 75 ft) fed by the 137°F hot springs. The geothermal spring, located about 1,300 feet east of the lodge, is almost odorless, with no trace of sulfur smell. As such, the water is piped underground to the town of Jackson, and serves as the town’s source of water. According to Birkby (1999), Jackson Hot Springs hosted celebrities, including Bing Crosby and Bob Hope, and the Lewis and Clark expedition passed by this area on their return from the Pacific Ocean.

Lolo Hot Springs is located southwest of Missoula in the Bitterroot region of Montana next to the Idaho border. The hot springs were well known to Native Americans, as a mineral lick for wild game and an ancient meeting place. Lewis and Clark visited there in 1805 and again on their return trip in 1806. The hot, mineralized springs became a land mark and rendezvous point for early explorers, and by 1885, Lolo Hot Springs had become a favorite vacationing spot for new homesteaders. Today, there is a large outdoor swimming pool, and indoor soaking pool, both heated by geothermal springs. There is also a hotel, restaurant, saloon, RV park, camping and picnicking area, and an extensive trail system. The Lolo Hot Springs produce 275,000 gallons of water per day at temperatures between 104 and 117°F. The hot water is collected in a 35,000 gallon holding tank which is used to supply drinking and shower water for the restaurant, hotel, swimming pool, and other establishments in the area (Lund, 2002). Water from the springs is used directly for filling the pool and for heating the decks and floors of the pool area (Lund, 2002).

The Lost Trail Hot Springs Resort is a rustic hot springs resort in a narrow, pine-covered mountain valley along the Lewis and Clark Trail. The 110°F hot springs are located on a hillside approximately 0.75 mile above the resort and are piped directly into a 25 ft x 75 ft outdoor swimming pool and an adjoining indoor hot tub. Unlike many hot springs in Montana, the water at Lost Trail is odorless, with no sulfur

smell. Pool temperatures average 95°F year-round, and the temperature averages 105°F in the hot tub. The resort also offers a restaurant and many outdoor recreation activities.

Norris (also known as Bear Trap) Hot Springs is a natural hot pool that has been in use since ancient Indians wintered in the area. The springs later served as a day trip destination for train travelers in the early 1900's when there was a booming local gold mine. Today, the 30 ft x 40 ft open-air wooden pool has changed little since the 1880s. Eight to ten separate springs with an average temperature of 127°F feed the pool at a flow-through rate of about 500,000 gallons of water per day. The odor-free hot water is air-cooled by forcing it through a small vertical pipe at one end of the pool; natural artesian pressure shoots the water out of the pipe in a graceful 12-foot arc above the pool, creating a constant hot water shower on the bathers below (Birkby 1999).

Quinn's Hot Springs Resort has six pools for soaking and swimming. Four soaking pools range in temperature from 60 to 106°F. Swimming pools (Figure 4) typically range in temperature from 80 to 95°F. All pools are monitored for cleanliness and temperature every three hours and adjusted as necessary. The resort offers several amenities, including dining and an events center.



Figure 4. Outdoor mineral/swimming pool at Quinn's Hot Springs (source: [www. http://quinnshotsprings.com/ Pools.aspx](http://quinnshotsprings.com/Pools.aspx))

Sleeping Buffalo Hot Springs in northeast Montana was discovered in 1922, when oil exploration drilling encountered a tremendous flow of hot mineral water at 3,200 feet. Legend has it that cowboys used the hot water for their Saturday night baths. The hot springs were named in honor of a particular rock resembling a buffalo which signifies the staff of life for several Native American tribes. Sleeping Buffalo resort includes two indoor pools: an 8 ft x 26 ft hot pool kept at about 106°F, and a 50 ft x 60 ft swimming pool kept at about 90°F. The indoor pools are open year-round. The geothermal water comes from a well about 3,200 feet deep that flows 750 gallons per minute of 106°F water. The resort also offers hotel rooms, cabins, a café, gift shop, and banquet rooms.

Spa Hot Springs Motel and Clinic, located in the city limits of White Sulphur Springs in southwest Montana, is owned by Dr. Gene Gudmundson, D.C., a licensed chiropractor. Thermal water for the pools and motel is of high sulfur content, and is provided by a 130°F geothermal well drilled near the site of the original springs. The outdoor pool is kept at 98°F in the

winter and 96°F in the summer. A 105°F indoor soaking pool is located near the main pool. The Spa Motel has 21 guest rooms, a natural health clinic, and several nearby attractions.

Symes Hot Springs and Mineral Baths are located near the town of Hot Springs in northwest Montana. The facility has three available pools kept at a hot (107°F), medium (101°F), and warm temperature (95°F) that are fed by geothermal springs at about 120°F. The Symes Hotel is a registered landmark; it features a restaurant, massage treatments, and many other amenities.

In addition to the numerous recreational and therapeutic uses of geothermal waters in Montana, there are many documented and undocumented uses of geothermal energy for space heating. Many of the documented uses are related to spas and resorts, with almost all of the larger resorts using their geothermal water to provide space heating for their hotels and their laundry needs. In addition, the laundry water at Warm Spring State Hospital northwest of Butte is preheated with geothermal water, saving a considerable amount of state tax dollars that would otherwise be spent on fossil fuel (Birkby, 2012). The Ennis RV Park near Ennis uses the hottest spring found in Montana at 180°F to provide hot water to vacationers for showers and laundry.

Major resorts in Montana using geothermal energy to heat their buildings include Boulder Hot Springs Inn and Spa (Figure 5), Bozeman Hot Springs, Chico Hot Springs Resort and Day Spa (Figure 6), Fairmont Hot Springs Resort, the Symes Hotel, and the Spa Hot Springs Motel and Clinic in White Sulphur Springs. Individual homes near hot springs also are heated with geothermal energy, including homes in Helena and the Bitterroot Valley north of Hamilton (Birkby, 2012). At Sleeping Child Hot Springs in the Bitterroot National Forest near Hamilton, a 25,000 sq. ft. exclusive living space is heated with geothermal springs on the property.



Figure 5. The Inn at Boulder Hot Springs. (source: [http://www. boulderhotsprings.com](http://www.boulderhotsprings.com)).

Greenhouse heating, another popular use of geothermal resources, is used at a few Montana locations. Chico Hot Springs Resort has had a geothermally-heated greenhouse (Figure 7) in operation for several years. The fresh herbs,

flowers, and vegetables grown in this greenhouse are featured in many of the menu items in Chico's gourmet restaurant (Birkby, 2012).

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Figure 6. Chico Hot Springs Resort. (source: Birkby, 2012).



Figure 7. A year-round banana tree grown in a geothermal greenhouse at Chico Hot Springs Resort. (source: Birkby, 2012)

At Silver Star Hot Springs in southwestern Montana, a 30 ft x 120 ft geothermal greenhouse has been raising organic tomatoes since the early 2000s (Figure 8). The greenhouse owners have found a niche market selling their product to local farmers' markets and restaurants in Bozeman and Butte (Birkby, 2012).

Madison Farm-to-Fork, an initiative to encourage and promote local food growing in Madison County, has completed two approximately 70 ft x 40 ft greenhouses in 2011 near Ennis (Figure 9). The greenhouses are heated using geothermal fluids at about 180°F issuing from Ennis Hot Springs. The current plan calls for one greenhouse to be used for food production, and the other as a facility to teach school children the skills and benefits of growing their own food.



Figure 8. Organic tomatoes grown in a geothermal greenhouse at Silver Star Hot Springs. (source: http://grannysstore.com/Silver_Star_About.htm)



Figure 9. Madison Farm-to-Fork greenhouse at Ennis Hot Springs. (source: www.madisonfarmtofork.com/mf2f-geothermal-greenhouse.html)

The numerous geothermal-related activities in Montana employ many people directly and indirectly. Geothermal uses significantly contribute to Montana's tourism economy, bringing revenue to the state, and creating many direct and indirect jobs. The use of geothermal energy that directly employs the most people in Montana is clearly related to the resort, spa, and recreation industry. Were it not for the many hot springs in Montana, these resorts would probably not exist. Using a standard multiplier of 2.5, geothermal businesses create an estimated 325 direct, indirect, and induced jobs in Montana.

Geothermal systems used for space heating are generally low-maintenance, and therefore employ only a few folks that are qualified to work on them. However, space heating of buildings and other applications using geothermal energy for heat results in significant energy cost savings to building and

business owners, which, in turn, results in money that can be kept in the local economy. Based on average 2012 natural gas prices, geothermal energy saves about \$1 million in annual energy costs for documented geothermal space-heating applications, and about \$1.8 million annually in the heating of spa and swimming pool water.

ENVIRONMENTAL BENEFITS

In addition to energy savings, geothermal energy usage prevents the emissions of greenhouse gases (GHG) and air pollutants, helping to keep a healthy living environment. If these activities used fossil fuels to generate the heat that geothermal water provides, they would emit at least 56,900 tonnes of carbon dioxide equivalent each year (Table 1) — the equivalent of removing 11,100 passenger vehicles from the road, saving 132,300 barrels of oil, and saving 12,100 acres of pine forest.

SOCIAL BENEFITS

Social benefits of direct-use geothermal utilization are difficult to measure quantitatively, but Jeff Birkby may be one of the first to undertake a social scientific assessment of the role of hot springs in the social fabric of societal development of Montana. The hot springs of Montana, Birkby says in Martin (2012), “often were the early social gathering areas of the state, where people would come for a bath on a weekend. The miners would gather there and tell stories . . . and so they became the early social centers.”

Today, hot springs resorts still serve as social centers. Another key social benefit from geothermal energy use in Montana is improved quality of life through recreation and spa therapy. Geothermal sources provide many unique recreational opportunities enjoyed by tens of thousands of people each year, attracting tourists to the state. Given the history of the geothermal spa industry, social benefits have been evident for many past generations. Providing a grand entrance to Yellowstone National Park, this area has provided unique educational opportunities of geothermal features to people worldwide.

THE FUTURE

Montana has significant geothermal potential for future uses, from new applications of direct use heating, to resurgence in mineral spa therapy, to development of low-to-moderate temperature resources for electrical power generation.

The Geo-Heat Center lists 18 communities in Montana that are within five miles of a geothermal resource with a temperature of 122°F or greater, making them possible candidates for district heating or other geothermal use. Also, Montana has a rich history related to the balneological use of geothermal waters, a practice which appears to be making a comeback. The southwestern, western, and eastern portions of the State have semi-developed springs and/or previously-developed springs from Montana’s grand era of bathhouses around the turn of the 20th century that are not currently commercially operational. Some of these areas

could be readily turned into viable businesses when the right buyers and market emerge. For example, Hunters Hot Springs near Livingston, once the site of the elegant Hotel Dakota in the early 1900s and a now-vanished bottled water plant, contains many thermal springs that produce one of the largest flows of hot water in Montana at more than 1,300 gallons per minute of 139°F water.

The potential of electricity generation from co-produced geothermal fluids from Montana’s oil fields is significant. Research and interest continues in the concept of generating electricity from co-produced fluids from deep petroleum wells in the Williston Basin, a portion of which underlies eastern Montana.

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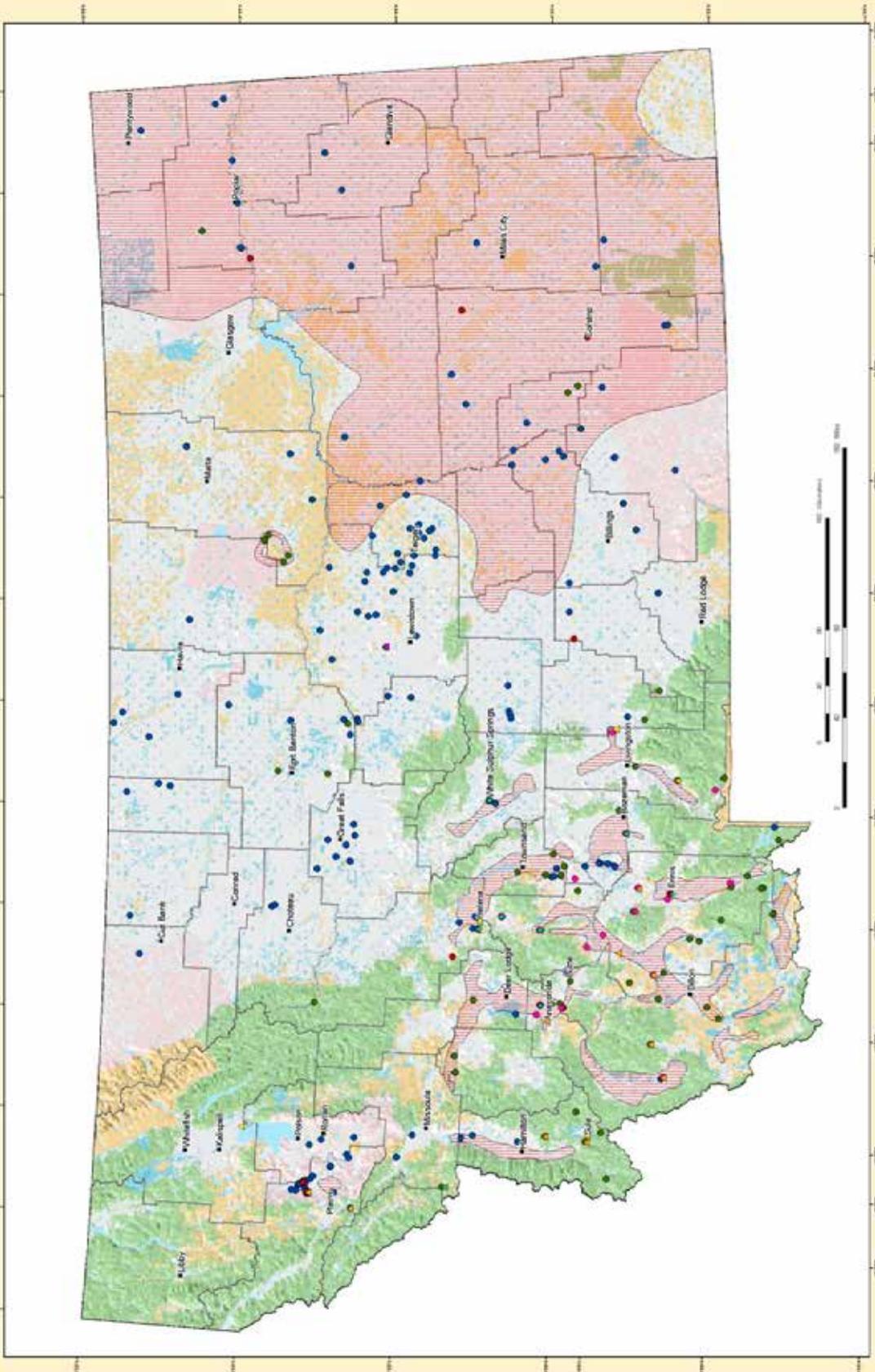
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Table 1. Energy Production and Carbon Emissions Offsets by Geothermal Energy Utilization in Montana.

Site	Location	Application	Temp. (F)	Annual Energy Use		Annual Emission Offsets (metric tonnes)		
				(10 ⁹ Btu/yr)	(10 ⁶ kWh)	NO _x	SO _x	CO ₂
Silver Star Hot Springs	Silver Star	Greenhouse	NA	0.3	0.1	0.1	0.1	81
Ennis Hot Springs	Ennis	Greenhouse	180°	0.5	0.1	0.2	0.2	136
Chico Hot Springs	Pray	Greenhouse	110°	0.3	0.1	0.1	0.1	81
Norris (Bear Trap) Hot Spring	Norris	Resort/Pool	130°	24	7.1	11	11.7	6,593
Boulder Hot Springs	Boulder	Resort/Pool	151°	7.0	2.1	3.2	3.4	1,899
Bozeman Hot Springs	Bozeman	Resort/Pool	142°	7.0	2.1	3.2	3.4	1,899
Broadwater Hot Spring	Helena	Resort/Pool	153°	7.0	2.1	3.2	3.4	1,899
Camas Hot Springs	Hot Springs	Resort/Pool	104°	0.7	0.2	0.3	0.3	190
Wild Horse Hot Springs	Hot Springs	Resort/Pool	124°	7.0	2.1	3.2	3.4	1,899
Chico Hot Springs	Park County	Resort/Pool	113°	4.6	1.3	2.1	2.2	1,248
Elkhorn Hot Springs	Polaris	Resort/Pool	140°	7	2.1	3.2	3.4	1,899
Fairmont Hot Springs Resort	Anaconda	Resort/Pool	143°	28	8.2	12.7	13.4	7,570
Jackson Hot Springs	Jackson	Resort/Pool	137°	7.0	2.1	3.2	3.4	1,899
Lolo Hot Springs Resort	Lolo	Resort/Pool	117°	7.0	2.1	3.2	3.4	1,899
Lost Trail Hot Springs Resort	Sula	Resort/Pool	NA	7.0	2.1	3.2	3.4	1,899
Quinn's Hot Springs	Paradise	Resort/Pool	120°	7.0	2.1	3.2	3.4	1,899
Sleeping Buffalo Hot Springs	Saco (10 mi. E)	Resort/Pool	106°	7.0	2.1	3.2	3.4	1,899
Sleeping Child Hot Springs	Ravalli County	Resort/Pool	125°	2.5	0.7	1.1	1.2	678
Spa Motel	White Sulphur Springs	Resort/Pool	120°	7.0	2.1	3.2	3.4	1,899
Symes Hotel and Springs	Hot Springs	Resort/Pool	90°	7.0	2.1	3.2	3.4	1,899
Ennis RV Park	Ennis	Space Htg.	180°	1.7	0.5	0.8	0.8	461
Warm Springs State Hospital	Warm Springs	Space Htg.	154°	15	4.3	6.6	7.0	3,961
Sleeping Child Hot Springs	Ravalli County	Space Htg.	125°	1.3	0.4	0.6	0.6	339
Bozeman Hot Springs	Bozeman	Space Htg.	131°	5.8	1.7	2.6	2.8	1,574
Broadwater Athletic Club	Helena	Space Htg.	153°	5.6	1.6	2.5	2.7	1,519
Fairmont Hot Springs Resort	Anaconda	Space Htg.	160°	14	4.2	6.6	7.0	3,934
Jackson Hot Springs Lodge	Jackson	Space Htg.	137°	2.9	0.8	1.3	1.4	787
Lolo Hot Springs	Missoula Cnty.	Space Htg.	111°	13	3.7	5.7	6.1	3,419
Spa Motel and Clinic	White Sulfur Springs	Space Htg.	136°	1.3	0.4	0.6	0.6	353
Boulder Hot Springs	Boulder	Space Htg.	169°	4.4	1.3	2.0	2.1	1,194
TOTALS				210	61	95	101	56,911

Montana Geothermal Resources



Legend

- City/Towns
- County Boundaries
- Rivers/Streams
- Lake/Reservoirs
- Greenhouse
- Agriculture
- Sports/Recreation
- Regions of Known or Potential Geothermal Resources

Geothermal Categories

- Wells > 50 Degrees C
- Springs > 50 Degrees C
- Wells 20 and < 50 Degrees C
- Springs 20 and < 50 Degrees C

Ownership

- Private Lands
- Bureau of Land Management and Other Federal Lands
- State Lands
- Native American Lands
- U.S. Forest Service Lands

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