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## The Economic, Environmental, and Social Benefits of Geothermal Use in Wyoming

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The marvels of geothermal energy have been made famous by Wyoming's Yellowstone National Park. The U.S. National Park Service states: *"with half of the earth's geothermal features, Yellowstone holds the planet's most diverse and intact collection of geysers, hot springs, mudpots, and fumaroles. Its more than 300 geysers make up two thirds of all those found on earth. Combine this with more than 10,000 thermal features comprised of brilliantly colored hot springs, bubbling mudpots, and steaming fumaroles, and you have a place like no other"*. Outside the park boundaries, documented direct uses of geothermal waters in Wyoming are limited to recreational uses, spas, and resorts. There are a few other sporadic uses for aquaculture, greenhouse heating, and individual heating uses by ranchers. Previously-reported snow-melting operations in Laramie and Cheyenne using ammonia heat pipes are no longer operational (J. Nydahl, 2012; personal communication). In addition to direct uses, the Rocky Mountain Oilfield Testing Center (RMOTC) has been conducting research on the feasibility of electrical power generation from co-produced fluids (petroleum and hot water) from deep petroleum wells near Casper, WY.

### ***Economic benefits***

According to U.S. National Park Statistics, Yellowstone National Park currently attracts

about 3 million recreational visitors per year, providing an enormous contribution to Wyoming's economy. Since Yellowstone was designated as a National Park in 1872 (America's first national park), over 156 million people have visited the park as of the end of 2011. Aside from tourism and limited recreational swimming and soaking, no other uses of geothermal energy are permitted in Yellowstone National Park.



*Figure 1. Heart Spring, one of the many colorful thermal spring features enjoyed by recreational visitors to in Yellowstone National Park.*

Outside of Yellowstone National Park, Wyoming's thermal spring resource is enormous, and (excluding the Park) Heasler (1985) estimates that 3 trillion British Thermal Units (Btu) of energy are released each year from natural springs as they cool to ambient temperature – enough thermal energy to heat approximately 8,000 Wyoming homes. However,

many of these thermal springs are currently undeveloped and/or primitive, and springs developed for commercial uses in Wyoming are essentially concentrated in four areas: Thermopolis, Jackson, Cody, and Saratoga.

Thermopolis, a Greek word for “Hot City”, is located in north central Wyoming, approximately 100 miles from Yellowstone National Park. Some of the geothermal features of Thermopolis, WY are described by Lund (1993). The city derived its name from the hot water that comes from Big Spring, which issues 3.6 million gallons per day of turquoise and green mineral laden water at 127°F. The water from this spring contains at least 27 different minerals, some say, making it very healthful to drink. The hot springs have created large terraces along the river, and these terraces are composed chiefly of colorful lime and gypsum layers known as travertine (from bicarbonate and sulfate ions). The springs are claimed to be the largest mineral hot springs in the world.



*Figure 2. Rainbow Terraces produced by Big Springs in Hot Springs State Park, Thermopolis.* (source: <http://thermopolis.com/todo/hot-springs-state-park>).

Commercial facilities at Hot Springs State Park consist of Hot Springs Water Park (formerly

Tepee Pools), the State Bath House, the Star Plunge, Best Western Hotel (formerly a Quality Inn), and a Days Inn Hotel (formerly a Holiday Inn). The State Bath House was constructed to fulfill a treaty that was signed in 1896 with the Shoshone and Arapaho Tribes, which allowed public use of Big Spring. The hot springs was known as having “healing water”, and there is no fee for using the State Bath House.



*Figure 3. The State Bath House in Hot Springs State Park, Thermopolis.* (source: <http://thermopolis.com/todo/hot-springs-state-park>)

The Days Inn and Best Western hotels have hot mineral water piped in from Big Spring. The Days Inn advertises a full-time certified licensed masseuse, hot mineral tubs, steam room, private jacuzzi room, and a year-round outdoor hot mineral pool. The Star Plunge was first built in the late 1800s and has been enjoyed by a number of celebrities such as Buffalo Bill Cody, Butch Cassidy (and “The Hole in the Wall Gang”), Marlon Brando, and Robert Redford. Both the Star Plunge and Hot Springs Water Park have large indoor and outdoor pools maintained at temperatures of about 90°F, and flow of spring water is kept continuous through the pools thereby requiring no chemical treatment of the water.

Also in the Thermopolis area is the Fountain of Youth RV Park and Resort using natural mineral

water from the historic Sacajawea Well flowing at the rate of 1.4 million gallons per day. This 900-ft deep well was originally drilled for oil in 1918, but hot mineral water was found instead at 128°F under such pressure that it destroyed the oil derrick. Over the decades, the hot water has deposited a colorful travertine cone around the well, which can be seen at the southern edge of the swimming pool. The park boasts the third largest mineral pool in the world.



*Figure 4. Fountain of Youth RV Park near Thermopolis. (source: [www.fountainofyouthrvpark.com/hot springspool.htm](http://www.fountainofyouthrvpark.com/hot springspool.htm)).*

The Chief Washakie Plunge offers a warm outdoor pool with hotter indoor private baths, and is located on the Wind River Indian Reservation (on the Shoshone and Arapaho Recreation Complex) in west-central Wyoming. The 112°F hot springs issues from a gravel-lined pool whose flow is controlled to maintain a 98°F outdoor pool, an outdoor Jacuzzi, and a small wading pool. Inside the bathhouse are nine private plunge rooms kept at 102°F for soaking.

Commercial geothermal spas of note in the Jackson area include Sulphur Hot Springs (near Auburn) and Granite Creek Hot Spring. Sulphur Hot Springs has a rich history, dating back to 1827 where trappers began to inhabit the area, trading furs with Indians. Prior to that, the Shoshone and Blackfoot Indians frequented the area for the healing effects of the waters. Today, Sulphur Hot Springs boasts at least 72 springs, with temperatures up to 168°F, and cabins are available with soaking tubs. Granite Creek Hot Spring is a picturesque soaking pool located at an elevation of 7,000 feet in the Gros Ventre Mountains. According to Birkby (1999), this spring is increasingly popular with winter visitors and offers one of the most picturesque soaks in the Rocky Mountains. The spring temperature varies seasonally from the mid 80s°F to 112°F due to runoff from snowmelt.

The Saratoga Resort and Spa in Saratoga is a resort and spa with numerous amenities. Historically, the Indians of the Platte River Valley would seek this area which they called “the place of magic waters”. Today, guests at the resort can soak either in a large outdoor pool or in private teepee-covered tubs with temperatures in the range of 105-112°F. In the town of Saratoga, the historic Saratoga Hobo Pool is located on the banks of the Platte River, and is a natural hot springs once believed to possess healing properties. Now the mineral waters of the hot pool continue to serve as a draw for locals and visitors alike. The pool is open 24 hours a day, 7 days a week year round, with a temperature ranging from 108 to 119°F.

In addition to the numerous recreational uses of geothermal waters in Wyoming, one documented significant aquaculture use exists at the Jackson National Fish Hatchery. This hatchery facility is physically located on the Fish & Wildlife



Service's National Elk Refuge and rears trout for a distribution area that covers close to 18,000 square miles, and is also a part of the Fish & Wildlife Service's National Broodstock Program.



Figure 5. Tepee-covered soaking tubs at the Saratoga Resort and Spa, Saratoga, WY. (source: <http://www.saratogaresortandspa.com/>)



Figure 6. Jackson National Fish Hatchery.

The Jackson National Fish Hatchery utilizes thermal water at 78°F from a well for tempering trout-rearing ponds. Since trout prefer cold water, the main use of the geothermal source is in the winter months. The well is also used as an open-loop source for space heating of the building with a geothermal heat pump.

The numerous geothermal-related activities in Wyoming employ many people directly and indirectly. Geothermal uses significantly contribute to Wyoming's tourism economy, creating many direct and indirect jobs. Yellowstone National Park alone employs thousands of people every year, some seasonally and some permanently. Exclusive of Yellowstone, using a standard multiplier of 2.5, geothermal businesses create an estimated 100 direct, indirect, and induced jobs in Wyoming.

#### ***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 154,841 tonnes of carbon dioxide equivalent each year (Table 1) — the equivalent of removing 30,200 passenger vehicles from the road, saving 360,000 barrels of oil, and saving 32,900 acres of pine forest.

#### ***Social benefits***

Social benefits are difficult to measure quantitatively. One key social benefit from geothermal energy use in Wyoming, however, 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. Yellowstone National Park has provided unique educational opportunities of geothermal features to people worldwide.

### ***The future***

Wyoming 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.

Much of Wyoming's geothermal resources have yet to be developed for direct uses, perhaps because of the State's low population of less than 600,000 people (the lowest state population in the entire U.S.). However, the Geo-Heat Center lists 5 communities in the State that are within 5 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, Wyoming has a rich history related to the balneological use of geothermal waters, a practice which appears to be making a comeback. The western and northwestern portion of the State, particularly the Cody area, have semi-developed springs and/or previously-developed springs that are not currently commercially operational (e.g., Astoria Hot Springs, DeMaris Hot Springs, Granite Hot Springs, Kelly Warm Springs, Kendall Warm Springs, and Steele Hot Springs). Examples of previously developed thermal springs in the eastern portion of the state include Jackalope Plunge near Douglas. These semi-developed and previously-developed springs could be readily turned into viable businesses when the right buyers and market emerge.

The potential of electricity generation from co-produced geothermal fluids from Wyoming oil fields is significant. Hinckley (1983) calculated that 24 trillion Btu is available from water as a by-product of oil production, and continued interest in co-produced fluids remains at RMOTC.

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

Site	Location	Application	Temp.  (F)	Annual Energy Use		Annual Emission Offsets (metric tonnes)**		
				(10 <sup>9</sup> Btu/yr)	(10 <sup>6</sup> kWh)	NO <sub>x</sub>	SO <sub>x</sub>	CO <sub>2</sub>
Jackson National Fish Hatchery	Jackson	Aquaculture	78	2.8	0.8	1.3	1.3	753
Hot Springs State Park	Thermopolis	Resort/Pool	135	383	112	174	184	103,811
Fountain of Youth RV Park	Thermopolis	Resort/Pool	125	107	31	48	51	28,897
Chief Washakie Plunge	Fort Washakie	Resort/Pool	112	14	4.0	6.2	6.5	3,690
Granite Creek Hot Spring	Teton County	Resort/Pool	112	7	2.1	3.2	3.4	1,899
Sulphur Hot Spring	Near Auburn	Resort/Pool	144	5.7	1.7	2.6	2.7	1,547
Saratoga Resort and Spa	Saratoga	Resort/Pool	114	32	9.2	14	15	8,547
Hobo Pool	Saratoga	Resort/Pool	118	21	6.2	9.5	10	5,698
<b>Totals</b>				<b>571</b>	<b>167</b>	<b>259</b>	<b>274</b>	<b>154,841</b>

\*\*Emission factors from Lund et al. (2010).



