THE ECONOMIC, ENVIRONMENTAL, AND SOCIAL BENEFITS OF GEOTHERMAL USE IN WASHINGTON STATE

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Geothermal waters in Washington have been enjoyed by many for centuries. Native Americans used naturally occurring hot springs for healing, cleaning, cooking and even negotiating. "Sol Duc" is a Native American word for "sparkling water." Early developments included grand hotels and sanatoriums to treat the ill.

Schuster and Bloomquist (1994) compiled a resource database including 975 thermal wells and springs, which was an increase of 165% over the number of entries reported in 1981. Most of the thermal springs occur in the Cascade Range, associated with stratovolcanoes. In contrast, 97% of the thermal wells are located in the Columbia Basin of southeastern Washington. These thermal wells are strongly associated with the Columbia River Basalt Group and the Columbia Basin (Shuster and Bloomquist, 1994).

According to the National Renewable Energy Laboratory (NREL, 2005), the Columbia River Basin boasts more than 900 low-temperature (less than 100°C or 212°F) thermal wells. There are also 30 known low-temperature hot and mineral springs in the Cascade Range. NREL (2005) also states that high-temperature (greater than 150°C or 302°F) resources have been identified in this area, but have yet to be developed; three of these areas may be particularly good for development of electric power generation. These sites include the Mount Adams area in the southern Cascades, the Wind River area east of Vancouver, Washington, and the Mount Baker area in the northern Cascades (NREL, 2005).

ECONOMIC BENEFITS

The economic benefits to Washington result primarily from the connection between the hot springs and the tourism industry. Sol Duc Hot Springs resort was founded in the early 1900s with a 164-room five-star hotel and resort. It now consists of 27 cabins, multiple RV hookups and a river suite, and attracts 50,000 visitors annually. Located in the Olympic National Forest, Sol Duc Hot Springs provides a favorite base camp for many hikers and outdoor enthusiasts.

Soap Lake, though not a true hot springs, has been attracting visitors since the early 1900s. In its heyday, celebrations, socials and gatherings were held continuously. World War I veterans flocked to Soap Lake when word got out that the mineral waters and mud of the lake were an effective treatment for Buergers disease. The 3-mile long lake maintains a constant summer temperature of 87°F (31°C) and a heavy mineral content (NREL, 2005). Spas along the lake attract tens of thousands of people annually (NREL, 2005). The Soap Lake Chamber of commerce reports that the town is experiencing a resurgence as more people turn to natural and healthier lifestyles.

The first spa in Washington was developed in 1901 with the completion of the St. Martin Hotel at Carson Hot Mineral Springs. Cabins and a bath house were added in 1923 and are still in use today. Continuing as a foundation for economic growth, an 18-hole golf course was added in 1974. Carson Hot Mineral Springs enjoys a range of 30 to 100 visitors per day throughout the year.

The Original Hotel St. Martin at Carson Hot Mineral Springs.

The economic benefits associated with Goldmyer Hot Springs began with its privatization as a patented mining claim and the Goldmyers ran a lodge in the early 1910s for miners and loggers in the area. Its popularity almost led to its destruction until ownership transferred to a non-profit organization who now limits access to 20 people per day.

Bonneville Hot Springs resort, renovated in 1991, is now an upscale resort and spa offering 78 "exquisitely appointed" guest rooms and suites and a whole host of treatments including: mineral baths and wraps, massages, facials and therapies. Geothermal water is also used for direct heating of the 13,000 square foot European-style spa facility.

The developed hot and mineral springs of Washington provide about 11 billion Btu of geothermal energy per year (NREL , 2005). Although this production results in cost savings through the offset of other energy usage, the energy produced makes up a small percentage of the statewide energy consumption and the economic impact is therefore relatively small in comparison to that of the tourism industry (NREL, 2005).

NREL (2005) projected that if the State's estimated geothermal electric potential of 300 MW were to be fully developed, the economic and energy impact would be significant. The 300 MW could produce about 2.5 billion kilowatt-hours (kWh) of electricity a year, which is enough to provide more than 265,000 average U.S. homes with electricity.

Low-temperature resources could be used directly to heat buildings, grow plants in greenhouses, heat water for aquaculture, and for other application that often incorporate heat pumps.

ENVIRONMENTAL BENEFITS

Because the spas and resorts are able to use the heat naturally occurring in the water, they do not have to heat water using electricity or natural gas, therefore preventing greenhouse gas emissions.

The revenues generated from the hot springs and resorts also depend directly on the careful maintenance of the natural springs. This maintenance directly relates to varying levels of area protection and conservation.

The Goldmyer hot springs was subjected to overuse, misuse and mismanagement in the 1960s and 70s. In response, the Northwest Wilderness Programs Inc. (NWWP), a non-profit organization, was formed by Veida, John and Josehine Morrow to carefully manage access and use of the springs. Now, access is limited to 20 people per day. In addition, the NWWP provides visitors with information about the ecology of the ancient forest ecosystem, and a plant identification guide is available for walking tours. If not otherwise busy with facilities maintenance, caretakers are often happy to lead ecological walks through one of the last remaining old growth forest areas in the Pacific Northwest.

Rock-lined pools at Goldmyer Hot Springs.

Similarly, the tourism of Soap Lake depends directly on the mineral water and mud contained in the lake. The Soap Lake community therefore carefully protects the quality of the lake (assuring that irrigation drainage does not end up in the lake) and the use of the waters and mud. The mud, a result of minerals deposited from glacial floods, cannot be replaced.

SOCIAL BENEFITS

Though difficult to measure quantitatively, geothermal resources provide many social benefits. Historically, hot springs served as gathering places and ceremonial sites for Native American communities. Hot springs continue to draw people together, creating foundations of tourism for local towns and improving quality of life through recreation. The mineral waters, muds and spas serve as the primary basis for the Soap Lake local economy and community gatherings. In the early 2000s, a Korean man visited the lake and, fascinated by its healing history, included the lake in a Korean-language tour guide, prompting more Koreans to visit (White, 2008).

Hot and mineral springs have and continue to be used for medicinal and healing properties. At Carson Hot Springs, St. Martin's wife, Margaret, recovered from neuralgia. Michael Earles, owner of the Puget Sound Mills and Timber Company in the late 1800s, claimed he was cured of a fatal illness after visiting Sol Duc Hot Springs. Soap Lake became well known for its ability to relieve symptoms of Buergers disease, suffered by many World War I Veterans. Many people continue to visit Soap Lake for the reported healing mud and water. They also come to enjoy the laid-back atmosphere of the town, its thriving arts community and the abundant sunshine and fresh air.

THE FUTURE

According to NREL (2005), high-temperature geothermal resources have the potential to produce approximately 300 megawatts (MW) of electricity. In September of 2010, the Geothermal Energy Association reported that the Snohomish County Public Utility District (PUD) is drilling geothermal test wells with hopes to use geothermal energy to power 35,000 homes by 2020. The PUD would be the first utility in Washington State to develop geothermal power. The PUD is spending $350,000 to drill five test holes. The desired 50-MW plant will cost between $150 million and $200 million. The plant would likely be built in 10-MW phases with the first potentially completed by 2016 (GEA, 2010).

In addition to high-temperature resources, there may be an even greater potential for direct-use applications from low-temperature thermal wells in the Columbia River Basin (NREL, 2005). Direct-use applications can include heating buildings, growing plants in greenhouses, crop and food drying and aquiculture.

Rather than prioritize limited areas within the Columbia Basin for detailed studies, Schuster and Bloomquist (1994) make three recommendations for greatly expanding geothermal use in the state. The recommendations are: (1) match existing thermal wells with proposed retrofit or new construction, (2) measure temperature gradients, obtain well-test data and drill cuttings, and collect water samples for chemical analysis, and (3) inform state residents and policy makers about uses of geothermal energy.

The Washington Geothermal Energy Status and Roadmap - a working-draft report produced by the Washington State University Extension Energy Program and the Washington State Department of Natural Resources – also identified information and action needed for future geothermal development. These needs were divided into categories including exploration and characterization of geothermal geology, geothermal leases and permitting, and geothermal policy (Sjoding, et. al., 2009).

There is great potential for future development of

Washington's geothermal resources. With updated data from existing wells, support for exploration and new or revised policies and incentives, Washington may expand the economic, environmental and social benefits that result from geothermal resources.

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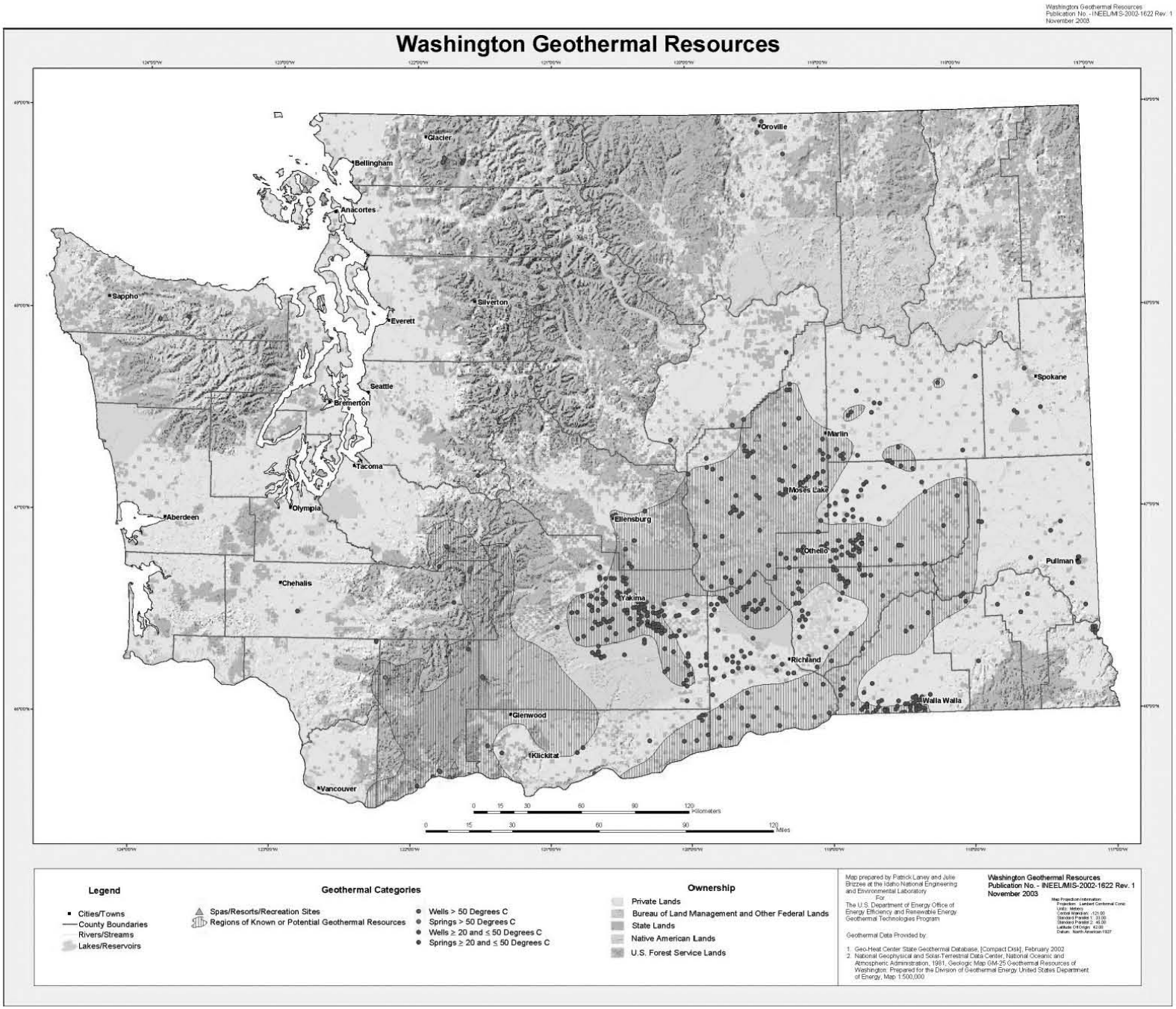
Table 1. Energy Production and Carbon Emissions Offsets by Geothermal Utilization in the State of WashingtonNotes:

Name	Temp.	Flow	Energy		Annual Emissions Offset[3] (lb.)		
			Peak Capacity	Annual	NO_x	SO_x	CO_2
Carson Hot Mineral Springs Resort[1]	119°F (48°C)	Unknown. Well is pumped 24 hrs/day.	1.0 X 10^6 Btu/hr 0.29 MWt	7.0 X 10^9 Btu/yr 2.1 GWh/yr	7.2	7.6	4.286
Goldmyer Hot Springs	117°F (47°C)	5 gpm (18.9 L/min)	2.0 X 10^4 Btu/hr 0.006 MWt	1.4 X 10^8 Btu/yr 0.04 GWh/yr	0.136	0.144	81.6
Sol Duc Hot Springs	133°F (56°C)	50 gpm (189 L/min)	8.0 X 10^5 Btu/hr 0.23 MWt	5.6 X 10^9 Btu/yr 1GWh/yr	5.5	5.8	3,266
Bonneville Hot Springs[2]	97°F (36°C)	100-150 gpm (378- 570 L/m)	6.5 X 10^5 Btu/hr 0.19 MWt	4.6 X 10^9 Btu/yr 1.3 GWh/yr	4.4	4.7	2,653
Totals			2.5 X 10^6 Btu/hr 0.72 MWt	1.7 X 10^{10} Btu/yr 5.0 GWh/yr	17.2	18.2	10,287

1. Flow rate was unknown according to facilities staff at time of publication. Capacity and Annual Energy figures were taken from Geo-Heat Center Database.

2. Capacity was calculated using an average flow rate of 100 gallons per minute.

3. Emission factors from Lund et al. (2010)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Oroville
Glacier
Bellingham
Anacortes
Sappho
Silverton
Everett
Seattle
Bremerton
Tacoma
Olympia
Aberdeen
Chehalis
Spokane
Marlin
Moses Lake
Ellensburg
Othello
Pullman
Yakima
Richland
Walla Walla
Glenwood
Klickitat
Vancouver
0 15 30 60 90 120 Kilometers
0 15 30 60 90 120 Miles
Legend
Cities/Towns
County Boundaries
Rivers/Streams
Lakes/Reservoirs
Geothermal Categories
Spas/Resorts/Recreation Sites
Regions of Known or Potential Geothermal Resources
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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Geothermal Data Provided by:
1. Geo-Heat Center State Geothermal Database, [Compact Disk], February 2002
2. National Geophysical and Solar-Terrestrial Data Center, National Oceanic and Atmospheric Administration, 1981, Geologic Map GM-25 Geothermal Resources of Washington. Prepared for the Division of Geothermal Energy United States Department of Energy, Map 1:500,000
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Projection: Lambert Conformal Conic
Units: Meters
Central Meridian: -120.00
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Standard Parallel 2: 45.00
Latitude Of Origin: 43.00
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