The Economic, Environmental, and Social Benefits
of Geothermal Use in Arizona

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Geothermal waters in Arizona have been used by many people for centuries. Today, the documented direct uses of geothermal waters are related to aquaculture, greenhouse heating, and spas.

Economic benefits

The aquaculture industry in Arizona enjoys significant economic benefits of geothermal energy. Desert Springs Tilapia in the Hyder Valley produces about 1 million pounds of Tilapia using the benefits of geothermal (Fitzsimmons, 2011). The facility uses three geothermal wells, capable of producing about 5,000 gallons per minute (gpm) at temperatures ranging from 95°F to 106°F (35 °C to 41°C). In addition, the warm water is also used for irrigation of crops such as wheat, sour gum, and olives. Desert Springs Tilapia employs about 10 people.

Desert Sweet Biofuels (formerly Desert Sweet Shrimp), located near Gila Bend is using geothermal energy for venturing into commercial algae production for biodiesel (Allison, 2011 and Fitzsimmons, 2011). This facility employs about four people.

About five other small aquaculture operations exist in the Safford area, each employing two to three people. These operations produce about 100 to 1,000 pounds of "pond-stocking" fish such as catfish, bass, and minnows. The Geo-Heat Center database had records of an aquaculture operation in Marana (near Tucson), which is no longer in operation (Fitzsimmons, 2011).

Desert Sweet Biofuels (credit: desertsweetbiofuels.com)

Geothermal energy has recently been employed at the Willcox Greenhouse for heating (Witcher, 2011). This is a 7.5 acre facility that employs about 40 people and primarily grows tomatoes. Based on the recommendations of a feasibility study funded by the U.S. Department of Energy, the greenhouse drilled a well in 2010 to a depth of 4,000 feet and tapped geothermal water at temperatures in excess of 135°F (57°C). The well currently produces about 1,000 gpm, but likely has a much greater capacity (Witcher, 2011).

Willcox Greenhouse (credit: J. Witcher)

Arizona has several small spas, a few historic resorts, and numerous undeveloped hot springs (Bischoff, 1999). The small spas include Essence of Tranquility and Kachina Mineral Springs near Safford, and El Dorado near Tonopah. Also, Muleshoe Ranch, northwest of Willcox, includes hot springs now operated for tourism by The Nature Conservancy (NREL, 2006).

Buckhorn Mineral Wells

The most famous geothermal site in Arizona was privately-owned Castle Hot Springs, 50 miles northwest of Phoenix (NREL, 2006). For several decades, many famous people visited there to play golf and soak in the hot waters. This facility is recently under new ownership which is adding an aquaponics operation that will raise tilapia, along with tomatoes, cucumbers, and lettuce (Fitzsimmons, 2011). Other historic resorts included Buckhorn Mineral Wells in Mesa and Agua Caliente near Sentinel.

The numerous geothermal businesses across Arizona employ many people. Using a multiplier of 2.5 (GEA, 2005), geothermal businesses create an estimated 210 direct, indirect, and induced jobs in the state.

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 in Arizona. If these businesses used fossil fuels to generate the heat that geothermal water provides, not only would most be unable to afford to stay in business, but they would emit at least 82,800 tonnes of carbon dioxide each year — the equivalent of 195,550 barrels of oil. In addition, they would emit 139 tonnes of nitrogen oxides and 137 tonnes of sulfur dioxides each year into Arizona's air (Table 1).

Social benefits

Social benefits are difficult to measure quantitatively. One key social benefit from geothermal energy use in Arizona, however, is improved quality of life through recreation. Geothermal provides many unique recreational opportunities enjoyed by tens of thousands of

people each year, attracting tourists to the state.

The future

Arizona has significant geothermal potential for future uses, from the growing deployment of geothermal heat pumps, to new and expanding applications of direct use geothermal, to development of high temperature resources for electrical power generation.

According to NREL (2006), geothermal resources with potential for electrical power generation in Arizona include the eastern San Francisco Volcanic Field near Flagstaff and several areas in southeastern Arizona. One of these is the Clifton area near the New Mexico border.

The Geo-Heat Center lists 14 communities in Arizona that are within five miles (eight kilometers) of a geothermal resource with a temperature of 122°F (50°C) () or greater, making them possible candidates for district heating or other geothermal use. Arizona has a strong aquaculture and greenhouse industry, which can experience significant growth with expanded use of geothermal energy for heating.

Historically, geothermal heat pumps have not been widely used in Arizona but demand is currently growing (Allison, 2011). One advantage of geothermal heat pumps is that no water is consumed in cooling (as opposed to evaporative cooling systems), thereby conserving precious water resources in the Arizona desert. With consumptive water uses in conventional cooling systems becoming more and more stringent, geothermal heat pump usage is almost certain to increase.

References

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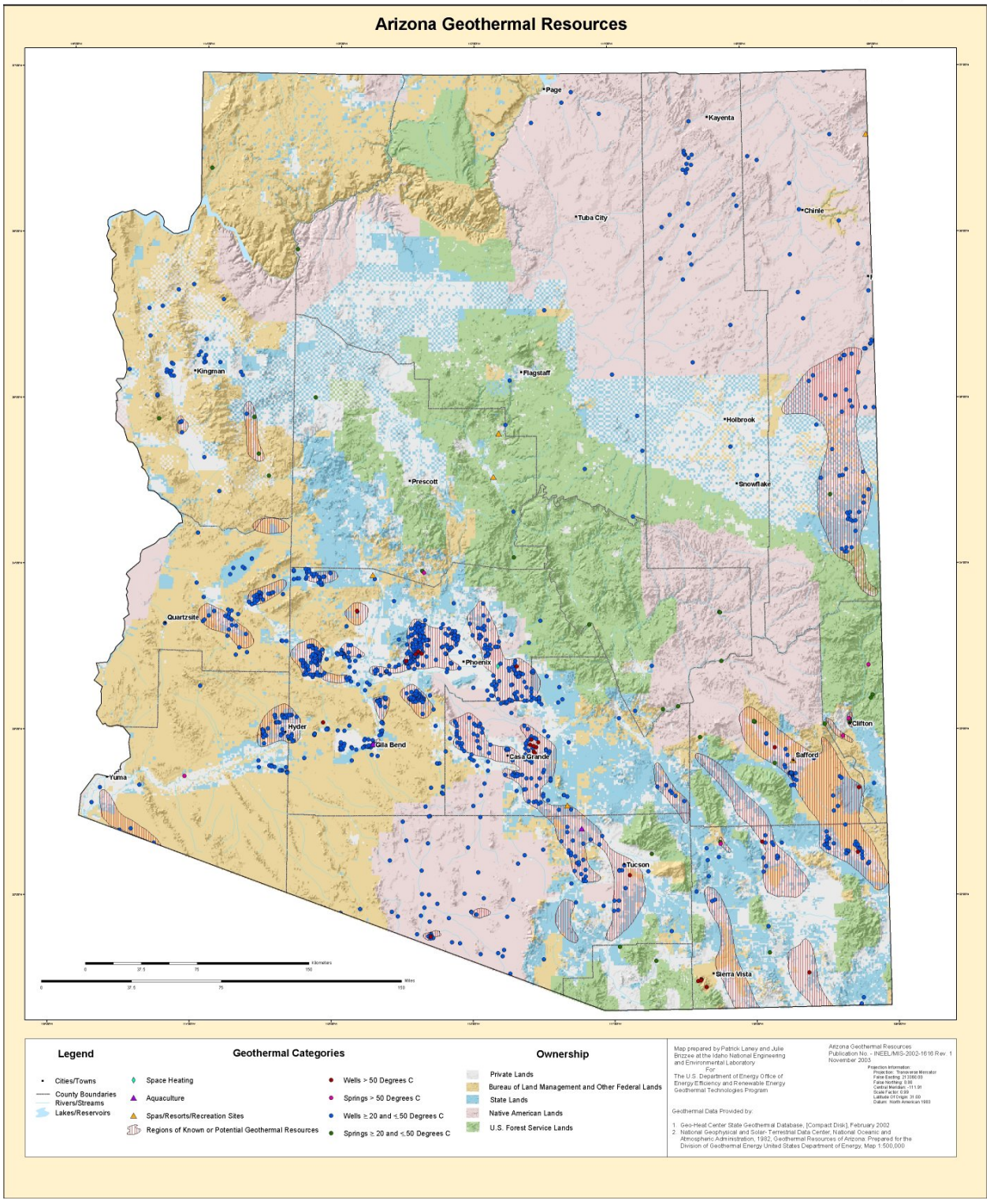
Table 1. Energy Production and Carbon Emissions Offsets by Geothermal Energy Utilization in the State of Arizona.

Site	Location	Application	Temp.	Annual Energy Use		Annual Emission Offsets** (metric tonnes)		
			(F)	(10^9 Btu/yr)	(10^6 kWh)	NO_x	SO_x	CO_2
Desert Sweet Biofuels	Gila Bend and Yuma	Algae	105	24.5	7.2	11	12	6,648
Desert Tilapia	Hyder Valley	Aquaculture	100	140.2	41.1	64	67	38,040
Safford, Misc. Aquaculture	Safford	Aquaculture	105	35.0	10.3	16	17	9,497
Willcox Greenhouses	Willcox	Space Heating	>135	35.0	10.3	16	17	9,507
Buckhorn Mineral Wells	Mesa	Resort/Space Heating	140	5.0	1.5	2.3	2.4	1,357
Castle Hot Springs	Near Wickenberg	Resort/Pool	131	2.5	0.7	1.1	1.2	678
Buckhorn Mineral Wells	Mesa	Resort/Pool	112	7.0	2.1	3.2	3.4	1,899
El Dorado	Tonopah	Resort/Pool	112	7.0	2.1	3.2	3.4	1,899
Kaiser Hot Springs	55 mi. SE of Kingman	Resort/Pool	99	7.0	2.1	3.2	3.4	1,899
Essence of Tranquility	near Safford	Resort/Pool	115	7.0	2.1	3.2	3.4	1,899
Kachina Mineral Springs	near Safford	Resort/Pool	108	7.0	2.1	3.2	3.4	1,899
Roper Lake State Park	near Safford	Resort/Pool	100	7.0	2.1	3.2	3.4	1,899
Potter's Aztec Baths	Clifton	Resort/Pool	150	7.0	2.1	3.2	3.4	1,899
Ringbolt Hot Springs	below Hoover Dam	Resort/Pool	110	7.0	2.1	3.2	3.4	1,899
Verde Hot Springs	20 mi. W of Strawberry	Resort/Pool	100	7.0	2.1	3.2	3.4	1,899
Totals				**305**	**89**	**139**	**147**	**82,821**

** Emission factors from Lund et al. (2010).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Geothermal Categories
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Regions of Known or Potential Geothermal Resources
Wells > 50 Degrees C
Springs > 50 Degrees C
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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
Map prepared by Patrick Laney and Julie Brizzee at the Idaho National Engineering and Environmental Laboratory
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Projection Information:
Projection: Transverse Mercator
False Easting: 31,500.00
False Northing: 0.00
Central Meridian: -111.91
Scale Factor: 0.99
Latitude Of Origin: 31.00
Datum: North American 1983
Geothermal Data Provided by:
1. Geo-Heat Center State Geothermal Database, [Compact Disk], February 2002
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