GEOTHERMAL GREENHOUSE DEVELOPMENT UPDATE

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INTRODUCTION

Greenhouse heating is one of the popular applications of low-to moderated-temperature geothermal resources. Using geothermal energy is both an economical and efficient way to heat greenhouses. Greenhouse heating systems can be designed to utilize low-temperature (>50°C or 122°F) resources, which makes the greenhouse an attractive application. These resources are widespread throughout the western states providing a significant potential for expansion of the geothermal greenhouse industry.

This article summarizes the development of geothermal heated greenhouses, which mainly began about the mid-1970's. Based on a survey (Lienau, 1988) conducted in 1988 and updated in 1997, there are 37 operators of commercial greenhouses. Table 1 is a listing of known commercial geothermal greenhouses, we estimate that there may be an additional 25% on which data is not available.

Table 1. Greenhouse Operations Using Geothermal Energy.

STATE	SITE	LOCATION	TYPE	AREA	RES. TEMP	CAPACITY	ANNUAL ENERGY
			CROPS	(acre)	(C)	(MWt)	(MWh/yr)
CA	Nakashima Nurseries	Coachella	roses	2.3	48	4.39	3838
CA	Tsuji Nurseries	Susanville	cut flowers	1.5	60	1.41	2696
CA	Lake County Ag Park	Lake Co.	potted plants	0.2	67	0.21	322
CA	Big Bend Preventorium	Big Bend	vegetables	0.1	82	0.09	176
CO	Old Wright Well	Mount Princeton	potted plants	0.5	71	0.47	2110
ID	Flint Greenhouses	Buhl	potted plants	3.3	44	2.67	5831
ID	Cal Flint Floral	Buhl	potted plants	1.8	71	2.20	4805
ID	M&L Greenhouses	Buhl	potted plants	1.7	44	2.17	4747
ID	Jack Ward Greenhouses	Garden Valley	potted plants	1.6	59	2.02	4424
ID	Warm Springs Greenhouses	Banks	potted plants	1.4	82	1.76	3838
ID	Edward's Greenhouses	Boise	veg. & flowers	1.2	47	1.44	3135
ID	Crook's Greenhouse	Caksia County	cut flowers	1	90	1.17	2637
ID	Hunt Brothers Floral	Boise	potted plants	0.7	47	0.88	1934
ID	Bliss Greenhouse	Bliss	potted plants	0.4	66	0.47	1084
ID	Donlay Ranch Hot Spring	Boise County	potted plants	0.3	54	0.35	938
ID	Green Canyon Hot Springs	Newdale	vegetables	0.2	48	0.23	615
ID	Express Farms	Marsing	vegetables	0.1	37	0.12	234
ID	Riggins Hot Springs	Idaho County	potted plants	0.1	45	0.12	234
ID	Weiser Hot Springs	Weiser	potted plants	0.1	70	0.09	205
MT	High Country Rose	Helena	roses	2	66	2.46	9698
MT	Bigfork Greenhouses	Bigfork	tomatoes	1	53	1.26	4952
MT	Hunter H. S. Greenhouse	Springdale	tomatoes	1	60	1.20	3194
NM	Burgett Wholesale	Animas	cut roses	32	118	32.82	61236
NM	Masson Radium Spgs. Farm	Radium Springs	cut flowers	13	71	13.27	34867
NM	SWTDI (NMSU)	Las Cruces	variety	0.3	64	0.15	527
NM	J.&K. Growers, Inc.	Las Cruces	mixed	3	64	3.08	8087
OR	The Greenhouse	Lakeview	veg. & potted	1.2	104	1.38	3633
OR	Liskey Greenhouses	Klamath County	potted plants	1.5	93	1.73	4541
OR	Cove Hot Spring	Union County	tree seedlings	0.2	42	0.21	410
OR	Jackson Greenhouses	Ashland	potted plants	0.1	44	0.09	146
SD	Lake Wagner Greenhouse	Philip	veg. & flowers	1	68	1.14	2989
UT	Utah Natural Growers	Newcastle	vegetables	2.5	95	2.87	6036
UT	Milgro Nursery, Inc.	Newcastle	potted plants	13.5	89	11.02	24114
UT	Milgro No. 2	Newcastle	potted plants	2	95	2.29	6006
UT	Utah Roses	Bluffdale	roses	3	88	3.05	6680
UT	Christianson Bros.	Newcastle	vegetables	2.8	95	3.52	8790
WY	Countryman Well	Near Lander	potted plants	0.2	37	0.23	615
Total				98.8		103.98	230325

GROWTH AND POTENTIAL

Between the early 1970s and through the 1980s, geothermal greenhouse sites and energy use approximately doubled every five years. Although not many of these were direct recipients of federal assistance, almost all indirectly benefitted through location and confirmation of resources by programs such as the recently completed "Low-Temperature Resource Assessment Program" (Lienau, 1996) and technical assistance programs. As fuel prices leveled, the growth slowed to only a 6% annual increase between 1985 and 1990. Since 1990, an annual increase of about 10% was due mainly to several new and expanding large projects in Utah and New Mexico.

DEVELOPMENTS

Brief descriptions are given of the leading geothermal greenhouse operations listed in Table 1.

California

In California, there are four known geothermal greenhouse operations. Nakashima Nursery is located on a 16 ha (40 acre) site in the Imperial Valley, just north of the Salton Sea. A 305 m (1,000 ft) artesian well supplies 1514 L/min (400 gpm) of 48°C (118°F) geothermal fluid to a 21-unit, 9290 m^2 (100,000 ft^2) greenhouse, which supplies cut flowers to the Los Angeles market. Tsuji Nursery, located in Susanville, produces carnations and roses for the cut flower market. At Big Bend a small greenhouse is used to raise vegetables and is heated by a natural spring also used to supply mineral tubs and pools. Lake County Ag Park was developed by the county and the initial greenhouse 650 m^2 (7,000 ft^2) was constructed by Mendocino Community College as a teaching facility. The county hopes to encourage commercial growers to locate in the park, selling them energy and leasing space.

Idaho

In Idaho, there are 14 known geothermal greenhouse operations. Three separate greenhouse facilities are located near Buhl on the Snake River in southern Idaho. M&L Greenhouses ships to local nurseries and florists over 130 varieties of bedding and potted plants. Two wells supply 44°C (112°F) water to 6968 m^2> (75,000 ft^2) of space heated by a forced air system. Cal Flint Greenhouses raise potted blooming plants such as poinsettia, lilies, and chrysanthemums. This greenhouse complex also uses a forced air system to heat 7072 m^2 (76,125 ft^2) with 44°C (112°F) water. Flint Greenhouses use 44°C (112°F) water to heat 8634 m^2 (93,000 ft^2), with a forced air system, but the air is blown through polyethylene tubes under the growing tables. Potted blooming plants, including 29 varieties of chrysanthemums, are raised (Street, 1985).

At Garden Valley, a thermal spring, one mile from the greenhouses, are used to heat 6503 m^2 (70,000 ft^2) with PVC pipes buried in the ground and at Banks, 5597 m^2 (60,250 ft^2) are also heated from hot springs. After the water is used in the greenhouse, it heats two homes. Edward's greenhouses are the oldest commercial greenhouses in the state to heat with geothermal, approximately 1858 m^2 (20,000 ft^2) are under glass and 2787 m^2 (30,000 ft^2) use polyethylene covering (Street, 1985).

Montana

High Country Roses in Helena grows 40 to 50 thousand rose bushes in 0.8 ha (2.0 acres) of greenhouses. The greenhouse is maintained at 22°C (72°F) with 89 km (55 miles) of small diameter tubing supplying geothermal heat from a 66°C (151°F) thermal spring. Montana Rose & Floral (1.2 acres) near Ennis, recently closed down their operation.

Hunter's Hot Springs greenhouse near Springdale grows tomatoes for local markets. The hot springs has a total flow of 5000 L/min (1320 gpm) at 60°C (140°F). Bigfork Greenhouses, near Flathead Lake grow tomatoes in a one-acre greenhouse utilizing a 53°C (128°F) hot spring that produces 4542 L/min (1200 gpm). They are expanding the operation by adding two greenhouses per year.

New Mexico

The largest single greenhouse operation in the U.S. is at Animas, Burgett Wholesale, in southwestern New Mexico. The 13 ha (32 acres) is used for growing cut roses. Animas is near the Lightning Dock KGRA, with a resource temperature of up to 118°C (245°F), and is located at 1402 m (4,600 ft) elevation. The Beall and McCant operations, in the area, have converted to aquaculture.

The Southwest Technology Development Institute (SWTDI), at New Mexico State University, Las Cruces, operates a 1115 m^2 (12,000 ft^2) greenhouse incubator facility. This facility has been under continuous lease to commercial growers since 1986. The geothermal greenhouse research and incubator facility features innovative heating and cooling systems, fully computerized environmental controls, and state-of-the-art film cover materials. The geothermal resource temperature is 64°C (148°F) and is supplied from a 305 m (1,000 ft) well adjacent to the facility (Whittier, 1990). Technical assistance related to geothermal energy use in greenhouses is available to lessees and to commercial greenhouse operators statewide through the SWTDI staff.

Oregon

In Oregon four greenhouse operators use geothermal energy. The Greenhouse, located at Lakeview, grows vegetables and potted plants in a 0.5 ha (1.2 acre) facility. Fan coils, finned tube radiators, soil warming pipes and a snow melt system are used at the site which is supplied by a 1658 m (5440 ft) oil & gas exploratory well that produces 116°C (240°F) geothermal fluid. In Klamath County, Liskey Greenhouses grow hanging and potted plants for the local market. Thirty-two raceways use geothermal effluent from the greenhouse for raising tropical fish.

South Dakota

An artesian well, about 2.4 km (1.5 mi) north of Philip at Lake Wagner is used to provide space heating to a 0.4 ha (1.0 acre) greenhouse. The well, 68°C (154°F), has a shut-in pressure of about 6.9 bar (100 psi) and is also used as the domestic water supply for Philip.

Utah

At Newcastle in southwestern Utah, there are three greenhouse operators with a total of 8.6 ha (21.3 acres) of greenhouses. In July 1993, Milgro Nurseries, Inc. began construction of a 1.9 ha (4.6 acre) new facility to grow poinsettias, potted chrysanthemums, Easter lilies and geraniums. Today, the facility has expanded to 5.5 ha (13.5 acres) and utilizes about 290 km (180 miles) of bare half inch tubing for the heating system. The geothermal well produces about 6057 L/min (1600 gpm) of 89°C (192°F) water delivered to two plate heat exchangers. A second well was drilled this past year. The geothermal fluid is disposed of by means of an injection well, that has to be back-flowed once a week because of sediments in the well. Milgro also purchased about 0.8 ha (2 acres) of previously existing greenhouse near the new facility. Utah Natural Growers 1.0 ha (2.5 acres) and Christianson Brothers 1.1 ha (2.8 acres) grow vegetables in the same area.

Utah Roses, at Bluffdale, utilizes a 88°C (190°F) geothermal well to heat three acres of greenhouses with disposal to an injection well. This project was a USDOE PON project of the early 1980s.

CONCLUSIONS

The utilization of geothermal energy for greenhouses is attractive because of the significant heat requirements for these facilities and thus, a large operating cost savings in conventional fuel. The growth rate of the geothermal greenhouse industry has increased in the 1990s due to increases in fuel costs, especially propane, and in some cases high land costs and development regulations where their previous facilities were located. Competition with foreign flower growers is often cited as an impediment to new developments in the U.S. The potential of new greenhouse developments in the western states is very large. A recent resource assessment (Lienau, 1996) for 10 states identified 1,900 thermal wells and springs with temperatures greater than or equal to 50°C (122°F), 1,469 were located within 8 km (5 mi) of a community.

REFERENCES

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