Presented at *Short Course VIII on Exploration for Geothermal Resources*,
organized by UNU-GTP, GDC and KenGen, at Lake Bogoria and Lake Naivasha, Kenya, Oct. 31 – Nov. 22, 2013.

DIRECT USE OF GEOTHERMAL ENERGY IN USA

Jack Kiruja
Geothermal Development Company
P.O. BOX 100746-00101, Nairobi
KENYA
jkiruja@gdc.co.ke

ABSTRACT

The state of Oregon, which is home to the Oregon Institute of Technology and the Geo-Heat Centre, is endowed with a geothermal resource which is mostly low-medium enthalpy. This resource is suitable mostly for direct use applications. Most of the direct uses in the USA are small scale. The applications highlighted in this paper are beer brewing, greenhouse heating, laundry, fish farming and onion dehydration. All the direct use applications covered in this paper are in Oregon apart from the Onion dehydration plant which is in Nevada.

1. INTRODUCTION

The United States has a large potential for geothermal energy spread across the country and especially in the mountainous western side of the country. USA is the largest producer of geothermal electricity with an installed capacity of 3,093 MWe and the second largest in direct uses at 12,612 MWt and 15,710GWh/yr, excluding geothermal heat pumps (IGA, 2010).

The most common direct uses of geothermal energy in the US are heating of individual houses, district heating, air conditioning, greenhouse heating, fish farming, industrial processing, agricultural drying, snow melting and swimming and bathing.

1.1 Oregon

The state of Oregon is located on the North Western part of the United States. The main direct use areas are Klamath Falls, Liskeys ranch, Oregon Institute of Technology and Lakeview which are located in southern Oregon as shown in Figure 1.

FIGURE 1: Map of the USA showing Oregon

2. HEATING OF BUILDINGS

2.1 Oregon Institute of Technology

The Oregon Institute of Technology (OIT) is constructed in an area known to have a geothermal reservoir underneath. The campus is 100% heated using geothermal energy and this has resulted in huge savings associated with heating cost. Within the campus is a 250kW binary power plant which utilises hot water at 85°C to provide some of the electric power needs of the campus.

2.2 The City of Klamath Falls.

The city of Klamath Falls has a population of about 20,000 (Klamath Falls demographics, 2012). The city has two geothermal wells with temperatures of 102°C and 108°C.

The geothermal water is pumped through a 1300m steel pipeline to the heat exchange building where it exchanges heat with city water as shown in Figure 2. The heated city water in a closed loop at 82°C is circulated in downtown Klamath while the geothermal water is injected back to the ground just outside the heat exchange building.

FIGURE 2: Klamath Falls heat exchange building. Some of the clients of the hot city water are 24 commercial and government buildings, greenhouses, sidewalk snow melt and a beer brewing company (Chiasson, 2006)

3. BREWERY

A brewery in downtown Klamath Falls utilises the heat in the city water to brew beer, melt snow on its sidewalks and heat the building which houses the brewery and a restaurant. City hot water at 82°C, exchanges heat with water in the brewery loop. The conversion of starch in malt to sugar takes place at 68°C in a process called mashing while lautering process, which marks the end of mashing takes place at 78°C. Figure 3 below shows some of the equipment used in geothermal brewing of beer. Use of geothermal energy by the brewery and the restaurant results in a 46% saving, on the price of gas, which would have been used to meet the energy requirements for heating and brewing.

FIGURE 3: Beer brewing equipment

4. GREENHOUSE HEATING

4.1 Tree Nursery heating

A tree nursery housed in a greenhouse in Klamath Falls uses heat from the city water to heat the greenhouse during the cold season. The tree seedlings are raised for up to 9 months and then sold for reforestation purposes. The tree nursery has its loop of water which exchanges heat with the city water. In addition, they also have a backup gas fired furnace which supplies the hot water when the city hot water supply system is not adequate. The heated water is used to heat air which is then circulated in the greenhouses to raise temperature. Figure 4 shows the seedlings inside the greenhouse.

FIGURE 4: Tree nursery greenhouse in Klamath Falls

4.2 Spider Mites Farming

Liskey's greenhouses are used to grow Lima beans and spider mites for their eggs. The leaves of the lima beans are rich in chlorophyll which provides food for the spider mites as shown in Figure 5. The spider mite eggs are harvested and then sold as food for predator mites which are used for biological control of bugs in crops. The greenhouses are heated using hot water from geothermal wells at a temperature of 88°C-93°C and a flow rate of 25.3litres/s. The hot water is carried in finned tubes inside the greenhouse to provide a temperature of 32°C through radiant heating.

FIGURE 5: Spider mite farming at Liskey's Ranch

5. AQUACULTURE

5.1 Gone Fishing

This farm rears tilapia and tropical fish from Lake Malawi in Southern Africa. The water in the ponds is of geothermal origin and considered suitable for fish farming as shown in Figure 6. It is introduced into the ponds at about 90°C but after mixing with the cooler water in the pond, its temperature drops quickly to 28°C ±2°C. However, this requires varying the flow rate from 3.15-18.9 Litre/s depending on the ambient temperature.

FIGURE 6: Geothermally heated fish ponds

5.2 Canby Tilapia Farm

The fish are grown in concrete fish ponds measuring 15 m in diameter and 2.5 m in depth as shown in Figure 7. This fish farm is the largest in the western side of the USA. The temperature of the water is kept at 29°C throughout the year by mixing water from a hot spring with cold water from a manmade lake. About 9100 kg of fish are harvested every week and transported to China Town in San Francisco where they are sold while they are still alive.

FIGURE 7: Tilapia farming tanks

6. ONION DEHYDRATION

FIGURE 8: Onion dehydration plant

An onion dehydration plant at Fernley, Nevada uses hot geothermal water from a nearby binary geothermal power plant to dehydrate onions, clean the onions, clean the processing equipment and heat the building and equipment to prevent freezing. Hot water at 140°C enters the dehydrators and hot air used in three stages to dehydrate the onions i.e. 120°C, 100°C and 70°C. Some of the water is then cooled to 110°C and used for cleaning equipment while the rest is discharged to a ditch and allowed to percolate into the ground. 6800 kg/hour of onions processed daily during the months of operation i.e. from May to December. Figure 8 shows the onion dehydration plant.

7. CANBY COMMUNITY PROJECT

A Christian community living in Canby owns geothermal wells that supply hot water for heating their buildings during the cold seasons, heating greenhouses for vegetable production and heating ponds for fish farming.

7.1 Aquaponics

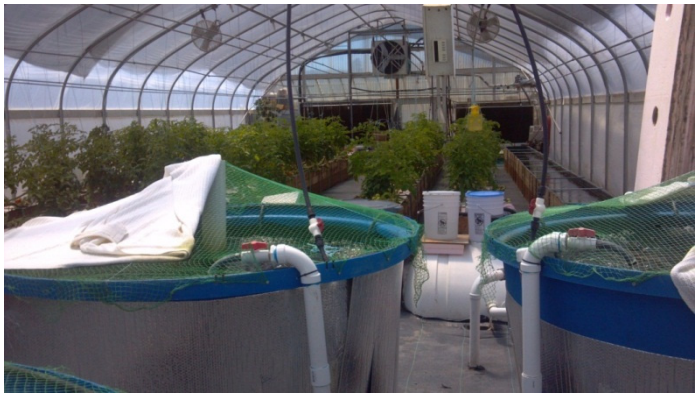

FIGURE 9: Canby Aquaponics Project

Aquaponics, a system of growing plants without using soil or fertilizer for the plants is employed. The spent water from the fish tanks, which is rich in ammonium, is filters and bacteria allowed to act on it so that ammonium is converted to nitrates, which in turn becomes food for the plants. The plants consume the nitrates and the resulting "clean water" is returned back to the fish ponds. Figure 9 shows the aquaponics

project inside a greenhouse.

7.2 Geothermal Laundry

The Canby community members have a common laundry where all the clothes for the members are washed using geothermally heated water as shown in Figure 9. Drying of the clothes is also done using geothermal energy. It is estimated that the community made up of 170 members saves about $16200/year from the use of geothermal in laundry as opposed to the use of propane.

FIGURE 9: Geothermal laundry

8. CONCLUSION

Though the United States has large energy consumption in terms of direct use of geothermal energy, the growth has been very slow due to limited funding. This is mainly because the Department of Energy is more interested in electricity generation. However, the persons who have direct use applications installed have nothing but praise for the technology especially due to the energy saving.

REFERENCES AND RECCOMMENDED READING MATERIAL

Chiasson A., 2006: *From creamery to brewery with geothermal energy: Klamath Basin Brewing Company.* Geo-Heat Centre, Oregon Institute of Technology, Klamath Falls, Oregon.

GHC Bulletin, 2003: *Gone fishing" aquaculture project Klamath Falls, Oregon.* Geo-Heat Center, Oregon Institute of Technology.

IGA, 2010: *Direct use*. International Geothermal Association. Website: www.geothermal-energy.ord/246.

Klamath County Department of Tourism & Visitors Center, 2012: *Demographics and relocation - Klamath Falls*, Oregon. Website: http://www.oregoncitylink.com/klamathfalls/demographics.html

Lund J. W. and Boyd T., 2007: *Chill out - Oregon Institute of Technology is a winner*. Geo-Heat Center, Oregon Institute of Technology

Riley L, 2006: *Inside the greenhouse; geothermal energy and spider mite production.* Oregon Institute of Technology, Klamath Falls, Oregon.