

GEOHERMAL HEAT PUMP CASE STUDIES OF THE WEST

Geothermal (ground-source) heat pumps (GHPs) have become a major growth area of geothermal energy use in the United States, Canada and Europe. Within the United States; however, according to geothermal heat pump shipment tracking by the Energy Information Administration (EIA), the west only represents 9% of the total GHP shipments. Thus, this issue of the Geo-Heat Center *Quarterly Bulletin* is devoted to seven examples of GHPs in the western regions of Canada and the United States. Two are open-loop (groundwater) types and five are closed-loop (ground-coupled) types. We have attempted to include operating and maintenance experiences along with the associated costs.

The number of GHPs has steadily increased over the past 10 years with an estimated 600,000 to 800,000 equivalent 12 kW (3.4 ton) units installed in the United States and 36,000 in Canada. They have been reported installed in all the states in the U.S. and all the provinces in Canada. We estimated that 60,000 units were installed in the U.S. and over 3,000 in Canada this past year. The U.S. units are mainly found in the Midwestern and Eastern states, and the Canadian units in Ontario and Manitoba with considerable growth in British Columbia. Of the installed units, we estimate that 44% are vertical closed-loop, 36% are horizontal closed-loop and 20% are open-loop systems. Interest in open-loop systems appears to be increasing, accounting for 25% of the units shipped from manufacturers this past year.

Using an average unit size of 12 kW (3.4 tons), the installed capacity in the U.S. is between 7,200 and 9,600 MWt, and based on approximately 1,200 full-load equivalent operating hours per year and a coefficient of performance (COP) of 3.5, the annual energy removed from the ground is between 6,171 and 8,228 GWh (21,060 and 28,080 billion Btu). The corresponding figures for Canada are 396 MWt and 600 GWh/yr (2,048 billion Btu). World-wide, 33 countries report the use of GHPs (from the World Geothermal Congress 2005). It is estimated that there are 1.7 million units installed world-wide, accounting for an installed capacity of 15,384 MWt and annual energy use of 24,300 GWh (82,960 billion Btu). In the United States,

most systems are designed for the cooling load, whereas in Europe they are designed to provide base-load heating, and average an equivalent 2,200 full-load operating hours annually. Cooling load cannot be considered geothermal, as heat is rejected to the ground or ground-water; however, cooling has a role in the substitution for fossil fuels and reduction of greenhouse gas emissions.

As reported in our March 2001 (Vol. 22, No. 1) issue of the *Quarterly Bulletin*, President George W. Bush installed a geothermal heat pump on his Texas ranch. The unit is 49 kW (14 tons) broken into five separate systems with desuperheater. The vertical closed loop installation cuts his heating and cooling cost by 40%. On the other side of the Atlantic, the *Sunday Times* of London (August 21, 2005 by Lois Rogers), reports that the Queen of England is planning to install a GHP for heating and to cut energy bills at Buckingham Palace. A closed-loop system placed below the surface of a four-acre (1.6 ha) lake will provide heating to state rooms and the formal area of the palace. The heat will be provided through either radiators, or by venting hot air through underfloor heating. The system will cost approximately £50,000 (US\$90,000) to install the outdoor equipment, and several hundred thousands additional Pounds (£) to make the system compatible with the existing palace heating system. This is estimated to reduce the heating and electricity bills by at least 70%. A trial system was installed in 2002 by drilling 400 feet into the chalk aquifer beneath the palace ground to run an air-conditioning system for a new art gallery, built at Buckingham Palace to mark the golden jubilee for the Queen. The results were impressive and led to the current project that will replace conventional heating sources for part of the palace.

Other famous persons from the United Kingdom who have installed GHPs are Sir Elton John, the pop star, Sir Richard Branson, the entrepreneur, Paul Allen, the billionaire co-founder of Microsoft, George Davies, the high street fashion guru, and Paul Lister, son of the found of the MFI furniture empire and owner of a vast Highlands nature reserve.

The Editor