The ground source heat pump at Geoscience Australia

Alison L. Kirkby

Alison L. Kirkby

Geoscience Australia, Canberra, ACT, Australia
Email: Alison.Kirkby@ga.gov.au

Introduction

Ground source heat pumps (GSHP) are one of the fastest growing applications of renewable energy in the world, with increases in installed capacity of over 10% per annum between 1995 and 2005 (Rybach, 2005). GSHP systems are widespread overseas, particularly in the USA and Europe, with a total installed capacity of 7.2 GWth (47% of world total) in the USA, and 3.84 GWth (25%) in Sweden. In comparison, Australia lags behind with a total installed capacity of 5.5 MWth, (0.036% of the world total) (Rybach, 2005).

GSHP systems utilise the stable nature of the earth's temperature at depth to provide cooling during the hot summer months and heating in the colder winter. They do not need elevated ground temperatures to operate, rather the constant ground temperature acts as a heat sink, or source, to augment the air conditioning system. GSHPs circulate a working fluid, usually water, through the ground and then through the building to distribute or absorb heat. They can be open or closed loop with a range of possible loop configurations (Figure 1). The loops are buried anywhere from several metres to over 100 m in the ground.

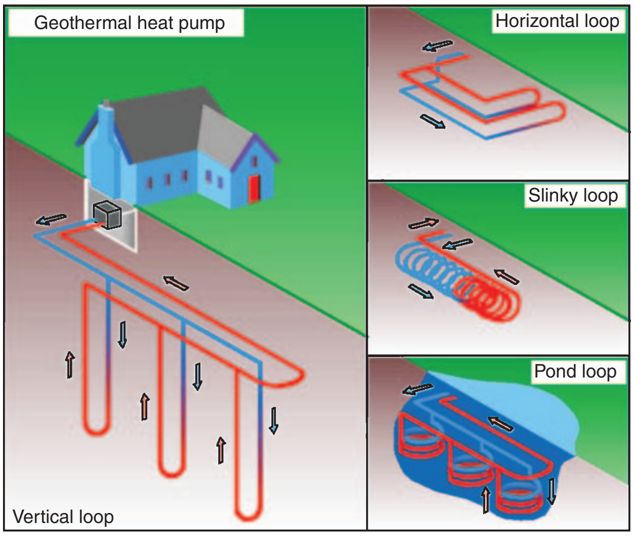

Fig. 1. *Examples of loop configurations that can be used for ground source heat pump systems.*

GSHP systems use electricity to circulate, not generate, heat, so they can provide considerable electricity savings over the life of a building. GSHPs are ideally suited to climates where extremes in both high and low temperatures are experienced. In this way, the systems are sustainable because the GSHP causes minimal net annual change in ground temperature – the ground is cooled by the GSHP due to the cool air temperature in winter and heated in summer. However, systems do exist where there is an imbalance between heating and cooling demand (e.g., open loop systems installed in the London Chalk aquifer (Etheridge, 2010)).

The Geoscience Australia ground source heat pump system

The Geoscience Australia (GA) building located in Symonston, ACT, accommodating 700 staff, utilises one of the largest GSHP systems in the southern hemisphere (Dickinson *et al*., 2007; Figure 2). The system was installed in 1997 when the Geoscience Australia building was constructed (Dickinson *et al*., 2007), and has an installed capacity of 2.5 MWth.

In the Canberra region, the ground temperature at about 100 m depth is fairly constant throughout the year at 17°C. This is a valuable resource considering the large range in surface air temperatures experienced in Canberra with lows well below 0°C and maximum temperatures in excess of 35°C (Figure 3). The constant ground temperature is used as a source of heating or cooling depending on the seasonal requirements of the building.

Fig. 2. *View from underneath the Geoscience Australia building showing pipes circulating water between the pump room and the underground bore field.*

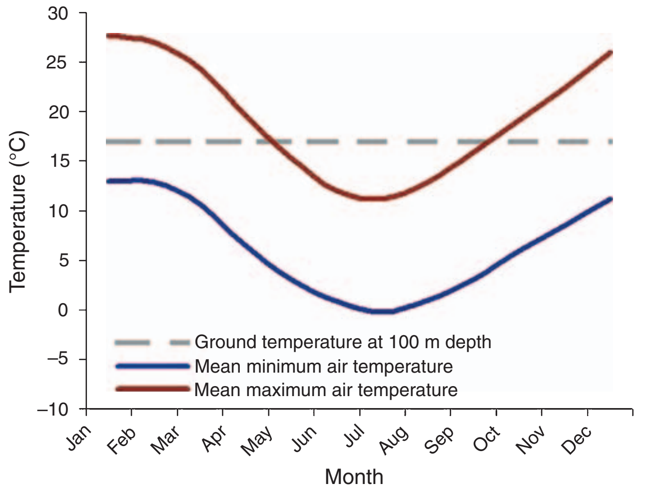

Fig. 3. *Seasonal air temperature variations in Canberra compared to ground temperature at 100 m depth (climate data courtesy of http://www.worldweather.org/185/c00302.htm).*

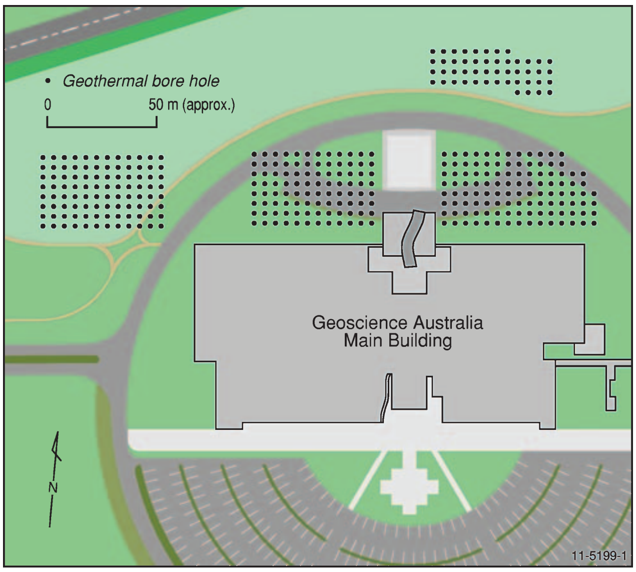

Fig. 4. *Distribution of boreholes associated with the ground source heat pump system at Geoscience Australia.*

The GSHP system at GA is a closed loop system consisting of three components: an underground bore field, which comprises 352 bore holes grouped into four fields located in front of the GA building (Figure 4). Each borehole is 20 cm in diameter, and contains a loop of 80 mm poly pipe through which water is circulated. The water is heated by up to 3°C in winter and cooled by up to 3°C in summer. The water is then aggregated to control and pump room. Here, if necessary, the fluid is further heated or cooled to bring its temperature to about 22°C. The fluid is then distributed via pumps to 210 individual heat exchangers located throughout the general office area of the building. The heat exchangers work in a similar way to conventional split system air conditioning units, with heat being transferred between the water and the air via a refrigerant.

The temperature of the returning fluid is measured in the control room before being sent out through the bore field. In spring and autumn when outside temperatures are mild, it is sometimes more efficient to bypass the ground loop. If this is the case the control centre will automatically recirculate the fluid through the building.

System performance

The GA system is one of the longest operating of its type in Australia, providing an opportunity to examine the long term performance of a GSHP system. A 10-year building review conducted in 2007 (Dickinson *et al.*, 2007) estimated that the system had saved a total of about $400 000 in electricity costs. Energy performance comparisons made with the 2007–2008 ‘Energy Use in the Australian Government Operations’ reports show that the GA building has maintained energy performance close to targets set for general office administration buildings. This is significant given the requirements to provide separate air conditioning to laboratories and special storage areas. The energy savings can be attributed to the GSHP system and other energy efficient design principles used in the building.

Conclusion

The uptake of ground source heat pump systems in Australia has been limited to date, especially when compared to the USA and Europe. The Geoscience Australia building is an example of a large scale GSHP system that can provide significant savings in both heating and cooling costs and CO_2 emissions.

References

Dickinson, P., Read, S., Deer, L., and Petersons, S., 2007, Geoscience Australia Building, Canberra, Geothermal Air Conditioning: 10 Year Review: Geoscience Australia unpublished report available from http://www.ga.gov.au/image_cache/GA10493.pdf.

Etheridge, Z., 2010, Aquifers as heat sinks: The UK Experience: *National Groundwater Conference Abstract*, 31 October – 4 November 2010, Canberra, Australia.

Rybach, L., 2005, The advance of geothermal heat pumps world-wide: *IEA Heat Pump Centre Newsletter*, 23/4, 13–18.