ENVIRONMENTAL BUILDING SERVICES

Earth's Energy

Writer Liz Light

It's abundant, renewable, available everywhere 24/7 and involves well-established above-ground technology. Yet New Zealand is lagging behind the rest of the developed world in embracing geothermal energy for space heating and cooling.

"We are not referring to the geothermal energy associated with volcanism or tectonic hot spots," Brian Carey, Chairman of the Geothermal Heat Pump Association of New Zealand (GHANZ), says. Members of GHANZ include geothermal heat pump suppliers, installers and designers, government agencies and other interested organisations.

"We are blessed with plenty of this, particularly in the central North Island and we utilise it well. It's not this type of geothermal energy that is being considered here but the low temperature geothermal energy stored in the earth, in soil, rocks, surface water and ground water, which is readily available everywhere. This low temperature ground energy can be harnessed for heating and cooling purposes using geothermal heat pumps. In other parts of the world these devices are also known as ground-source heat pumps or geo-exchange systems.

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"Geothermal heat pumps move heat energy from the ground, using a heat pump to raise the temperature and deliver the energy for use in a building. This differs from the familiar air-sourced heat pumps that are popular in New Zealand, which move heat energy from the air outside a building to air inside it. The effectiveness of geothermal heat pump technology comes from taking the energy from earth or water, which has much less temperature variation in comparison to the extreme seasonal and daily temperature fluctuations that ambient air can have. With good design this results in better energy transfer efficiency."

Typically, geothermal heat pumps use one unit of electricity to move about four units of heat energy, whereas, on average, air-source heat pumps move less than 70 per cent of that. Geothermal heat pumps are quiet and unobtrusive. The energy collection system is underground or under water and the heat pump can be in a plant room or a garage. The energy delivery in a building often occurs using circulating water in loops in the floor slab.

"The downside to geothermal heat pumps is that they are more expensive to install than air-sourced heat pumps. But commercial systems, with high usage factors, can achieve payback in under five years. In general, with lower usage, the payback period is longer. But the in-ground energy collection system has a long life; they are guaranteed for 50 years in many European countries."

Mr Carey explains there are three parts to geothermal heat pumps - the building distribution system, which includes space heating or cooling using either forced air or water circulated through radiators or under floor pipes, the heat pump mechanism and the ground loop.

The heat pump mechanism uses a circulating refrigerant with two heat exchangers, one exchanger to gain heat and the other to lose it. The temperature of the refrigerant is increased by vapour compression which delivers the energy to the distribution system at a higher temperature.

There are numerous options in the design of ground loops, which are used to collect (or dispose of) heat.

"If the building site doesn't have access to a lake or a river the ground loop will be imbedded in the earth near the building. This will require a closed loop system which operates by circulating fluid (either water or an antifreeze mixture) through a pipe network. The fluid flows in a continuous loop, collecting or discharging heat as it circulates with heat transferred through the pipe walls.

"The pipes can be installed horizontally, laid in unshaded ground in a grid pattern at a depth of about 1.5 metres. A slinky looped arrangement can also be employed if the space available is more restricted. If open space is not available, such as in built-up areas, the ground loop can be installed vertically into boreholes.

Above: Groundworks for a straight, horizontal closed loop for a goethermal heating installation. Photo: Central Heating NZ Ltd.

Below: Pipe arrangement in a slinky ground loop. Photo: Central Heating NZ Ltd.

"In an industrial setting, the pipe loops can be built into concrete pile reinforcing cages or into the walls of tunnels. In Europe, pipe loops are being installed in large infrastructure slabs, such as floor slabs of train stations.

"Once the pipes are in the ground, either vertically or horizontally, and the system is commissioned, they require little maintenance," Mr Carey says.

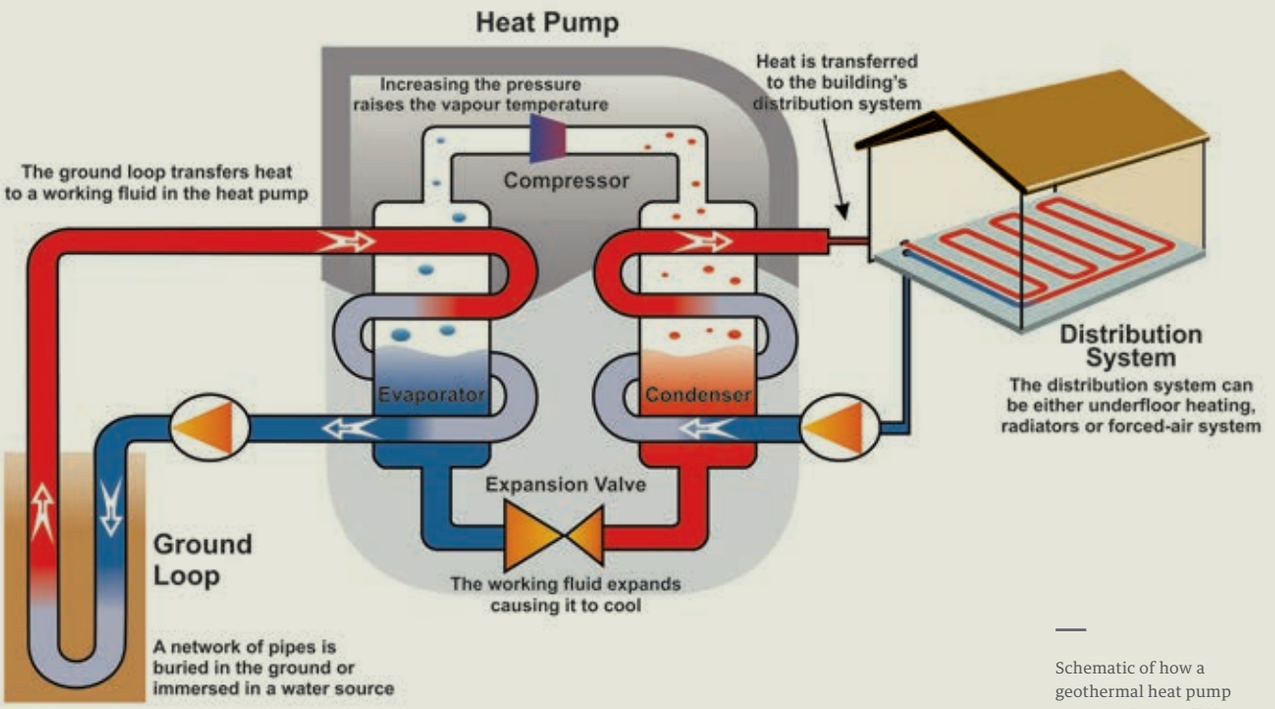
"If a building has access to a lake, river or groundwater, the water can be used as the medium from which heat is taken or received. If, however, the water body is of a sufficient size, a closed loop system can be installed within the water body. Alternatively, water can be taken and used directly as the energy source and discharged. This is known as an open loop system and resource consents will be required for such installations."

Mr Carey says although they are common in northern hemisphere countries geothermal heat pumps are not widely used in the southern hemisphere. "There are, as yet, only a couple of hundred installations in New Zealand. At Melbourne University, under the leadership of Dr Ian Johnston, there is a programme looking at the sizing of ground loops in the Australian context. Auckland has a similar climate to Melbourne so this research will be useful."

Although not particularly common in New Zealand, Mr Carey cites three installations undertaken recently.

The first involved a home renovation in Christchurch. A 50-year-old home was renovated, doubling its size. The existing diesel powered hot water radiator system was retrofitted with an open loop geothermal heat pump. Well water is passed through the heat pump and energy extracted to supply domestic hot water and water for the radiator heating system. The electrical cost to run the heat pump is the same as the diesel cost to heat just two rooms, and the domestic hot water is a bonus.

The next one was for a 400-square-metre house in Kapiti, with underfloor heating and a large heated indoor swimming pool. "There was space alongside the house so the owners chose a horizontal, closed loop, geothermal heat pump," Mr Carey says. Seven trenches



Schematic of how a geothermal heat pump operates. Image: GNS Science.

were dug (25 metres long, one metre wide and two metres deep) and the coils were placed inside. The filled trenches are part of the garden and thanks to the geothermal heat pump the owners have a warm house and a luxurious pool without a big energy bill."

The third example is of a 280-square-metre Queenstown home with hot water and home heating using a vertical closed loop system. Mr Carey says two 120-metre-deep bore holes have a closed loop pipe system, accessing the energy from the earth. "There is no visual impact, low running costs, minimal noise and the house is kept cosy."

Mr Carey hopes that in a decade or so, geothermal heat pumps will be well-established, with New Zealand reaping benefits from renewable geothermal energy use. "We consider ourselves having a temperate climate, so New Zealand hasn't embraced this technology. This is changing. And, overall, architects, engineers and designers have limited experience with geothermal heat pumps. This, too, is changing and the formation of GHANZ, in 2012, is seeking to assist."

Want to know more?

For more in-depth reading on the technology, see the paper "The Rise and Rise of Geothermal Heat Pumps in New Zealand". Other learned and technical papers are also available in *IPENZ Transactions*.

www.ipenz.org.nz/transactions