GEOTHERMAL ENERGY: SHALLOW SOURCES

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EXTENDED ABSTRACT

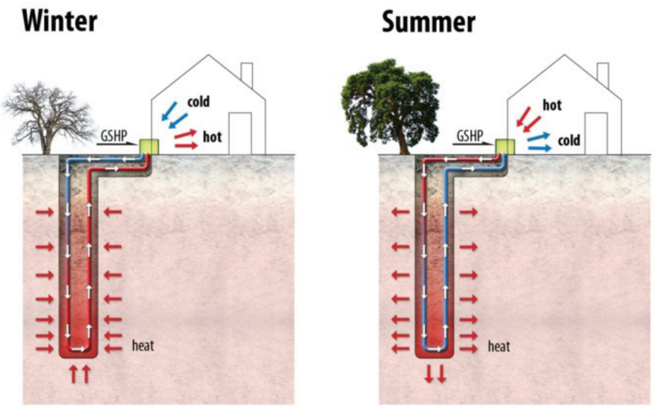
Below a depth of around 5 to 8 metres below the surface, the ground displays a temperature which is effectively constant and a degree or two above the weighted mean annual air temperature at that particular location. In Melbourne, the ground temperature at this depth is around 18°C with temperatures at shallower depths varying according the season. Further north, these constant temperatures increase a little; while for more southern latitudes, the temperatures are a few degrees cooler.

Shallow source geothermal energy (also referred to as direct geothermal energy, ground energy using ground source heat pumps and geoexchange) uses the ground and its temperatures to depths of a few tens of metres as a heat source in winter and a heat sink in summer for heating and cooling buildings. Fluid (usually water) is circulated through a ground heat exchanger (or GHE, which comprises pipes built into building foundations, or in specifically drilled boreholes or trenches), and back to the surface. In heating mode, heat contained in the circulating fluid is extracted by a ground source heat pump (GSHP) and used to heat the building. The cooled fluid is reinjected into the ground loops to heat up again to complete the cycle. In cooling mode, the system is reversed with heat taken out of the building transferred to the fluid which is injected underground to dump the extra heat to the ground. The cooled fluid then returns to the heat pump to receive more heat from the building. Figure 1 shows a schematic view of a reversible system in which the ground loops of the GHE are installed in a borehole and are connected to the structure's heating and cooling distribution system via a GSHP. Note that these drawings are not to scale and the borehole would only be around 75 to 150 mm in diameter.

According to the CSIRO, energy use in buildings accounts for 26% of Australia's greenhouse gas emissions, and heating and cooling accounts for over half of this. Introduction of direct geothermal heating and cooling to Australia on even a moderate scale would have a significant impact on power requirements with enormous economic and environmental benefits.

The key to this is that for each kilowatt of electrical energy put into a direct geothermal system, about 4 kW

Figure 1: Schematic view of a direct geothermal heating and cooling system



of energy is developed for the purposes of heating and cooling. This means that outside the capital costs of the installation, 75% of the power is free. Furthermore, as much of the electrical power in Victoria is generated with brown coal, replacing 75% of the energy used with a clean renewable energy source, the greenhouse gas emissions are reduced to as little as about 25% of what occurs with current practice. Clearly, these are crude assessments of what is possible and other fuel sources must be taken into account. However, the figures do indicate some of the significant economic and environmental benefits that can be achieved. A further important economic advantage is that if a significant proportion of buildings can be heated and cooled by geothermal systems, the demand for electricity is likely to fall resulting in a reduction of energy infrastructure, including power stations, to produce electricity. This has resulted in some considerable savings in some Canadian provinces.

While the capital costs of installation of a direct geothermal system are still a little high in Australia, with industry becoming better geared to needs, and with better systems of design and installation, costs should fall rapidly over the next few years. This, combined with the likely major increase in costs of conventionally derived energy, will mean that capital costs can be recovered in a few short years.

With over 3 million commercial and residential direct geothermal installations around the world, there is no doubt that it is one of the fastest growing sustainable technologies. North America, Europe and several Asian countries have been at the forefront of adopting the technology. Switzerland has installed energy foundations for more than 30 years. The United Kingdom has major incentives to install energy piles in new commercial buildings, Germany and Austria are using tunnel linings as GHEs and Korea has built its new capital, Sejong, with geothermal systems. Most of these countries have various forms of subsidy or financial incentives in place.

The symposium presentation considered the three main elements of a direct geothermal system: the ground heat exchanger, the ground source heat pump and the heating and cooling demand of a building. The critical aspects of these elements were discussed and examples of a range of their many different forms provided. The principal methods of design and installation are also considered.

Research recently completed at the University of Melbourne in collaboration with a number of industry partners has indicated that considerable additional savings can be made in both capital and running costs if the geothermal systems are designed specifically for local conditions. The university has obtained significant funding from the Victorian Government to develop demonstration projects representative of different conditions across the state and to develop local design rules. These include a new teaching building in Parkville, the Sustainability Centre on campus, a large horizontal ‘slinky’ system at Main Ridge, and a number of other residential projects across Victoria together with state-of-the-art detailed numerical modelling of geothermal systems for Victorian conditions. The university is also organising various courses so there are an increasing number of people able to design and install the systems.

Although the Australian direct geothermal industry is in its infancy, if we can mobilise acceptance and demand, knowledge and expertise, training and accreditation, the sooner the trades, professions, developers, architects, regulators, politicians and general public can have a mature direct geothermal industry providing clean, efficient and cost-effective heating and cooling for our buildings.