Beaurepaire Geothermal Experiment: Heating and Cooling Buildings using Ground-Source Heat Pumps

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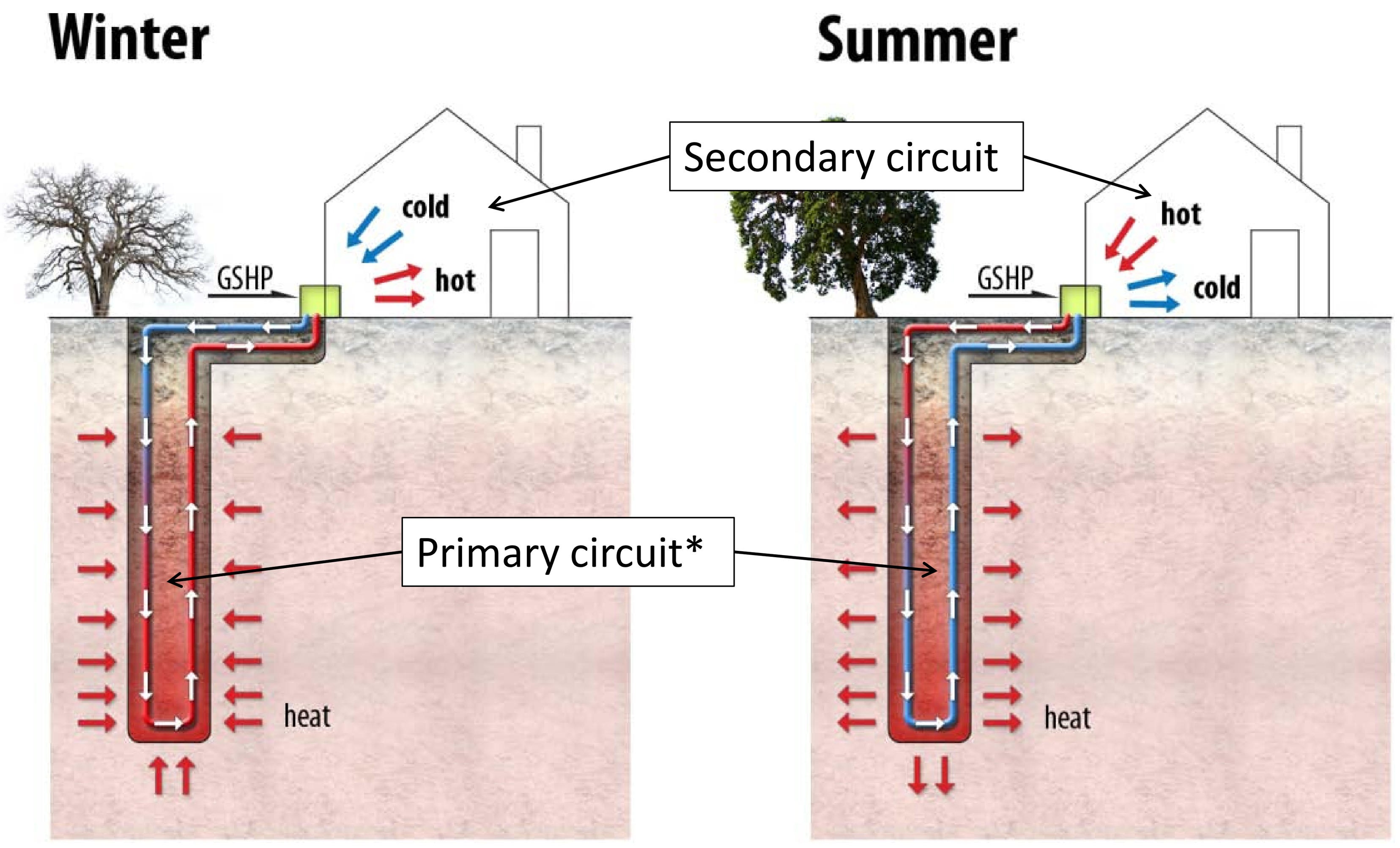
ENERGY Research Institute

Energy use in buildings accounts for 26% of Australia's greenhouse emissions (CSIRO, 2010). Over half of this energy is for heating and cooling. Ground-source heat pumps (GSHP) use the Earth as a heat source or sink to heat and cool buildings using considerably less electricity than conventional systems. By reducing electricity demand (GSHPs do not directly generate electricity), GSHPs have the potential to significantly cut Australia's electricity use and carbon footprint.

This research aims to demonstrate the potential for GSHP systems in Melbourne and to improve design techniques.

Energy generated during the experiment will be used to heat and cool the adjacent heavy weights room of the Beaurepaire Sports Centre



*Not to scale: boreholes are typically 100-300mm in diameter

GSHP systems comprise a primary circuit linked to a secondary circuit through a heat pump.

The primary circuit is piping embedded in the ground, through which water or refrigerant is circulated. This fluid will then be warmed or cooled by the surrounding ground, as required. The secondary circuit is the building to be heated or cooled.

The heat pump moves heat between the primary circuit and the secondary circuit. Heat pumps operate on the same principle as fridges, using refrigerant to efficiently transfer and upgrade heat with the input of some electricity.

In heating mode, the pump will extract heat from the circulating fluid in the primary circuit (the cooled fluid will then be heated by the ground) and the extracted heat will warm the building. In cooling mode the process is reversed, with heat extracted from the building and rejected into the ground.

The Beaurepaire Geothermal Experiment comprises a number of different types of primary circuit, including energy piles (building foundations fitted with HDPE piping), borehole installations and direct exchange systems (where copper piping extends into the ground). Piles and boreholes drilled at the Beaurepaire Centre are all about 30 m deep.

Left: The primary circuit of an energy pile comprises HDPE pipes attached to a steel reinforcement cage . Water will circulate through the pipes

Left: A section of reinforcement cage (with piping attached) is lifted before being lowered into a 30m deep energy pile

Most forms of geothermal energy require ground temperatures in excess of 100ºC. However, GSHP systems operate at "normal" temperatures as the ground needs only to warm or cool the circulating fluid. At about 10m depth, the temperature of the ground is relatively constant and is typically warmer than the air in winter and cooler than the air in summer. The temperature at this depth at this site is about 18ºC.

Left: Copper loops, through which refrigerant will circulate as part of a direct exchange system, are lowered into a 30m deep borehole

The "constant" ground temperature at depth allows GSHP systems to be more efficient than conventional air-conditioners which rely on the air as a heat source or sink. Imagine trying to dump heat from your house into 40ºC air, when you could be using 18ºC ground!

Unlike many other sources of renewable energy, GSHP systems can potentially be used in almost any geographic location and the energy is available 24/7 – rain, hail, sun, storm or calm. This gives GSHP systems a significant advantage over alternative forms of renewable energy.

The Beaurepaire Geothermal Experiment is expected to run for most of 2011 – please check back for regular updates!

Ground-source heat pumps can provide cost-effective and environmentally sustainable energy to heat and cool buildings

For further information please contact Prof Ian Johnston, Dr Guillermo Narsilio or Stuart Colls, Department of Infrastructure Engineering, or visit the department's website at: www.ie.unimelb.edu.au

The assistance of the following organisations is gratefully acknowledged:

Melbourne Energy Institute
Melbourne University Sport – P&CS
Geotechnical Engineering Pty Ltd
Direct Energy Pty Ltd
Golder Associates Pty Ltd
Supaflow Plumbing