Energy resources

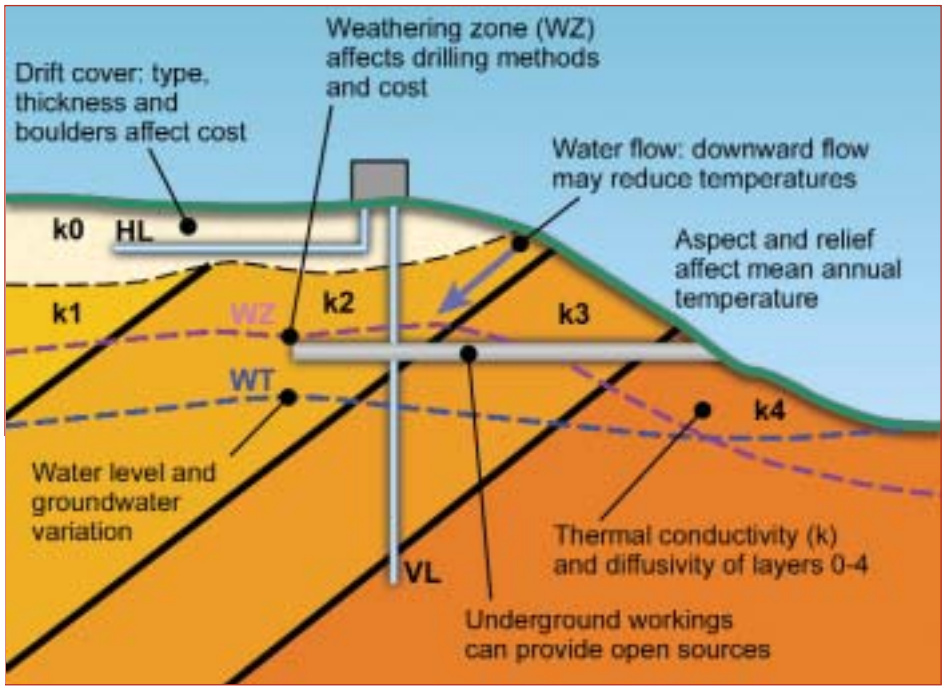
Ground source heat pumps

A low-carbon energy technology

by Keith Rollin, *Keyworth*

A heat pump is a device which takes up heat at a certain temperature and releases it at a higher temperature. Ground source heat pumps (GSHP) are one of the most energy efficient, environmentally clean, and cost effective space conditioning systems available. They use the thermal store of the Earth in either a closed or open loop heat exchange system. The thermal energy output is not generated, so that GHSP systems have a coefficient of performance of about 3.5. Typically the output is 3–20 kilowatts, so GSHP systems are well suited to domestic and small commercial heating, or cooling, requirements.

In the UK approximately 30 per cent of final energy consumption is in domestic premises, with about 82 per cent of this for space and water heating. GSHP systems are widespread in other European countries but have not yet developed in the UK market for a variety of reasons, including the maritime temperate climate and low prices for primary energy. Typically, total installation costs may be three to five times conventional space heating and external installations are up to 30–50 per cent of the capital costs of a GSHP system. However, running costs for a GSHP system can be about half of conventional space heating, and carbon saving can be about 40 per cent. In addition a GSHP can reduce residential primary energy consumption by up to half and typically saves about one to two tonnes of carbon dioxide annually for each installation.



Chris Wardle, BGS © NERC

Some of the geological factors affecting use of vertical loop (VL) and horizontal loop (HL) GSHP systems.

Most GSHP systems are vertical-loop indirect exchange systems using electrically powered vapour compression cycle heat pumps. Geological factors impact directly on the site characterisation and therefore the design and cost of the system. The UK has an extremely varied solid geology and the Quaternary cover is extensive and variable. The geological prognosis of the site and rock properties will influence the drilling methods and system costs. Other very important aspects are the predicted subsurface temperature, the thermal properties of the strata, the water saturation level, and the natural or induced hydraulic flow.

The thermal characteristics of the site are affected by the mean annual air temperature, the conductive heat flux, fluid flow and heat transport effects, rock thermal conductivity and diffusivity, terrain effects, and palaeoclimate. Existing models used for site temperature prediction and system design are very approximate and increase uncertainty in the output and performance. Measured equilibrium temperatures at a depth of 100 metres show a variation across the UK between about 7–16° C. This variation needs to be predicted, verified and incorporated into a new model. Data from shallow water boreholes and from groundwater temperature observations will also be used to develop and verify the model.

The BGS has applied for co-funding for a project to deliver site-specific data for GSHP installers on-line via the World Wide Web. These outcomes are essential to system design and performance, will reduce risk and enhance the commercial adoption of a proven low-carbon technology.

The project will provide site assessment of:

- Predicted ground temperature at shallow depths and rock thermal properties.
- Geological prognosis, drilling conditions and rock strength prognosis.
- Hydrogeological parameters groundwater level, water level variation and groundwater flow.