GUIDE TO GEOTHERMAL ENERGY

Geothermal energy is the natural heat that exists within our planet.

The Geothermal Energy Challenge Fund is targeting 3 geological settings within Scotland.

Minewater

Water is held naturally in rocks as groundwater and flows continuously into active mineworkings, requiring them to be pumped out. However, when mining ceases the pumping ceases and the abandoned mineworkings become flooded. Mines can extend to relatively deep levels so, in some cases, abandoned mineworkings can provide easy access to warm water. A compilation of minewater temperatures from boreholes in the Midland Valley shows a mean temperature of 17^{o}C. This warm minewater can be accessed by means of a borehole, and the heat can then be made available for space heating or domestic hot water heating.

Hot sedimentary aquifers

Aquifers are bodies of permeable rock that can conduct significant quantities of groundwater. The largest and most conductive of these generally occur in sedimentary strata, and those that are deep enough to hold warm or hot water can be classed as Hot Sedimentary Aquifers (HSA). Most HSAs will yield water in the temperature range 20 to 80^{o}C. The hot water can be abstracted from the aquifer by means of a borehole, and the heat can then be made available for space heating or domestic hot water heating. The Midland Valley is the largest onshore part of Scotland to be underlain by sedimentary strata.

Hot dry rocks and hot wet rocks

Crystalline rocks at several kilometres depth can be hot enough to generate electricity. Such rocks usually lack open fractures and consequently have very low permeability. They are therefore essentially dry, hence they are known as Hot Dry Rock (HDR) resources. Some granite intrusions generate their own heat, so they can be hotter than other rocks at the same depth and therefore are popular HDR targets. In Scotland, granite intrusions with the greatest HDR potential occur mainly in the East Grampians region. The concept for exploiting HDR resources relies on creating an Engineered Geothermal System (EGS), in which a network of open fractures is created to hydraulically connect boreholes drilled some distance apart into a hot rock zone. Cold water injected into the open fractures through one borehole passes through the fractures, and the resulting superheated water or steam (typically at 100 to 200^{o}C) is then extracted through another borehole. The thermal energy stored in the water can be converted into electricity at the surface in various ways.

Some crystalline rocks are naturally permeable; these can contain significant amounts of hot water and are sometimes known as Hot Wet Rock (HWR) resources. Because they are naturally permeable the water can be abstracted by means of a borehole, and an EGS is not required. HWR resources can be close to the surface in

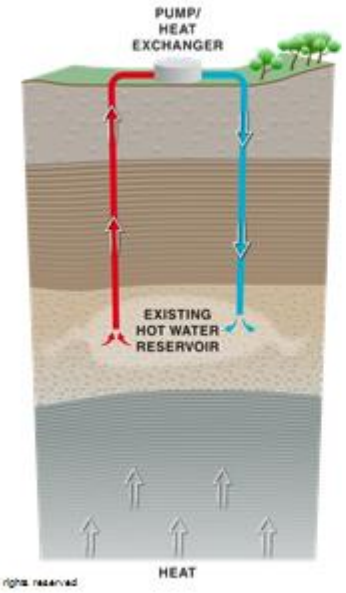
volcanically active parts of the world. HWR resources may also exist in other settings, for example around some geological faults.

In each case, following the extraction of the heat, the water can be re-injected at the site, maintaining the level of the groundwater available for future abstraction.

EXTRACT FROM BRITISH GEOLOGICAL SURVEY PRESENTATION

(full presentation is available at: http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/GeothermalEnergy/SEPresentation)

Hot Sedimentary Aquifers



- Require bodies of permeable rock (aquifers) at depth
- The largest and most productive aquifers are in sedimentary strata
- Likely to yield water in the range 20-80 ºC
- Since 1986, a combined heat and power system in Southampton has exploited an HSA

Hot Dry Rock concept

- Requires a body of impermeable rock at depth
- Intrusions of granite are the best prospects, especially High Heat Production (HHP) granite
- Heat energy sufficient to generate electricity
- Needs an Engineered Geothermal System (EGS) to exploit the energy