Geophysical Research Abstracts, Vol. 7, 04352, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04352


# Ground source heat pumps and seasonal thermal storage in the subsurface: Methods to assess the hydrogeological conditions with regard to efficiency and ecological impacts

R. Barthel, J. Jagelke

Institute of Hydraulic Engineering, University of Stuttgart
(roland.barthel@iws.uni-stuttgart.de)

The utilization of geothermal energy, especially the extraction of heat with so-called ground source heat pumps (GSHP) or earth coupled heat pumps has become very popular in several European countries and the US during the last decade. Especially in Germany, the number of installations has increased rapidly. Although less frequently applied, the seasonal storage of solar heat or waste heat in Underground Thermal Energy Storages (UTES) is, nevertheless, an interesting option. Both techniques can be used for cooling purposes as well - a possibility that becomes more and more important even in Central and Northern Europe. If applied properly, such applications provide reliable and sustainable energy sources or, in case of UTES, enhance the performance of renewable or fossil energy sources (solar heat, biomass, co-generation power plants etc.).

From the ecological point of view, two issues have to be critically considered: the efficiency of such systems, and ecological threats brought about by the installation of the ground heat exchangers themselves. The efficiency of all energy systems using heat pumps is, of course, determined by the ratio of heat energy extracted to the amount of power needed to run the heat pump. Here the primary energy needed to generate power has to be considered. The efficiency of a heat supply system based on a GSHP is determined not only by the technology of the heat pump, but also by the geological and hydrogeological properties of the subsurface. Installed in an inappropriate rock or soil, a GSHP can lead to higher energy consumption and CO2 emissions than a traditional heating system. Since installing a GSHP requires drilling, or at least digging,

the installation always means a manipulation of the subsurface. Direct contamination by cooling fluids is a possibility but, more importantly, each borehole represents a potential pathway of groundwater contamination. Both ecologically relevant aspects, efficiency and direct groundwater impacts, require that a detailed assessment of the geological, hydrogeological and thermal properties be carried out before a GSHP is installed. On the other hand, the individual assessment of each site by a hydrogeologist would be far too expensive. Therefore, reliable, cheap, standardized assessment methods are required.

The suitability of the subsurface depends highly on the regional and local geological and hydrogeological conditions. Apart from the obvious importance of parameters like heat conductivity and heat storage capacity, the hydraulic rock properties as well as the groundwater flow conditions are decisive for the feasibility of projects in that field. It has been shown that GIS can be used interactively to assess the suitability of individual sites or larger areas for different geothermal applications. A study area of about 8500km2 located in the northwestern region of Bavaria, Germany was chosen for the study. A variety of approaches were examined and applied to this area. The different concepts were evaluated and analyzed for relative effectiveness and ease of use. The two most promising concepts were developed and studied in greater detail. The first of these concepts is a method to produce simple, medium-scale regional potential or suitability maps that can be used in regional planning and development. The second approach is based on the concept of expert systems. It provides a means for an interactive, site- and project-specific analysis of the geo- and hydrogeological setting.

Two aspects have proven to be crucial to meaningful site assessment and potential analysis: sufficient availability of geological and hydrogeological data, and availability of information on existing projects in similar geological settings that can be used to define the assessment criteria and to validate the system. These factors determine both the effort that has to be put into setting up an expert system and the efficiency of the tool. The more complex the regional geological conditions, the more unbalanced effort and efficiency usually become. One aim of this study, therefore, was to determine the limits of feasibility for sophisticated expert systems and comparatively simple regional potential maps.