Science 4 Technology – Poster Exhibition 2024

Department Applied Geosciences and Geophysics

Chair of Energy Geosciences

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Geothermal groundwater wells

Sustainable energy for heating and cooling

The use of near-surface groundwater for heating and cooling is a sustainable and efficient alternative to conventional energy sources. Shallow geothermal well systems offer consistent water temperatures year-round and cost-effective shallow drilling.

Groundwater heat pumps extract water from a production well, extract heat, and reinject it into the same aquifer through a reinjection well with a lower temperature gradient (Fig. 1). The distance between production and reinjection wells depends on geological and hydrological conditions.

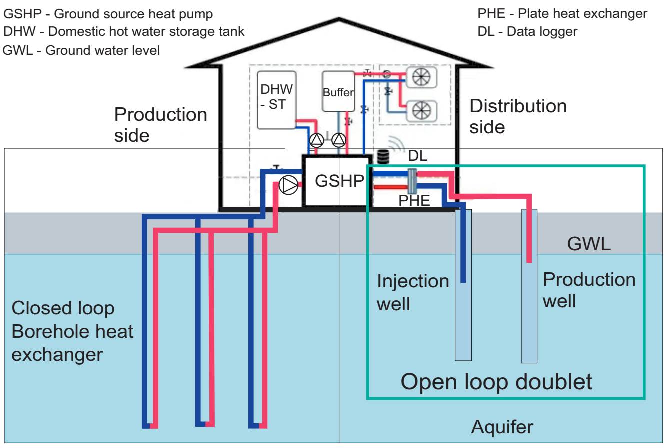

Figure 1. Schematic diagram of an open loop system in comparison with a closed loop borehole heat exchanger (Boon & Herms, 2020).

Implementing an open near-surface geothermal system requires specific geological and hydrological conditions, such as an aquifer with sufficient porosity, permeability and adequate water quality because dissolved cations can build blockages in production and reinjection wells, and the hydrological conditions must meet the required volume flow rate.

The geological und hydrological framework of the investigation area is outlined in Fig. 2. The sediment series of the groundwater horizons show average hydraulic conductivity coefficients (k_f-values) between 10^{-2} m s^{-1} to 10^{-4} m s^{-1}.

For calculating the energy potential (Eq. 1), parameters of a selected borehole (k_f-value, temperature values) were used. A one-step pumping test achieved withdrawals of 4-5 l/sec, reaching a quasi-stationary state after lowering the groundwater level.

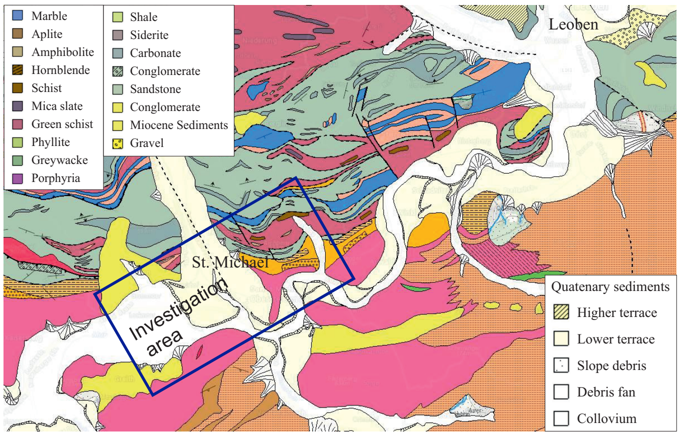

Figure 2. Geological map of the investigation area near Leoben (modified after Kriegl et al.).

$$Q = m \times cp \times (T_1 - T_2) \quad (1)$$

Q = quantity of heat in [J] or [kWh]
m = mass of the substance - water
cp = specific heat capacity of water [kJ/kgK]
T_1, T_2 = Temperature [°C]

Depending on the temperature spread between water withdrawal and injection, the selected site showes annual groundwater energy withdrawal potentials between about 160 MWh/a and 650 MWh/a. In this example energy outputs between 35 kW and 50 kW can be achieved.

A comparison of groundwater temperatures in a borehole observed in an interval of 35 years, revealed a consistent trend of higher temperatures , as a trend over the period.

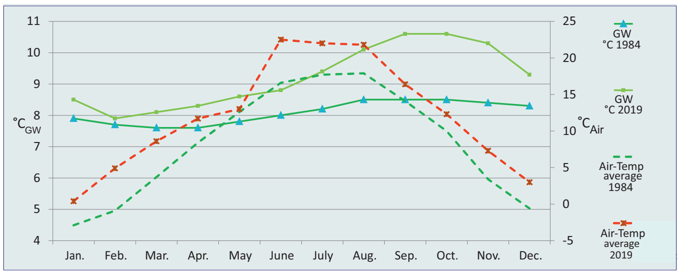

Figure 3. Comparision of groundwater (GW) temperatures and air temperatures of a selected borehole in corresponding years, viewed over an annual course.

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