Potential assessment for the use of near surface geothermal energy in the Alpine region within the GRETA project

The project GRETA aims to foster Near-Surface Geothermal Energy (NSGE) in the territory of the Alpine Space. Main goals are to assess potentials of NSGE, exchange knowledge and best practices on a transnational basis and to integrate NSGE into policy instruments. Besides these overall objectives, every of the participating countries (Austria, France, Germany, Italy, Slovenia, Switzerland) is carrying out detailed analysis in their case study area.

For Austria, this focus region is represented by the two communities Leogang and Saalbach-Hinterglemm where settlements are located in altitudes of about 800 – 1,000 m. In these communities, as well as in large parts of the Alpine space region in Austria, winter sports tourism is an important economic factor. The demand for heating and domestic hot water in this region of about 6,000 inhabitants rises significantly in the winter months due to around 2 million guest nights per year. This is the reason why the focus was set on the potential of NSGE use for touristic infrastructure like alpine huts or hotels. The detailed analysis of aquifers and of current NSGE installations as well as ground temperature studies will represent the base for the potential assessment of the region.

The use of NSGE in Alpine regions in Austria

Ground temperature assessment

Temperature plays a significant role in high-altitude regions where ground temperatures may stay very low the whole year and the question arises, to which point the NSGE use is still efficient. The objective of detailed investigation is, to which extent the elevation, the gradient and the orientation of the hillside influence the geothermal usability of the shallow underground. Using a software developed by the University of Soil Sciences in Vienna a ground temperature map will be compiled. The calculation is based on climate data considering parameters like soil composition, solar radiation and snow cover. For model validation, measurement stations are necessary but were missing in the case study area. That is why, in autumn 2016, monitoring stations were realized in the municipality of Leogang - two stations in the valley at about 800 m, two further up the mountain at 1,250 m (south slope) and 1,400 m (north slope).

Aquifer characterization

The characterization of the defined aquifers in the valley of Leogang and the valley of Saalbach-Hinterglemm have shown that large parts of these valleys are suitable for the thermal use via groundwater heat pumps. Ten suitable aquifer bodies characterized by fine- to coarse-grained Quaternary gravels were identified. They show thicknesses between 10 and 20 m with hydraulic heads of maximum 20 m. Their hydraulic conductivity values range between 0.0002 to 0.0035 m/s. Red dots in figure 5 indicate the locations of GWHP installations, from where mean annual aquifer temperatures of about 8 °C are derived.

Drilling, construction and first results of the T-measurement stations

The measurement chains consist of single digital thermodiometers (DH3820S) measuring the underground temperature. They are attached to a data cable in depths of 10 cm, 20 cm, 50 cm, 1 m, 1.5 m and 3 m below surface. The data loggers are based on an Arduino Micro controller and were, after programming, connected to the measurement chains. Power is supplied by lead accumulators and a solar panel. Data is collected every two hours and stored on an SD card. The drillings were carried out using an electric hammer. Depending on underground properties, the drillings reached depths of 1 to 3 m. Samples were taken from the drilling cores in order to perform soil analyses. The remaining material, mixed with bentonite pellets, was used to backfill the drillings.

Ground temperature measurements for BHE potential assessment

Almost over the winter measurement period - not the sensors in the valley show the highest temperatures but the sensors located in the mountains at an altitude of 1,250 m (station 4, heading south). This can be seen in all measurement depths. Also “soil input” temperatures remain higher in station 4 during winter than in the valley. Due to an early snow cover in November, the soil temperature stays above zero at all locations. The earliest, thickest and longest lasting snow cover is at the north facing station 1. Here, the temperature drops the least significant (only about 3 °C, March). Large temperature differences (7 - 12 °C) were measured in March between the snow-covered and snow-free stations.