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Nachhaltige Energiegewinnung im Nationalpark Harz. Inter- und transdisziplinäre Herausforderungen für Ingenieur*innen und Sozialwissenschaftler*innenLehren und Lernen (FoLL)

Geothermally Heated Public Swimming Pools in Harz Region

Abstract:

Incessant dependence on hydrocarbon as major energy source has given birth to the creation on other sources of energy. Geothermal energy which is sustainable and renewable is one of the outcomes. Geothermal, which is the heat that comes from the earth is the major focus in this report. The temperature at which this heat is extracted at the surface will determine whether it will be directly utilized or passed through a heat pump.
The geological history and formations were analysed and an assessment of mining tunnels was conducted to avoid interfering into a tunnel while drilling. A coaxial annular inlet deep borehole heat exchanger (BHE), as well as a typical well completion was designed for this research work. A finite element model called FEFLOW 6.2 was used to determine the feasibility of this project. The simulation results show that the produced water temperature is very low, thereby making this project economically not feasible.

Selection process

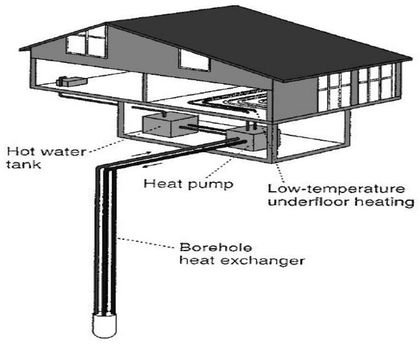
The main challenge is to implement the BHE into the existing heating system of the swimming pool as the already existing heating modules are in serious connection, an easy connection and disconnection of modules is granted.
A BHE could be used as an independent heating module or as a pre-heating source. Once established, is would contribute to the diversity of the already existing heating modules (combined boilers, CHPs, electric heaters) and would prove to have the best cost-benefit relationship.

Geological Assessment

The encountered geological formations of the RE of interest are greywacke with slate and conglomerate in alternation layers that goes approximately until 1km depth with no faulting zones. This combination results in a sturdy subsurface with a minimum chance of developing leakages for water inflow.
The mining tunnels system that undergoes in the subsurface of Clausthal-Zellerfeld does not interfere with the chosen drilling area.
The geothermal gradient of the area is 2.8˚ C/100m, which was determined using the temperatures from the web application of Geotis (Geothermal Information System for Germany).

BHE

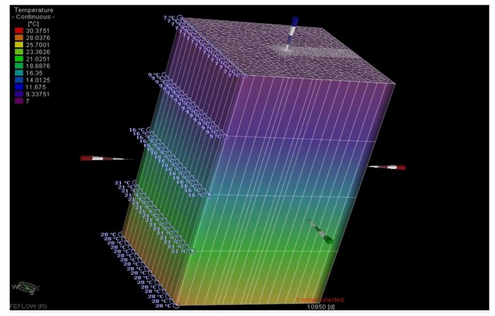
Borehole heat exchangers are utilized in heating and air-conditioning of building interiors. It can be installed in all geological materials except in dry gravel due to its low thermal conductivity. Coaxial annular inlet pipe type of BHE configuration was designed with a well depth of 770m. Water was circulated through the annular inlet pipe; the water gets heated up by thermal conduction and comes up to the surface through the tubing. The produced water is passed through a heat pump to extract heat and elevate the heat temperature before the heat is transferred to the swimming pool heating system.



FEFLOW 6.2 Simulation

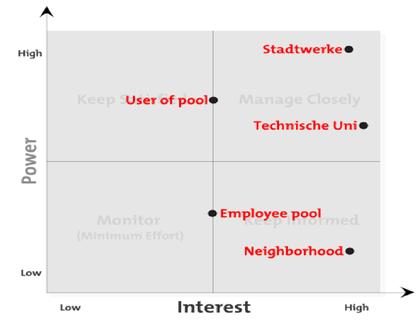
FEFLOW 6.2 is a finite element software, here applied to run a BHE simulation.

Elevation [m]	Well Depth [m]	Temperature [°C]
+570	0	7
+320	250	9
+70	500	16
-180	750	21
-430	1000	28



Stakeholder Analysis

Stake holders in this research work were analysed under four groups. The swimming pool owners are the most important stakeholder with the highest interest and power. The decision to implement or reject this project depends on them. The users of the swimming pool and TU Clausthal are other major stakeholders. They contribute to the income of the swimming pool as they frequently use the pool. The employees and the neighbourhood do not weld much power on whether the project will be implemented though their interest is high.



Conclusion

A FEFLOW 6.2 computer simulation has been conducted, picturing the expected temperatures according to Geotis. Lower temperatures are encountered than initially expected. In the next step, the impact of the heat pump needs to be implemented and expert interviews have to be done in a more detailed way. This joint-venture project can be regarded as ground work for similar projects.

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