Donnerstag, 20. Februar 2025, 16.40 Uhr
Baden Arena Kongress 2
Oberflächennahe Geothermie

Thursday, 20 February 2025, 4.40 pm
Baden Arena Congress 2
Shallow geothermal energy

Web Tool for Analyzing the Impact of Geothermal Borehole operation on Ground Temperature in densely populated areas

Web-Tool zur Analyse der Auswirkungen des Betriebs von Erdwärmebohrungen auf die Bodentemperatur in dicht besiedelten Gebieten

Anuj Keshav, Maria Letizia Fascì, Julian Schoch, José Acuña, Willem Mazzotti Pallardl, Max Hesselbrandt
Bengt Dahlgren AB

The need for advanced tools to assess ground temperature and capacity becomes increasingly important as Ground Source Heat Pumps (GSHP) are implemented in densely populated areas around the world. Existing tools such as EED is widely used by heat pump designers for detailed borehole design, leveraging the g-function-approach (Spitler et al., 2022) to model thermal responses. However, these tools lack dynamically integrated geothermal borehole data, which could provide rapid insights into ground temperature variations due to existing and new borehole operations, thereby preventing overcrowding and overexploitation in high-density areas.

This work presents the development of a specialized web application tailored for geothermal boreholes in Stockholm. With 131,1921 active boreholes, shallow geothermal energy is in Sweden a viable source for heat pumps. The tool developed in this work simulates ground temperature responses, both at existing and potential borehole sites, offering predictions for the present and the next 20 years. The tool solves an important need for the city of Stockholm and can potentially be implemented in any other city.

Utilizing a full-stack web development approach, with JavaScript for the frontend and Python for backend calculations, the tool integrates mathematical models based on the finite line source theory with real-world borehole data visualized on an interactive map. The tool is based on the work done by Letizia Fasci during her PhD2. It utilized the Finite line source model which is one of the analytic methods that provides accurate results when compared to the other models such as Infinite line source or cylindrical line source models. The borehole can be considered a finite line heat source, with heat transfer occurring along the same axis as the borehole. The model ignores the details of the complicated geometry of the U-pipe loop and the differences in thermal

[1] *SGUs Kartvisare*
[2] *Thermal Interference Between Neighbouring Ground-Source Heat Pumps : Tools to Calcualte it and Solutions to Limit it (diva-portal.org)*
[3] *An Analytical Method to Calculate Borehole Fluid Temperatures for Time-scales from Minutes to Decades*

properties of the grout and soil. 3Claesson and Javed (2011) obtained a single integral solution for this equation which is shown below:

To illustrate, the equations above evaluate the thermal response of the borehole 2 having depth D2 and height H2 due to the operation of the borehole 1 having depth D1, height H1 and heat extraction of q1. The implementation of this function along with the important supporting function makes the base of this application. Its simulations demonstrate how borehole activity affects ground temperatures, even in areas without direct installations, due to the influence of neighboring boreholes. This functionality allows for quick assessments of long-term temperature impacts due to constant heat load, helping to guide decisions on future borehole installations.

As one of the applications, the generated heatmap highlights temperature trends, assisting in identifying colder zones and informing energy planning. The heatmap creation process starts with data sampling on the map, where borehole details are plotted. The sampling of points is carried out at 10-meter intervals along both the horizontal and vertical axes. During this data sampling phase, an algorithm is employed to extract boreholes data within a 150-meter radius of each sample point on the map. The extraction process generates a dataset that is subsequently employed to calculate the thermal response at each point through the utilization of the implemented finite line source mode, considering the data associated with the sample points up to the present time

This tool is specifically crafted to serve a wide audience, from government authorities overseeing geothermal energy expansion to designers and the public. Its user-friendly interface ensures accessibility for all, requiring minimal technical expertise. Whether you're a policy maker, an energy planner, or a designer, this tool provides an easy-to-use platform to support informed decisions in geothermal energy management. The presentation follows along with the problem description, methodology and Online App Demonstration.

Link to the Demo Webapp: - Borehole Calculator