GEOSOL: Transient Analysis of seasonal Heat Storage

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Project consortium:

Considering the EU 2020 targets, solar heating will play a significant role in the future. Unfortunately there is a big surplus of solar energy in summer, while the energy for space heating is needed mostly in winter. The GEOSOL approach is to store the required amount of energy in the underground in summer and to restore it in winter using BHE. The aim of the project is to design an economic viable geothermal heat storage for supplying small to micro heating networks (approximately up to ten buildings). The results on this poster are preliminary, because the project is still in progress.

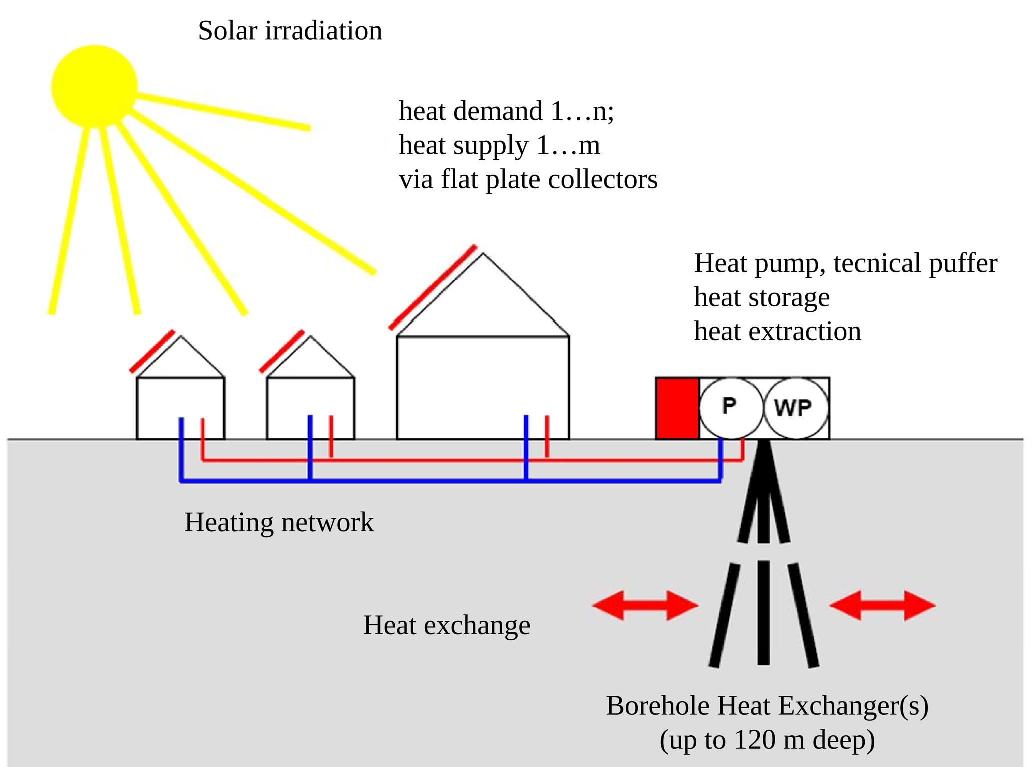


Figure 1. Components of the model system

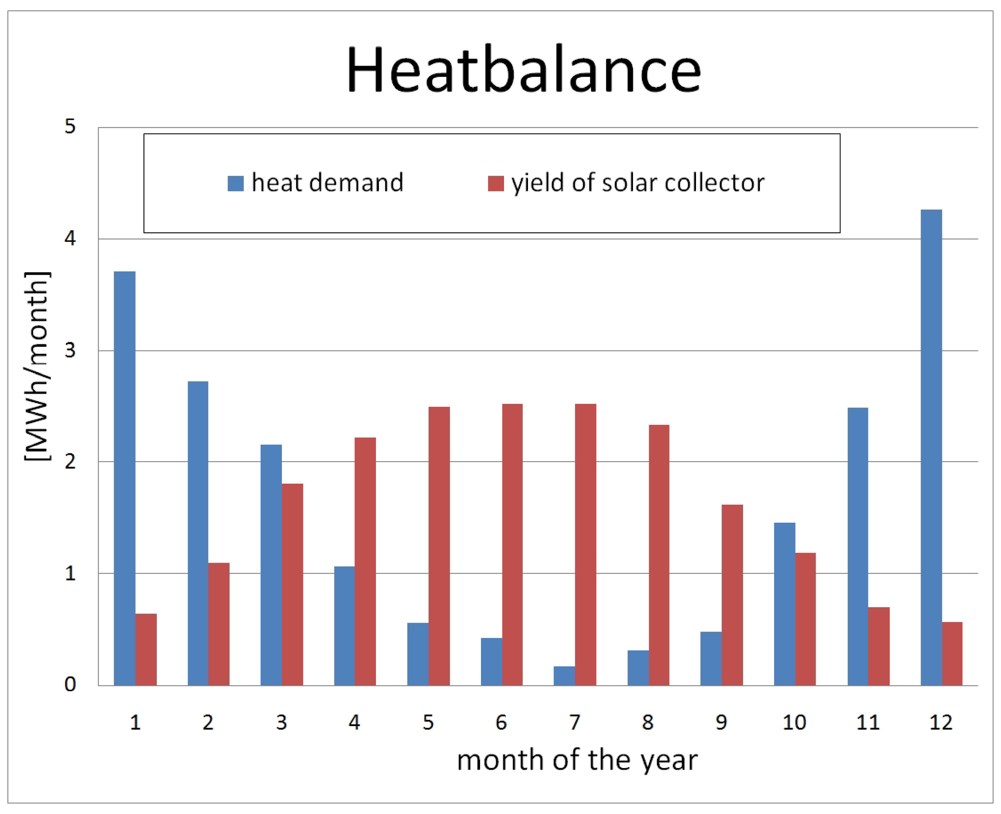
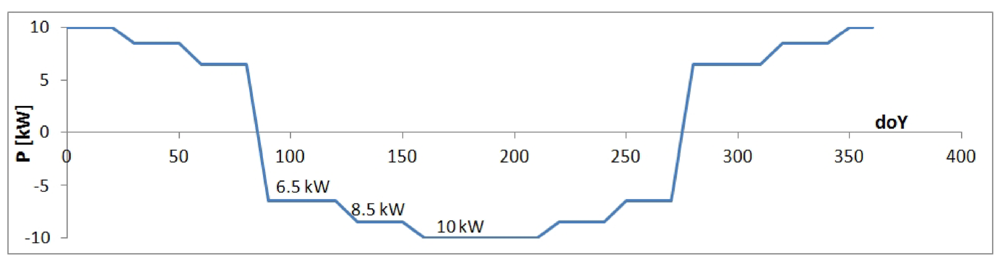


Figure 2.

a.
Heatbalance, calculated using a TRY of one of the possible locations



b.
Operating function of the BHE field

Since both, the heat flow and the temperature along the BHE are a priori unknown, the core issue of this simulation is to find a proper boundary condition for the boreholewall. The complexity of modeling the BHEs interior, because of the big dimensional differences inside (10mm) and (100m) outside the well, was circumvented by the *"form factor method"*[1], where the heat flux is calculated iteratively at each timestep. Previous studies [2] have shown that a lot of heat is lost when using only one BHE. This leads to the necessity of a BHE field with at least four independent charging and discharging BHEs, therefore full 3D modelling is required. The original open-source code presented in [1] is restricted to radial-symmetric 2D, for full 3D modeling we decided to use Comsol V3.4 and Comsol script for coding.

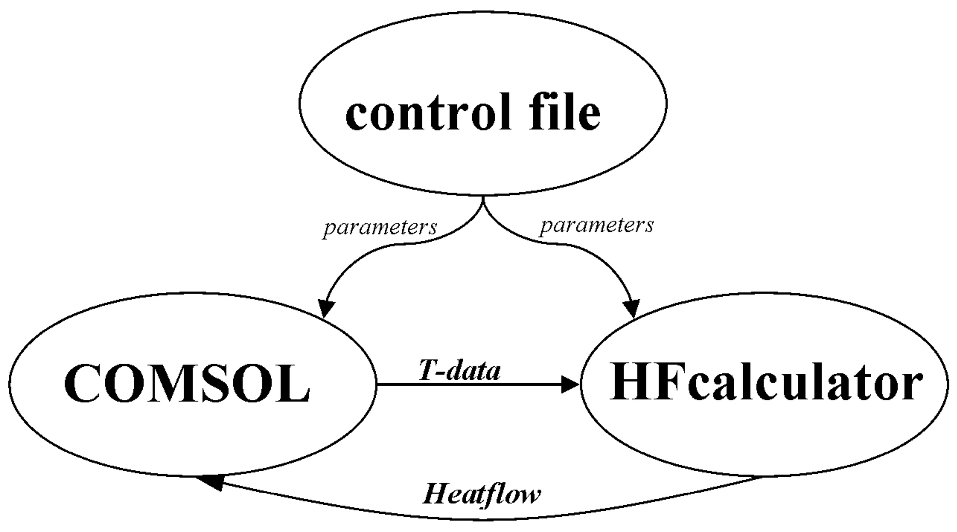


Figure 3. flowchart

Figure 3 displays the flow chart of the modelling process. The program „HFcalculator" calculates the heat flow distribution along the BHE based on the temperature data exported from Comsol and parameters from the control file.

At the moment we are testing different configurations of the BHE field to optimize the geometry as well as the operating function of the BHE's. Figure 4 displays five images of the temperature distribution in the underground during one year. In summer the temperatures around the boreholes reach up to 25°C, while in winter the temperature goes down to about 8°C.

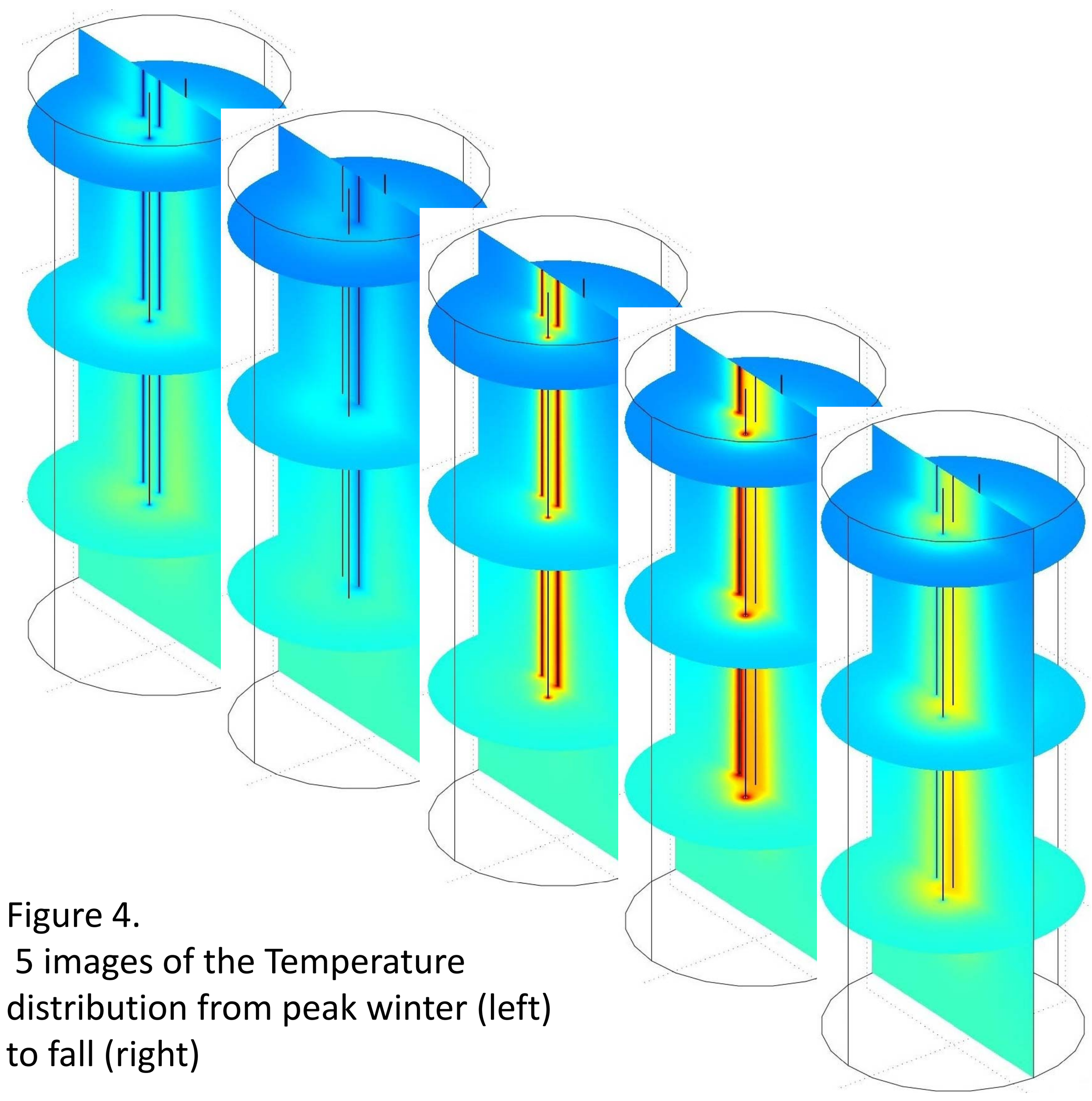


Figure 4.
5 images of the Temperature distribution from peak winter (left) to fall (right)

Conclusions, Outlook:

The current results are promising that an economical "Geo-solar" storage system is feasible. The main issues for further research will be a.) the optimization of the geometry of the BHE-field and b.) investigation of the influence of groundwater flow on the thermal regime of the storage field.

References:
1. Bernd Glück, Simulationsmodell "Erdwärmesonden", open report 2008
2. Richard Niederbruckner, Erkenntnisse aus faseroptischen Temperaturmessungen in Erdwärmesonden, talk at VDI-forum in Linz, April 2011

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