Integration of Geothermal Energy from Medium-Depth Aquifers in New Urban Districts

The case study of Malley

Antoine Boss

1. Motivation and objective

In the city of Lausanne (Switzerland), the large industrial wasteland of Malley offers an opportunity to build new districts. Following the national energy strategy for sustainable development, the planned new districts aim at having greenhouse gas emissions below 2 tons of CO\textsubscript{2}-eq per person per year. Geothermal energy could be used for space heating and hot water supply via a district heating network. The objective of this study is the evaluation of the viability of different medium-depth geothermal resources for these districts accounting for cost and greenhouse gas emissions.

2. Principle of a geothermal doublet

Heat from medium-depth aquifers is usually exploited with a geothermal doublet. This system pumps the hot water from the aquifer via the production well, transfers its heat to a district heating network, and re-injects the cold water into the aquifer via the injection well. A heat pump can be used if the temperature of the geothermal heat is not high enough and a boiler can provide additional heat in periods of high heat demand.

3. Methodology

An optimization model of the districts energy system was developed to evaluate different scenarios of heat production and supply. Four geothermal resources at depths between 1200 and 3500 m were compared: the aquifers Cretace, Malm, Dogger and Muschelkalk. For the Malm, three options of depth are considered: ¼, ½ and ¾ of its thickness. Natural gas was taken as a reference for the comparison. In a second step, an uncertainty analysis was carried out to better inform the decision makers.

4. Results and conclusions

The scenario exploiting the aquifer Malm at about 1840 m (Ma ¾ in the figure) is the most interesting geothermal scenario regarding both the total annual cost and greenhouse gas emissions. Thanks to the use of heat pumps, this scenario can fully satisfy the heat demand of the new districts. Studying the system performances under uncertainty, this scenario is cheaper than the natural gas scenario in 30% of cases. It is then close to be economically competitive. Equal median total costs are obtained with a cost of greenhouse gas emissions of 73 CHF/t\textsubscript{CO}_2\textsubscript{-eq}.

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