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Baden Arena Kongress 2 – Oberflächennahe Geothermie

Friday, 1 March 2024, 11.20 am
Baden Arena Congress 2 – Shallow Geothermal Energy

Performance of full-scale HT-ATES in practice: Lessons learned from two years of successful HT-ATES operation in Middenmeer, the Netherlands

Leistung von HT-ATES in vollem Maßstab in der Praxis: Lehren aus zwei Jahren erfolgreichem HT-ATES-Betrieb in Middenmeer, Niederlande

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The European objective to drastically cut back on carbon emissions brings a huge assignment for transition towards carbon-free space heating of buildings and (green)houses. Although sustainable heat sources like geothermal, residual and solar heat provide great opportunities, they also come with a major challenge: there is a seasonal mismatch between the supply and demand of heat, resulting in heat surpluses in summer and heat shortages in winter. Large scale heat storage is needed to solve this problem. High Temperature Aquifer Thermal Energy Storage (HT-ATES) is a technology facilitating huge amounts of heat to be stored in the subsurface in summer and its recovery in winter.

In 2021, a full-scale HT-ATES system with a storage capacity of ~30 GWh was realized in Middenmeer (the Netherlands) to store surplus geothermal heat at 85 °C in the shallow subsurface (380 mbgs). With this HT-ATES, the annual yield of the geothermal wells are increased while natural gas consumption of greenhouses fell significantly.

This presentation focusses on the field data gathered during the operation in the period 2021 – 2023 and addressed various topics regarding the operational performance of the system and the effects of HT-ATES on the subsurface:

- The thermal efficiency of HT-ATES is the ratio of the recovered heat and the stored heat. Does the practical operational data line up with the estimations by numerical models during the design phase? What does the thermal monitoring using Distributed Temperature Sensing (DTS) tell us about heat transport processes occurring in the subsurface? And how big are heat losses through the hot well pipes? These aspects were researched at Middenmeer.

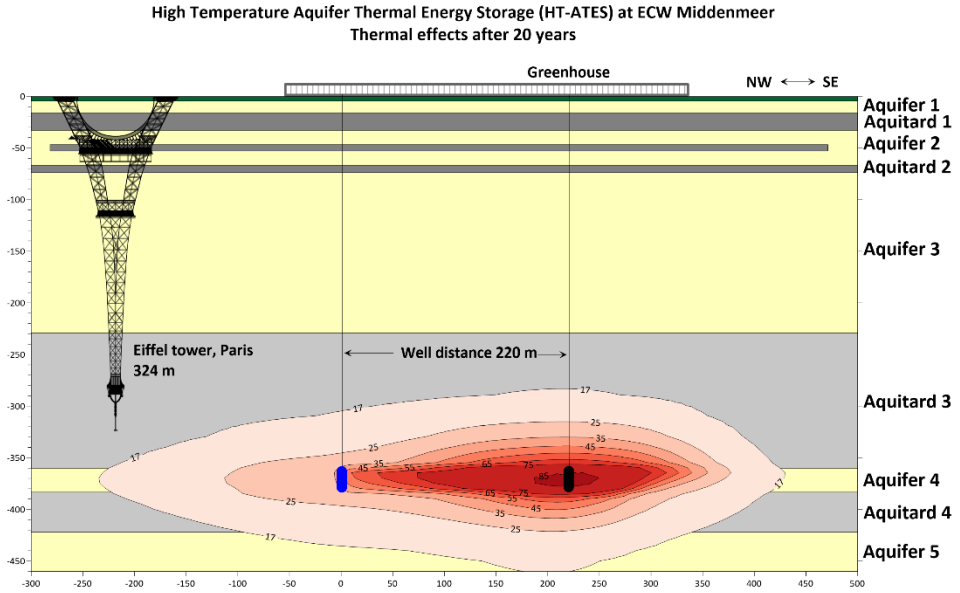

Figure 1: Temperature distribution in the subsurface after 20 years of HT-ATES operation, as estimated by numerical models before operation.

- Former HT-ATES projects have failed because of operational challenges, the most important of which is well clogging by calcite precipitation due to heating of the groundwater. At the HT-ATES in Middenmeer, CO2-dosing is successfully applied to prevent calcite scaling. The most recent experiences on the effectiveness and flexibility of this water treatment method are shared.

- An important legal threshold for HT-ATES application in NL and other countries is the uncertainty about the subsurface effects that occur, when HT-ATES heats the storage aquifer and its surroundings. Practical data is essential to tackle this. Therefore, at Middenmeer, frequent temperature measurements (hourly) were carried out over the last years using DTS-technology in all boreholes. Meanwhile frequent groundwater sampling offered a unique chemical and biological (DNA) dataset, from which effects of HT-ATES on the subsurface system were researched in full. The outstanding recent findings are shared in the presentation.

Figure 2: Picture of groundwater sampling at the monitoring well of the HT-ATES in Middenmeer. Here, groundwater is sampled from the storage aquifer to learn how the increased temperature has affected the groundwater composition (chemically, microbiologically).