Five adjacent Aquifer Thermal Energy Storage (ATES) systems in Cenozoic and Palaeozoic aquifers in Brussels: numerical simulation of their possible interactions

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A first shallow open-loop system (ATES) with pumping and reinjection wells in Cenozoic mixed sandy and silty shallow formations was started in 2014 in the center of Brussels for heating and cooling an important building. A second one started in 2017, was designed with an ideal thermal energy balance of the concerned building between the heat and cold seasonal needs. However, the first simulations of the interactions between these two systems showed how the thermal imbalance of the first system was potentially affecting (i.e., warming) the aquifer in the mid- and long-term (Bulté *et al.* 2021) and thus also impacting the future efficiency of the second ATES system, especially in the long term if nothing was changed in the energy use of the first building.

Then, a third one, a larger ATES system was started in 2020 with 5 doublets of wells in the underlying Palaeozoic fractured phyllites and quartzites to provide heating and cooling power to a large multi-service building. Using Feflow© (as previously), the subsequent numerical simulations of the groundwater flow and heat transport in a 3D model have shown relatively small interactions between this 3rd system and the two others through the aquitard layers formed by low permeability Cretaceous base deposits and the weathered top of the bedrock (De Paoli *et al.* 2023).

Two additional adjacent ATES systems are projected in these Palaeozoic formations, one for a residential complex, and the other one for an office building. The model is now detailed to include these two additional ATES systems, and also calibrated to the most recent measured data (i.e., potentiometric heads, groundwater temperatures, detailed pumping, injection flow rate, etc.). The first results show clearly that the sensitivity of the simulated ATES interactions depends strongly on an adequate hydrogeological characterization. Understanding better the spatial variation of hydraulic conductivity values especially in the Palaeozoic bedrock appears to be a key challenge. The model results are nevertheless very useful to guide the optimized future management of the five adjacent ATES systems to prevent losses in efficiency for some (or all) of them.

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