A holistic method to integrate the potential of thermal groundwater use in spatial energy planning

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The European Union consumes nearly half of its energy for heating and cooling. Nowadays, already 85 % electricity is produced from renewable energy sources, whereas the share in heating and cooling is only at 20 %. Especially the City of Munich fosters a continuous growth of this share by performing a high-detailed spatial energy planning. Apart from demand analysis, all relevant renewable resources including shallow geothermal energy will be integrated. The quaternary sediments below Munich offer a highly productive aquifer, which is already frequently used for heating and cooling by open loop systems. In consequence, a comprehensive potential assessment method capable of integrating thermal groundwater use in a densely urbanized area was needed. In the framework of the EU-Project GRETA, the Chair of Hydrogeology cooperates with the local authorities and energy planners to achieve this on a city scale. Therefore, a new spatial assessment method was developed. The method includes all relevant regulatory and operational constraints of open loop systems to provide technical potential estimates. Major influences on constraining factors are governed by hydrogeological properties of the aquifer. In consequence, a resilient potential estimate relies on a detailed knowledge about groundwater-level, -gradient, - thickness and - temperature, as well as the hydraulic conductivity of the porous medium. This Data is available in outstanding resolution throughout the city area and was elaborated by the Chair of Hydrogeology in the Projects GEPO and GeoPot, funded by the Bavarian Ministry of Environment and Health. Based on this data, the method calculates sustainable flow rates to get the volume flow potential. This includes a drawdown threshold of 1/3 of the saturated groundwater thickness, an infiltration limit to prevent flooding and a restriction to prevent a hydraulic breakthrough between extraction and injection well. Further, the spatial hydraulic influence is considered to lower negative influences on neighboring well pairs. As thermally altered water is reinjected into the same aquifer, a temperature anomaly occurs downstream of every injection well. This anomaly may interfere with neighboring thermal usages and have to be avoided. Therfore, regulatory thresholds on the temperature spread, the volume flow potential and significant hydrogeological parameters are merged to estimate the footprint of the anomaly for a comprehensive spatial analysis. The method’s mathematical relations are entirely based on numerical simulations. The results from extensive parameter studies have been used in non-linear regression analysis to obtain all required dependencies.