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Integrating the potential of thermal groundwater use in urban energy planning

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In complex urban environments, spatial energy planning is used to develop political strategies for a sustainable energy supply. Consequentially, knowledge about available energy sources is crucial for covering the continuously growing demand, while increasing the share of renewable energy sources (RES). Particular improvement can be made by the facilitation of RES in the heating and cooling sector as it consumes nearly half of the produced energy. In this sector, the thermal use of groundwater can contribute significantly to increasing energy efficiency and mitigating greenhouse gas emissions. Therefore, it should be taken into account in any energy development strategy.

In 2019, Munich conducts a detailed energy planning study with a specific focus on heating supply concepts. As the City is located on a productive shallow aquifer, an approach was required that quantifies this vast potential and offers technologically achievable results on the building scale in a densely urbanised area. In the EU-Interreg funded project GRETA (2016 - 2018), we developed a method that copes with the requirements from spatial energy planning and estimates technologically achievable flow rates of well doublets. The concept includes the relevant regulatory and operational limits and considers hydraulic footprints of well doublets to allow spatial queries of potential estimates. In Munich, the flow rates are constraint by:

- A maximum tolerable drawdown of 1/3 of the saturated groundwater thickness
- A maximum groundwater level rise at the injection well to 0.5 m below the ground surface
- An avoidance of thermal recycling by preventing a hydraulic breakthrough

The maximum flow rates of the specific constraints are analysed by numerical parameter studies. The simulation results are used to fit non-linear regression functions that capture influences of relevant parameters. In the assessment procedure, the derived equations calculate the flow rates of each constraint, depending on the local hydrogeology and the well distance. The resulting technical flow rate is defined by the lowest result. The developed method can be integrated in GIS-workflows and will enable energy planners to consider thermal use of groundwater in a straightforward and adjustable way.