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Geo.KW, a coupled hydrothermal and infrastructure model at urban scale

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To reduce anthropogenic climate change, our energy demand needs to be met by renewable energies, wherever possible. So far, only a minor part of heating and cooling is met by such sources. Shallow geothermal energy, powered by green electricity, can close this gap at a high level of efficiency, while reducing intermittency problems current renewables have. As there are various competing uses of the underground in urban environments, e.g. drinking water protection and infrastructure, local authorities are more and more restrictive in granting licenses for new shallow geothermal systems.

In the project Geo.KW we created a coupling approach, which combines hydrothermal and infrastructure modeling to efficiently position shallow geothermal systems between existing uses and other conflicting groundwater usage, optimized by economical and ecological constraints. This should act as a planning tool for water authorities and policymakers.

We are using PFLOTRAN, a finite volume Darcy-Richards model as our flow and heat transport model.
The energy infrastructure optimization is done with urbs, a linear optimization model for distributed energy systems.
For our iterative coupling, we are using preCICE, a multi-physics coupling library, which facilitates fully parallel peer-to-peer exchange between these modeling domains.

The city of Munich is the pilot-region for the implementation of our tool, supported by local government and water authorities. The size and complexity of the model makes it necessary to run the optimization approach on a supercomputer, i.e. the SuperMUC-NG of the Leibniz Supercomputing Centre. Even there, the model needs to be partitioned for the energy infrastructure optimization to be feasible.