Observations from shallow geothermal modelling case studies in Canada and the UK

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Global demands for energy efficient heating and cooling systems coupled with rising commitments toward net zero emissions building infrastructure have resulted in wide deployment of shallow geothermal systems and in the continued growth in the global geothermal heat pump (GHP) market. With increasing deployment of these systems in urban areas, there is growing potential and risk for these systems to impact the subsurface thermal regime and to interact with each other or with nearby heat-sensitive subsurface infrastructures.

GHP systems have been studied in urban environments with respect to their effects on the subsurface thermal regime, and various modelling studies have investigated the sensitivity of their performance to key (hydro)geological and operational parameters. The focus of these studies has been on isolated systems, where flow conditions and background subsurface temperatures are assumed to be constant, impacted only by the modelled system itself during its operation. However, less attention has been paid to the effects on GHPs functional efficiency from perturbations in the wider hydrogeological and thermal regime, e.g. due to urbanization, multiple BHEs within tight (residential) clusters or competing subsurface uses requiring pumping of groundwater.

In this paper, we present three numerical modelling case studies, from the UK and Canada, which examine GHP systems response to perturbation of the wider hydrogeological and thermal regime. We investigate the influence of key parameters and different model realisations, e.g. relating to system design, unbalanced thermal ground loads and environmental conditions, on the modelled GHP system efficiencies and thermal interference. We highlight findings that are relevant from an economic point of view but also for regulations. Findings are discussed within the context of the contrasting design and operational pattern typical for the UK / Europe and Canada/ North America.