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The impact of storage conditions on heat losses of HT-ATES systems

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Heating and cooling is responsible for about 50% of the European total energy use. Therefore, renewable sources of heat are needed to reduce GHG emissions (e.g. solar, geothermal, waste-heat). Due to a temporal and spatial mismatch between availability and demand of heat, large scale heat storage facilities are needed. High Temperature Aquifer Thermal Energy Storage (HT-ATES) systems are one of the cheapest and most adequate ways to store large amounts of sensible heat. Regular/Low-T ATES systems are considered a proven technology with currently more than 3 000 systems operable world-wide. However, at higher storage temperatures (e.g. 40-100 °C) temperature dependent water properties (density, viscosity) more strongly affect physical processes, resulting in higher and unpredictable heat losses. While first applications and research on this subject started more than 50 years ago, many uncertainties still remain. In this research we study the (hydrogeological) storage conditions that affect the heat losses of HT-ATES systems. Numerical simulations of a wide range of storage conditions, are done to obtain generic insights in the performance of HT-ATES systems. These insights allow to identify which heat transport processes dominate in contribution to heat losses. Results show that conduction always contributes to heat losses for HT-ATES systems and relate to geometric storage conditions. While buoyancy flow (free convection) may also contribute considerable to heat losses under specific conditions.