Aalto University
School of Engineering

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Ground Source Heat Pumps (GSHP) and Underground Thermal Energy Storage (UTES) – Key Vectors to a Future Energy Transition

Title of the dissertation	Ground Source Heat Pumps (GSHP) and Underground Thermal Energy Storage (UTES) – Key Vectors to a Future Energy Transition.
Contents of the dissertation	This dissertation analyses in the first place the integration of GSHP and aquifer thermal energy storage (ATES) in both district heating and cooling networks, in terms of technoeconomic feasibility, efficiency, and impact on the aquifer. A holistic integration and a mathematical modeling of GSHP operation and energy system management are proposed and demonstrated throughout two case studies in Finland. Hydrogeological and geographic data from different Finnish data sources are retrieved for calibrating and validating the groundwater models, used to simulate the long-term impact of GSHP-ATES operation. Another Finnish case study and large-scale GSHP / borehole thermal energy storage (BTES) application - Aalto New Campus Complex - is also investigated in this research. The specifically developed methodology for management of measured data is considered essential due to its capability to handle data with high uncertainty (thermal meters) by using highly accurate data regarding GSHP power demand. Operational data and relevant GSHP performance indicators are presented and analyzed, and a variety of measures for improving system operation are proposed. Additionally, several methods are developed for modeling the effective thermal resistance of groundwater-filled boreholes, deploying a working algorithm coupled with BTES simulation tool. It is observed that in real operation the effective thermal resistance can vary significantly, concluding that its update is crucial for a reliable long-term simulation of the BTES field.
Field of the dissertation	Energy Technology
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Electronic dissertation	https://aaltodoc.aalto.fi/handle/.....
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The dissertation is publicly displayed online 10 days before the defence at
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