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Economic and environmental analysis of an Aquifer Thermal Energy Storage (ATES) of a hospital in Germany

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Hospitals have a large and constant heating and cooling demand over the entire course of the year. To reduce the energy costs and to contribute to environmental relief, it is essential to replace conventional energy technologies by efficient and sustainable energy systems. Thus, in regions with moderate climates, Aquifer Thermal Energy Storage (ATES) systems are suitable technologies to store excess heat in summer and cold in winter to reuse the energy when needed. In this study, we analyse the economic and environmental performance of an ATES system for a building complex of the municipal hospital in Karlsruhe, southwestern Germany. Currently, the studied building is supplied by compression chillers and district heating and has a heating and cooling demand of 4,800 MWh/a and 3,685 MWh/a, respectively. The ATES system includes 6 wells with an overall pumping rate of 963 m3/h. A Monte Carlo simulation provides the most likely value of the capital costs of the ATES system, which amounts to 1.3 ($\pm$ 0.08) million Euro. Thus, the ATES system is a capital cost intensive technology with additional capital costs of about 190 €kW compared to the current conventional energy system. Nevertheless, due to much lower operating costs, the ATES system shows an average payback time of about 3 years. Since direct cooling with the ATES system is feasible, 80 % of the electricity costs can be saved compared to the compression chillers. The ATES system shows average CO_2 emissions savings of 262 tons per year. For this reason, ATES systems are a feasible technology for the energy supply of hospitals in moderate climates.