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Impact factors on the long-term sustainability of Borehole Heat Exchanger coupled Ground Source Heat Pump System

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In recent years, Ground Source Heat Pump System (GSHPS) has been recognized as an efficient technology to utilize shallow geothermal energy. Along with its wide application, some GSHPS are experiencing a gradual decrease in Borehole Heat Exchanger (BHE) outflow temperatures and thus have to be turned off after couple of years' operation. A comprehensive numerical investigation was then performed to model the flow and heat transport processes in and around the BHE, together with the dynamic change of heat pump efficiency. The model parameters were based on the soil temperature and surface weather condition in the Leipzig area. Different scenarios were modelled for a service life of 30 years, to reveal the evolution of BHE outflow and surrounding soil temperatures. It is found that lateral groundwater flow and using BHE for cooling will be beneficial to the energy recovery, along with the efficiency improvement of the heat pump. In comparison to other factors, the soil heat capacity and thermal conductivity are considered to have minor impact on the long-term sustainability of the system. Furthermore, the application of thermally enhanced grout material will improve the sustainability and efficiency. In contrast, it is very likely that undersized systems and improper grouting are the causes of strong system degradation.