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Advanced Coupled Simulation of Borehole Thermal Energy Storage Systems and Above Ground Installations

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Seasonal thermal energy storage in borehole heat exchanger arrays is a promising technology to reduce primary energy consumption and carbon dioxide emissions. These systems usually consist of several subsystems like the heat source (e.g. solarthermics or a combined heat and power plant), the heat consumer (e.g. a heating system), diurnal storages (i.e. water tanks), the borehole thermal energy storage, additional heat sources for peak load coverage (e.g. a heat pump or a gas boiler) and the distribution network. For the design of an integrated system, numerical simulations of all subsystems are imperative. A separate simulation of the borehole energy storage is well-established but represents a simplification. In reality, the subsystems interact with each other. The fluid temperatures of the heat generation system, the heating system and the underground storage are interdependent and affect the performance of each subsystem. To take into account these interdependencies, we coupled a software for the simulation of the above ground facilities with a finite element software for the modeling of the heat flow in the subsurface and the borehole heat exchangers. This allows for a more realistic view on the entire system. Consequently, a finer adjustment of the system components and a more precise prognosis of the system's performance can be ensured.