Geophysical Research Abstracts
Vol. 18, EGU2016-8512-3, 2016
EGU General Assembly 2016

Sensitivity Analysis on the Performance of Medium Deep Borehole Thermal Energy Storage Systems

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Seasonal thermal energy storages using arrays of medium deep (400 m – 1500 m) borehole heat exchangers (BHE) have two main advantages over near surface (< 400 m) BHE storages. Medium deep borehole thermal energy storages (MD-BTES) have a lower thermal impact on shallow groundwater resources and require less surface area. However, the storage performance indicators like the efficiency, the storage capacity and the supplied fluid temperature of MD-BTES are unknown as such system has not been put into practice so far. To study the influence of various design and operation parameters on the storage performance, more than 240 numerical models of different MD-BTES systems were compared in a sensitivity analysis. Most importantly, the BHE length, the number of BHEs, the spacing between the BHEs, the inlet temperatures of the heat transfer fluid into the BHEs and the underground properties were varied. A simplified underground model was used and also a simplified operation procedure was applied for a period of 30 years of storage operation. The results show a strong dependency of the storage performance on the studied design and operation parameters as well as on the underground properties. In the best case, storage efficiency reaches over 80 % in the 30th year of operation, whereas poorly designed storage systems show efficiencies of less than 20 %.