Geophysical Research Abstracts
Vol. 19, EGU2017-3626, 2017
EGU General Assembly 2017

Thermal energy storage with geothermal triplet for space heating and cooling

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Many governmental organizations and private companies have set high targets in avoiding CO_2 emissions and reducing energy (Kamp, 2015; Ministry-of-Economic-affairs, 2016). ATES systems use groundwater wells to overcome the discrepancy in time between the availability of heat (during summer) and the demand for heat (during winter). Aquifer Thermal Energy Storage is an increasingly popular technique; currently over 2000 ATES systems are operational in the Netherlands (Graaf et al., 2016).

High temperature ATES may help to improve performance of these conventional ATES systems. ATES systems use heat pumps to get the stored heat to the required temperature for heating of around 40-50°C and to produce the cold water for cooling in summer. These heat pumps need quite a lot of power to run; on average an ATES system produces 3-4 times less CO_2 emission compared to conventional. Over 60% of those emission are accounted for by the heat pump (Dekker, 2016). This heat pump power consumption can be reduced by utilizing other sources of sustainable heat and cooling capacity for storage in the subsurface. At such operating temperatures the required storage temperatures do no longer match the return temperatures in the building systems. Therefore additional components and an additional well are required to increase the groundwater temperature in summer (e.g. solar collectors) and decrease it in winter (e.g. dry coolers). To prevent "pollution" of the warm and cold well return water from the building can be stored in a third well until weather conditions are suitable for producing the required storage temperature.

Simulations and an economical evaluation show great potential for this type of aquifer thermal energy storage; economic performance is better than normal ATES while the emissions are reduce by a factor ten. At larger temperature differences, also the volume of groundwater required to pump around is much less, which causes an additional energy saving.

Research now focusses on energy balance and energy loss in the subsurface, well design requirements, working/operational conditions of each well, as well as building system components like the influence of weather conditions on performance of system components. At EGU we like to present and discuss the results of this research.

references

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