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Optimizing ATES performance by increasing warm well temperature and harvesting waste/solar heat

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Aquifer Thermal Energy Storage (ATES) systems combined with a heat pump stores and thereby reduces energy use for space heating and cooling of buildings. In most countries, the temperature of the stored heat is limited to maximum 25-30°C for such systems. However, when heat is available at higher temperatures (e.g. waste heat, solar heat), it is more efficient to store higher temperatures because that improves heat pump performance or may even makes it abundant. As a result there is a large potential for additional energy savings by transforming 'regular' low-temperature ATES systems to a HT-ATES. Such a transformation is tested for a greenhouse in the Netherlands. This greenhouse has a LT-ATES system operational since 2012. From 2015 onwards the storage temperature increased and currently heat is stored in the warm well at temperatures up to 40°C. In this HT-ATES transformation pilot, water quality parameters are closely monitored as well as temperature distribution in the subsurface (using DTS). Together with the operators, the results from the ATES monitoring are used to continuously improve system performance. Numerical groundwater and heat flow simulations of actual and expected well pumping data are used to evaluate how well operation can be optimized. Results show that due to the extra heat harvested and higher warm well temperature CO_2 emissions are reduced by 70%, due to larger contribution of heat delivery by the ATES and a more efficient heat pump due to the higher warm well temperature. Groundwater infiltration temperature peaks are up to 40°C during the hottest summer days, while the average warm well temperatures increased mildly by 6°C to about 21°C. Groundwater monitoring results therefore only showed limited water quality changes. The changes that were identified are predominantly contributed to mixing processes, as the ATES system is installed in 2 different aquifers.