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Brownfield remediation combined with sustainable heating and cooling of buildings

Pioneering methods used in the Netherlands combine remediation of brownfield sites with the use of groundwater for heat cold storage (HCS, or ATES: Aquifer Thermal Energy Storage) to achieve both low-cost remediation and sustainable use of energy. A new study demonstrates how HCS can be used to help decontaminate groundwater on brownfield sites.

In recent years, there has been a major increase in the use of HCS in groundwater in the Netherlands, with a view to use more sustainable sources of energy. Usually in HCS systems, with the help of a heat-pump and heat exchanger, the heating or cooling of buildings is used to cool or warm different zones in groundwater. Warmth that is stored in summertime in one groundwater zone is used for the heating of the buildings in winter. In summer, water that has reached low temperatures during winter can be used for cooling. But, difficulties arise if the water is contaminated, as is often the case on brownfield sites.

However, this study highlights how HCS can be used to actually help decontaminate groundwater on brownfield sites, thanks to new techniques and technological developments. The developers and researchers present two brownfield case studies from the Dutch cities of Eindhoven and Utrecht, which incorporated HCS systems, and highlight the benefits of combining technologies to achieve efficient and cost-effective outcomes.

Redevelopment of a brownfield site in Eindhoven created an opportunity to install heat-pumps to allow sustainable use of energy via HCS. However, groundwater at the site was polluted with contaminants from past industry, and the effective combination of remediation and HCS required special control of water flow to contain and eventually remediate the contaminants. To achieve this, rather than designating hot and cold storage zones, engineers developed a recirculation system with extractions that surround the contaminants. This meets energy demand and offers the opportunity to contain the contamination. This technique also provides the added benefit that natural degradation conditions can be optimised through the increased mixing of groundwater, and when necessary by adding substances to the water, such as nutrients.

Although exact figures were not available, initial calculations suggest that this innovative system resulted in approximately a 3,000 tonnes reduction in CO_2 emissions (30-50%) and a decreased consumption of natural gas from 2.8 to 0.6 million m^3. Although the use of electricity increased, from 2.4 to 4.7 million kilowatt hours as a result of heat-pump use, overall costs for heating and cooling were reduced by 30-40%, and there were no separate investments needed for remediation. After two years of operation of the system, the first monitoring results indicate that increased mixing has already led to a significant increase in natural degradation of the contaminants.[1]

The second case study was in the city centre of Utrecht. More than 20 new HCS systems were planned, but the proposed city centre suffers extensive groundwater contamination. Over the large areas considered, there were several different sources of contaminants mixed in the groundwater, making remediation targeted at any single source ineffective and would lead to extreme costs. A management zone was therefore designated, within which contaminants from several sources were allowed to mix. This enables sustainable use of city groundwater for HCS, so long as the surrounding groundwater was protected from any contamination. Results from a mathematical model demonstrated that, under this strategy, the risk of contamination of clean groundwater was low. Improvement of groundwater quality was predicted; increased mixing through the HCS leads to increased natural degradation, and over a 30 year period the total amount of chlorinated solvents was expected to decrease from 6,000 to 4,000kg.

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1.Slenders H.' Verburg, R. *et al.* (2012) Biowashing machines really can work, Experiences after two years with Sanergy, the sustainable combination of groundwater energy and remediation. Conference Sustainable Remediation, Vienna November 2012