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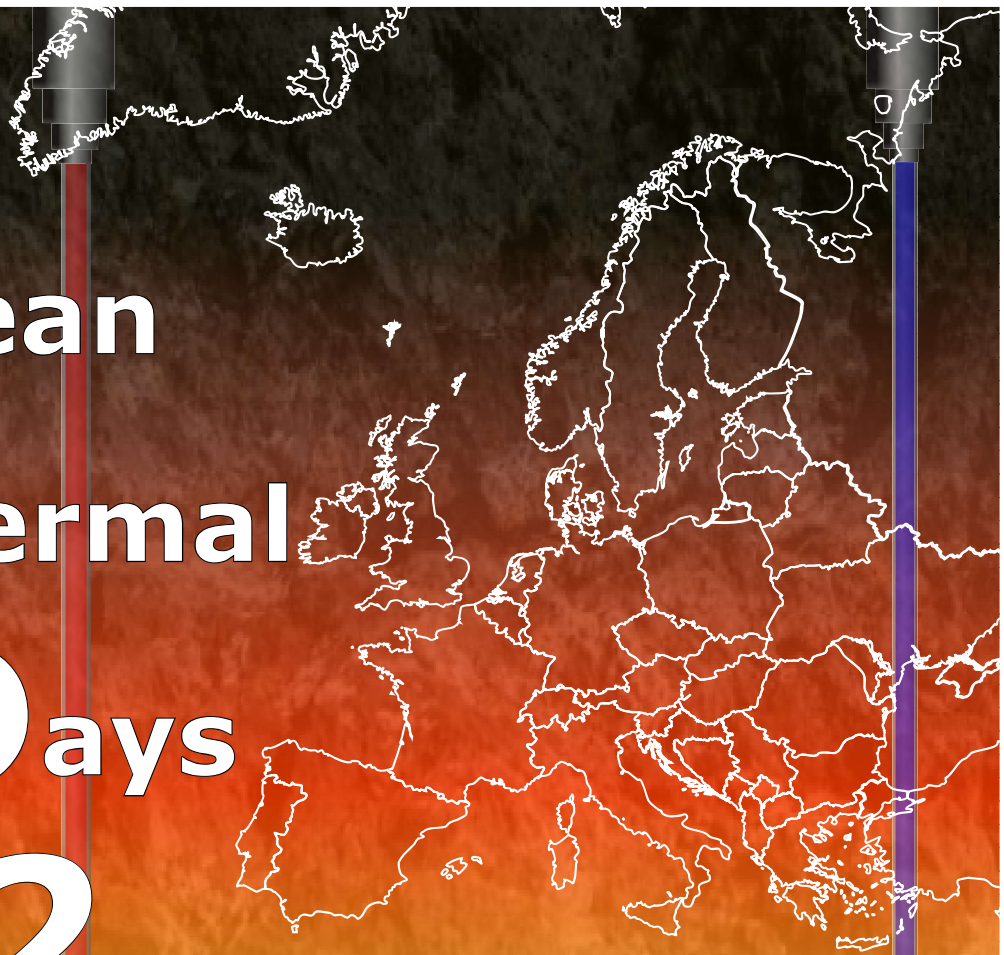

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Aquifer thermal energy storage triplet: Moving towards self-sufficient space heating and cooling.

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Aquifer Thermal Energy Storage (ATES) is mostly used to store heat and cold in groundwater at relatively low temperatures for heating and cooling buildings. These systems emit 3-4 times less CO_2 when compared to gas heating, but still require substantial amounts of electricity to run due to the use of a heat pump (60%). In typical ATES systems in the Netherlands, when there is a cooling demand, groundwater is pumped from the cold well for cooling, raising the temperature of the water to 18°C which is then injected in the warm well. When there is a heating demand water is pumped from the warm storage well and concentrated using a heat pump to the required heating temperature of the building (40-50°C). This process typically cools down the water to 7°C which is then injected into the cold well.

Storing groundwater at a temperature that matches the required heating and cooling temperature can reduce or eliminate the need for a heat pump. This can be achieved by using sustainable sources to supply the heat and cold from the environment (e.g. solar panels, dry coolers). However, the availability of these sources can be insufficient to reach the required temperature level. Therefore a third well is added where water at the return temperature after building heating or cooling is stored, until it can be again heated or cooled to temperatures matching the demand. This is the concept of an ATES triplet.

Initial simulations are presented which show a factor of 10 reductions in CO_2 emissions compared to conventional systems, while the systems are calculated to have an improved economic performance, although require a higher initial investment. Further research will investigate the subsurface and above ground system layout and operational conditions which impact the economic and environmental performance (CO_2,thermal efficiency and pollution).