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Investigating the environmental impact of Shallow Geothermal Energy systems across Europe

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Geothermal energy finds application with Shallow Geothermal Energy (SGE) systems for space heating and cooling. Ground Source Heap Pumps (GSHPs) constitute the main systems used in SGE when coupled with Ground Heat Exchangers (GHEs). GHEs are essentially a network of tubes that extract or reject heat to and from the ground. GSHP systems have recently gained more attention and are recruited for the reduction of fossil fuels and CO2, as an alternative to Air Source Heat Pump (ASHP) systems. However, recent advancements of the ASHP systems through the improvement of their coefficient of performance (COP) classify these at a very competitive scale against GSHP systems.

The directive of the European Union (EU) on the nearly Zero Energy Buildings (nZEB) is already in effect, and requires the residential buildings to have better insulation on the building's envelop, leading to a reduced heating and cooling demand. Such cases could further weaken the higher energy performance of GSHPs and make these systems a not so attractive alternative compared to ASHP systems.

This research aims to investigate such scenarios using seven case studies, at seven different locations across Europe. The same residential building is used in all cases with nZEB technical characteristics. To this extent, a Life Cycle Analysis (LCA) is performed for the environmental evaluation using the ReCipe impact method from a midpoint perspective. The openLCA software is considered, coupled with the Ecoinvent 3.6 dataset for the impact methods and databases. A comparison is made of the case studies through an analysis of the global warming potential impact category. The results show that the northern European countries exhibit a better comparison performance between the ASHP and GSHP systems, compared to the southern European countries.