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Comparative Environmental Impact of Ground Source Heat Pumps and Air Source Heat Pumps for Dwellings with high and low insulation profiles

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Following the European Union (EU) targets towards the “Fit for 55”, the heat pump (HP) sales have seen an increase. The recent increasing demand in the utilization of HP towards space heating and cooling, underscores the pivotal role of Shallow Geothermal Energy (SGE) systems and the Ground Source Heat Pumps (GSHPs). Although GSHPs exhibit higher performance compared to Air Source Heat Pumps (ASHPs), the high initial cost and the consequent long payback period has been a preventive factor for the GSHP systems. The GSHP systems however also benefit for additional CO₂ reduction. The evolving efficiency of ASHP systems in recent studies challenge the perceived advantages associated with GSHPs, particularly in light of the continual refinement of ASHP systems.

This research embarks upon a comprehensive analysis to compare the environmental impacts, in terms of CO₂ emissions, between ASHP and GSHP systems using different case studies. High insulation profile case studies were considered, following the nearly Zero Energy Buildings (nZEB) technical characteristics, as well as retrofitting at older dwellings with a low insulation profile. The current study engages a Life Cycle Analysis (LCA) with the OpenLCA software in conjunction with the Ecoinvent database, and the employment of the ReCiPe impact method, both from a midpoint and an endpoint perspective. The findings derived from this investigation demonstrates a favorable performance of the GSHP systems where there is an increasing demanding in heating such as in the retrofitting cases. This research highlights the important environmental implications of employing the GSHPs over the use of ASHPs.