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# Economics of a sustainable geothermal system for air-conditioning a typical house in moderate climates

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## ABSTRACT

Air-to-Air Heat Pumps (HPs), used for air-conditioning buildings are very efficient as they use the atmosphere as heat source/sink to absorb/reject heat. Yet, in a town in summertime for example, heat is collectively rejected to the surrounding environment, increasing its temperature in the absence of breeze. A sustainable way of utilizing HPs is the use of the deeper ground layers around a building to absorb/reject heat with ground heat exchangers (GHEs). Such systems, shallow geothermal energy systems (SGES), exhibit increased HP efficiency, minimizing electricity expenses, as in summer the ground has lower temperature than the air in the environment (vice-versa in winter). The evolution of SGES has led to competition with Air-to-Air HPs and the manufacturing of custom-designed inverter technology ducted series HPs.

This paper studies the SGES case of a typical house thermal load in moderate climate, through an experimentally validated CFD model based on the convection-diffusion equation and transient time analysis. Water inlet temperatures are examined for summer/winter. The GHE length is optimized and the power rejected to the ground is discussed with regard to system efficiency, affected by the fluid temperature entering the HP. A lower entering fluid temperature increases the system cost as the GHE will need more boreholes for temperature reduction. A cost analysis and a comparison of total energy savings is also done.

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