A cost and environmental impact analysis of Ground Source Heat Pumps in European climates

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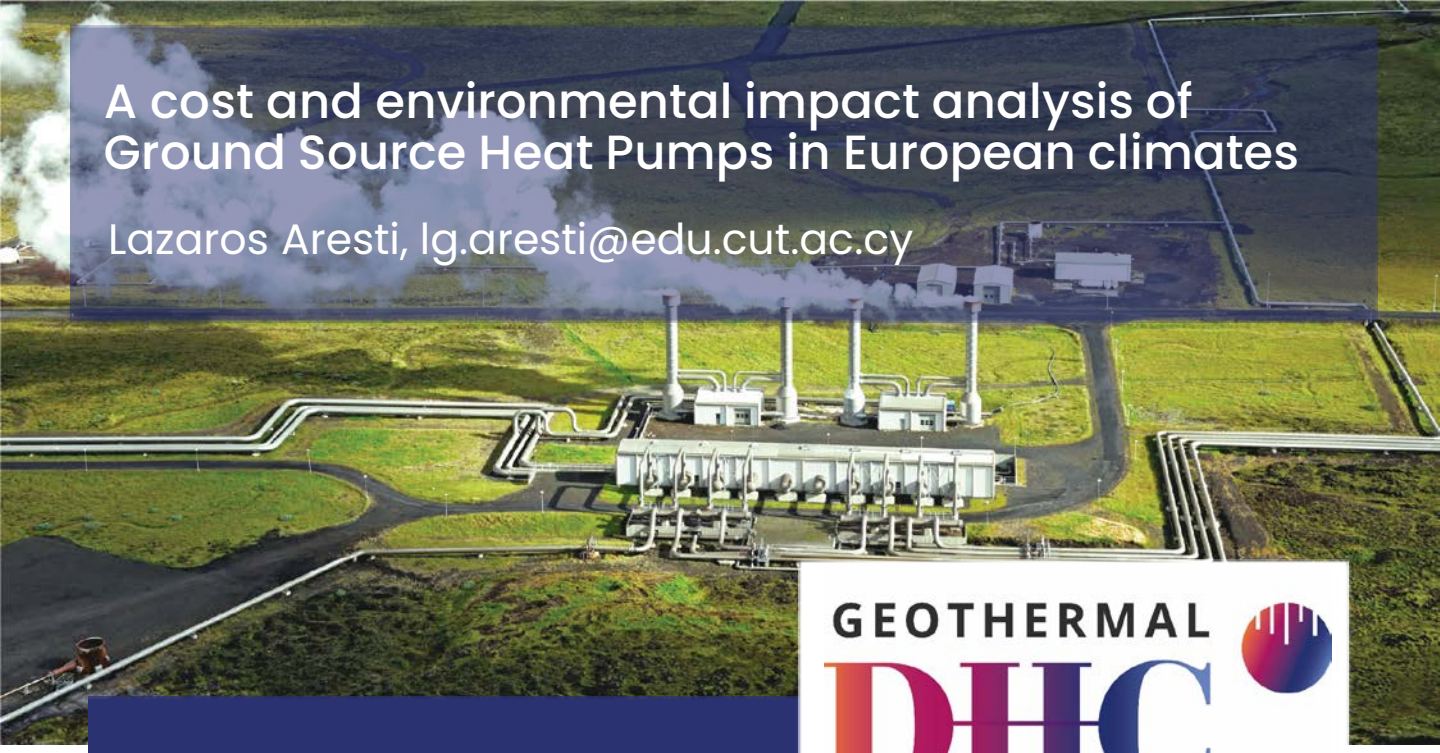

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The aim of this study was to identify whether a Ground Source Heat Pump (GSHP) system is a sufficiently greener overall solution compared to an Air Source Heat Pump (ASHP) system, using specific case studies across EU.

- An environmental impact investigation was performed using the Life Cycle Analysis (LCA) method, and the Global Warming Potential (GWP) indicator.
- A simplified cost savings comparison was also performed

Key Findings

- GSHP outperforms ASHP in most cases, however the environmental impact highly depends on the energy mix used for each case.
- With the increase of cost per kWh, the GSHP presents higher yearly savings, and therefore a shorter payback period

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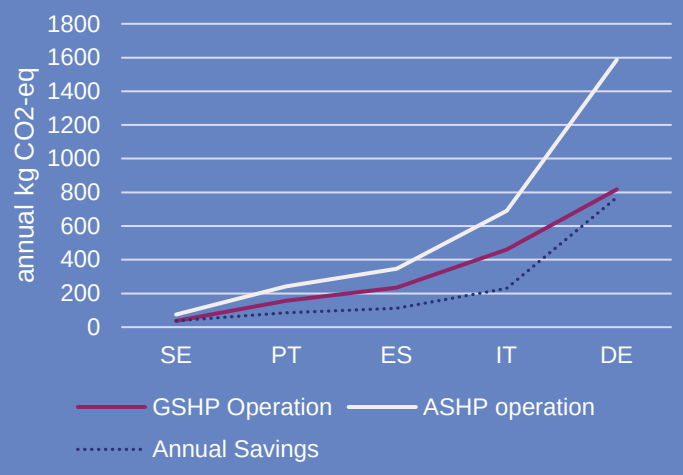
- The comparison on the environmental impact difference between the Ground Source Heat Pump (GSHP) systems and the Air Source Heat Pump (ASHP) system for residential use is presented here
- 5 cases are compared, each case in a different country; Spain (ES), Portugal (PT), Italy (IT), Germany (DE), and Sweden (SE).
- All cases follow the technical characteristics of the nearly Zero Energy Buildings (nZEB)
- The buildings' heating and cooling loads vary for each case as these depend on the location of the building, the masonry characteristics, the usage of the building, and the locations' weather conditions.
- The electricity mix of each case/country is considered by using data from Eurostat (for year 2020)

Environmental impact was performed using the Ecoinvent database and methods

- ✓ Total borehole length required by the cases is: ES: 216m; PT:153m; IT: 151m; DE: 161m; and SE: 215m;
- ✓ The operation process has recorded the highest impact among processes for all cases, and it is presented below.
- ✓ Sweden, exhibits the lowest emissions on the operation process.
- ✓ This is explained by the low usage of fossil fuels in the electricity mix of the country.



GWP of annual kg CO2-eq emissions for the operation of the systems per FU

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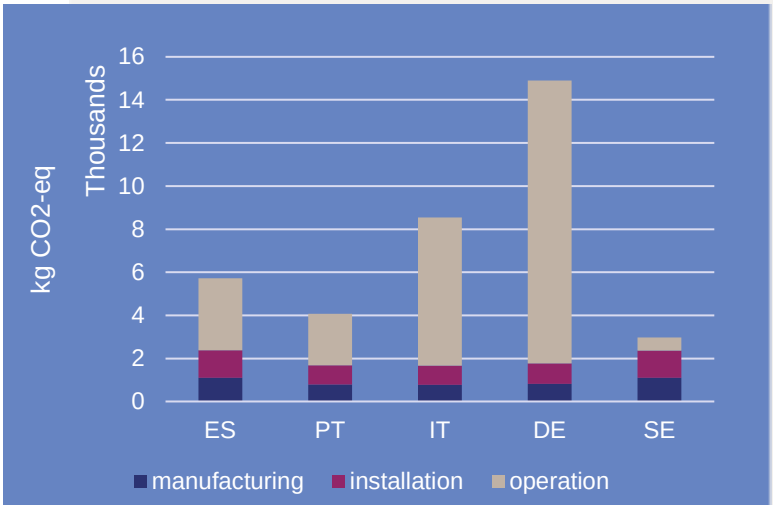
- ✓ Comparing to the ASHPs, not all GSHP systems provide a lower environmental impact (in the lifetime of the system) in all cases/zones.
- ✓ The electricity mix of each country plays a vital role in the environmental impact difference between ASHP and GSHP systems



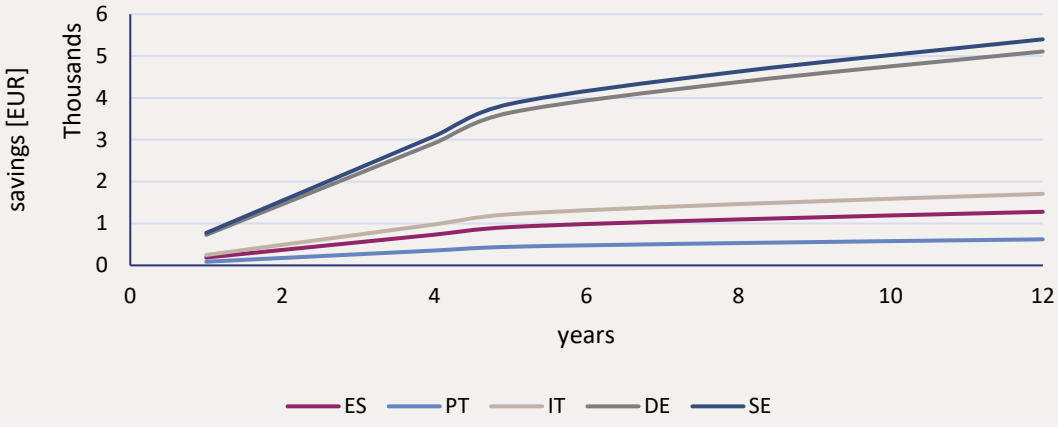
GWP of annual kg CO2-eq emissions for the operation of the systems per FU.

The main difference in the cost between an ASHP and a GSHP system is because of the GHE and the associated equipment and processes, such as:

- borehole extraction,
- U-tube Ground heat exchanger,
- grout material,
- ground loop installation,
- header flow meter valves,
- horizontal pipe circuits,
- as well as other general expenses

➢ For the estimation of the costs, the first season (S1) of year 2021 was used in this study.

✓ The SE and DE cases, are having the highest cost per kWh, and hence the savings are higher



Cost savings between the difference between GSHP and ASHP

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