Implementation of Energy Geo-Structures for Micro-Scale District Heating and Cooling in Mediterranean Environment

Lazaros Aresti[1,2]*, Christos Makarounas[2], Georgios Florides[2], Paul Christodoulides[2]

[1]EMERGE CoE, Lemesos, Cyprus
[2]Faculty of Engineering and Technology, Cyprus University of Technology, Lemesos, Cyprus

*Corresponding Author: lg.aresti@edu.cut.ac.cy

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Ground Source Heat Pumps (GSHPs) are used to heat and cool spaces using shallow geothermal energy (SGE) systems making use Ground Heat Exchangers (GHEs) (i.e., a network of pipes buried in the ground). GSHPs perform better than alternative traditional Air Source Heat Pump (ASHP) systems and can thus fit well in European Union's "Fit for 55" set target for reducing CO2 emissions. However, the primary preventing factor for using GSHPs is the high initial capital expenditure needed. An additional preventing factor is the lower heating and cooling demand resulting from EU's demand for nearly Zero Energy Buildings (nZEB) leading to a higher insulation.

With the current evolution of Geothermal Energy District Heating (DH), GSHP systems could become at last more viable. Having a central unit for distribution however, requires a large plant area, as well as the need for infrastructure and insulated pipes. Unfortunately, such infrastructure is primarily present in central and northern Europe, where a higher heating demand is required than in the southern EU. To overcome these fixes, using SGE systems on a "micro-scale" could serve as an alternative.

To this end, the overall goal of this research is to computationally examine the viability and potential of using SGE systems for a micro-scale urban setting using Energy Geo-Structures (EGS). A theoretical case study on residential blocks is thus performed for the production, distribution, and usage of EGS as a type of District Heating and Cooling (DHC) in the Mediterranean environment of Cyprus. The case study comprises several residential structures within a residential block, which is common for the island of Cyprus, with nZEB features. The COMSOL Multiphysics software is employed to investigate the effect of the ground temperature and the temperature gain or loss from the heat distribution. Subsequently, the potential of using GSHP systems as EGS at a micro-scale DHC residential level is concluded to be advantageous in relation to costs reduction and promotion of the geothermal energy use.