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A low surface footprint ground source heat pump system for collective buildings in urban environment

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The European Union has recently emphasized the need to swiftly reduce the carbon emissions of our buildings: There is only ten years to divide by a factor 2 their Heating and Cooling (HVAC) related emissions. Replacing fossil fuels burners by efficient ground source heat pump can strongly contribute to this objective.

In dense urban areas, and for existing collective buildings, the lack of available land for drilling sometimes hinder the possibility to implement a Shallow Vertical Borehole Array for a heat pump system. We propose to address this limit by creating a non vertical pattern of geothermal probes with equivalent thermal performance as a classic vertical probe field, thus reducing the required surface footprint. We propose as well to review design workflows, from building to ground and heat pumps to optimize the system.

A Celsius Energy demonstrator was designed and implemented in 2020 on a 3000 m2 office building nearby Paris, with both Heating and Colling needs. In this paper we propose to present this system and the implemented technologies, from the ground up : Geological analysis, using some advanced mud logging techniques (mineralogy mud logging), slanted drilling trajectory control strategies and control (direction and Inclination logging), the use of Distributed Temperature Sensing for cement evaluation, permanent thermal monitoring and for Enhanced Thermal Response Testing. Specially designed drilling surface wellheads, heat pump room design for heating and cooling are presented as well as initial performance data of the implemented system.

The paper will conclude on further required improvements – scientific and technical – to enable these innovative systems to scale up across our European cities.