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Assessment and mapping of shallow geothermal potential of open and closed loop systems in Aosta Valley (NW Italy)

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Ground Source Heat Pumps (GSHPs) are very low carbon-intensive systems [1] and they can strongly contribute to the reduction of CO_2 emissions since, heating and domestic hot water account for 40% of the total final energy use in Europe. Furthermore, they do not produce any in situ pollutant emission and they have low operational costs. Nevertheless, the number of installed shallow geothermal plants is still very limited.
The GRETA project, funded by the EU program INTERREG Alpine Space, aims at boosting the exploitation of shallow geothermal energy through a number of actions, among which tools to integrate shallow geothermal energy in the renewable energy planning of three pilot areas in Italy, Germany, and Slovenia. The Italian one is Aosta Valley, a small mountainous region of 3,000 km2 and 130,000 inhabitants in NW Italian Alps where GSHPs have gained an increasing popularity in recent years.
We hereby present a work divided into two sections. The first one deals with the modeling of closed-loop geothermal potential in order to estimate the thermal power which can be exchanged with the ground with a typical 100m-deep BHE. Four estimation methods are compared, i.e. the German standard VDI 4640(2000) [2] and its update of 2015 [3], the English norm MIS 3005 [4] and the recently developed G. POT [5].
In the second part, we address the open-loop geothermal potential of the Aosta plain. We present a simplified analytical model to estimate the thermal plume size, calibrated with numerical simulations on FEFLOW. This model allowed to estimate and map the maximum sustainable density of GWHPs, expressed as thermal power per unit area (W/m2), depending on the groundwater Darcy velocity and on the aquifer saturated thickness. A demonstration is finally shown for a block in flats of Aosta, proving that the open-loop potential provides a conservative estimation of the thermal power which can sustainably be installed in a urban area.
Together, the delivered tools will help public authorities in managing the future development of shallow geothermal technology through energy and land planning.

References

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