**ABSTRACT TITLE:**

# *Open-loop Groundwater Heat Pump Systems (GWHPs) as a solution for decarbonise energy systems in urban areas: the case study of Politecnico di Torino.*

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In order to reduce $CO_2$ emissions and meet the European target by 2030, Italy expects to achieve a 34% share of renewables in the heating sector. Currently, the renewables' share is limited to 20%, with a contribution of geothermal energy of 2.1%. In this context, open-loop groundwater heat pumps (GWHPs), which are currently one of the most suitable technologies for heating and cooling buildings in densely urbanised areas, can contribute to increasing the percentage of renewable energy sources in the thermal sector. In an open-loop geothermal system, water from the shallow aquifer is extracted from a well, passed through a heat exchanger, and then returned to the aquifer at a different temperature. The Politecnico di Torino open-loop geothermal system is an example of a GWHPs application in an urban area with over 12 geothermal wells used to cool areas of the university. The reconstruction of the groundwater flow direction and aquifer's temperature is fundamental for protecting the resource from the GWHPs' environmental impact. This is possible through the prediction provided by numerical models. The use of predictive models for at least three years of geothermal plant operation is also required by the authorities. However, the lack of a clear Italian regulatory framework leads to high fragmentation of the limited data available, which limits the development of this technology.

A transient state numerical model of the Politecnico di Torino GWHPs was carried out to monitor and depict the impact of such a plant on the shallow highly productive unconfined aquifer of the Turin city (Po Plain, NW Italy). Modelling plays an important role in promoting the development of open-loop geothermal plants and should be better integrated into the urban and regional planning strategies and tools to allow for rapid deployment of this technology, ensuring an adequate long-term protection of groundwater bodies.