Enhancing Sustainable Urban Heating and Cooling with Groundwater Heat Pumps: A Case Study in Torino Urban City

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Selected Session	3. Shallow Geothermal
Title of Abstract	Enhancing Sustainable Urban Heating and Cooling with Groundwater Heat Pumps: A Case Study in Torino Urban City
Abstract	Groundwater Heat Pumps (GWHPs) are an efficient solution for reducing carbon emissions in heating and cooling systems in urban areas with favourable geological conditions. These systems draw water from shallow aquifers, undergo heat exchange processes, and return water at a modified temperature. It is important to preserve the groundwater quality of aquifers, which serve as renewable energy sources, for urban sustainability. In order to promote the adoption of GWHP, urban planning should be carried out while ensuring the long-term protection of groundwater. Torino Urban City has an alluvial shallow aquifer that is a valuable source of low-enthalpy geothermal energy. However, it is essential to conduct a comprehensive site assessment to evaluate the environmental impacts, taking into account well characteristics, locations, pumping rates, and thermal effects on local groundwater resources. A model and numerical simulations were developed to analyze two scenarios of over 150 geothermal wells in Torino City, accounting for maximum and average flow rates. The aim was to define changes in piezometric levels and the extent of thermally affected zones. The results at an average flow rate indicate that energy extraction is possible with minimal environmental impact due to the hydrogeological characteristics. The thermal plumes, which are shaped by water extraction and reinjection rates, have an impact only on downstream neighbouring plants. Accurate hydrogeological characterization is crucial for constructing new facilities, as positive aquifer responses to long-term disturbances demonstrate. The proposed urban-scale model is a valuable tool for experts and authorities, enabling the assessment of thermal disruptions at both localized and urban levels. Using this tool ensures the sustainable use of aquifer resources in complex systems, promoting informed decision-making for urban heating and cooling strategies.