



## **Sustainable Use of Geothermal Resources: applications and case studies in Northern Italy**

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### **ABSTRACT**

The increasing interest in the use of geothermal resources in Italy in the last decade, as well as the key role hydrogeology plays in the study of geothermal systems, in the design of installations and in the related sustainability, were considered to set up the Working Group IDROGEOTER (WGI) in October 2012 within the IAH (International Association of Hydrogeologists) Italian Chapter. The WGI started operating in February 2013, with a first analysis of the state of the art in the current use of low-to-high enthalpy geothermal resources in Italy, to be achieved through an inventory of data, applications and case studies, aimed at determining the relationship between the hydrogeological settings resulting from features such as hydrostratigraphy, hydraulic and hydrodynamic conditions, hydrogeochemistry, and the availability of the resource and the potential of the systems; a further development will form part of the activities of WGI, corresponding to the preparation of a proposal of guidelines, specifically focused on sustainability, for hydro-geothermal studies. Whatever the type of geothermal system, groundwater plays a key role in the study of geothermal installations. The hydrogeological characteristics, such as the piezometric pattern, the recharge mechanism, hydraulic parameters, hydrodynamic conditions and hydrochemical features, influence the availability of the resource in terms of temperature, amount and quality. Detailed hydrogeological studies, carried out in Italy in order to optimize the use of geothermal resources, regarding different enthalpy levels and various geological environments (volcanic, carbonate rock aquifers,...), are described. In the Lombardy Region (N Italy), currently the most populated and industrialized region in Italy and therefore the area where the highest number of Groundwater Heat-Pump (GW-HP) plants are installed, a representative sample of both open-loop and closed-loop systems could be selected, considering the need to identify the critical hydrogeological factors contributing both to the geothermal potential and to a sustainable use of the resource in the current trend of urban sprawl. In the Piedmont Region (NW Italy) several experimental sites have been investigated in order to assess the potential subsurface effects of open-loop GW-HP plants for the cooling and heating of buildings; a comparison between field measures and numerical modelling results reveals that the most important aquifer parameters affecting the developing of the Thermal Affected Zone (TAZ) around the injection wells are those related to advective heat transfer. In the Veneto Region (NE Italy), with regard to low enthalpy, other studies are in progress on sites potentially suitable for closed-loop and open-loop systems, and together with data from automated monitoring of several wells, these could be used for advanced analysis of different hydro-geothermal systems; advanced analyses have been carried out at the pilot site of Vicenza, to characterize different hydro-geothermal systems. The design of the GCHP system, combining a heat pump with a ground heat exchanger (closed loop systems), was authorized temporarily, until the results of the monitoring phase become available; these results may be useful for completing in particular the hydrogeological and environmental assessment and achieving a more specific knowledge of the local application for a vertical closed loop heat exchanger system, which in the studied area is marked by the presence of excellent aquifers, in terms of both qualitative features and quantitative peculiarities.