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The importance of geological conditions for the utilization of low enthalpy energy by vertical ground heat exchangers *(Case Study of the Lodz area)*

In the search for renewable resources, geothermal energy quickly emerges as a clean widely available energy source. The status of GHPs (Geothermal heat pumps) in Poland is lower compared to other European countries. One of the problems is insufficient recognition of the specific ground-water conditions for vertical ground heat exchangers which affects the economical efficiency of GHP installation. Geothermal heat pump systems are a growing sector in the space conditioning market as energy efficiency has become a critical issue in building operations. GHPs have been successfully operated for decades in virtually every building type for both heating and cooling. However in Lodz area use GHPs is relatively new.

Analysis of archival materials from the drillings made possible to analyze the geological structure, the thickness of each series, their lithological formation, lithofacial differentiation and origin of sediments in Lodz area. Complicated geological conditions in the Lodz indicate the need for a detailed study on the conditions for low enthalpy energy consumption by vertical ground heat exchangers. The review of the literature shows that is no studies on productivity and opportunities for vertical ground heat exchangersin the city. A geological approach is necessary from the starting phase of the project of GSHP. Collecting any kind of geological, geotechnical, hydrogeological and thermogeological information for the project area will be useful and can save lots of money. The geological situation is that part of GSHP design which cannot be changed by the planner. Hence the design needs to adapt to geology, and thus requires knowledge of geological data: rock type and hardness, ground thermal characteristic and groundwater situation. The most important data for proper sizing of closed loop system is thermal conductivity. The thermal conductivity λ [W/(K · m)] describes the ability of a rock to transport thermal energy by means of heat conduction. Different types of rock/soil mineral and moisture contents conduct heat differently. Understanding how GHP systems interact with the ground is essential for proper design and requires a brief of overview of geology and hydrogeology. Published information on Polish Geological Survey is readily available and provides general information for geology in Poland. However geology in Lodz can vary widely even on a small site. In order to identify the geological conditions for suitability for ground heat exchangers in the study area were analyzed over 2000 profiles of boreholes located in Lodz agglomeration. Boreholes database gave rise to:

- performance of 18 geological cross-sections; 3 maps of drilled deposits of a depth 30 m, 50 m and 100 m below the surface; 3 maps of estimates thermal conductivity λ [W/(K · m)] in different geological conditions in Lodz area; 3 maps of estimated thermal performance factor of vertical ground heat exchanger in analyzed boreholes in Lodz area. The results of the work are presented in graphical and descriptive. In the descriptive part discusses the elements of the geological conditions relevant to

the installation of vertical ground heat exchangers. Made a set of schematic geological cross-sections, thematic maps on the coefficients of thermal calculations and analysis of existing materials, allowed for the presentation and description of the geological conditions for the installation of vertical ground heat exchangers in the.

Lodz is essentially characterized by a layer of varies unconsolided glacial deposits overlying various types of sedimentary bedrock. Variations exist in their origin, distribution, thickness and hydraulic properties. Geology formations identified in the Lodz range from Craterous bedrock to modern unconsolidated deposits. The oldest analyzed and drilled sediments in Lodz area belong to Upper Cretaceous (Maastrichtian) and are represented by limestones and marl. Neogene sediments are represented by a complex of sands and clays sediments. In the study area the quaternary deposits form a continuous sedimentary cover. These formations are the result of geologic processes that include sedimentation and erosion. Unconsolided deposits are composed of sand, silt, clay, gravel or mixtures thereof. They generally contain ground water. In contrast, bedrock is a consolided highly fractured Craterous material. It is presented everywhere however varies in depth. Bedrock is typically weathered and strongly fractured. Unlike consolidated deposits, bedrock is generally not permeable. However ground water can collect in fractures and faults to create a bedrock aquifer. Craterous bedrock is overlain by significantly younger unconsolided glacial and postglacial deposits.

In Lodz area Pleistocene and Cretaceous are the most significant deposits associated with GHP system. Deposits are not homogeneous and may be solid, unsoiled, fractured, extensively weathered or a combination thereof. The best conditions for ground sources heat pump system have been identified in different parts of the city. Because of the complicated geological structure in the ground, conditions for GSHP systems which are observed in the city are very heterogeneous and unevenly distributed. Generally, in areas where the aquifer is shallow under the surface the conditions for GSHP are the most favorable and convenient. Ground water presence is an important factor determining the suitability of GHP system. System will benefit from the additional thermal capacity gained from surrounding ground water. Generally, unconsolided deposits in Lodz, water-bearing sand and gravel aquifer have optimal condition - have high thermal conductivity. Sillty/clayey material have low thermal conductivity. The conditions for GSHP in Lodz are better when Maastrichtian bedrock is shallow.