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Geothermal Potential Increase Related to Low- and Ultra-low Temperature District Heating Systems Application – Preliminary Version

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ABSTRACT

Although high-enthalpy resources are raising main attention among investors looking for high-interest rates, low-temperature geothermal resources are significantly easier to access and occurring more frequently. Thus, in order to increase geothermal heat use worldwide, it is crucial to facilitate the use of geothermal water, even if it does not necessarily depict with "hot" adjective.

One of these ways of increasing geothermal energy use is the application of ultra-low temperature district heating systems (ULTDH). When applied, not only so-far neglected geothermal resources may gain in importance, but also even more energy from already exploited reservoirs may be extracted. There are obvious difficulties in LTDH (50 – 55 °C supply temperature) and ULTDH (below 50°C supply temperature, not formulaic so far) implementation. Among them pointed out may be not suitable heating systems in dwellings, yet there are opportunities to mitigate those inconveniences. Main advantages of lowest-temperature geothermal aquifers exploitation are increased the prevalence of geothermal energy use. In this way, local communes may gain an important source of merely mineralized water while creating a central heat source which may easily cooperate with various renewable and waste heat sources. Not negligible is also a limitation of heat loss and potential applicability of the ULTDH system as a heat receiver (cooling network).

In the paper, there will be presented crucial obstacles in 4th and 5th district heating generation sourced with geothermal energy, increase of useful energy available from given geothermal reservoirs and increase of country's area where use of geothermal water would be enabled by application of ULTDH, along with proposed methodology (on example of Poland).

1. INTRODUCTION

Decreasing temperature of supply in district heating (DH) systems is well-known and applied worldwide. Limitation of temperatures within the district heating tends to increase exergy [1], leading both to improved economic and ecological performance of the system. Low and ultra-low temperature district heating systems facilitate waste and renewable energy sources use [2], including solar and geothermal resources. Indeed, temperatures in low-temperature district heating (LTDH) systems are in the range of 50-55°C (supply node) and 20-25°C (return node) [2], [3] whilst temperatures in ultra-low-temperature district heating (ULTDH) systems may be even lower [4]. Observing mentioned temperatures it becomes clear, that each and every low-temperature geothermal reservoir may potentially be the only heat source for LTDH or ULTDH systems, regardless of which definition of low-temperature resources would be affirmed (one of the most liberal definition says about temperature lower than 90°C [5]). Important is, that LTDH and in some ranges ULTDH do not require heat pumps to provide enough energy for heat receiver for the entire year, although they are not excluded.

Decreased temperatures of DH systems entail opportunity of using more commonly occurring geothermal resources on one hand and sell larger amounts of geothermal energy – on another. It is related to comparatively low return temperature, which causes the possibility of providing district heating thermal water with heat of relatively low temperature. Simultaneously, the lowered temperature of the supply node leads to a high share of energy covered by the source which would not be sufficient for a typical district heating system. Significant drawbacks of the LTDH and ULTDH are an incompatibility with typical radiator-based installations, vast mass flow (especially in ULTDH case) and limited opportunity of increasing power of the district heating node. Therefore the implementation of LTDH or ULTDH in existing DH systems may be difficult and not feasible. Yet, if a new system is planned, it may be efficiently adjusted to LTDH or ULTDH standard and often sourced with geothermal heat.

2. MEANING

Although in volcanic regions where pressurized geothermal steam is available listed advantages are paltry (supply/return temperature) or of minor meaning (amount of heat sold), for regions of shallow sedimentary basins LTDH or ULTDH parameters may colour decision of geothermal resources use for district heating purposes. Thus, although the amount of geothermal energy is settled and does not depend on any infrastructure, the potential of geothermal power may vary depending on the planned way of geothermal energy use. It is related not only to improved cooling geothermal water but also due to more spread occurrence of required temperatures. Consequently, more towns and cities may use untapped geothermal potential, if their infrastructure is ready for that.

3. INFLUENCE

GIS analyses have been performed to check, what area might use geothermal heat directly, without heat pumps, if LTDH or ULTDH became a standard. The Jurassic basin in the Polish Lowland was considered [6]. Operations were performed for three scenarios: (1) LTDH without an additional heat source, (2) ULTDH without a peak heat source and (3) LTDH with a peak heat

source. ULTDH with additional heat source was neglected. As heat exchanger's finite heat transferring ability has been considered, the temperatures required for LTDH and ULTDH supply has been increased by 5°C. Accordingly, minimal temperatures in scenarios 1, 2, 3 were 55-60, 45-40 and 25-30°C, respectively.

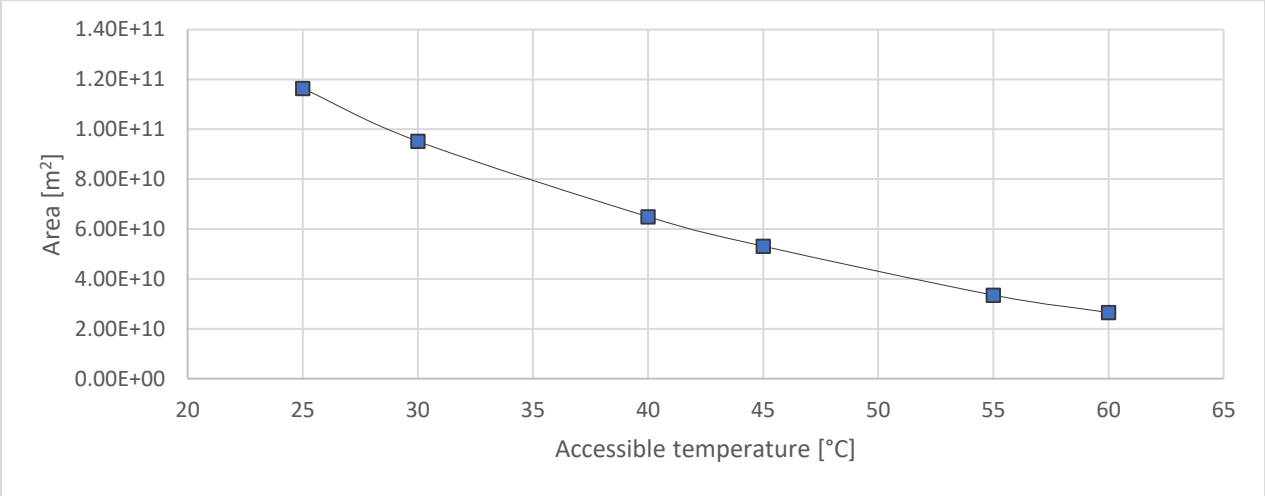

Figure 1: Area with geothermal resources of a given temperature of geothermal water.

The first step was the assessment of the difference in the area covered. It turns out, that area in which LTDH with additional heat source may operate is more than 4 times larger than the area in which LTDH may operate based solely on a geothermal heat source. Simultaneously, theoretically accessible power is 5 times the power for more demanding DH configuration. It is a matter of fact that temperatures of geothermal water as low as 25-30°C would entail a very restrictive obeying return temperature respecting to keep the geothermal heat accessible for heat receivers. Nevertheless, such a situation is not excluded and might be facilitated by supplying the receivers other than dwellings.

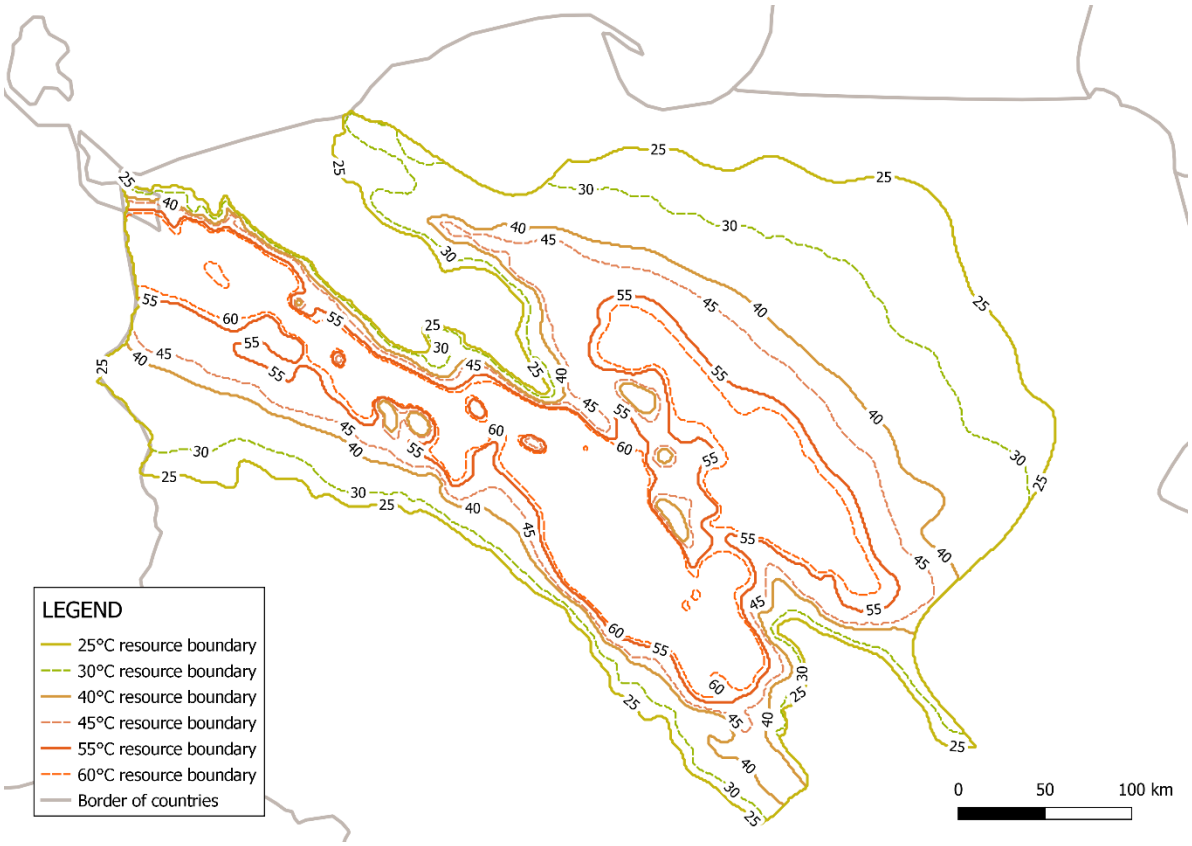

Figure 2: Envelopes of Jurassic geothermal resources of given temperature in Poland.

4. CONCLUSION

Use of low- or ultra-low-temperature district heating leads both to increased use of geothermal resources and extends their availability to the areas, where previously they were difficult to use for district heating purposes. If LTDH or ULTDH is developed in the area with geothermal water of temperature higher than required, such systems offer deep cooling of obtained geothermal water, facilitating sustainable exploitation of the reservoir. In areas, where temperatures of geothermal fluids are not sufficient for typical DH, (U)LTDH systems offer the possibility of taping potential of existing resources.

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