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GEOTHERMAL ENERGY AS A SOLUTION OF THE CITY AIR POLLUTION – AN EXAMPLE FROM CZECHIA

Abstract: Small cities and towns in the Czech Republic face problems with air quality especially during colder part of the year. The main sources of the air pollution are connected with the heating of buildings. The paper illustrates the situation on example of a typical mid-size town of the Czech Republic. Due to a long-term effort of the municipality, the dust imissions have dropped to one third of their original level since the beginning of the 1990's. However, further improvement would require a conversion of the 43 MW coal burning heating plant to natural gas. This would cause a steep increase of the heating price for users of the district heating system and might lead to disconnection of many of them. The town of Litoměřice therefore looks for suitable solutions in using renewable resources and since 2008 has been preparing project of building a geothermal heating plant.

INTRODUCTION

Whereas the electricity power supply and its production in the Czech Republic is well organised and does not represent a serious source of environmental pollution, a situation with heat supply is different. Especially in smaller cities and towns there are heating plants for district heating systems using brown coal as primary source of energy. Similarly, many houses and apartments burn coal or other fossil fuels and deteriorate the air quality in the immediate vicinity of people. One of typical mid-size towns of the Czech Republic that faces this problem and struggles to improve the situation is the town of Litoměřice with 25.000 inhabitants.

1. AIR POLUTION IN THE TOWN OF LITOMĚŘICE

Owing to overall effort of the Czech state after regime changes in 1989 to solve critical situation of the air quality in industrialised regions of the country and thanks to a long-term effort of the Litoměřice focused on conversion of coal burn-

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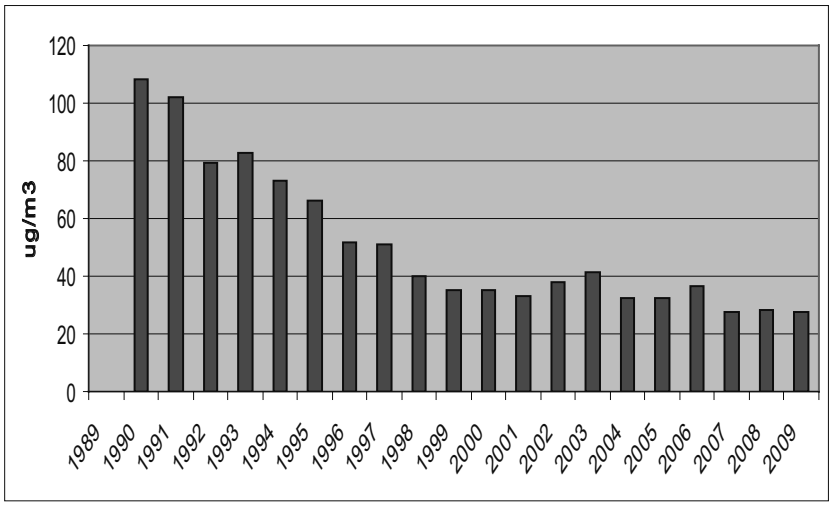

Fig. 1. History of PM 10 dust imissions (μg/m3) in Litoměřice in the period 1989–2009.

ing in the individual houses and public facilities to less polluting sources like natural gas, heat pumps etc., the dust imissions have dropped to one third of their original level since the beginning of the 1990's (Fig. 1).

Even larger improvement was achieved in imissions of sulphur dioxide, where the values dropped to one tenth within a 20-year period 1989 – 2009 (Fig. 2). The main reason for this improvement, beside measures taken in the town itself, was the national programme of desulphurization of large coal burning power plants in

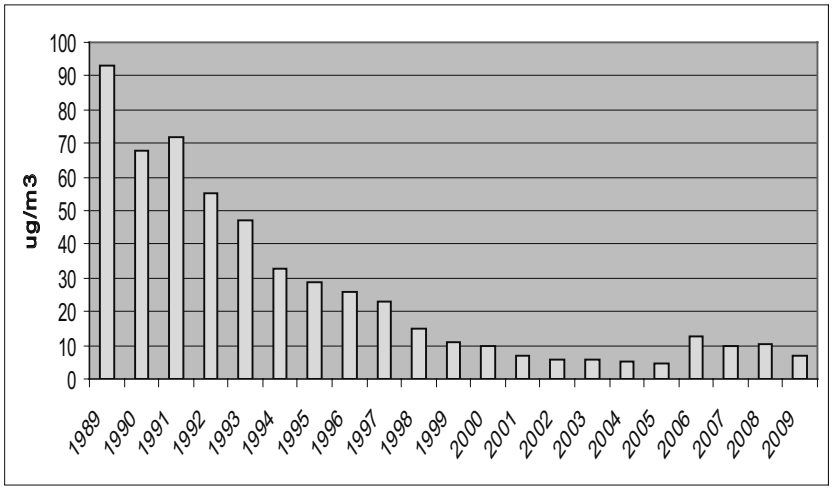

Fig. 2. History of sulphur dioxide imissions (μg/m3) in Litoměřice in the period 1989–2009.

the Czech Republic, most of which are located in the Northern Bohemia 100 – 150 km distance from the town.

However, further significant improvement is beyond possibilities of the town itself because it would mean to convert main heat source in the town – the 43 MW heating plant providing heat to the district heating system (DHS) – from brown coal to natural gas. This solution, however, has not been acceptable for the private owner of the heating plant due to enormous investments so far. In addition to it, the conversion would cause a steep increase of the heating price for users of the DHS and might lead to disconnection of many of them. Furthermore, subsequent increase of heating plant and DHS operation costs would impose another pressure on heat energy costs and other households might disconnect and get back to burning fossil fuels in their old boilers. This would again deteriorate local air quality. Similar situation has already taken place in some of the Czech cities. That is the reasons why the town management has decided to explore the possibility of using geothermal energy as one of the main resources of heat energy for households and tertiary sector, too.

1. RESULTS OF THE EXPLORATORY BOREHOLE

An important step in realisation of this intention was drilling the 2.1 km deep exploratory borehole at the site of the planned geothermal heating plant at the periphery of the town in the area of former military barracks in years 2007–2008. The money for drilling was provided mostly by the Ministry of Industry and Trade of the Czech Republic, but not negligible amount of finances came from the municipality itself. Several research groups from institutes of the Academy of Sciences of the Czech Republic, Czech Geological Survey and Charles University in Prague were involved in collecting and interpreting geological and geophysical data obtained from the borehole. The results contributed to better knowledge of geological conditions of the site and confirmed high terrestrial heat flow, which means fast increase of temperature with increasing depth [1].

The results enabled scientists from the Institute of Geophysics of the Czech Academy of Sciences to do a more reliable prognosis of temperature for the depth of 5 km, which was considered as a maximum depth for the geothermal energy extraction, because it was a maximum depth accomplishable by conventional drilling rigs. Despite narrowing the range of possible geological and geophysical conditions by analysing the data from the exploratory borehole, there are still some poorly constrained parameters below the depth of the borehole. That is why several slightly different geothermal models were considered in the temperature prognosis. The results were described in [2] and the forecasted temperature – depth profiles are shown in Fig. 3. The most probable temperature expected at 5 km depth is in the range 140 – 150 °C, but in the least favourable case it could be only 130 °C, whereas in the most favourable case 160 °C. It is noteworthy that the average temperature curves for the two geological models considered approximate very tightly, one from below, the other from above, the temperature profile measured in German super-deep (9 km) borehole KTB located some 180 km to west-southwest of Litoměřice, close to

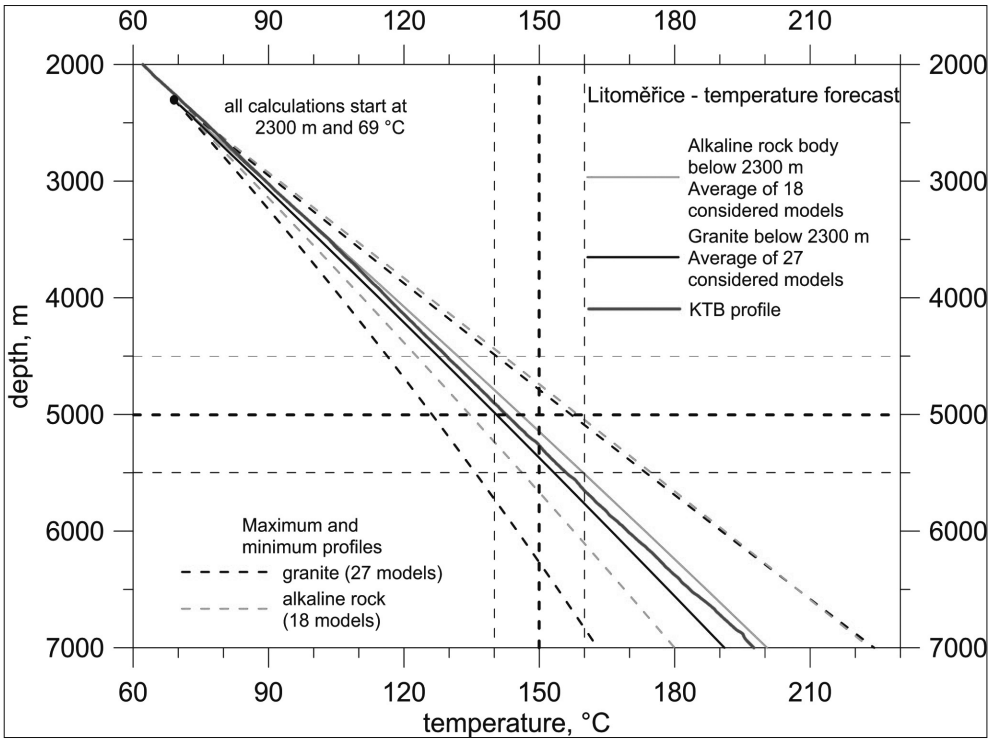

Fig. 3. Temperature forecast down to 7 km based on geothermal models consistent with the results of the exploratory borehole in Litoměřice.

the rim of the same geological structure, the Ohře rift, as the town of Litoměřice. Current considerations, however, go beyond the depth of 5 km as the technology has developed significantly and the well design should be based on 5.5 km deep well to allow for some contingencies and achieve temperature by 10 – 15 °C higher (Fig. 3) than in 5 km, if necessary and technically feasible.

2. OUTLOOKS FOR SUCCESS

The realisation of the exploratory borehole and the interpretation of its results from the point of view of deep geothermal energy exploitation improved bankability of the project which is, nevertheless, still greatly dependent on public funding, mainly the EU structural funds. There are other favourable facts: i) the large majority of town's citizens supports the project, ii) the municipality is ready to participate financially on it, iii) the private owner of the heating plant is ready to cooperate in possible integration of the new source in the DHS, iv) the site of the geothermal plant is available and it is a property of the town, v) the permission for drilling of 5.5 km borehole has been issued. However, this is not enough to overcome a reluctant position of public institutions (mainly ministries) and banks to finance the project. The

main reason is the risk of its failure, which is difficult to estimate before drilling the first borehole. Namely the formation of a deep heat exchanger by hydro-fracturing the hot rock is always a unique operation depending on many hardly predictable parameters of the rock massive. One of the possibilities how to deal with geological risk is to insure this risk. However, there is no such an insurance scheme available on the market in the Czech Republic, yet, despite the fact that such schemes have already been used in other countries in Europe. Another negative factor is a missing or only low "verbal" support on the regional and national level, which contrasts with a strong local support. This lack of support was even deepened by passing a new bill in the Czech Parliament in September 2013 that limits financial support for renewable resources (RES), including geothermal sources, between 2013–2016, and practically stops further support in terms of feed-in tariffs for new RES after 2016. This negative and distrustful attitude of the Czech national agencies and ministries do not allow use any domestic funding now. The main hope for the future is therefore new funding programme of EU called Horizon 2020 where the renewable energy sources, including deep geothermal energy exploitation, are among priorities. Another possible source of support could be the new EU cohesion funds for the Czech Republic for the period 2014–2020. All these possibilities are closely monitored and the municipality is prepared to exploit them as much as possible.

CONCLUSION

It turned out to be very difficult for citizens of a typical Czech town Litoměřice to improve quality of their environment below the pollution levels reached 10 – 15 years ago. Even under very favourable social, political and natural conditions the town is not able to raise money necessary for the project of geothermal heat plant. The only feasible way seems to be that of smaller incremental steps financed from the EU cohesion funds or from the projects of the EU programme Horizon 2020 starting with first well for R&D purposes and then continuing, based on the results of the first well, with another one or two wells. This procedure would limit the geological risk to a minimum and allow banks to consider this project as interesting and as investment with a good potential.

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