THE ROLE OF THE COMMUNITIES IN THE UTILIZATION OF SUBTERRANEAN GEOTHERMAL ENERGY

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UNTERHACHING'S GEOTHERMAL PROJECT

According to Clause 83 of the Bavarian Constitution, towns and communities in Bavaria are required to provide basic living standards in areas under their jurisdiction. Clause 28 of the Federal German Constitution also refers to this fundamental obligation on part of the community.

Among other factors, a reliable supply of energy contributes to one's living standards. Communities can mange this in accordance with the principle of subsidiarity. They can either realize this on their own or use the resources of outside institutions and companies. The essential charge of the constitution is to guarantee the basic necessities to the citizens. This often results in setting up municipal or community works which apart from guaranteeing an adequate water supply, garbage and sewage disposal, also provides electrical energy and heating within its areas. A supply of energy by the community occurs especially in areas when it can rely on its own resources.

Due to the fact that the provision of usable energy in any form is connected with the transformation of primary energy and depending on the choice of the latter source results in climate relevant emissions. Communities are therefore obliged to adopt precautions regarding climate protection. The conservation of an intact climate is an extremely important part of one's living standards. The Bavarian Constitution does not stipulate this explicitly as the duty of the community, but it is seen as a communal responsibility as mentioned in the concluding document of the United Nations Conference on Environmental Protection and Development (UNCED) held in 1992 in Rio – Agenda 21.

The community of Unterhaching (just south of Munich) has been dealing with the problem of climate protection since the 1990's and the supply of an efficient and alternative source of energy.

Important measures towards realizing this included financial support for using potential energy saving methods, the promotion of alternative forms of energy for domestic households, the construction and development of inter-connected power-heating systems as well as solar thermal and photovoltaic plants, finally setting up the Geothermie Unterhaching GmbH & Co. KG, a communal company for the utilization of deep subterranean geothermal energy.

A requirement for the exploitation of subterranean geothermal energy in Unterhaching and in general in the Alpine foothills is the favourable geological formation of soft light sandstone in southern Bavaria. This is suitable for the effective use of calcareous limestone as a high yield aquifer. The expected temperature in the aquifer exceeds 100˚C especially in regions in a line south of Munich.

On the basis of a feasibility study by the Institute for Geological Community Tasks (GGA, Hannover) dealing essentially with the analysis of the results of oil and gas drillings carried out in southern Bavaria until 1990, the local council decided to go ahead with the task of realizing the two stage usage of a hydrothermal source of energy (Fig. 1). The requirements for a successful realization under viable economic conditions were as follows: water temperature in excess of 115˚C, a yield of 150 l/s, the construction of a closed thermal water cycle on the basis of twin boreholes, as well as building of power stations with power-heat coupling for the efficient conversion of the subterranean geothermal energy to electrical and thermal energy for local supply, independent as far as possible of fossil energy suppliers. This would guarantee energy supplies and at the same time make a significant contribution to climate protection.

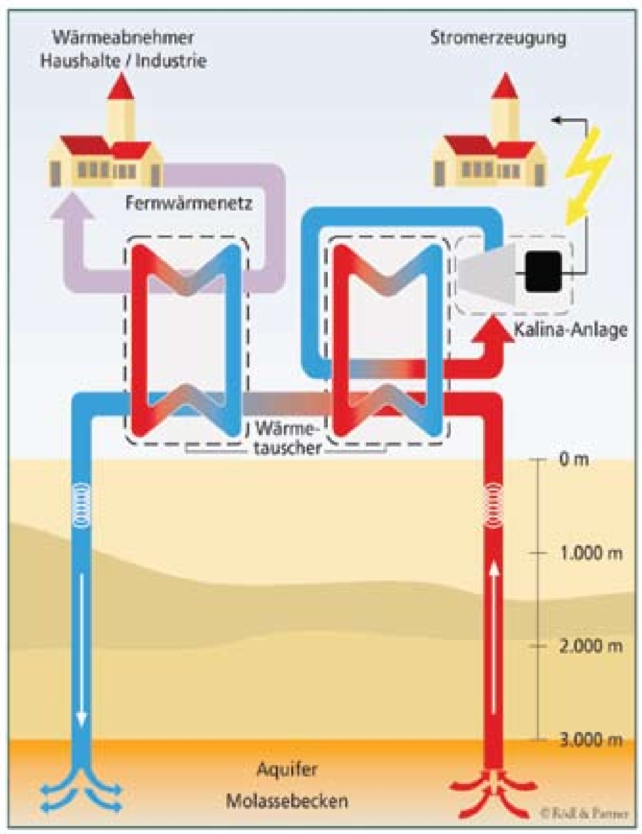

Figure 1. Schematic view of a geothermal power plant for the operation of a power-heat coupling system.

A decisive factor in deciding to adopt this form of energy was the economic safeguard provided by the Renewable Energy Law (EEG) of the Federal Republic of Germany which over a period of 20 years guarantees a fixed payment by the regional energy supplier for the delivery of electricity generated by geothermal energy.

Planning began in the spring of 2002 after being allocated an exploratory area by the Bavarian State Ministry for Economics, Infrastructure, Traffic and Technology (BStMWIVT). The hydrogeological values for temperature and yield were fixed in the allocated text. This was certainly courageous, but it provided to be right.

Derrick with 54m height for drilling the reinjection drillhole. At the rear side one can see the assembled drilling rods with a length of 27m.

The planning of the boreholes is decided by the data for the expected water temperature and yield set down to the feasibility study. In order to generate electricity with a yield in excess of 100 l/s, a larger borehole is necessary than one required for a similar geothermal project with a lower yield. In other words the feasibility study for a project of this kind is extremely important for deciding for or against the use of hydrothermal primary energy in a power station based on power–heat coupling. The water temperature is the decisive parameter for this decision. If it is too low, a two stage utilisation of hydrothermal energy is impossible thereby significantly restricting the chances of long term economic success. The feasibility study is decisive for the economic viability and the overall efficiency of the plant.

This meant, for example, that for the Project Unterhaching the aquifer had to be tapped with an 8-1/2 inch diameter borehole with meant an outer bore diameter of 22 inches for the upper pipe. Using hydrothermal energy for supplying heat only an e.g. 6-inch bore diameter in the aquifer would have been sufficient. A subsequent correction of the drilling results is either virtually unfeasible or cannot be expressed in economic terms. One cannot or only to a slight extent realize the efficient transformation to electrical energy which could cover a basic minimum power supply. Reduced heating requirements in sparsely populated areas, would result in a loss of a source of income thereby preventing the achievement of a better economic result. This economic aspect has also to be urgently considered by the communities.

Furthermore the location of the borehole in the limestone aquifer is decisive for the drilling plan and for the economic success of the project. The analysis of seismic profiles for the region around Unterhaching is helpful. This resulted from earlier investigations of exploratory oil drillings. This procedure is certainly advisable in order to increase the chances of realizing a high yield, because from the seismic profile analysis one can localize gaps in the limestone which can then be accurately targeted when drilling. Boring in limestone can become a risky business.

In order to cover any risks involved, the local council requested an insurance for the Project Unterhaching to cover the success of the undertaking. This was achieved after lengthy negotiations. The BStMWIVT supported this first ever insurance for a private enterprise thereby safeguarding the success or partial success of an exploratory drilling in Unterhaching. For the insurance company, firm temperature forecasts and a data based evaluation concerning the southern Bavarian sandstone (Molasse) were the determining factors. The drillings were carried out with the following results: approx. 123˚C and >150 l/s. The expectations of the feasibility study were exceeded. Consequently there was no need to make any claims on the insurance. Despite widespread knowledge of geology and success of the project, it must be mentioned that technical difficulties were encountered when drilling as a result of which schedules were exceeded. A discussion of these technical difficulties would be outside the scope of this article. Basically they are avoidable as shown by some very successful drillings in the Molasse. They were also carried out within the allotted time frame in order to limit the technical risks it would be necessary to keep in mind all previous difficulties and setbacks.

View upward to the top of the derrick along side the drilling rod. In order to gain time for the round trip three drilling rods of 9m each are assembled.

Disassembly of drilling rods after finishing a drilling tour.

Based on the exploratory drilling the Geothermie Unterhaching GmbH & Co. KG built a power station working on a power–heat coupling modus. The central plant is based on inflow technology according to the Kalina process, the realization of which is promoted by the Federal Environmental Ministry (BMU). Further important elements are the heat exchanger for the supply of heat over long distances (district heating), a peak load and redundant heating plant, a long distance heat network and a thermal water system for re-injection.

Delivery of heat is of prime importance as required by a coupling of power and heat. Optimum usage of the Kalina process for generating electricity requires a temperature of approximately down to 60˚C for the thermal water which has to be reheated to approximately 85˚C when used for district heating. This must not be carried out using fossil primary energy. For the operation of a power–heat coupling for normal heat requirements a constant volume of the thermal water required for reheating is conducted via a by-pass to the heat exchange plant (flow plant). In case of long periods of very cold weather, the operation of the Kalina plant can be cut back or shut down completely. Consequently instead of building a 4 MW power plant, a reduced unit with a 3.35 MW output is adequate. As a result a geothermal wattage of 40 MWt is sufficient for providing 60% of private household heating in Unterhaching, a community of 22,500 citizens.

Moreover heat supply on the basis of power–heat coupling and transformation of hydrothermal energy in electrical energy is CO_2 free. This means a possible reduction of CO_2 emissions in Unterhaching by 40,000 tons per year, or up to 2/3 of the emission value defined in the heat atlas of 1998 for Unterhaching. The efficiency of the total plant can be increased to approx. 85% using the principle described above. The delivery of heat energy is a major economic factor and location in Unterhaching would be of great future benefit to its inhabitants. The community can be supplied with heat energy at a favourable price. The energy is virtually independent of fossil energy sources except for redundant or peak load energy for repair operations or extreme heat requirements. For periods of low heat demand, geothermal energy is optimal for generating electricity. A further application for the use of this energy would be the delivery of heat in the summer months to operate absorber refrigeration plants. Furthermore it is certain that after re-injecting the thermal water following its usage for energy transformation, heat energy which is not required is not dissipated by balance coolers. After its usage as an energy supplier, thermal water is returned to the limestone energy storage via a closed circuit.

For the successful transformation of the power–heat coupling it is of primary importance that the working of the entire plant is in the hands of one operator in order to guarantee reliable delivery of heat energy. In accordance with EEG conditions, a favourable return on capital is to be achieved alone by generating electricity. Above all this applies when significant investments have to be made when setting up long distance networks. Splitting the generation of electricity and heat delivery between two operators (companies) should then be carried out when both partners contractually on the prior importance of heat delivery.

Heat is utilizable primarily in one location, because transport over very long distances results in a significant loss of heat. Consequently communities play a very important role as partners for private investors, especially those who want to invest in the generation of electricity. They are often the only partner as they are also customers for residual heat after the generation of electricity. After the allocation of exploratory sites by the BStMWIVT, the utilisation of hydrothermal energy for heat supply is of great significance, but its transformation to electrical energy is of prior importance. In this case a definite participation of the communities regarding the allocation of exploratory rights is indispensable and has to be accorded top priority. Until now successful heat energy projects based on subterranean geothermal energy in the Molasse region were carried out with communities.

Unterhaching is an example that only the community is in a position to build geothermal power stations even if such a project has to be financed only with bank credits. Economic operation can certainly be achieved on a long term basis. A further advantage regarding communities is that they do not have to realize a high return on capital expenditure from the start. Their main priority is to provide their inhabitants with a reliable supply of energy at moderate prices. Geothermal projects run by the community are the best possible guarantee for achieving this.

ACKNOWLEDGEMENTS

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