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Geothermal Energy Plant Unterhaching, Germany

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In the Bavarian town of Unterhaching inhabitants can lean back relaxed. They do not have to be worried about rising prices of heating oil and gas in the future, because the first geothermal energy plant for heat- and power generation has been realized in their community. This is possible because of the advantageous geologic location in the upper Bavarian Molasse Basin. There is an aquifer three kilometers below the surface. This hot water carrying layer, the so called Malmkarst, allows the utilization of heat, which is stored in the earth's interior, nearly for free and in an unimaginable dimension. Furthermore the utilization of renewable thermal energy is an environmentally friendly alternative to heat supply by heating oil and gas.

The commune of Unterhaching has already started the first steps towards a geothermal energy supply in the year 2001. The public company called "Geothermie Unterhaching GmbH & Co KG" has been specially founded for managing and handling the geothermal project in Unterhaching. Project partners of the commune of Unterhaching were the Business Consultants of Rödl & Partner from Nuremberg. The consulting company has attended the Geothermie Unterhaching GmbH & Co KG from the very first moment and was in charge of the complete project management.

1. DRILLING SUCESS

The geothermal drilling constitutes the most important step during the course of the project, being the part of the investment with the highest technical and geological risks.

It was an aim to reduce this risk during the course of the project. Thus, the second drilling and the planning of the surface facility were only started after the analysis and testing of the information from the first drilling were completed. The results, which were on hand by September 2004, beat the forecasts for the project: at a depth of 3,350 meters the well achieved 122°C and a possible yield of 150 l/s. At the beginning of 2007 the data of the 3,590 meter deep second drilling were on hand: 133°C and theoretically a flow rate with even more than 150 l/s.

Figure 1: Drilling at Unterhaching – leaking stream

On the basis of the test results, the submersible pump for the extraction of the thermal water could be constructed. With the test results and the construction of the borehole pump the essential technical and economic basic conditions of the plant were fixed.

Both wells are connected by a thermal water pipeline, so that once extracted, the cooled water can be led back into the thermal water carrying layer (aquifer) by the reinjection well. But before that, the hot thermal water is used for power- and heat production. This is done by a parallel assembly of heat exchangers. Due to the installation of a three-way valve, the flow rate is directed either to the power generation plant or the district heating grid; usually depending on the heat load in the district heating network.

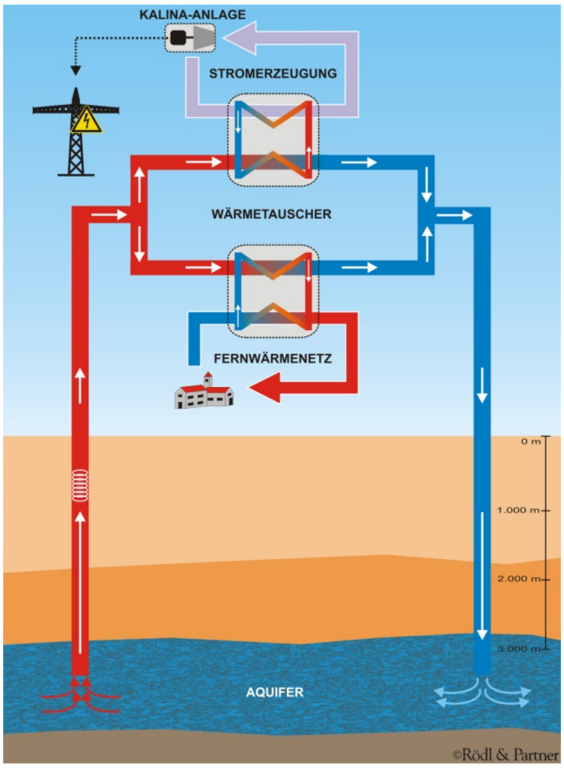

Figure 2: Schematic exposition for power generation by a geothermal doublet

2. HEAT SUPPLY

Since October 2007 (heating period 2007/2008) the complete geothermal energy is available to be used for the district heating grid. Currently about 38 MW of thermal energy are available during the whole year, to supply the inhabitants of the commune of Unterhaching with heat. Due to external circumstances like the high prices of oil and gas during 2008 as well as the rising awareness of climate change, this geothermal heating product was considered fantastic. An enormous demand for access to the network arose after definition and announcement of the heat price. The district heating grid is currently 28 km long (length of pipes: 56 km) and has a power input of more than 30 MW_{th} (with about 300 attached houses). The extension of the district heating grid is in 2009 again at the focus of the

Geothermie Unterhaching GmbH & Co KG. Final objective of the extension of the district heating is a heat load capacity of 70 MW_{th}, which will approximately cover the full heating energy supply for the commune.

3. POWER GENERATION

The district heating grid and the power generation can not be regarded separately from each other. The maximum electric energy of the Kalina facility amounts to about 27,000 MWh_{el} per year at a dimensioned output capacity of 3.36 MW. The effective output is regulated by phasing of the heat exchangers against the power demand of the district heating grid. That means, if the district heating grid has an increased heat demand, the power generation is reduced to partial capacity. As soon as this demand declines, more thermal water can again be used for power generation, so that the utilization of the thermal energy is optimized throughout the year. The Kalina cycle itself is an innovative system of power generation. The heat energy from the thermal water is passed by the heat exchangers to a binary steam system, which runs with an Ammonium – Water mixture. There are presently only three plants of this type in the world.

4. ADVANTAGES OF GEOTHERMAL ENERGY

The advantages that geothermal energy can offer are unbeatable arguments especially in the context of current political, ecological and social circumstances: geothermal energy is base load capable and can be used day and night, and therefore does not depend on wind or solar radiation.

Now a dependency on fossil fuels hardly exists and the environmentally friendly power- and heat production is a real alternative to heating with oil or gas, etc. In addition, the utilization of geothermal potentials in Germany is subsidized by the State of Germany. Emissions compared to a conventional facility (power and heat) are reduced by about 35,000 t of CO_2 per year.

This shows that geothermal energy is subsidized intensively and target-oriented by the State of Germany. Besides the Renewable Energy Source Act, other measures have paved the way for geothermal energy like the Renewable Energies Heat Act (EEWärmeG), the market incentive program and the Energy Savings Act (EnEV). To use existing resources at the particular locations in Germany is the obvious objective.

Figure 3: Power generation facility in Unterhaching

5. POLITICAL SUBSIDIES

In Germany an incentive for the implementation of geothermal energy projects is the Renewable Energy Sources Act (EEG). This law is the economic engine for power generation projects. In the context of the amended Renewable Energy Sources Act it is fixed that all the produced power has to be purchased by the local grid operator at a fee, which is fixed for 20 years. The fee consists of a base fee of 16 €-Ct/kWh (facilities < 10 MW) and of an early starter bonus of 4 Ct/kWh for facilities which are commissioned up until the year of 2015. Furthermore, a CHP-bonus of €-3 Ct/kWh is paid for a heat extraction of more than 20%. Additionally, there is another 3 Ct/kWh bonus for the use of petrothermal resources. In addition, the conditions for subsidies in Germany are also ideal for district-heating-only projects without energy production. Besides the drilling costs, potential additional costs which might occur (up to 50%), the construction of the facility and of the district heating grid are funded. Furthermore, a support program for the geological exploration risks exists, which covers 80% of the drilling costs in case of an unsuccessful drilling.

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4. RISK MANAGEMENT TOPICS

The process of the creation of a functioning risk management system generally starts simultaneously with the first economic analysis of the geothermal project, but at the latest within the scope of the acquisition of the debt capital. The risk management system is initially used for the fundamental decision about the project´s realization. If the project is realized, the system has to be enhanced regularly. Besides the business plan, it is used as the basic control aid for the overall project management and the investors.

The phases of the risk management process are risk identification, risk transparency, risk handling and risk monitoring.

At first, the fundamental risks are identified. This phase is of exceptional relevance and can only be entirely worked on jointly with all consultants involved in the project. Although the identification is an extensive task, it provides the basis for the further risk management process, because unidentified risks cannot be assessed and included in the specific risk budget. The identified risks of a geothermal project are classified into four risk categories: operational risks (failures in planning, etc.), technical risks (quality, etc.), economic risks (increasing operating costs, etc.) and political risks (licenses, etc.).

Based on the identified risks, a risk assessment, with an aim to make the risks clear, will be conducted. The occurrence probability and the extent of the possible monetary losses are determined in the process. This value provides the basis for the future project based risk budget.

When the respective risks of each risk field are identified and clear the task is to define strategies to reduce the particular risks.

A first step is thereby the avoidance of risks. Within this first step, most of the risks can be avoided. One example is the specification that a plant only use state-of-the-art component is allowed, or the fact that all current standards and directives have to be observed.

In the next step, the remaining risks are attempted to be reduced. In this case, the risk can be lowered by an insurance program for the geological exploration risks. At this point, it should be pointed out, that it is not possible to ensure a target return for e.g. 20 years, but that, in case of loss, the paid drilling costs are refunded. For this reason, a certain residual risk remains for the project developer. The insurance premium is based on the desired level of insurance, which means the higher the desired level (volume and temperature of the drilling), the higher the risk and therefore the insurance premium.

Another possibility for risk handling is the so called risk shifting. Thereby, during the composition of contracts, attention is paid to the distribution of risks, to shift the risk as much as possible to the co-contractor.

Because of the fact that it is not reasonable to insure against every risk, in particular small risks with low occurrence probability, certain risks should be borne oneself. Therefore an individual and specific risk budget is necessary.

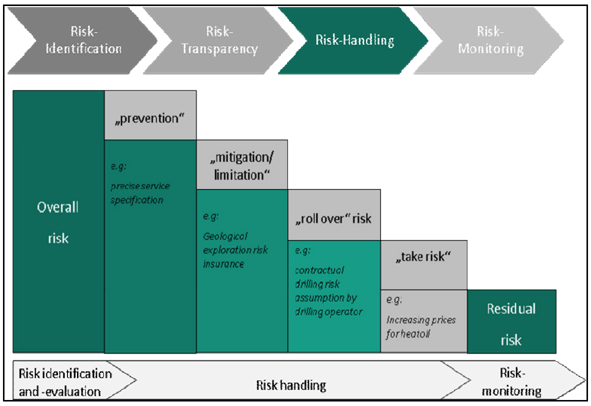

Figure 4. Risk monitoring diagrams

Finally, a responsibility for the permanent risk monitoring must be implemented in the project. In most cases, the project management is in charge of the task, because there is generally the most information about the overall status of the project available.

6. COMPARISON BETWEEN TWO RISK INSURANCE CONCEPTS IN EUROPE

A risk, which has to be evaluated and primarily reduced by a professional risk management system, is the exploration risk. The impacts of an insufficient water flow rate and temperature are part of the exploration risk which could significantly threaten the existence of a geothermal project. Since no solution was created by the private insurance sector to cover this risk until the risk insurance concept in Unterhaching 2004, the exploration risk in European countries was borne by the state, because the big advantages of geothermal energy were politically supported. For this reason, today there exist governmental approaches in France, Germany and Switzerland apart from the different solutions of the private sector. In the sixties a risk insurance concept was already introduced in France, which is still in use today. In this article for the WGC 2010 we compare the French system to that offered by the German Development Bank (KfW). The analysis shows that there are several different possibilities to make the risk calculable for the investor. However it has to be stated, that each model pursues different targets that the investor and the project developer have to be aware of.

6.1 Insurance Coverage

The German Development Bank (KfW) covers drilling costs for the proper completion of at least two hydrothermal deep boreholes (one for production and one for injection). Additionally, stimulation measures, which were coordinated with the KfW before, can be covered as well. The deciding factor for the success of a well is the thermal power, which is defined by the flow rate and the temperature. Not supported are single drillings, extraordinary costs and equipment manufacturing companies and companies with economic difficulties.

The concept of the French Agency for Energy Management (AFME) offers two mechanisms to cover the geological risks. The short Term Partial Risk Guarantee system ensures the result (thermal power, defined by flow rate and temperature) of the first well. The Long Term Partial Risk Guarantee enters into force with the start of operation of the facilities and guarantees the sustainability of the resource and the risk of total or partial depletion during 15 years of operation, excluding events like i.e. sabotage, theft, operating losses, fines, economic and financial difficulties, absence of maintenance and events of major force.

6.2 Extent of the Insurance Coverage

The KfW offers two financing models, both up to a maximum loan of 16 m Euro per drilling project and with a maximum loan term of ten years. Financing Model A consists of a 100 % indemnity of the loan for up to 80 % of the eligible investment costs. Financing model B consists of Financing Model A plus a partial dept cancelation of the amount of the effective loan disbursement for coordinated and executed stimulation. In both cases an additional risk charge on the base rate and a disagio is charged. Both numbers are slightly higher for Financing Model B.

The Short Term Partial Risk Guarantee of the AFME covers up to 90 % of the total costs of the first well including tax minus subsidies. It can support unexpected costs as well. The amount of the indemnity paid varies, depending on the degree of project success, evaluated by the AFME. 1.5 % of the maximum guaranteed sum has to be paid as contribution to the fund. The allocated sum is calculated according to the three zones of the Success – Failure Curve, which is based on the profitability – flow rate/temperature sensitivity study conducted before the drilling.

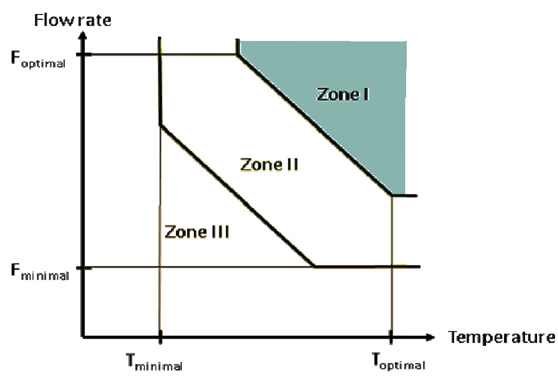

Figure 5. Three zones of Success - Failure curve

- Zone I, total success: Flow rate and temperature are within the ideal range and no compensation is paid.

- Zone II, partial success: Flow rate and temperature are above the minimum economic feasibility. Compensation up to the optimal IRR is paid.

- Zone III, total failure: Flow rate and temperature are below the minimum economic feasibility. Full compensation is paid.

The Long Term Partial Risk Guarantee compensates the consequences of possible damage for a 3.2 % share of the maximum guaranteed sum as contribution to the fund and annual rates. There are three different damage categories defined:

In case of repairable damage, i.e. crushing, disengagement or collapse of casing pipes, leaks and tightness defects of tubes, etc., the expenses incurred are compensated. For the amount of time elapsed until the exploitation is resumed additional immobilization compensation is paid.

If the damage is irreversible and causes a definite change of the thermal power (75 % to 50 % of the reference power), annual compensation is calculated according to the failure rate.

In the event of total damage, an irreversible and definite drop on less than 50 % of the reference thermal power, annual compensation is paid according to a contractual ceiling and the plant´s residual value. In case of a total breakdown a single installment is paid after the agreement of the Technical Committee.

6.3 Preconditions for Founding

The KfW requires the beneficiary to deliver

- a technical description of the drilling plan including, e.g. a development concept and the specification of the amount of loan,
- a preinvestment study, containing e.g. geologic and seismic researches, a geologic model and a drilling plan,
- a feasibility study,
- and official authorizations.

The creditworthiness and the expertise of the investor have to be given. The planed owner of utilization of heat generation, combined heat and power generation or power generation of the project must last at least for seven years.

For the partial risk guarantees, the AFME requires a complete economic, judicial and financial analysis of the project by the CRC (Comité réseaux de Chaleur). Additionally, the CTG (Comité Technique de Géothermie) has to give a recommendation concerning the relevant geothermal parameters (flow rate, temperature) provided by the planed location of the drilling. An economic sensitivity study based on the expected thermal power has to be conducted by the CTG to generate the Success-Failure Curve, as well as a feasibility study including the calculated IRR. The Long Term Partial Risk guarantee requires immediate notification of the SAF (insurance company) in case of malfunction. Flow rate, temperature and pressure, as well as break downs have to be documented. An annual maintenance report has to be generated and passed on to the SAF. The CTG and the SAF are allowed to conduct inspections anytime.

7. ABOUT THE AUTHOR

Roedl & Partner is a multi-disciplinary professional services firm. We provide audit, accounting, tax, legal and business consulting services for international businesses. Founded in 1977 in southern Germany, Rödl & Partner has expanded into 83 offices in 40 countries. We have 104 partners worldwide and 3,000 people, of whom 340 are attorneys or solicitors, 242 chartered accountants and 309 certified tax consultants.

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- Calculation of possible returns and production costs
- Calculation of heat prices and development of price sliding
- Clauses according to AVBFernwärmeV
- Tax consulting
- Consulting regarding drilling contracts, e.g. choice of the optimal type of contract and adjustment to a suitable insurance concept
- Implementation of a risk management system
- Tender management, e.g. issue of legally proven tender documents for planning companies
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- Company law

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