NOTICE CONCERNING COPYRIGHT RESTRICTIONS

This document may contain copyrighted materials. These materials have been made available for use in research, teaching, and private study, but may not be used for any commercial purpose. Users may not otherwise copy, reproduce, retransmit, distribute, publish, commercially exploit or otherwise transfer any material.

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted material.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specific conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law.
Keywords
Exploration risk, risk mitigation, insurance schemes, financial aspects, insurance negotiations

ABSTRACT

The financial risks associated with deep geothermal projects form a major obstacle to accelerated industry development. Different approaches have evolved in order to mitigate the sector-specific risks. This paper introduces insurance schemes mitigating the risks of deep geothermal projects focusing on the exploration risk. The topic is presented using the example of Germany. Terms and conditions of insurance solutions in the private market sector as well as the new German federal risk mitigation program are summarized. The author’s practical experience from insurance negotiations allows an insight on status, applicability, challenges and pitfalls of these insurance solutions. Improved possibilities for risk coverage within a growing competitive market are an important market incentive and will facilitate the further development of deep geothermal projects.

1. Introduction

The specific project risks associated with deep geothermal development can be classified into two main categories. The drilling risk comprises drilling problems due to unexpected geology or technical problems with the equipment. It includes e.g. the risks of losing equipment inside the borehole and the risk of a blocked drilling string. On the other hand, the risk of not finding the economically viable temperature or flow rate in a geothermal reservoir is described as discovery or exploration risk. The risk of adverse chemical conditions also forms part of the exploration risk.

A geothermal well not being able to produce a certain minimum of thermal capacity might not be economically viable and investments for the drilling works might be lost. Therefore, the exploration risk constitutes one of the main constraints for investments in the industry sector. Many project owners communicate their desire for exploration risk insurances, especially in the early stages of geothermal project development, when the risk of project failure is particularly high.

While policies to cover drilling risks are offered on a standard basis, policies covering the exploration risk are still only offered for projects located in one of the two main geothermal provinces in Germany (the Molasse Basin north of the Alps and the Upper Rhine Graben). They require a mature project status and comprehensive project documentation. The opportunity of exploration risk coverage always depends on the individual case.

This paper summarizes risk mitigation solutions available on the private market and through governmental schemes especially with regard to exploration risk mitigation. It reports on the conditions and financial terms of the different schemes as well as on status and challenges of the programs.

Special attention is paid to the practicability and pitfalls of the two options for risk mitigation. Also, a number of recommendations and subjective comments are given. These statements are based on the involvement of the GeoThermal Engineering GmbH in risk mitigation discussions for different geothermal projects in Germany (with both private insurance companies and governmental funds) as well as on the collaboration with the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the German Reconstruction Loan Corporation “Kreditanstalt für Wiederaufbau” (KfW), which is administering the German nationwide support program.

2. History of Exploration Risk Insurances in Germany

The first exploration risk insurance in Germany was signed in 2003 for the project Unterhaching in the Molasse Basin. The concept was not purely private, but supported by the state of Bavaria. This first policy – from the Munich Re Group - remained a singular case for several years and was not repeated, despite the project being successful and part of the premium having been paid back.

Over the last years, other insurance companies and brokers entered the market. Several policies were offered to projects in the
Molasse Basin. Some of them did not come into effect because of the developers preferring a multi-project structure for failure risk reduction and hence deciding to carry the risk on their own while saving the insurance premium. This was especially the case for bigger companies with a firm financial background. Other geothermal development companies owning exploration concessions for several projects signed frame contracts with insurance brokers with attractive contract terms. Smaller companies on the other hand didn’t always succeed in the overall financing of their project, even though a contract covering the exploration risk of the wells was signed.

3. Regional Aspects of Risk Mitigation in Germany

The three primary regions for the use of geothermal energy are the Upper Rhine Graben, the Molasse Basin and the North German Basin. In general, geothermal projects in Germany are mainly bound to hydraulically active and productive faults and fracture zones.

Over the last decades, thermal spas were the reason for many geothermal wells in the Molasse Basin being drilled. In the last few years, many successful geothermal heat projects for direct use have also evolved there. With the number of tested and productive wells, it is now possible to perform statistical calculations on the basis of about 40 project results. This procedure allows the calculation of the probability of success for a project in the Molasse Basin.

In the Upper Rhine Graben however, experience with the realization of geothermal projects is still limited. Only nine results from geothermal well testing are available, distributed over a range of three reservoir rocks and the whole graben area with a length of over 300 km from north to south. Seeing such limited data basis, no serious calculation of the probability of success (POS) is possible. As a consequence, it is much more challenging – both for a project developer and for an insurance company – to negotiate an exploration risk insurance in this geothermal province.

4. Financial Aspects of Risk Mitigation

An exploration risk insurance provides financial security to developers of geothermal projects. Yet, the policy itself is also a significant investment which needs to be accounted for in the project budget.

In the past, due to the lack of experience with the probability of success of a geothermal project, a considerable premium of up to 25% of the drilling costs was charged for exploration risk policies. Given the first successful projects, more experience and more competition on the insurance market, the premium has now become significantly lower. Terms and conditions were modified in favour of the projects. Currently, a premium of around 1 Mio. € for an insured sum of about 10 Mio. € plus an own risk share (deductible) of about 1 Mio. € are common. Individual companies also offer to cover the premium in case of project failure.

An exploration risk insurance provides security for the venture capital needed until completion of drilling works and successful well testing. Proof of risk coverage also facilitates the acquisition of loan capital.

The following sections introduce both insurance schemes on the private market and the state risk mitigation program in Germany. The business aspects of the topic are reflected through examples and suggestions, mostly from the developer’s point of view. They are based on a number of practical business cases negotiating risk coverage for geothermal projects in the Molasse Basin, the Upper Rhine Graben, but also outside the traditional geothermal provinces.

5. Private Insurance Market

The private market sector for exploration risk insurances is covered by both insurance companies acting as a direct, unique insurer and insurance brokers distributing the risk between one leading and several contributing partners. Insurance companies active on the German geothermal market include Munich Re, Swiss Re, Axa, Gothaer, R&V and others. Insurance brokers include Marsh and Willis. Both individual insurance companies and the brokers offer frame contracts for developers with several projects.

Over the last months, several new policies have been negotiated, both in the Molasse Basin and in the Upper Rhine Valley. Projects in the North German Basin have not been insured yet, the reasons being the lack of reference projects, the relatively large depth required for a sufficient temperature level and the necessity for EGS-components for most projects in this region. So far, exploration risk policies on the private market are only offered for hydrothermal projects. EGS projects are still considered as too risk-prone because of lack of experience.

5.1. General Requirements

The conditions for an offer of discovery or exploration risk insurances on the private market are a mature project preparation and a substantiated geological-technical exploration and development concept of the project. In addition, the financial strength as well as the technical ability and know-how of the project developer need to be proven.

The minimum requirements for an offer of an exploration risk insurance include a project description with a geological feasibility study, seismic investigations including interpretation, a development concept, the drilling path and well design as well as a stimulation and hydraulic test program, the power plant and heat use concept, all necessary permits, information on contractors and key personnel plus a business plan. In addition, an independent expert’s report on the conclusiveness of all data and an estimate on the probability of success to generate the requested thermal capacity (flow rate and temperature) are required.

As no standards have been established for this kind of insurance yet, the co-operation between project developer and insurer is of major importance. The clear definition of scenarios, best- and worst-cases, measures and procedures is crucial in order to produce a reliable and transparent policy. Both the stimulation concept and the layout of the test program for the certification of results should be specified in advance and form part of the insurance policy.
5.2. Definition of Project Success

The exploration risk is defined as the risk of not being able to exploit a geothermal reservoir with sufficient quality or quantity, whereas the quantity is defined by the thermal capacity $P$ which can be extracted from the brine. $P$ is calculated employing the following formula 1:

$$P = \rho F (T_i - T_o)$$

in which $\rho$, $F$, $Q$, $T_i$, and $T_o$ stand for density, capacity, flow rate and the temperature spread.

The threshold value for exploration risk insurances (i.e. the parameter which defines project success or failure) is set individually for each project and is based on economical considerations. The project developer decides on the threshold value which forms part of the insurance request.

From a developer’s point of view, $P$ is the most important parameter. The combination of the individual factors is usually of minor importance. Therefore, it should be requested to insure the thermal capacity $P$ instead of fixed parameter pairs for $Q$ and $T$. Covering $P$ rather than fixed pairs of parameters gives the insurance company a higher flexibility and therefore allows for a lower premium. Several insurance companies accept a threshold value for thermal capacity as the success criterion. A tested thermal capacity below the threshold value results in the full payment of the insurance sum.

The threshold value for exploration risk insurances is set individually for each project and is based on economical considerations. The project developer decides on the threshold value which forms part of the insurance request.

The decision over project success or failure is determined by means of a hydraulic pump or injection test. The layout, procedure and measurement parameters need to be defined in advance. They should form part of the insurance contract as well.

5.3. Probability of Success

Most insurance providers require an external report quantifying the probability of success (POS) of a geothermal project. This so-called POS-study plays an important role on the insurance market. These studies are based on an evaluation of reference well data and are currently mainly prepared by the independent LIAG (Leibniz Institute for Applied Geophysics) in Hanover. Some studies are also prepared by state institutes. In Germany, only state and federal geological surveys have access to all relevant reference data forming the basis of a POS-study, including those of the oil and gas industry.

If the calculation results in a probability of success above a certain threshold value (mostly 80%), insurance companies submit an offer. Whether the threshold value for the probability of success can be reached mainly depends on the thermal capacity a client wishes to have insured. The higher the POS, the lower the insurance premium will be.

By now, a number of insurance companies and brokers have employed in-house experts for geothermal projects. These providers do not depend on a POS-value calculated by external geothermal experts, but judge the facts presented by the project developers, consultants and experts themselves.

Especially in the Upper Rhine Graben with only a few experiences and data, calculating a reliable statistical probability of success in the conventional way is impossible. However, some insurance companies insist on a POS-value and are therefore not willing to insure projects in this region. Others accept an alternative procedure with special emphasis on the quality of project exploration (3D-seismics and a detailed, high quality structural analysis) plus an ongoing communication and co-operation between developer and insurance experts. In this way, it recently became possible to obtain insurance coverage also for projects in the Upper Rhine Graben.

5.4. Insurance Terms and Conditions

The general concept of the private insurance solutions is to let the customer choose the desired insurance sum according to the expected investment costs. The own risk share (deductible) also needs to be negotiated. Usually, all costs spent on drilling, stimulation, test program can be insured. Individual companies offer to cover costs like seismic investigation or the drilling site construction as well.

A cap for individual cost items should be avoided, as it reduces the flexibility of a project developer. A further measure to reduce the premium is the inclusion of a residual value concept, where – in case of project failure – a reduced insurance payment is made depending on the achievable flow rate and the possible alternative use scenarios of the well. With POS values just below the threshold, a smaller or different project can still be carried out. Therefore some insurance companies define a project, which is “partly successful”. In this case, not the total insurance sum, but a smaller sum is paid out. This sum can be defined beforehand in the contract negotiations.

6. The German Federal Risk Mitigation Program

After realizing that over the past years, the development of geothermal projects in Germany had been slower than expected and that there is an obvious need for risk mitigation in the geothermal industry, the BMU established a further risk mitigation program aimed at minimizing the financial risks of geothermal development. This federal program serves as an addition to the private insurance market and is supposed to facilitate the fast development of geothermal power and heat projects in Germany.

The national risk mitigation scheme is part of the Renewable Energy Incentive Program MAP („Marktanreizprogramm“). The guidelines are specified in the “Richtlinien zur Förderung von Maßnahmen zur Nutzung erneuerbarer Energien im Wärmemarkt” (Guidelines for the support of measures to use renewable energies in the heat market). The program is administered by the German Reconstruction Loan Corporation “Kreditanstalt für Wiederaufbau” (KfW). Only deep geothermal
projects (deeper than 400 m) in Germany are eligible for this program.

The support scheme consists of project funding via subsidized long-term loans with low interest rates. It also contains two risk mitigation modules, the first one covering the technical drilling risks, the second one covering the exploration risk. The subsidies are only available for geothermal heat projects. The risk mitigation components are available for both heat and power projects.

For all applicants apart from municipalities or communities, the application forms may not be submitted to the KfW directly, but need to be conveyed by a clearing bank which is affiliated to the project developer (the so-called “Hausbank”).

6.1. Technical Drilling Risk

The technical drilling risk mitigation is incorporated into the KfW incentive program for renewable energy. Both geothermal heat and power projects are eligible for the drilling risk module of this program. The module partly covers the risk of excess drilling costs compared to the initially planned expenses. It mitigates the risk of additional work and expenses exceeding the anticipated costs in the case of technical drilling problems. Up to 50 % of the original planning costs of drilling and a maximum of 1.25 Mio. € are covered.

6.2. Exploration Risk

In addition to the drilling risk mitigation, a new program specially tailored to cover the exploration risk was launched in 2009 by the BMU and KfW in co-operation with the Munich Re Group. The risk mitigation module is based on a 60 Mio. € revolving fund. Projects can apply for a loan of up to 16 Mio. € covering a maximum of 80 % of their drilling costs. The program implies a credit indemnification clause of 100 % of the loan amount during the drilling phase. In case of not reaching the specified project success parameters (the thermal capacity of a well), the investor is indemnified from repaying the remainder of the loan. Thus, the loan will be for-given and the fund will cover up to 80 % of the drilling costs, if the well is not successful. The own contribution (deductible) in case of project failure consists of 20 % of the drilling costs.

The risk surcharge (loading) is represented by a high interest rate during the credit risk period until the termination of drilling works and hydraulic tests plus a specific disagio, which is also defined by the project risk. Stimulation costs can optionally be included in the indemnity, provided that a higher risk surcharge plus higher disagio are accepted.

In either case, the indemnity is only applicable until successful testing of a well. After completion and positive testing of the well, the credit is continued without indemnity and at a reduced interest rate.

The application fee of this program amounts to 65,000 € covering the assessment of the project documentation by Munich Re and KfW. With promise of the loan, a further 45,000 € are charged for ongoing auditing and expert monitoring of the project progress.

Prerequisite for an application to the Hausbank and KfW is a mature project status. In order to be eligible for the program, a series of project documentation comparable to the one required for market-based insurances needs to be submitted. All documentation has to be complete and allowing for a qualified assessment of the project, the exploration risk and the eligibility by internal and external experts.

The main difference to insurance policies on the private market is that no conventional POS-study is requested for the KfW program. Thus, “alternative” projects outside the traditional geothermal provinces or EGS-projects might have a chance to obtain risk coverage under this scheme, provided that their project concept and documentation promise project success.

6.3. Challenges and Pitfalls

One problem with the public support schemes is that large governmental funds like the KfW program are sometimes difficult to administer. The development of guidelines, the answering of inquiries and the processing of application is expected to be longer than on the private market. This is due to the number of involved parties and the political and legal discussions associated with such programs.

Furthermore, governmental funds rely on external expertise in order to structure their programs. This is the case for the specification of the project documentation requirements as well as for the project assessment and the certification of results.

The major challenge with the KfW program however, and first hurdle to be taken by a project, is the need for private developers to find a Hausbank willing to convey the application forms to the KfW and to guarantee the payback of the loan to the KfW. A Hausbank basically carries the risks for the KfW. In case of a developer going bankrupt, the clearing bank is obliged to back the loan to the KfW. Therefore, every potential Hausbank vigorously checks the credibility of the developer and the quality of the project as well as requiring guarantees from project developers.

The majority of potential clearing banks are not familiar with geothermal projects. Furthermore, they only receive a small fee for the service of conveying the KfW funds. It is therefore common that an extra fee is charged for internal and external assessment of project information. Still, the application process is often not attractive to the banks. Especially during the current financial market situation, banks are very reluctant to act as the intermediary institution. A relatively small project with a total investment volume of less than 30 Mio. € is usually confronted with serious difficulties finding a Hausbank for this process.

The indemnification clause is a step in the right direction. Yet, the indemnity is only applicable during the drilling period and prior to proof of a successful well. The clearing banks in Germany still require securities for the entire loan period. As a consequence, they only support developers being able to guarantee 100 % indemnity until the end of the loan duration. This requirement can only be fulfilled by financially strong, usually large companies like utility companies or communities which cannot become insolvent.

Another problem of the new risk mitigation program of the KfW is the relatively high application fee combined with the fact that the increased interest rate and the disagio (as a further risk participation of the project developer) are only disclosed at the date of loan promise. The credit conditions depend on the success parameters defined by the project developer as well as on the project risk level. The judgment of this risk level is an extensive process concluding with the notification of individual credit conditions. The interest rate for the high risk period is expected to
be between 10% and 20%, but is uncertain until the date of loan promise. Not knowing the costs of a credit beforehand renders reliable budget calculations difficult.

This aspect was raised to the program initiator. It was suggested to define a range of interest rates, if possible associated with specific POS-values. In this way, a project developer would be capable of calculating best- and worst-case scenarios in advance.

7. Conclusions

Since 2009, geothermal project developers in Germany can choose between two options of mitigating their exploration risk: the federal risk mitigation scheme administered by the KfW and private market-based insurance solutions.

The main advantage of the KfW risk mitigation scheme is that it combines both project financing via a credit and the mitigation of exploration risk in one program. The risk coverage consists of a loan being for-given if the project is unsuccessful.

This program is the preferred option for “alternative” projects in areas with little reference data or EGS-projects, as it does not require a classical POS-study.

When a project is able to find a clearing bank willing to submit the application forms to the KfW, the fund will most likely be granted. The difficulty in finding such a Hausbank however, is a serious pitfall for the program. The issue was raised to the program administrators and discussions have started to take the risk off the clearing banks and rather cover it directly by the KfW.

Another problem of the KfW program is the uncertainty of interest rate and disagio prior to loan promise. Not knowing the costs of a credit renders reliable budget calculations difficult for developers.

Until the clarification of the above-mentioned issues, the private insurance sector offers an attractive alternative to the governmental scheme. Over the past years, insurance conditions have become much more favorable to geothermal project developers and premiums are a lot more affordable than previously.

8. References