Non-technical Barriers preventing a Further Use of Geothermal Energy

The aim of this paper is the identification and analysis of non-technical barriers which could hinder the wider use of geothermal energy within Europe. First, the financial challenges to carry out a successful project are discussed. Then the problems, which could arise due to legal and administrative reasons and affect the construction and operation of a geothermal energy provision plant, are identified. This is also true for the organisational and perception challenges which influence the further use of geothermal energy. Finally, instruments and measures to overcome these non-technical barriers to reduce the risk of non-technical delays or failures are presented.

Keywords: geothermal energy, non-technical barriers, financial challenges, administrative challenges, organisational and infrastructural challenges, perceptual challenges

1 Introduction

Whereas using geothermal energy of high enthalpy fields for heat and power production has a long tradition and is in Europe predominantly established, low enthalpy resources – which have by far a larger and more widespread potential – are only scarcely exploited so far. Additionally they are mainly used for heat provision.

Besides the technical challenges which heat and rather power production from low enthalpy fields are facing, also non-technical barriers hinder the wider use of such geothermal resources within Europe. One of the most important aspects hereby is the higher costs of the provision of heat and/or electricity from low enthalpy geothermal energy compared to energy production from fossil fuel energy. Additionally quite a lot of economic promising geothermal projects have been delayed, modified or failed due to various non-technical issues. The following reasons can be analysed for such failures:

- difficulties with funding, financing and insuring,
- unfavourable administrative conditions,
- organisational difficulties,
- lack of knowledge and adequate flow of information, and
- insufficient perception and acceptance.

These non-technical aspects can be identified as the main challenges which can hinder or delay the planning and realisation and/or can even lead to the failure of economically feasible geothermal energy provision projects. Even without failing, these non-technical challenges often have significant negative impacts on the overall project costs and the conditions under which financing is available. They can also cause significant time delays resulting in a further increase of the costs of a low enthalpy geothermal project. In general, more time is needed to plan and implement a geothermal based plant compared to one based on fossil fuels. This is due to the significantly higher complexity of low enthalpy geothermal projects involving a great number of different partners compared to a fossil-fired plant with proven technology and a clear procedure how to construct and run such a plant.

On this background the aim of this paper is to identify, analyse and systematise the different non-technical challenges which have to be met for the successful implementation of low enthalpy geothermal plants to provide useful heat and/or electricity and to present measures to reduce the risk of non-technical delays or failures.

2 Financial challenges

Whereas heat production even from low enthalpy geothermal energy is in Europe already widely competitive due to the high oil and gas prices and thus the fossil fuel energy price level, geothermal electricity production faces in most countries huge financial challenges.

The technology to convert fossil fuel energy into heat and/or electricity is commercially available on the market. Also the costs of heat and/or electricity production from fossil fuels are relatively modest due to – compared to some options based on renewable sources of energy – still relative low prices for fossil fuel energy and the relatively high efficiency of the conversion technologies together with relatively low local environmental effects. Thus apart from very promising geological constraints (e.g. high enthalpy fields like in Island or Italy) especially the generation of electricity from geothermal resources is not competitive without significant financial support under the existing energy price conditions within Europe. One reason for this lack of competitiveness is that geothermal electricity (and also heat) generation from low enthalpy fields is a very complex system of different subsurface and surface components whose interaction is a matter of the specific site conditions and therefore has not yet been established.

Public funding and governmental measures to improve the economic situation of a geothermal heat and/or electricity generation can be justified by the significant environmental advantages which are associated with the use of geothermal energy instead of fossil fuel energy. These benefits are so far not (fully) reflected in the market prices which are achievable today in the energy market. It is well known that the consumption of fossil fuel energy could cause significant environmental damages like global climate change, acid rain or damage of the atmospheric ozone layer. To stabilise the greenhouse gas concentrations in the atmosphere at a level that would prevent significant damage, the EU has set a target to reduce anthropogenic CO_2 and other greenhouse gas emissions (Kyoto Protocol). The use of geothermal energy can contribute to meet that commitment.

The EU as a whole and a number of EU Member States have set up measures and/or programmes for financial support of research, development and demonstration activities based on low enthalpy geothermal energy. Additionally in some EU countries financial instruments for a wider market introduction of geothermal energy and other renewable sources of energy have been put into force. For example a few governments have set up legal rules or made agreements with the national utilities on the reimbursement for geothermal generated energy (i.e. heat and/or electricity). These feed-in tariffs rates for electricity fed into the grid guaranteed by the government are at least equal to the avoided cost of electricity production from fossil fuel energy on a low voltage grid of a distributor. More often the reimbursement includes a premium reflecting the associated social and environmental benefits of the increased use of geothermal energy. In Germany, for example, a feed-in tariff of up to 0.15 €/kWh is guaranteed for electricity produced from geothermal energy which is fed into the public grid due to the "Erneuerbare-Energien-Gesetz (EEG)" (Renewable Energy Law). Similar measures have been put into force also in other European countries. These activities in R&D as well as in market introduction have already led to a significant higher number of geothermal projects in various countries throughout Europe.

Even despite the assured income for electricity (and maybe heat) from low enthalpy geothermal energy which might be available due to such incentives and such measures, there are market risks which can jeopardise the economic viability of geothermal power or CHP plants even under promising circumstances. Such market risks are:

- The energy supply conditions and the energy systems are underlying ongoing changes which are bringing new alignments into the energy equation (e.g. internalisation of external costs).
- There are also uncertainties about the demand for heat and/or electricity in the mid and long term future due to the changes in the energy markets and the stable or even decreasing population.

- Changes in the national energy and environment policy can lead to changes in the guaranteed reimbursement of geothermal heat and/or electricity and in the compensation practice.

Changes in the energy market can lead to a lower return of investment of the geothermal energy conversion plant and thus additional commercial risks for the plant owner, the operator and the financier. Facing these economic uncertainties and market risks on the one side and the higher costs for the provision of geothermal heat and/or electricity compared to the energy costs from fossil fuel energy on the other side, a broad and long lasting market introduction programme consisting of R&D as well as of market introduction measures is required to build up a stable and long lasting market for the provision of geothermal energy. To finance such a programme financial resources with a sufficient financial layout and a high probability of availability during a sufficiently long period of time should be available. The funds needed for such a programme could be provided by the governments through different financial measures.

2.1 Governmental support

Currently geothermal plants participating in R&D-programmes can get funding from the EU and from national governments. However, numerous forms have to be filled to get funding and the conditions for funding are not always very clear. Sometimes the funding conditions can change within the duration of the funding or even the application period. Long and complicated approval procedures can lead to a significant time lag between an application for funding and the final decision. Such time delays can make projects even more expensive and hence less economic. To improve the procedure of deciding whether or not to fund a specific project it seems advisable

- to make the handling of the support regulations more simple and easy,
- to guarantee a short and defined time for decisions on funding applications, and
- to further improve the co-ordination between European, national and local funding institutions.

If a geothermal project seems to be profitable without subsidies an important obstacle on the way to realise such a project is often to get funding from a private bank. This situation could be changed with the help of public funds and special funding conditions or with the help of sureties and guarantees by the government. The confidence of a private bank could also be increased by long lasting arrangements on special reimbursements for the feed-in of geothermal energy guaranteed by law or by the utilities.

In order to realise more geothermal projects and to increase private investments in geothermal plants the following governmental instruments and measures could be applied:

- Improvement of the funding conditions for specific geothermal demonstration projects with challenging or unproven technologies (i.e. a higher percentage of funding related to the overall costs for technologies which are still in the stage of development and demonstration such as low enthalpy electricity generation systems).
- Sufficiently high funding and flexible handling of the annual budgets for geothermal projects depending on the conditions and requests of the respective project.
- Tax incentives, e.g. a high difference between the energy taxes on the energy generation from fossil fuel energy on the one hand and from low enthalpy geothermal energy and other renewable sources on the other.
- Tax allowances (i.e. preferential conditions of depreciation) for investments in low enthalpy geothermal projects and tax reductions on the interest rates gained from investments in such projects.
- Governmental supported investment credits with especially low interest rates and a very long lifetime.
- Using geothermal energy for public buildings and paying higher energy prices for it.

The implications and effects of these instruments are not the same. Some financial support measures, such as the tax allowance for investments, seem to be more promising than direct funding, because hereby economic strong companies or persons with high profits receive incentives to invest in technologies for the use of geothermal energy.

The best way to support the provision of heat and/or electricity from geothermal energy would probably be a combination of different financial instruments and measures. Special assessment studies are needed to find out which support strategies are most suitable in order to maximise the benefits on the economics, the environment and on the employment as well as to avoid unnecessary and insufficient funding (i. e. "cash and carry effects") and permanent support (i. e. waste of public money). Such a optimal support strategy is very much dependent on the local conditions as well as the existing legal framework and might therefore significantly differ between different countries.

2.2 Private financing and risk insurance

Private financing of geothermal power and/or CHP plants can be achieved through credits from banks or other financing institutions. However, such credits from commercial companies with acceptable conditions are not easy to obtain due to given technical and non-technical uncertainties and challenges due to e.g. changes in the economic efficiency of the plant.

Thus the chances of obtaining sufficient funding from private banks are not so favourable for geothermal technologies compared to proven and well-known energy technologies based on fossil fuel energy. Presently, electricity production from geothermal low-enthalpy fields is an example of such a non-proven technology. The lack of confidence in this type of energy conversion technology is due to its early stage of development. Despite the considerable progress which has been achieved in the last years, geothermal heat and/or electricity production from low-enthalpy geothermal systems is still in the stage of R&D as well as demonstration. World-wide only relatively few geothermal low-enthalpy plants are operating and even less can be used as reference cases.

The chances to get financial credit can be increased if

- well-established and experienced operators with good relations within the energy market are involved in the project such as utilities and companies in the oil and/or natural gas business,
- co-operation and/or joint venture are made with professional power plant manufacturers and well known engineering companies,
- purchasing contracts with well-known and reliable customers are signed, and
- environmental impact and risk studies have been assessed by independent institutions.

Private financing institutions (like private banks) have in general insufficient knowledge about geothermal plants to judge about the pros and cons of such projects. Therefore, it would be helpful to increase the competence of decision-makers in banks and thus their willingness to take the risks associated with such projects. This could be done by the provision of sufficient and adequate information about the actual chances and limitations of such low enthalpy geothermal power and/or CHP plants sponsored by public funding institutions.

Financing can also be provided by private institutions using other financial instruments than credits. This might make it easier to obtain the capital investment needed for such a challenging project. Such instruments are for example

- venture capital funds,
- risk share holdings, and
- voluntary green pricing by private energy customers, i.e. if the extra money collected by the utilities by charging higher prices for "green energy" compared to energy from fossil fuel energy is used for investments in geothermal projects.

The financial risks of a geothermal project associated with the exploration, exploitation, testing and operation of the plant can be covered by an adequate insurance. Extended coverage insurance for business interruption and additional (overrun) costs or loss of operating profit is possible,

but quite expensive. The insurance companies cover the possibility that an action, an arrangement or a measure might result in different outputs than expected. They also cover all consequences which result from such unforeseeable risks. But in general they do not insure applications of scarcely proven technologies or new processes (like geothermal power and/or CHP plants). Therefore technologies which are in the demonstration stage or within an early market introduction generally need money from other sources to take the risk of extra money for necessary technical modifications or the risk of technical and financial failure. In most cases the government is the only institution which is able to cover such risks.

In order to reduce the financial risks and thus to increase the chances of finding private banks and investors to finance the project it is helpful to have a risk insurance. However, it is not easy to find an insurance company for a geothermal power and/or CHP plant due to the complicated and not fully market mature technology available so far.

3 Administrative challenges

In order to construct and operate a geothermal power and/or CHP plant, various administrative permissions are needed e.g. for

- the exploitation of the underground,
- the long term operation of the geothermal resource,
- the technical processes involved,
- the construction of the geothermal plant and
- the long term operation of the power and/or CHP plant.

In the EU member states, the necessary permission procedures and the given regulations to run a geothermal power and/or CHP plant are different. Additionally, the pre-conditions and requirements for a permit to operate a geothermal plant might vary significantly on a national and regional level. In most cases, within the overall procedure to obtain the operation permissions significantly more than one application form are required. For example a proposed geothermal project needs numerous permissions during the exploration and exploitation of a geothermal low enthalpy field as well as for the construction and operation of the power and/or CHP plant. In the process of obtaining these different permissions from various governmental institutions very different challenges can occur with non-existing, unclear or existing but unsuitable frameworks.

There is a considerable uncertainty about the requirements which have to be met to get the necessary permissions for the construction and operation of a geothermal power and/or CHP plant. Authorities can have difficulties in judging such new concepts due to the lack of experience due to one of the first plants of its kind. Their search for existing regulations for similar technologies which could be applied or adopted to geothermal power and/or CHP plants is time-consuming and can lead to long approval times. Therefore the implementation of new geothermal projects could be hindered by e.g.

- absence of a clear und understandable regulation framework designed for the use of geothermal energy,
- unclear interpretation of frameworks which do not contain specific regulations or guidelines for geothermal systems,
- existing frameworks for similar technologies which do not fit or which hinder the implementation of geothermal projects, or
- legal frameworks which are designed for proven technology and not for technology which is still within the developing phase.

Therefore feasible ways to enhance the existing regulatory framework are needed. The existing legal framework should also be more flexible to take care of new technologies and innovative processes which are still within a demonstration phase. But this is a complex task because different policy areas as well as various policy levels have to be addressed. And this has to be realised

in a similar way throughout Europe. In order to develop and establish specific and well-defined permission procedures and regulations for geothermal plants concerted political action across different countries, institutions and authorities is needed.

4 Organisational and infrastructural challenges

Especially planning and realisation but also operation of geothermal power and/or CHP plants for the provision of heat and/or electricity is a demanding task because it comprises various technical fields and hence involves the participation of different persons, groups, companies and institutions. The participants involved in the implementation of such projects can be

- decision-makers from very different areas e.g. geology, engineering science, energy economics,
- European, national and regional funding institutions,
- private and public financiers,
- insurance companies,
- administrative and local permission authorities,
- planning offices, manufacturing, engineering and construction companies,
- plant owners and operators,
- customers for the geothermal energy maybe accepting to pay higher prices, and
- the public, especially the local people personally affected by the plant.

Contracts with partners and subcontractors need to be signed to regulate the co-operation of the different participants to carry out a successful geothermal project during the various stages of the overall project life time. Well organised teamwork between specialised and competent partners or the delegation of tasks to even more specialised subcontractors with a strong project management is the optimum pre-condition to overcome such organisational challenges. Consulting with experienced companies can obviously be very helpful.

The lack of the existing support infrastructure to be used by project developers, which is necessary to support the market introduction and a wider dissemination of technologies to convert geothermal energy into heat and/or electricity, can be an important barrier delaying or hindering the realisation of new geothermal plants. For example the successful construction and operation of a geothermal plant strongly depends among others on the availability of drilling rigs, material and of skilled and motivated personnel. It is a critical barrier in the beginning of a new technology, that the necessary infrastructure will only be established if the technology achieves a certain critical dissemination in the market and the region. However, geothermal technology based on low-enthalpy resources cannot reach this required minimum diffusion without the necessary supporting infrastructures in place. Recent research has established the concept of "strategic niche management" to overcome this paradox, which is a typical problem for decentralised renewable energy technologies.

5 Perceptual challenges

In general, there is a broad acceptance of plants using renewable sources of energy by the public at present. However, this is not always the case for geothermal energy. People who are not familiar with the opportunities and benefits from the use of geothermal energy and who have only little knowledge about technology tend to have prejudices. Often these people have had, or have heard about, negative experiences of not-comparable projects and transfer this experience to new geothermal power and/or CHP plants. Another point is that renewable energies are often related to subsidies which finally have to be paid by the public not knowing that also fossil fuel energy have been or still are supported by public money to a considerable amount.

To correct these prejudices and to improve the understanding of the use of geothermal energy by the public, the necessary information about the technical background and the benefits, but also about the challenges of the geothermal provision of heat and/or electricity, should be presented in an adequate, objective and fair way.

5.1 Perceptions of the public and politicians

The rating of geothermal energy provision among the broad public but also among politicians has partially improved in the last couple of years. This is mainly based on the cognition that the use of geothermal energy in general can make a substantial contribution to reducing the increase in concentration of greenhouse gases in the atmosphere due to anthropogenic sources (i.e. mainly the use of fossil fuel energy). However, geothermal energy is often perceived within the various measures to reduce greenhouse gas emissions as playing small role compared to other renewable sources of energy such as wind or solar. Therefore, more information should be provided about the opportunities and advantages from the provision of geothermal energy. The focus should be placed on:

- the reduction of greenhouse gas emissions,
- the contribution to a more sustainable energy supply system throughout Europe and the world,
- the creation of new jobs with innovative technology and the provision new opportunities especially for drilling companies and power plant manufacturer,
- the contribution to a more safely energy system due to the use of a domestic energy carrier with a huge technical potential.

The lack of awareness about these benefits has led to a lower financial support from public money for geothermal energy technologies compared to other renewable energies like e.g. photovoltaic. A stronger promotional support from the public, politicians and administrative decision-makers is therefore urgently needed to get the financial support necessary to introduce geothermal energy technologies into the market. To achieve a much better understanding and more positive acceptance of geothermal energy more emphasis should thus be put on the promotion of this source of energy.

5.2 Perception of local authorities and the public concerned by a plant

The personal attitude towards a geothermal power and/or CHP plant can change if people are confronted with such a plant in their direct neighbourhood. This is the so called NIMBY effect - everybody likes the use of renewable sources for the provision of energy but Not In My BackYard. Like any other plant which is build within a populated region or within an urban or industrialised area, the erection and operation of a geothermal plant is associated with several advantages and disadvantages. Thus the opinion of the local authorities as well as the local public towards a geothermal power and/or CHP plant is strongly dependent on the effects such a plant will have on

- traffic infrastructure within and outside their town or village during the construction phase,
- noise exposure during the construction and operation phase,
- emissions of locally active substances (like water vapour from the cooling tower affecting the micro climate),
- local employment (e.g. the number and quality of new jobs) and tax income, and
- attractiveness and image of the community as a working, living and/or tourist place.

The weight of such possible impacts within the local authorities and/or the concerned public is mainly dependent on the perception and evaluation of the pros and cons compared to the present situation and to the given alternatives. The perception can be influenced significantly by the way in which information about the benefits and challenges of a geothermal power and/or CHP plant is disseminated at the local level within the surrounding community. The timing and targeting of the provision of information at an adequate disaggregation level and the facilitation of an open discussion are important aspects to be successful in meeting people's requirements. Starting too early with the information campaign can be dangerous because plant modifications necessary during the implementation phase can lead to a general distrust of the project. Starting too late

may also be detrimental as informal information dissemination can occur with information being disseminated which does not describe the actual facts. From a strategic point of view it is also important at an early stage to involve local and regional politicians and non-governmental organisations and to form alliances with partners of common interest. Therefore a broad democratic decision process with a good time management including the public affected by the plant is much more promising than to establish a geothermal plant by a political top down decision.

The use of geothermal energy can contribute significantly to local employment and income also. The establishment of a geothermal power and/or CHP plant can have a profound effect on the people who live in the direct neighbourhood of the plant site and on the people connected to the district heating system (if there is heat sold to the public). Heat as well as electricity is an essential commodity and the public trustworthiness of the plant owner and operator can play a central role in the acceptance of a geothermal plant and the acceptance of the energy delivered from this plant (this is mainly true for heat). Therefore, the social acceptance and competence of the plant owner and operator within a community are often an important factor for the public acceptance of a project.

6 Recommendations

Geothermal power and/or CHP plants using low enthalpy sources for the provision of heat and/or electricity are still associated with a significantly higher number of technical challenges than plants fired with fossil fuel energy. Moreover, there are also various non-technical challenges e.g. with funding, financing and insurance, administrative regulations, organisational complexity, acceptance by the public, commissioning the geothermal plant etc. Such non-technical barriers can delay or hinder the implementation of even economically promising projects. These challenges can be decisive as to whether or not invest in a geothermal project, especially when there is uncertainty of adequate profits which would justify the troubles to overcome these barriers.

In this context different measures and instruments could be pursued in order to avoid geothermal projects being delayed, hindered or failing due to non-technical issues in the future. Among others, the following actions are recommended:

- The procedures to obtain permissions from the government to run geothermal plants depending on the size and the technologies should be improved substantially and become simpler, less time consuming, and less costly as well as more transparent and predictable. Additionally the co-ordination, harmonisation and timing of the different regulatory authorities during the overall procedure should be enhanced.
- The acceptance of geothermal energy by the public and especially by the politicians and administrative decision-makers on the local level needs to be improved. This could be achieved, for example, by a public relation's campaign launched to inform the public about the socio-economic and environmental benefits of geothermal energy. If a geothermal power and/or CHP plant is implemented with bottom-up-decisions involving the public at the right time and stage of planning, it can be expected that in general there will be broad acceptance of the plant. District heating plants are fully supported by the public in most cases when a democratic decision is taken to establish them.
- The local municipality and public should be convinced by the opportunities associated with a geothermal power and/or CHP plant and should be involved in the project. As a consequence different forms of support may be possible, such as the promise to connect all public buildings and new development sites for connection to the district heating grid of the plant.
- Credits for building such a plant can be obtained more easily if the funding organisation is fully aware of the challenges associated with such a plant. Their decision can be supported if gov-

ernmental support – e.g. as a subsidy to the overall investment costs and/or a fixed feed-in tariff for the produced electricity – is also available.

The importance of non-technical challenges for a wider use of geothermal energy could be much less than today if the economics of the provision of geothermal heat and/or electricity were to be substantially improved. Funding activities that address non-technical or semi-technical issues (such as quality control) can decrease the need for subsidies significantly without compromising the goal of introducing geothermal energy to the market.

Facing the economic uncertainties and market risks on the one side and the higher costs for the provision of geothermal energy compared to the energy costs from fossil fuel energy on the other, a broad and long lasting market introduction programme is required consisting of R&D measures on the one side and market introduction measures on the other. To finance such a programme, funds with a sufficient finance over a significantly long period of time must be available. The funds needed for such a programme could be provided by the government through different financial support measures taking the environmental and other benefits of an increased use of geothermal energy into consideration. Based on such a programme it might be possible to create a market for plants to produce geothermal heat and/or electricity which could be economically viable over the long term.

References

1. Questionnaires of work package 5, ENGINE-project *Non-technical barriers and benefits of geothermal energy production*. November 2006, not published
2. Ungemach, P., Antics, M. *Non Technical Barriers in Developing Geothermal District Heating in Paris*. In: Ledru, P., Huenges, E. (eds.) Actes/Proceedings of the Engine Mid-Term Conference, 9-12 January 2007, Potsdam, Germany
3. Romagnoli, P. *Non Technical Barriers in Tuscany*. In: Ledru, P., Huenges, E. (eds.) Actes/Proceedings of the Engine Mid-Term Conference, 9-12 January 2007, Potsdam, Germany
4. Seibt, P., Kabus, F., Wolfgramm, M. *Von der Projektidee bis zur Inbetriebnahme – Projektentwicklung geothermischer Anlagen aus Sicht des Planers.* In Tagungsband 9. Geothermische Fachtagung 2006, 16.-17. November 2006, Karlsruhe, Germany
5. Mégel, T. *Requirements for the Development of EGS.* In: Ledru, P., Genter, A. (eds.) Actes/Proceedings of the Engine Launching Conference, 12-15 February 2006, Orléans, France
6. Sanner, B., Bußmann, W. *Politische und rechtliche Rahmenbedingungen für Geothermie in Deutschland und der EU*. In Tagungsband 8. Geothermische Fachtagung 2005, 16.-17. November 2005, Unterschleißheim, Germany