GEOFAR – Financing Geothermal Energy in European Regions

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ABSTRACT

The GEOFAR project aims to reduce financial barriers hindering the initial stages of geothermal energy projects through the development and proposal of appropriate financing and funding schemes. The analysis of financial instruments across Europe is necessary to this work. Feed-in tariffs are the common instruments supporting electricity production from geothermal sources. Besides bank facilities, grants, risk insurance instruments, and tax reduction are the most widespread tools. However, a lack of harmonization of these instruments across Europe is obvious. Also, not all phases of geothermal projects are covered, and their specifications are rarely taken into account by traditional financing tools. These main barriers are not overcome by all target countries. GEOFAR aims to support these countries by promoting appropriate financing and funding schemes in order to provide a targeting instrument for overcoming the barriers of high up-front costs and high investment risks.

1. INTRODUCTION

In September 2008 the EU-funded project GEOFAR was launched by eight partners from five European countries (Germany, France, Greece, Spain, and Portugal) under the premises of the Intelligent Energy II Program for 30 months. All partners realized that deep geothermal energy has high potential, but that its exploitation is very difficult. This is especially due to non-technical (financial) barriers and a lack of awareness among decision makers which hinders investments in geothermal power plants and industrial geothermal applications.

Generally speaking, the GEOFAR project follows a set of objectives to reach its goal of fostering a deep geothermal energy sector across Europe:

- Reducing financial barriers hindering the initial stages of geothermal energy projects through the development and proposal of appropriate financing and funding schemes. This helps to boost investments in geothermal energy.

- Promoting and raising the awareness of emerging industrial geothermal applications. These awareness-raising activities are mainly directed toward local and regional decision makers and other potential stakeholders.

- Increasing consideration of geothermal energy as a sustainable, competitive and secure energy source within European communication and directives. This is done by providing legal framework and outlining new or modified EC directives and communications in which geothermal energy is appropriately considered as a relevant means to achieve a sustainable, competitive and secure energy portfolio in Europe.

- Improving the knowledge and awareness among regional decision makers by exchanging experience among the target groups.

- Spreading all findings and results as widely as possible in order to ensure that the maximum number of local and regional decision makers receive valuable information for evaluating the benefits of geothermal energy to the local/regional economy.

In fulfilling these aims, GEOFAR is expected to enable all European geothermal stakeholders to overcome the non-technical (especially financial) barriers and to significantly raise the awareness of geothermal energy among the European target groups. The basic work was the analysis of existing financial instruments across Europe in order to determine each country's specific instruments and differences and to discuss best practices. The reduction of financial barriers is discussed in this paper, and a detailed overview of the results GEOFAR has drawn in the report "Financial instruments as support for the exploitation of geothermal energy" is given (report published in July 2009).

2. METHOD OF ANALYSIS

The GEOFAR project began with the currently implemented European, International and country specific financial instruments for the eight European target countries included in GEOFAR (Germany, France, Greece, Spain, Portugal, Bulgaria, Slovakia, Hungary). In the analysis of country-specific financial instruments, Italy and Iceland were included as two of the high potential countries in order to get an idea of the role of financial instruments in the exploitation of geothermal resources in these two countries.

In order to provide a detailed overview of the existing financial instruments across Europe, GEOFAR analyzed not only instruments dedicated specifically to geothermal energy, but also financial instruments dedicated to RES

including geothermal energy, environmentally friendly projects, and even infrastructure projects from which geothermal energy projects can benefit.

The consortium set its focus on the analysis of laws and funding mechanisms from public and semi-public institutions. Traditional means of project financing like ordinary loans from banks were not part of the analysis. The analysis was mainly based on internet research and personal contact with national and European financial institutions as well as investors through phone **interviews** and one-on-one meetings. The interviews enabled the consortium to get an insight into the financial institutions and their instruments. The one-on-one meetings were also a good opportunity to discuss the financial barriers and how the currently offered financial instruments can help to overcome them.

The basic analysis was focused on five criteria

- the type of funding scheme,
- the project scope,
- the project phase,
- the funding amount,
- who is eligible and who manages it.

The eligibility criteria and administrative procedures were analyzed in order to enable investors to have a brief, informative overview of the funding possibilities and the means of application in selected European countries. To ensure a quality standard and ensure international comparability, the analysis followed strict guidelines. The results of the analysis of each financial instrument will soon be available for download as fact sheets from the project's website (www.geofar.eu).

Based on this analysis of existing financial instruments across Europe, the report "**Financial instruments as support for the exploitation of geothermal energy"** was redacted and clearly reflects the outcomes of each single analysis on the following questions:

- What are the differences between the instruments?
- What financial instruments are the best practices for a newly developed European financial scheme?
- How can the financial instruments support investors in overcoming financial barriers?

This paper briefly introduces the analyzed instruments on national, European and international levels. The following issues are discussed in this paper: the financial barriers tackled by each instrument, the stages of geothermal projects marked for development, and the criteria for a new European financial scheme.

2. BASIC KNOWLEDGE ON GEOTHERMAL ENERGY PROJECTS

2.1 Generalities on geothermal energy projects

Power generation and heat production from geothermal resources are two different technologies, which makes the drawing of generalities on geothermal energy projects rather difficult. These two different technologies are even difficult to compare in their respective economic environments. One major difference is that power generation from geothermal resources requires higher temperature than direct use applications. The characteristics of each project depend on the location, intended plant capacity, natural conditions, needs in surface, etc.

Basic Information: Knowledge of the quality and quantity of the geothermal resources in question are key to the success of geothermal projects. A major problem for investors is that the quality and quantity of a resource can only be estimated and not proven before explorative drilling. In the early stages of geothermal energy projects, the risk of the resource is very high, and explorative drilling very expensive.

Risk: As described, the risk is high during the exploration and pre-feasibility phase, while the costs are already significant. For example, either seismic data must be purchased or seismic investigations have to be conducted. One of the largest obstacles for investment in deep geothermal systems is that the presence and quality of the resource is not proven until the first exploration well is drilled. In consequence, the feasibility of a project can only be proven if the coupled flow rate and temperature fulfill the expectations of the investors. After successful drilling, the risk decreases and reaches a reasonable level. However, funding must be obtained in the most risky phase of the project under uncertain framework conditions. This is a crucial point for each geothermal project and probably the greatest barrier in project implementation that GEOFAR has attempted to find solutions for.

Costs: In comparison to other renewable energy technologies, geothermal energy projects have high up-front costs (mainly due to the costs of exploration, like seismic investigations, reprocessing, and drilling wells) and low operational costs. These operational costs vary to a great extent from one project to another (size, quality of the geothermal fluids, etc.) but are predictable in comparison to power plants using traditional energy sources. The largest part of the project costs are the costs for the drilling under high risk. The investment for the power plant after having evaluated the risk is predictable.

District heating networks can significantly increase investment costs. For example, in a high density quarter in Paris, the costs for a network can reach 15 to 20 million €. Some countries, like those in Eastern Europe, benefit from that fact because of the large number of existing networks. This could also facilitate the development of geothermal energy projects in combination with district heating networks that are currently supplied by nonrenewable energy sources in countries with a high number of existing heat networks.

Time Schedule: Time periods can vary from project to project, depending mainly on permitting and administrative issues. It is common for geothermal projects to have long pay-back periods due to high investment costs that reduce profitability.

Profitability: The consideration of profitability is a key point for an investor. The operating plants create revenue from electricity and/or heat sales and sometimes from selling by-products. Multiple forms of utilization have to be considered at the beginning of the project to create new revenue possibilities during the operating phase. A single use project has high investment costs, and revenue is limited to one source, (e.g. feed-in tariffs for electricity from geothermal energy). A multi-use geothermal plant has

the potential to be more profitable due to multiple sources of revenue.

2.2 Financing geothermal energy projects

The financing of geothermal energy projects is rather difficult as the project phases of geological research (feasibility study, drilling, investment, operation and maintenance) are all associated with different risks and costs, but are interoperable. The stakeholders of geothermal energy projects are manifold: consumers, investors, suppliers, developers, governments, operators, and financial institutions. They all contribute to defining the economical and financial terms of the project, and all have multiple interests of what the project's benefits means to them. The financial institution focuses on the viability and the risks of the project and will expect repayment of the debt, which is usually expressed in the Debt Service Cover Ratio (DSCR). The investor will focus on the return on equity of the project. The considerations of all stakeholders have to be taken into account to assess the viability of the project in a very early phase of the geothermal energy project.

Drilling: Considerations about investment costs and risks underline that the financing of the exploration and (pre)feasibility studies are an important barrier. Unsuccessful drilling is an important risk that has to be taken into account, as drilling costs are consequent and can represent a significant part of overall project costs. However, this risk must be assumed. Financial institutions often argue that for traditional financing, the risk is too high to provide a loan or other financial sources at this early stage of a project. The financial institutions will wait to provide loans to a geothermal project until the existence and the quality of the resource has been proven. Therefore, equity from one's own resources or grants from public bodies could be needed to cover these expenditures in the early phases of the project. Private equity investors expect a high rate of return at these initial stages of the project due to the risk their investment faces. Finally, classic project finance schemes can be used at a very late project phase.

Investment: Grants can reduce the amount of investments and feed-in tariffs regulated by law and fix revenues during the operational phase. Therefore, a combination of financing schemes and incentives can be a key point for the economic success of projects and should be analyzed. Proposals of funding schemes (equity, loan, subsidies, grants, etc.) for geothermal energy are presented and analyzed in this paper for each target country, at national and international levels. A special focus of each geothermal project must be set on the geological risk insurance mechanisms that guarantee the presence and the quality of the resources. This is a necessary requirement for each project to overcome these difficulties.

2.3 Main financial barriers for geothermal energy projects

To understand the necessity of public or semi-public funding instruments, it is important to get insight regarding the main financial barriers of deep geothermal projects. This is a necessary condition before analyzing the financial instruments that have been installed by the national governments or EU institutions to offer a solution to overcome these barriers.

The regulation barriers affecting deep geothermal projects have recently been analyzed in great detail by the EU-funded project GTR-H and some financial barriers have been indentified. The GEOFAR project picked up where the GTR-H project left off and performed its own analysis. It is common knowledge that especially in Europe, the main financial barriers that hinder investments in deep geothermal energy projects are

- the high up-front costs (exploration, like seismic investigations, reprocessing and finally drilling wells) of deep geothermal energy projects and
- the high drilling risk combined with high drilling costs.

These main barriers lead to two types of problems:

- The profitability of geothermal plants is far behind the profitability of other renewable energy sources because of high investment costs. The interest of investors in geothermal energy is thus far weaker than in other renewable energies.
- Because of high costs in combination with high risk, institutional investors often tend not to lend money to these projects, because they fear the risk. That makes it difficult to realize the investment because venture capital must to be attracted or one's own capital must be used. Except in the rare case that one can provide their own funding, the search for a risk-taking investor can be a costly alternative.

These barriers affect the investment in geothermal energy and its profitability. On national, European and international levels, a bundle of instruments has been developed to overcome the main barriers that hinder investment in geothermal energy.

3. FINANCIAL INSTRUMENTS

3.1 The country situation

3.1.1 Germany

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) together with the KfW (Kreditanstalt für Wiederaufbau – Banking Group) offers a set of financial instruments which are dedicated to support the German geothermal energy sector.

Research: The BMU sets a very strong focus on research activities in geothermal projects. A program dedicated to demonstration projects has been set in order to support projects with demonstration character that influence existing or planned operations. The KfW provides bullet loans with interest subsidies to demonstration projects. The amount of financial support can be up to 70 % of the fundable costs of the research project without a limit.

Investment: To boost investment, the BMU has developed several financial instruments under the "Market Incentive Program" for deep geothermal projects that comprise funding and risk mitigation in the stages of drilling, plant design and construction, and infrastructure.

As part of the "Program to Promote Renewable Energies" that is part of the "Market Incentive Program", the KfW offers loans with redemption grants to support deep geothermal projects in the phases of drilling, plant design, and plant construction. The financing share can be up to 100% of the eligible net investment costs. A maximum loan amount of 10 million € per project can usually be granted by geothermal energy projects. The redemption grants amount to a maximum of:

- 2 million € for plant funding,
- 5 million € for drilling cost funding (for one doublet),
- 2.5 million € for additional expenses for deep drilling (for one doublet),
- 1.5 million € for heat networks.

The newly implemented instrument "Fündigkeitsrisiko Tiefengeothermie" has supported deep geothermal projects in sharing the risk associated with the explorative drilling stages of deep geothermal projects since early 2009. The financing share is up to 80% of the eligible drilling costs including the investment for stimulation measures with a maximum loan of 16 million € per drilling project (one doublet). The indemnification clause will be discharged after non-discovery is proven and approved by KfW at up to 100% of the liability for the repayment of outstanding loans.

Feed-in tariffs: The Renewable Energy Sources Act (EEG) regulates the feed-in tariffs. The first 10 MW of geothermal electricity output is reimbursed by 16.0 c€/kWh, and it is reimbursed by 10.5 c€/kWh for output over 10 MW. The reimbursement increases by 4.0 c€/kWh for a plants that start running before January 1, 2016. Several bonuses can increase the tariff for geothermal energy, such as the heat bonus of 3.0 c€/kWh for the first 10 MW of output if at least one fifth of the available heat capacity is decoupled or the technology bonus of 4.0 c€/kWh for the first 10 MW of output if petro-thermal techniques are used.

However, support mechanisms for geological research and pre-feasibility and feasibility studies dedicated to geothermal energy are not offered for German geothermal projects.

3.1.2 France

France offers a bundle of supporting instruments for geothermal projects that cover different stages of geothermal projects.

Feasibility studies: Public grants for geothermal energy projects are offered by ADEME (French Environment and Energy Management Agency). These grants dedicated to feasibility studies for geothermal projects grant up to 50% of the cost of the study and are limited to 300,000 € for deep geothermal energy projects. Additionally, a grant for an expert consultant supporting the project owner during the feasibility studies can be applied for a maximum of 30% of the costs for the feasibility study (limited to 100,000 €).

Feed-in tariffs: French electricity grid operators are obliged by law to buy electricity from renewable energy sources at a fixed price. For geothermal power production with contracts signed after the year 2006, the tariff is fixed at 12 c€/kWh (a bonus of between 0 and 3 c€/kWh can be realized if heat is also used) for Metropolitan plants (binary cycles) and at 10 c€/kWh for plants located overseas with the same bonus. These values for the year 2006 are updated each year following the inflation rate.

VAT reduction: The French government reduced the VAT rate for district heating using renewable energy sources in order to decrease the price of renewable energy. The reduced VAT rate applies for renewable heating, including geothermal energy. For electricity, the VAT rate decreases from 19.6 % to 5.5 % if an average of more than 60% of the electricity comes from renewable sources.

District Heating: The French Ministry and ADEME launched the "Heat Fund" dedicated to heat production from renewable energy sources. It provides grants for investment by selling the heat at rates 5% cheaper than those of heat produced with fossil energy (with natural gas as the reference). All projects are evaluated case by case. 20% of the grant is given after checking the real production for the first 2 years of exploitation.

Risk Insurance: The French risk insurance system, which offers insurance contracts for 20 years to cover the geological risk, is based on two complementary mechanisms: a short-term procedure based on the socialization of risks which guarantees the risk during the drilling phase of not obtaining geothermal resource matching the flow rate and temperature requirements enabling to assure the profitability of the planned operation (with an insurance rate based on the cost of the drilling). The risk insurance secures also the long term profitable exploitation of the deep geothermal resource that is to say that the risk of seeing this resource lessening or disappearing before the amortization of the equipments as well as the risk of damage affecting the wells, the material and the equipment of the geothermal loop during the first 20 years of the exploitation period.

3.1.3 Greece

In order to meet regulations, the Greek government installed several financial instruments that are dedicated to promote the Greek geothermal sector.

Investments: The Greek "law for incentives for the private investments for economic development and regional convergence" is the main financial instrument supporting the development of geothermal energy for all uses. It offers support for investments in geothermal energy projects.

Grants for investment can be applied for the design and construction of geothermal plants. The percentage of the grants for investment in combination with other financial supports has a maximum limit of 55% of the total investment cost.

Leasing subsidies can be applied for investments in new mechanical equipment and other equipment. The percentage of the investor's own participation in investments which are included in the cash grants and/or leasing subsidy systems cannot be less than 25% of the subsidized expenses.

Feed-in tariff: The Greek law for the promotion of renewable energy sources sets tailored feed-in tariffs for electricity production from geothermal energy. In the interconnected electric system, the selling price of electricity is 73 €/MWh, and it is 84.6 €/MWh in the non – interconnected island system.

Operation and maintenance: The Greek law for incentives for the private investments for economic development and regional convergence also offers support for the operation and maintenance of geothermal energy projects.

Tax reduction (exemption) on non-distributed gains can be applied to investment plans. The tax reduction can range from 50% to 100% and is effective for the first ten (10) years of operation. In the investments which are included in the tax exemption, at least 25% of the costs should be covered by the financial participation of the investor in the form of either self-funding or loans.

A wage subsidy for employment created varies from 10% to 40% according to the employment positions relative to the investment.

3.1.4 Portugal

The Portuguese government introduced different financial instruments to improve geothermal energy development with a clear focus on electricity production.

Investment: The main incentives in Portugal are subsidies provided by regional institutions. These incentives can cover up to 85% of the total amount of a project for heat, electricity or cogeneration production. The funding, which is not only dedicated to geothermal energy projects, is comparable for all regions, but the conditions of allocation vary from one region to another. The grants are dedicated to pilot projects and particularly to public projects or recognized public interest projects.

Additionally, a reduced VAT (12%) for geothermal energy projects is possible for the acquisition of new equipment for renewable energy production and for cogeneration from micro turbines (which have a maximum power of 100 kW and consume natural gas), including additional equipment indispensable to operation.

Feed-in tariff: The Portuguese government has introduced a guaranteed feed-in tariff with a purchase obligation for electricity suppliers, which is calculated by a formula based on various factors like system output and capacity. The payment is guaranteed for 15 years to the beneficiary.

3.1.5 Spain

The Spanish government has installed several financial instruments geothermal energy projects can benefit from.

Feasibility studies and investment: The IDAE financing instrument managed by the IDAE (Institute for Diversification and Saving of Energy) offers a bundle of schemes such as loans, technical assistance, etc. for geothermal heating, cooling and electricity projects. The funding can be applied to feasibility studies and investments. The amount of funding depends on negotiation with the investor in the geothermal project.

Investment: Power plant operators can also obtain a fiscal reduction for investments. A certain percentage of unsubsidized investments in systems and equipment required for the generation of electricity may be deducted from business tax over 10 years.

Feed-in tariffs: The operator of an electricity producing geothermal power plant can be supported with a feed-in tariff of 6.89 c€/kWh or a bonus of 3.84 c€/kWh for the first 20 years depending on the geothermal power plant capacity. For a power plant with a capacity of up to 50 MW, a guaranteed feed-in tariff and a bonus paid on top of the free market price is applicable. For power plants with a capacity between 50 and 100 MW, only the bonus for the produced electricity is applicable. No feed-in tariff or bonus is applicable for power plants with a capacity of more than 100 MW.

Research: The Ministry of Science and Innovation offers three instruments for R&D projects that geothermal energy projects developed by public and private organizations can apply for. The instruments go into effect as soon as the feasibility studies begin.

The **National R&D&I Plan** offers subsidies and/or loans with special interest that can support up to 50% of the project depending on the body and without a maximum amount of support.

Unique strategic projects in the field of energy can apply for a minimum funding of 2 million € if the development of new processes and technologies is included in the project.

Private companies in cooperation with public bodies, universities, and research centers can be supported by subsidies from the CENIT program for large R&D projects.

3.1.6 Bulgaria

The Bulgarian government installed incentives to foster investment in geothermal projects. The measures taken were:

- Reduction of customs duties for imported items
- Free utilization of existing wells
- Reduction of Value Added Tax (VAT) by 2%
- Reduction of income tax by 3%

Besides these government incentives, financial instruments are provided that offer financial support to investors in geothermal energy projects.

Investment: To strengthen investment in energy projects including geothermal projects, the Bulgarian Ministry of Economy and Energy passed a law on the promotion of investments to strengthen the domestic energy market. The possible funding can be up to 60 % of total project costs. At least 40% of the investment costs must be financed by private equity or third party loans.

The EBRD together with Bulgarian banks has developed the **Bulgarian Energy Efficiency and Renewable Energy Credit Line** (BEERECL). The BEERECL offers loans with incentive grants for geothermal energy projects. The loans are limited among the participating banks between 150,000 € to 2 million €. The incentive grant can be received on the specific loan upon project completion. These grants offer:

- 15% of the disbursed loan principal for industrial energy efficiency projects
- 20% of the disbursed loan principal for small renewable projects

Feed In tariffs: Energy generated from renewable energy sources is given preferential pricing. Transmission and distribution entities are required to purchase all renewable energy produced at a fixed rate. The incentives also include a mandatory connection of RES electricity to the electrical grid, a preferential price for the sale of RES energy and a securing preferential treatment for producers of RES power.

3.1.7 Hungary

Hungary provides a funding structure for geothermal projects that mainly consists of two instruments.

Investment: The main support structure for geothermal energy is the Environmental and Energy Operational Program (KEOP). It is one of the 6 Operative Programs of the 2007-2013 New Hungarian Development Plan and is mainly funded by structural and cohesion funds from the European Union. The KEOP provides a total budget of 253 million € for renewable energy. The offered grants, credits

and guarantee instruments are subject to operating calls for application and vary greatly between operating calls.

Feed-in tariff: The feed-in-tariffs for renewable energy including geothermal energy vary according to time of day and technology and are adapted on a yearly basis taking the inflation rate into account. It is a flexible system, contrary to the fixed basic systems like those in Germany

3.1.8 Slovakia

The Slovak government launched several instruments to promote renewable energy.

Investment: Geothermal plant operators can apply for subsidies through the European Structural Fund according to open calls. The subsidies range from

- 20,000 € to 200,000 € for small projects and
- 60,000 € to 5 million € for larger projects.

The amount of funding is subject to the regional location of the project. For projects in the Bratislava region, the subsidies may not exceed 40% of the eligible cost of the project. For all other Slovakian regions, the subsidies can be up to 50% of the eligible project costs.

Tax reduction: In Slovakia, electricity from renewable energy sources is subject to a consumption tax exemption. Geothermal energy benefits from the tax exemption because of this. The amount of tax is calculated on the basis of the amount of electricity tariffs.

Feed in tariffs: Feed-in tariffs have been installed to support electricity generation for geothermal power plants with capacities higher than 5 MW. The feed-in tariff sets the price regulation for electricity generated by geothermal energy to 195.84 €/MWh. This price is fixed for 12 years following the start of operations. If the plant operator receives an investment grant from the state or the EU, the amount of payment decreases by a clearly defined percentage.

3.1.9 Iceland

In Iceland, the major instrument that supports the geothermal energy sector is the National Energy Fund. It provides the following support:

National Energy Fund loan: Maximum of 60% of the Fund-approved costs. The interest rate on National Energy Fund loans is 6%.

National Energy Fund grant: Shall not exceed 50 % of the estimated costs of the individual project.

National Energy Fund Venture loan: Additionally, Glitnir (Icelandic Bank) proposed **a hybrid mezzanine financing vehicle** to overcome financing barriers under the name of Resource Verification Loan, which provides funding to geothermal energy projects during their early stages.

3.1.10 Italy

Quota System (Certificati Verdi): Geothermal resources in Italy are mainly used for electricity production. The quota system obliges all producers and importers of electricity to generate a certain quota of electricity from renewable sources. If this is not possible, producers and importers must purchase a certain amount of green certificates. All those businesses importing or producing more than 100 GWh of electricity are obliged to satisfy the national quota. The value of electricity generated from renewable sources is the sum of the base price of the energy plus the market value of the Green Certificates, where the latter is limited to the first eight years of plant operation. In the year 2007, this mechanism led to an average market price of 1.3 c€/kWh for the Green Certificates in addition to the average price for the sale of electricity, which was around 7 c€/kWh.

Feed-in tariff: Small plants and expensive technologies can make use of various kinds of price regulation, which might be more cost-efficient than participation in the certificate system. The Italian feed-in tariffs are dedicated to promoting small geothermal systems. Systems generating less than 1MW can benefit from these feed-in tariffs. The payment depends on the profitability of the geothermal system, the amount is set at 20 c€/kWh, and the guarantee period is fixed at 15 years.

Tax credit: There is a contribution in form of a tax credit for investors for **heat production** and utilization in district heating plants. These grant represents about 21 €/kW in capital costs and 0.0258 €/kWh in yearly operation costs.

3.2 The European dimension

On the European level, several instruments are implemented by different European institutions that geothermal energy projects can benefit from.

Research and Development: The EU Commission runs the FP7-Energy Program to promote R&D in order to foster the development of new technologies in the renewable energy field (including geothermal energy). Beneficiaries (especially research institutions and research driven SMEs) can get funding between 50% and 100% of project costs depending on the type of beneficiary and its role. However, the projects must prove their demonstration character.

Early stage and investments: The European Investment Bank offers loans to support investment in geothermal energy projects. These loans are normally 50 % (and in some cases up to 75 %) of the actual project costs. For a project to receive a direct loan, its total costs must be at least25 million € . Smaller projects are not served directly but through a financial intermediary.

The EBRD Renewable Development Initiative supports geothermal projects from 29 countries located throughout Central and Eastern Europe and the former Soviet Union. Large projects with project value between 5 million and 250 million € can apply for a minimum loan size of 5 million to 15 million €. The EBRD funds up to 35% of total project costs for a greenfield project or 35% of the long-term capitalization of an established company.

Smaller projects can apply for investment ranging generally from 500,000 to 6 million € with an equity share target ranging from 25 - 30% (but limited to a maximum of 49%).

Structural Funds and **Cohesion Funds** allocated by the European Union support projects in poorer European regions and the integration of the European infrastructure. Renewable energy (RE) and energy efficiency projects realized on a local level can be some of the best options to effectively use the funds. Geothermal projects can apply for funding according to National Development Plans (NDP) that has been approved by the European Commission. The maximum contribution of the funds to a project depends on the type and location of the project. Basically, each project

needs national co-financing. During the 2007-2013 period, the cohesion policy provides large amounts of funding for renewable energy. Geothermal energy projects can apply for funding in:

- Germany: ca 226 million €
- France: ca. 365 million €
- Spain: ca. 164 million €
- Greece: ca. 293 million €
- Portugal: ca. 105 million €
- Hungary: ca. 202 million €
- Bulgaria: ca. 66 million €
- Slovakia: ca. 90 million €

The European Commission has launched **JASPERS, JEREMIE and JESSICA** to enhance the support for start-ups and micro-enterprises through technical assistance, grants, and non-grant instruments such as loans, equity, venture capital or guarantees of cooperation with the EIB group. Support may be given to activities in all EU member states. Geothermal energy projects can be the beneficiaries of support to country-specific activities. This possibility must be checked country by country.

Pre-Accession Assistance: The European Commission also developed instruments for EU candidate countries or potential candidate countries in the Western Balkans in the form of the Instrument for Pre-Accession Assistance (IPA) – Energy Efficiency Finance Facility. The IPA offers a credit facility with investment incentives for end-beneficiaries and a credit facility with administration fees for financial intermediaries. Geothermal projects can benefit from this instrument.

3.3 International finance

On an international level, one financial instrument in particular has a large impact on the European geothermal sector, especially in Central Europe. The Geothermal Energy Development Program (GeoFund), which is funded by the Global Environment Facility (GEF) Trust Fund, provides technical assistance, partial risk insurance, straight grants and contingent grants for investments in geothermal energy projects. Investors and project developers of geothermal energy projects in the member countries of Albania, Armenia, Azerbaijan, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Georgia, Kazakhstan, Kirgizstan, Macedonia, Moldova, Montenegro, Romania, Russia, Serbia, Ukraine, Tajikistan, Turkey, Turkmenistan and Uzbekistan can benefit from GeoFund.

The GeoFund provides a total amount of 25 Million US$ to eligible geothermal energy projects. A geothermal project in GeoFund member countries is eligible in three different funding windows:

- Technical Assistance-Window: 7 Million US$
- Direct Investment Funding -Window: 8 Million US$ (contingent grants, low cost loans or, in limited cases, grant financing in the form of direct grants to support part of the investment cost for exploration)
- Geological Risk Insurance - Window: 10 Million US$ (grants for use during the risky exploration phase)

GeoFund also covers early (exploration) phases such as geological research, pre-feasibility studies and feasibility studies, the drilling of exploration wells and development wells, and plant design and construction.

4 RESULTS

4.1 Overcoming financial barriers

4.1.1 Practicable instruments

The GEOFAR analysis of financial instruments showed that the instruments provided across Europe are not harmonized. Each analyzed country provides a different set of financial instruments. The majority of financial instruments are not dedicated to geothermal energy in general. Although geothermal energy and other renewable energy sources have common characteristics (relatively high investment costs concerning specific energy power capacity and low operational costs), instruments do not consider the particularities of geothermal projects: high up-front costs and initial insecurity concerning the size and output of projects.

The main barriers and the financial instruments that where identified to overcome them are shown in Table 1.

- To overcome high up-front costs, public subsidies or venture loans are provided in countries like France and Spain or by the GeoFund on an international level.
- To cover and mitigate geological risk, subsidized insurance mechanisms are provided in Germany and France as well as on international level by the GeoFund.
- To support projects during their long pay-back periods, the high investment costs will be supported by bank facilities, such as those in Germany.
- Low outcomes will be supported by feed-in tariffs for electricity produced from geothermal energy. This is perhaps the most common instrument provided in all the analyzed countries except some instruments in Iceland and tax incentives in Bulgaria and Spain.

It was obvious during the analysis that in no instruments had been provided in any of the analyzed countries that addressed every project phase and thus provided an all-encompassing environment of funding and support. No GEOFAR target country offers the complete scheme of financial instruments and there is a lack of finance for the exploration phase in most cases. If banks propose instruments dedicated to geothermal energy, which is rarely the case, this usually occurs only after the feasibility studies. In consequence, no potential projects can be identified that are above all of the substantial expenses associated with geological investigations.

Tax reductions promote increased capital investment. This is a direct instrument that affects profitability, but it comes into effect at a very late stage, as it mainly affects the operational phase during which revenues are generated.

Grants substitute equity, as they provide public money to investors that they do not have to repay . The problem with this is the management of the public money. Is the public money best used for a certain project? What are the criteria for using public money for a project?

Table 1: Financial instruments to overcome the main financial barriers (Source: GEOFAR 2009)

Main barriers to overcome		**Financial Instruments that exist actually**
High up-front costs		Public Subsidies
		Venture loan
Geological Risk		Subsidized Insurance Mechanism
Long pay back period	High investment costs	Bank Facilities (e.g. subsidized interest loans)
	Low outcomes	Feed-in Tariff *for electricity production*
		Tax reduction

Table 2: Strengths and weaknesses of the offered financial instruments (Source: GEOFAR 2009)

Instruments offered	**Main strengths**	**Main Weakness**
Feed-in Tariffs	Secure income over a long term period	Acts at a very late project stage
Tax reduction	Promote increased capital investment	Affects mainly operational phase when revenues are generated
Grants	Substitute equity	Management of public money
Bank Facilities	Possibility to finance projects with high investment volumes	Difficult to apply in the stage of exploration without insurance mechanism
Tradable certificates/Quota systems	Deals with very few public money	No long term secured and fixed income

Bank facilities offer the possibility to finance projects with high investment volumes, which promotes investments in large scale projects. The problem for geothermal energy projects is the high risk due to unproven geothermal resources. Thus, it is difficult to apply to apply for loans from bank facilities in the stage of exploration without an insurance mechanism.

Tradable certificates/Quota systems are favourable as they deal with very little public money, but they are not real financing instruments, as they offer no long term secured or fixed income on the one side and provide grants or subsidies on the other side.

4.1.3 Necessary framework

All existing financing instruments are generally undertaken in partnership with:

- national or local authorities
- national or local financial institutions
- entities that make up a significant financial contribution to the financing of the project.

These partnerships have been proven to be very successful in

- mitigating the risks of moral hazards in the selection and monitoring of projects
- promoting efficient decision making
- maximizing the economic benefits resulting from investment of taxpayer money

But the existing financing instruments show additional features:

- no specific focus on leading industrial sectors or champion-firms
- reliance on markets or “quasi-markets” to guide the allocation of financial resources

These additional features are less desirable when financial markets operate with relative inefficiency, as they do in times of generalized uncertainty. Review of the literature shows that market and quasi-market signals are obscured by increased uncertainty by as much as 50%. Given the same product price (including subsidy) and demand information, firms will invest half of the rate that they would normally invest if they perceive uncertainty. For financial intermediaries, this effect is greatly amplified through leverage. Thus, strengths during good times can become weaknesses in bad times. Moreover, policy in abnormal times can lead to faulty logic. With states intervening heavily in the financial system of most countries and committing large amounts of taxpayer money, one should expect financing decisions to be influenced by a more complex, less predictable and less uniform set of criteria. This should produce efficiency losses and, more importantly, additional uncertainty.

There are also acknowledged weaknesses to the financing instruments made available by international institutions to geothermal energy projects, like the superficiality of supervision, monitoring, and control of large project portfolios in large institutions.

In former times, international institutions could count on the expertise of specialised long-term credit institutions in many countries. Those have evolved or been merged into much larger universal and international banks. Projects that are part of sectors which are classified as peripheral are not able to attract banks' attention. Venture capital can fill this void, but is also dependent on well-functioning financial markets both for loan finance and for the ultimate success of projects.

Inadequate supervision in large banking institutions, which has been traced by researchers, exists mostly due to conflicts of interest. Even with present-day information and telecommunications technology, there are limits to organization size beyond which the costs of supervising, monitoring and controlling outweigh the efficiency benefits.

Concerning the aforementioned, in the medium term (the next five years), one should expect a significant realignment of the financing instruments that will be made available by international institutions. It would not be wise to expect the present instruments to remain unchanged. There will be pressure on financial resources to be more focused on existing rather than emerging industries and technologies, if only to ease the conversion of resources from uses that will become obsolete in a new world economic environment. The energy industry and the geothermal energy industry in particular can position themselves to benefit from these forthcoming structural changes.

4.2 Insurance mechanisms

An insurance mechanism is the preferable solution to overcome the major barrier presented by the high risk of geothermal resources. Insurance mechanisms are not financial instruments in the common sense, as they are not a way to obtain money to explore or to increase the profitability of a project. However, they are a key point to boost investment in geothermal energy. They are dedicated to geothermal energy and taking its specificity into account.

As there is a gap in available financing instruments that correlates to the highest risk period of project development phases (i.e. the early stage of the project when the resource is not proven), each investor has to face a disproportionate share of project risk compared to other renewable energy investments. The investor must have access to adequate capital to move a geothermal project into the later stages of development and must be willing to put that capital at significant risk. This pairing of risk and funding gaps multiplies the risk of geothermal projects. Getting a loan for such an investment is difficult, as most banks will not lend money to high-risk projects. Mitigating the risk is necessary to realize the investment.

Such geological uncertainties are specific to the geothermal activities, and traditional insurance policies do not offer any specific solutions for this type of risk in view of its inherent nature. A risk-sharing instrument helps to overcome this barrier in order to foster investments in geothermal energy projects.

Specific financial guarantees designed to cover project investors against the geological uncertainties specific to this activity could secure the financing of a project.

Currently, only a few European countries provide such risk-sharing systems for geothermal projects: France and Germany. At an international level, GeoFund also provides a partial insurance system for GeoFund member countries that Eastern European countries like Bulgaria can benefit from. Furthermore, there are private enterprise insurance solutions available in Germany and abroad that have to be negotiated on an individual basis and include high insurance premiums.

4.3 Feed-in tariffs

Guaranteed feed-in tariffs are the only instrument that can be found in all target countries (except Iceland). And yet, although all agree that the principle is efficient, systems vary extremely from one country to another regarding amount, duration and whether the tariff is paid for the gross or net (reduced by the self consumption) electricity production.

The increased deployment of renewable energy sources is regarded by many as critical to combating climate change. One major obstacle to this adoption is the retail price of electricity generated from renewable sources (including geothermal), which is typically higher than the retail price of electricity generated from fossil fuels. A feed-in tariff is a revenue-neutral way of making the installation of geothermal energy more appealing. Electricity generated from geothermal energy is bought by the utility at legally secured tariffs, and furthermore, the utility is obliged to purchase the electricity produced.

Lenders are interested in long-term sustainable projects with high profitability. (This may differ from some private funds which favour high profitability in a short term.) The feed-in tariffs are a long-term guarantee, as the contract is signed for a given period at a fixed price. This secure source of income should increase the profitability of the project and should be large enough to ensure profitability. The feed-in tariffs are already taken into account at the early stage of the project but act at a very late stage. The feed-in tariff is a strong incentive to promote electricity from renewable energy. The tariffs are usually independent of the time of the day, except in Hungary where the tariff is higher at peak demand times. The guarantee period should be long enough to make this instrument totally viable.

Although principles are largely accepted and recognized as an efficient incentive, systems and tariffs vary significantly

from country to country making them more or less effective.

4.4 Other

Tax exemptions and tax reductions are other ways of supporting geothermal energy projects. These instruments are directly proportional to the real production. For example, this occurs in France and Italy (tax credit). The analyzed countries and their instruments dedicated to taxes are displayed in Table 3.

Some countries specially dedicate their instruments to private operators, such as Greece ("Incentives for private Investment"), Bulgaria ("Law on promotion on Investment"), and small/medium-sized enterprises like Slovakia ("Operational Program Competitiveness and Economic Growth").

Grants are also quite common to boost investment. Subsidies are offered mainly at regional level but are also offered at a national level. Subsidies mainly cover the investment phase for drilling development wells. However, they can also cover the purchase of equipment for central production and can account for 30% or 40% of the investment.

France offers special subsidies for feasibility studies that are a first step in the financing exploration phase. Meanwhile, the Portuguese regional programs are more oriented to the development of pilot projects.

Grants can also be provided by global **bank facilities** where projects are submitted to calls for applications and are subject to a strict selection process. Financing schemes are adapted and negotiated according to the projects submitted. This occurs mainly for European financial instruments or for calls for applications in Hungary or Slovakia (for which funds are provided mainly by the European Structural Funds).

This is also the case for European instruments that are more global: they offer not only instruments to finance launched geothermal projects, but they can also include technical assistance.

Special **bank facilities** with low interest loans rarely exist in the target countries, except in Germany and Iceland.

The European Union allocates funds **for research and pilot projects**. Some countries also dedicate money to promote the research and development of new demonstration projects, which geothermal projects can benefit from. Classical instruments are subsidies; for example, the Ministry for Environment in Germany creates bank facilities as bullet loans with subsidized interest rates.

At a European level and a national level, these instruments should permit the launching of new technologies, such as the development of EGS Systems that will enable electricity production where resources are less favorable.

Public subsidies are the only way to finance the exploration phase. Funds dedicated to research and demonstration programs could be another way, but nothing systematic can be found on a European level. Indeed, banks are afraid of the high risk, which is the key aspect that makes financing geothermal energy projects difficult. Venture loans are offered in Iceland and by the European Investment Fund. Subsidized Geological **Risk Guarantee Systems** are offered in France, in Germany, and by the GeoFund as an **Insurance Mechanism.** These instruments provide solutions to overcome the barrier presented by financial risk.

5. CONCLUSIONS

Some common instruments such as feed-in tariffs exist across Europe that foster investment in geothermal projects, but the lack of harmonization of these instruments is obvious. Moreover, not all phases of a geothermal project are covered and its specifications are rarely taken into account, despite this broad panel of solutions. Instruments that are not dedicated to the specific needs of geothermal energy projects seem to be inefficient. They can support project implementation, but not the overcoming of financial barriers.

Table 3: Country-specific instruments for tackling taxes (Source: GEOFAR 2009)

	Country	Name / Analysis	Beneficiaries	Project Scope	Project phase when the instrument tackle
VAT Reduction	France	VAT Reduction on selling heat price	Public & Private	Heat Production (District Heating)	O&M
	Bulgaria	VAT Reduction	Public & Private		O&M
	Portugal	VAT Reduction for new equipment	Public & Private	Electricity production	Pant design & Construction
Tax Exemption	Greece	Tax exemption on non distributed gains	Private	Heating & Electricity & Cogeneration	O&M
	Slovakia	Exemption from consumption tax	Public & Private	Electricity production	O&M
Other Tax Reduction	Bulgaria	Income Tax Reduction	Public & Private		O&M
	Italy	Credit tax reduction	Public & Private	Heat Production (District Heating)	Drilling wells and during O&M

Geothermal energy features high up-front costs and low operating costs. In summary, grants can support the financing of investments, and guaranteed feed-in tariffs ensure the profitably and can increase revenues during the operational phase. The combination of financing schemes and incentives is a key to the success of geothermal projects. Rather than the high investment costs of geothermal projects, the main barrier to overcome is the financing of exploration and prefeasibility studies. Geological risk insurance systems are insufficiently developed in the target countries (only offered in Germany and France) but are necessary to overcome the main barrier in geothermal projects. Further, conditions to foster early stage funding mechanisms are insufficiently developed in the target countries.

Developing geothermal financial instruments at the European level that would support geothermal projects in their early stage by financing and risk-sharing, and which would take specificities of geothermal energy projects into consideration, could be a solution to foster investments in geothermal energy projects.

Therefore, a European solution should address two main aspects: the lack of financing for the exploration phase and the risk of insufficient quality or quantity of the geothermal resource compared to the expectations for the project. This solution would have to take project-specific aspects and the investment environment of the project into account.

The next step of the GEOFAR project will be the proposal of appropriate funding schemes and financial instruments that cover these aspects. The results will be expected in late 2010.

REFERENCES

The GEOFAR Project, Report “Financial instruments as support for the exploitation of geothermal energy”, 2009.