GEOELEC project: Develop Geothermal Electricity in Europe to have a renewable energy mix

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ABSTRACT

The objective of GEOELEC project is to convince decision-makers about the potential of geothermal electricity in Europe, to stimulate banks and investors in financing geothermal power installations and finally to attract key potential investors such as oil and gas companies and electrical utilities to invest in the geothermal power.

The action plan that will be developed towards removing the non-technical barriers will result in geothermal electricity to drawing the attention of policy makers and industry, giving geothermal power the high profile it has in other parts of the world, and in persuading capital venture and other companies to seek the benefit of investing in the technology.

This project aims also at effectively exhibiting the potential contribution of geothermal electricity in all EU-27 countries, for a short and mid-term perspective. A strategy to reach these objectives will be elaborated in describing the technical, financial, legal, social and environmental issues and in presenting concrete solutions. Notably special attention will be dedicated to training new professionals in the sector and on the future jobs creation.

Figure 1: Geoelec project and IEE program logos.

1. INTRODUCTION

Although geothermal energy has provided commercial base-load electricity around the world for more than a century, it is often ignored in national and European projections of energy supply. This could be a result of the widespread perception that the total geothermal resource is often associated with identified high-grade, hydrothermal systems that are too few and too limited in their distribution in Europe to make a long-term, major impact at a European or national level.

This perception has led to undervaluing the long-term potential of geothermal energy by missing an opportunity to develop technologies for sustainable heat extraction from large volumes of accessible hot rock anywhere in Europe. In fact, many attributes of geothermal energy, namely its widespread distribution, availability 24 hours per day all year round, base-load ability without the need for storage, small footprint, and practically zero greenhouse gas emissions, are desirable for reaching a sustainable energy future for the EU. This has been recently understood by decision makers in other parts of the world, where new geothermal prospects under development will result in doubling global installed geothermal power generation capacity in the next years.

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The consortium covers 7 EU Member States (Belgium, France, Spain, Germany, The Netherlands, Italy, Greece) plus Iceland. The objective is to have an impact in the all the Member States; notably in countries with a hydrothermal potential with a special focus on Central and Eastern Europe countries.

2. PROSPECTIVE FOR GEOTHERMAL ELECTRICITY IN EUROPE

This work became even more crucial after the publication of the 27 National Renewable Energy Action Plans (NREAPs) of EU Member States. Indeed, many countries showed their lack of knowledge about their deep geothermal potential. Geoelec proposes to study the potential to produce geothermal electricity in each of the 27 Member States and some surrounding countries like Norway, Iceland, Norway, Turkey.

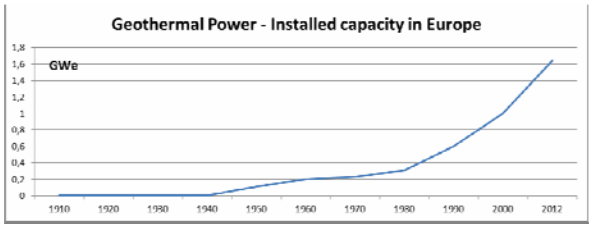

Figure 2: Geothermal power, installed capacity in Europe 1913-2013, in GWe.

2.1 Resource assessment

The first exercise is to present the available geological information in the different Member States. The long-term success of geothermal energy technologies depends upon a detailed characterization of geothermal energy resources europewide:
-an assessment of high temperature resource potential to fully leverage new low-temperature and EGS areas.
-development of a geothermal resource classification system for use in determining site potential.
-development of a data system to make resource data available to experts and professionals of the geothermal sector.
This collection of information about geothermal resource assessment in Europe– estimating the magnitude and distribution of the EU Geothermal power/EGS resource, means at completing the EC “Atlas of Geothermal Resources in Europe” published in 2002. This Atlas presents the geothermal resource (hydrothermal) up to 2Km depths. The Geoelec project will use these data, extrapolate them and complete them. The objective is to use all the existing maps and data in order to estimate the magnitude and distribution of hydrothermal and for the first time EGS resources 0-5 Km depth all over Europe.

2.2 Electricity demand and grid infrastructures

After having collected data to present the geothermal potential, Geoelec will study the electricity demand and the grid access for geothermal in order to evaluate the potential contribution to electricity supply of the sector in the future.

Recommendations as well as technical justifications will be made for the inclusion of geothermal power in existing networks. Like other generating technologies that are integrated into the electricity grid, the basic principles of balancing, backing up, and aggregating apply to geothermal power as well. But geothermal electricity plants have the advantage of more than 90% availability, so it provides the ‘base load’.

A geothermal resource developer must be able to connect to the grid. No matter how hot the resource nor how close it is to the surface, the developer must be able to connect to the electric grid at a point where there is sufficient available capacity to sell the electricity. The ability to negotiate a Power Purchase Agreement with a local/regional/national utility having a respectable credit rating will also enable the developer to gain access to financing on more favourable terms.

Geoelec will make recommendations as well as technical justifications for the inclusion of geothermal power in existing networks, and on construction of new grid infrastructures.

2.3 Forecasts and prospective

Based on potential power supply from the resource assessment, grid constraints and the match to power and heat demand, forecasts on the geothermal power production will be done.

Today information utilised in locating and estimating the geothermal resource and potential is spread out in different ministries, universities, national institutes, oil & gas companies and various private entities. The location of the necessary data is furthermore not standardised in the different countries. A barrier to the development is not knowing where to get the information and the time consumed in the search for it. Geoelec would give a comprehensive overview of the existing information with interpretation to further aid the first step in the development, choice of location.

Data gathered will be collected and disseminated digitally in a web-serviced subsurface resource GIS system.

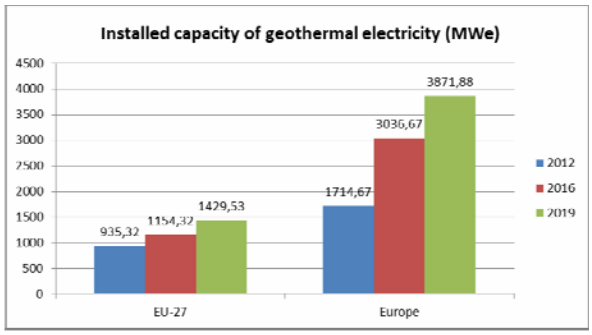

Figure 3: Installed capacity of geothermal electricity in Europe 2012-2016-2019, in MWe.

3. FINANCE GEOTHERMAL POWER PLANTS

The development of geothermal electricity will need large amounts of money. Some public incentives schemes like the feed-in tariffs in Germany bring a great support for this development but it will not be enough. Banks, capital venture and other public or private financial companies will be key actors. Geoelec must convince them in presenting the project financing for geothermal electricity and improve the knowledge among venture capital and financial institutions concerning the benefits from investing geothermal power.

3.1 Project financing

This task consists in modelling of the work cycle and an estimation of capital investment for the geothermal power plant unit of conventional, binary and in Enhanced Geothermal System in sample projects.

Geoelec will describe market demands (investors and banks) for project financing and how projects are generally

financed. A basic financial model will be created for investors and banks to evaluate geothermal electricity projects and to estimate costs for geothermal power-supplied electricity. The modeling will be based on sample projects with a description of the financing through the development phases: site identification / pre feasibility –surface exploration / feasibility – drilling exploration / resource development / plant construction / operating and maintenance.

A software developed by GGSC (with the support of a subcontractor: an IT company to be selected) will present project results on financial modelling, project evaluation and project financing. The objective is to build a proper but simple financial project model (based on excel) as a guideline for investors and not as a substitute to detailed project evaluation. The software will provide a basic project evaluation based on IRR (internal rate of revenue) and NPV (net present value). Thus, given their capital costs (WACC – weighted average cost of capital), project initiators and investors can judge upon economic feasibility. To achieve this, the model will provide an input sheet for all relevant geological, technical, economic and financial project parameters resulting in an integrated financial modelling of project cash-flows, profit and loss statements as well as balance sheets.

3.2 Geothermal risk insurance

One of the two most important financial barriers to develop geothermal power projects is the risk associated with the first drilling. Indeed, the financial obstacles to the development of geothermal energy remain:

- The success of such projects mainly depends on the properties of the geothermal resource that directly impact the exploitation costs, but are only known at the end of drilling work

- Traditional insurance policies do not offer any specific solutions for this type of risk in view of its very specific nature and because the fairly small number of operations involved does not provide a sufficient statistical basis

- Moreover, financial organisations refuse to invest unless the public or private operator gives a formal guarantee

In the absence of coverage against geological and mining risks, any failure of a drilling operation would require to charge back the taxpayers of the city or the tenants of subsidised housing concerned. Officials considered this as an unacceptable constraint. This was the main barrier preventing the development of geothermal energy.

Geoelec aims at creating a system of risk guarantees to facilitate the development of geothermal energy.

A financing system to cover the geological risks, based on two complementary mechanisms

•a short-term procedure (STR), based on the socialisation of risks and to guarantees the result of the first well drilled. The STR covers geological risk in the event of total or partial failure of the first drilling operation. STR insurance is used to secure the project's profitability in spite of the geological model's uncertainties

•Long-term procedure: Begin at the starting-up of the facilities and guarantee the sustainability of the resource and the risk of total or partial depletion during 15 years of operation. Long term risk (LTR) insurance principles: After the doublet setting, the geothermal characteristics are known, but their long term behaviour are unknown, as well as long term chemistry effects on wells and reservoir. LTR insurance is used for securing long term profitable exploitation, covering the risks of drilling exploitability's degradation

3.3 Geothermal deep drilling market

Drilling represents from 30% to 50% of the cost of a hydrothermal geothermal electricity project and more than half of the total cost of Enhanced Geothermal Systems (EGS). This Geoelec report aims at presenting proposals to overcome this substantial financial barrier.

Research and Development (R&D) can improve geothermal drilling technologies in order to reduce its costs, but the main challenge today is to improve market conditions for geothermal deep drilling.

However, the deep geothermal drilling market has still not been thoroughly assessed. For instance access to available geothermal drilling cost data is very limited. Moreover, the interaction between project developers and drilling contractors could be improved.

In order to stimulate both the market and the competition, this Geoelec report aims at:
- providing information, when available, on drilling costs in some EU countries;
- creating an European database listing drilling companies in order to pave the way for a dynamic and regularly updated tool to be published online;
- producing a best practice geothermal drilling handbook for project developers

3.4 Boost investment in the geothermal sector

The contribution of the geothermal sector for the future renewable energy mix in 2030 will need large investments. This task will evaluate the investments needed to finance the strategy developed in the prospective study. An analysis of the economic consequences will complete this study.

Advancement of geothermal energy will require massive investment that cannot solely rely on public funds, private sector involvement is needed.

Developers and investors are essential for renewable energy advancement. Developers need to know their financing options while investors need to have basic knowledge of and confidence in emerging technologies. In addition, a mutual understanding between developers and investors is essential. This is especially true for geothermal energy since this technology usually needs high up-front investments.

The guide will present notably:
- New strategies for raising capital in today's turbulent financial climate
- Understanding what today's investors are looking for in a geothermal investment prospect
- The emerging role of private equity companies in geothermal investment
- Assessing the current volume of deals and the outlook for 2010 and beyond
- Project finance for large-scale geothermal development
- New alternative financial instruments for geothermal exploration

4. REGULATORY, SOCIAL AND ENVIRONMENTAL CONDITIONS

One objective is to contribute to the transparency, reliability and cohesion of legal framework conditions of geothermal power development and implementation and therefore the long-term security of investments in the sector.

A Reduction of legal barriers through the implementation of clear/standard administrative procedures to obtain concessions is a second goal. A special attention will concern licensing procedures for EGS exploration.

Secondly, the project will present the critical environmental problems associated with geothermal energy. The objective is therefore to communicate environmental impacts and to work on diminishing them. It is an integral part for further developing geothermal energy.

Thirdly, Geoelec will present preventive steps to be taken to mitigate the risk of damaging seismic events and to counteract the erosion of public support and not having geothermal projects abandoned due to strong opposition from local community.

Finally, this will also present the contribution of geothermal energy to fight climate change, in showing the potential CO2 emissions reduction.

4.1 Regulatory barriers

Geoelec will make recommendations regarding the need or requirement for national primary legislation to demonstrate that geothermal electricity is regulated effectively either through existing or new legislation. One objective is to simplify these administrative procedures.

4.2 Environmental issues

General information will be given about the environmental issues that can be encountered when developing, constructing and operating geothermal facilities for conventional use, binary cycles and EGS. Especially information regarding what emissions can generally be expected from geothermal fluids/steam with examples taken from Iceland, Italy and Hungary. Geoelec will describe these environmental issues and will explain these issues to the general public and the environmental authorities during Geoelec workshops, articles and press releases.

4.3 Public acceptance

Some geothermal projects had to be abandoned due to strong opposition from local community. Geoelec project will tackle acceptance issues in relation to geothermal projects, and will address issues related to environmental concerns, opportunism, finances and ‘not in my backyard’ syndrome. The project will analyse the several sources for local community resistance, will present the possible solution for this resistance and notably the benefit sharing mechanism. Geoelec will present solutions on how to reduce the risk of public opposition:

- Establishing dialogue with local authority is primordial. Local authorities should be contacted before the general public becomes aware of planned activities. The purpose of the project has to be explained to and to be appreciated by them. Long-term costs and benefits need to be listed in detail. Potentially induced seismicity, its consequences and a mitigation plan have to be addressed and openly discussed. It also helps to ask their advice and guidance on regulatory issues. In addition, authorities should always be kept informed on progress, changes and problems as they occur. It may also be helpful to involve them in the next steps, mainly in the interaction with stakeholders. Ideally, information is shared and updated on a regular basis, to keep the level of involved and appreciation and to get support when it comes to addressing the public.

- Educate stakeholders. Prior to operations, the interested public as well as policy makers and institutions with a potential concern such as environmental groups, the forestry commission, local community groups need to be educated in regular public meetings and briefings on the planned operations and their implications, risks and benefits. All public concerns should be addressed and be taken seriously.

4.4 Potential CO2 emissions reduction

Geothermal energy, as a renewable energy form, is an indigenous energy source and its use results in stimulating local development and increasing local employment. In addition, as it replaces imported fossil fuels it results in improving the trade balance of the European Union and reducing carbon dioxide emissions. As EGS plants have practically zero carbon emissions per kilowatt-hour of electricity generated, the increase in deployment of geothermal energy will have a large net positive effect on the environment in comparison with the development of fossil fuels, which is in alignment with the Kyoto and post-Kyoto targets. In addition, geothermal power plants have considerably lower sulphur emissions rates than fossil-fuel alternatives, including natural gas.

To convince policy makers; Geoelec will also present the contribution of geothermal energy to fight climate change, in showing the potential CO2 emissions reduction.

5. EDUCATION AND EMPLOYMENT IN THE GEOTHERMAL SECTOR

The objective is to quantify the potential jobs creation in the geothermal sector. Geoelec will present the direct / indirect employment today, with a methodological approach for employment quantification.

The geothermal sector is already suffering from a lack of skilled workers. Geoelec will make proposals on education, mobility and dissemination of information, as an action plan to raise this barrier. Several professionals take part in the process of building a geothermal power plant. In describing the job profiles, Geoelec will make proposals for each situation. Training geothermal power staff and notably on EGS is an important issue today. The present situation shows that:

-The limited available higher education specialisations related to geothermal energy exploration, exploitation and utilisation, is inadequate to supply the highly skilled personnel needed in the geothermal power industry, as important geothermal topics are not presented in existing graduate courses.

-Basic training on geothermal technologies is rarely available in EU member states.

-The same applies to post-graduate specialisation in geothermal energy, as most geothermal courses around the world stopped or reduced activity due to lack of financial support.

As geothermal power projects need specialists in many fields of geology and engineering, on-the-job in-company training is still absolutely necessary. The closest fields in terms of available technical expertise are the oil, gas and coal sectors, but even these workers need to be re-qualified in order to operate in the geothermal sector, where technology has to cater for the high temperatures and the chemistry of the fluids concerned.

So geothermal training is expected to grow together with the growing of the geothermal sector.

5.1 Employment survey

Firstly, Geoelec will analyse the current situation in presenting the job profiles of the geothermal electricity sector: engineers, drillers, operations and maintenance technicians, site manager, etc. Currently, there is already a shortage of candidates in the sector. Geoelec will suggest actions to raise this barrier by drafting an action plan for promoting workers mobility and establishing an educational system. Special attention will be given to measures to allow workers to transfer from related economic sectors to the geothermal power sector.

A forecast will be developed according to the scenario presented in the prospective study and the forecasts for 2020, 2030 and 2050. The survey will quantify the potential jobs creation in the geothermal sector. Geoelec will focus here on the EGS sector: categories of professionals needed, identify industrial sectors in crisis for a potential reconversion of people, presenting them jobs opportunity in the EGS sector. This work, presented during Geoelec events, will be communicated to policy makers and politicians, who will obtain a clear view on the potential jobs creation in the geothermal power sector.

5.2 Training activities

Geoelec will try to coordinate and organise the following training activities in Europe:

-First step: basic curricula and training materials with references on EGS will be defined or updated, also using any available experience already acquired in a few institutions.
-Second step: start new training courses during the Geoelec project, 3 courses will be organised
-Third step: identify the very few universities and training centres offering training in fields related to geothermal and try to add specific topics in their regular courses. Create a network of Universities in order to continue training activities after the end of the project.

Furthermore, Geoelec will monitor and analyse the employment situation in the geothermal sector of EU and evaluate it as part of the prospective study. A study will be prepared, which will assess the economic effects of geothermal power in detail, looking not only at jobs in the geothermal sector itself, but taking into account the impact on all sectors of the economy as well.

6. MASTERPLAN TO PROMOTE GEOTHERMAL

The project team aims to use Geoelec results to convince notably policy-makers in developing geothermal power. The communication will be crucial as the main objective is to increase awareness about geothermal power.

6.1 Action plan

The objective is to raise awareness among decision makers on the central levels, national regulators and utilities in EU, and to increase the interest of stakeholders to invest in geothermal power, also through private/public join initiatives.

The target groups of these communications actions are:
-National, Regional, Local and European policy makers.
- Financial actors
- Potential investors: Oil & gas sector, Utilities, Developers and operators
- Professionals of the geothermal power sector
All Geoelec publications are available on project website: www.geoelec.eu

6.2 Promote the creation of National Geothermal Committee

One dissemination activity will focus on the promotion Across the EU to create National Geothermal Committees. Such a Committee has already been created in France in July 2010. The Energy Ministry launched a ‘Comité National de la géothermie’ to propose actions and recommendations for a geothermal development in France. They should be constituted by representatives from different public and private sectors: State level, Local authorities, NGOs, Employers, Workers, etc.

During the Geoelec project, a proposal will be made to several Energy Ministries and National Energy Agencies for the creation of such a Committee.

6. CONCLUSIONS

GEOELEC will result in an action plan towards more geothermal electricity generation in Europe, with the objective to double installed geothermal power capacity in Europe from 11 TWh per year in 2010 generated mainly in Italy and Iceland, to 22 TWh per year in the short/medium term and initiate new projects in every EU member state leading to 55 TWh per year by 2020. GEOELEC will also result in setting concrete actions to reach these objectives: conditions for financial feasibility, a regulatory framework, and public acceptance.

GEOELEC will first use available geological and technological information to present the potential contribution of the geothermal power sector in the EU. These projections in all EU countries will take into account the electricity grid and the present/future electricity demand. Based on this prospective analysis, an action plan for technical, legal, environmental, financial and socio-educative aspects will be developed. The identified initiatives will be presented in a series of seven promotional workshops and a final conference, where key decision makers will participate actively. The conclusions will be presented and explained in a final Geoelec report. Then, political support will be gained through a series of meetings in the seven partner countries. For this purpose an advisory committee will be created. This committee will be formed by the main stakeholders of geothermal energy in Europe.

Italy and Iceland are the only European countries today with medium scale development of geothermal power, corresponding to approximately 90% of overall geothermal power generation in Europe, and only utilising conventional geothermal (hydrothermal) resources. The GEOELEC objective is to spur geothermal development all over Europe,

by developing additional hydrothermal and new EGS resources, also using technology developed by European programmes, already successfully proven in Soultz, Simbach and Unterhaching geothermal power plants. The whole action shall be accompanied by targeted communication and information actions, culminating in a final EU conference.

The final result will be to have more European countries developing geothermal electricity, an increased installed capacity with grid stability and a larger contribution of the geothermal sector to the European energy mix.

REFERENCES

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

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