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How Political Decisions Can Boost the Development of Geothermal Energy in France?

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ABSTRACT

Final agreement on renewable energy directive at EU level creates a positive climate for a much-needed investor confidence in the renewable energy sector. The Directive on the promotion of the use of renewable energy sources sets the framework to achieve the target of a 20% share of renewable energy sources in the final energy consumption by 2020. The attainment of this target will require the use of the diverse renewable non-fossil energy sources, including geothermal energy. The adoption of a definition for geothermal energy: meaning that it is the energy stored in form of heat beneath the surface of solid earth. Geothermal energy is a sustainable, renewable, nearly infinite energy source, delivering heat and power 24 hours a day throughout the year and available all over Europe. In France, a new Heating Fund (HF) has been created in the beginning of 2009, covering biomass, solar thermal, deep and shallow geothermal and district heating network. The HF will ensure that subsidies granted will guarantee a selling price of the geothermal MWh with a discount of 5% compared with other energies in competition. Following the adoption of this new fund, more than 20 geothermal doublets are planned and 4 already realized using the deep Dogger reservoir in Paris area. Hundreds of shallow doublets using wells at less than 100 m are in construction and the development of ground source heat pump shows a growing trend of 25% per year.

1. INTRODUCTION

France has a plentiful geothermal resources made of numerous shallow and deep aquifers which are suitable for direct geothermal use or source for heat pumps. Hot resources are not frequent in France, except in Alsace and Limagne but good potential exists in Guadeloupe, Martinique and Reunion islands. Both oil crisis in 1973 and 1979 stimulated researches for alternative energy, but the obstacles to the development of geothermal energy remained that the success of such projects mainly depends on the properties of the geothermal resource that directly impact the exploitation costs. Unfortunately, these parameters are only known at the end of drilling work and traditional insurances 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 organizations often 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 subsidized housing concerned. Officials considered this as an unacceptable constraint. This was the main barrier preventing at that time the development of geothermal energy. French government decided to create a system of risk guarantees to facilitate the development of geothermal energy. During the first stage of development, about 100 plants built in ten years, both in Ile de France with doublet of wells with injection in same aquifer and in the Aquitaine with fresh water single well without injection. The French geothermal risk guarantee system has been working since 1980.

We are now in a second period with important increase in the oil price up to mid 2008 and strong growing concerns about climate change.

2. DESCRIPTION OF THE RISK GUARANTEE SYSTEM FOR DEEP GEOTHERMAL RESOURCES

The risk guarantee system has been reactivated in 2006. The system is a financing fund to cover the geological risks; it is based on two complementary mechanisms and addressed to deep geothermal drilling for direct heating and/or electricity generation.

2.1 Short Term Procedure

The Short Term Procedure (STR) which is based on the socialization of the risks, which guarantees the result of the first well drilled, covers the geological risk in the event of total or partial failure of the first drilling. The success parameters are: the flow rate (Q) and the temperature (T), which are of paramount importance for the project profitability (Figure 1). STR insurance is used to secure the project's profitability in spite of the geological model's uncertainties.

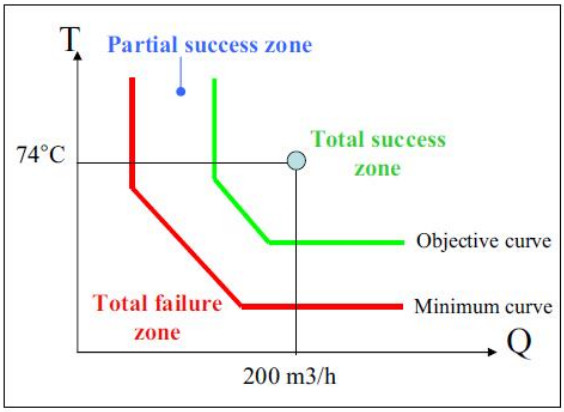

Figure 1: Diagram showing the definition of success for the STR procedure (Bélzègues-Courtade Nov 2008)

The insurance principles are the acceptance of the project by a technical committee which is based on an exhaustive

economic, financial and juridical analysis. The fee is 1, 5% of the costs which are covered and the level of compensation can reach a maximum of 90% of the eligible cost (total cost of the first well – subsidies + over costs due to unforeseen events during drilling works). For a normal Dogger geothermal well (deviated well at 2500 m) the full cost is about 4 - 5 MM€. The insurance mechanism is based on success-failure curves and different sums are granted according to the degree of success of the project.

2.2 Long Term Procedure

The Long Term Procedure (LTR) begin at the starting-up of the facilities, it guarantees the sustainability of the resource and the risk of total or partial depletion during 15 years of operation. LTR principles are based on the final results after the doublet completion when the geothermal characteristics are known, but their long term behavior is unknown, as well as long term chemistry effects on wells and reservoirs.

The main risks are related to the temperature and/or flow rate decrease and the corrosion and/or scaling which can occur in the wells. LTR insurance is used for securing long term profitable exploitation, covering the risks of drilling exploitability's degradation. The conditions for subscript to the LTR insurance are the acceptance of rule of good technical management and respect of the regulations. The initial payment represents 3.2 % of insured costs and the payment of an annual contribution. The level of compensation depends on the drilling exploitability's degradation. If partial damage (the exploitation is still economically viable after repairing), the compensation is calculated according to the plant's lifetime and its power loss according to the contract reference. If total damage (non repairable damages or accidents and consequently the exploitation is no more economically viable), the compensation is calculated according to a contractual ceiling and the plant's residual value. All details are contractual: reference situation, franchises, depreciation policy on the value of equipments etc… The decision to grant the guarantee is taken by the technical committee composed of ADEME, SAF-Environnement (Société Auxilliaire de Financement; manager of the fund), representatives of private and public owners, representatives of financial institutions specialized in Renewable Energy Projects, BRGM (Bureau de Recherches Géologiques et Minières), experts appointed to analyze files. The balance of the fund is ensured by public funds (ADEME as a State Agency), owners of geothermal plants (public or private), initial payment, annual contribution and financial products from the investments of the fund itself. The diagram showing the deep drilling geothermal activity proves that this type of funds is a fantastic tool, but cannot boost the geothermal development to attain the ambitious targets for 2020 without accompanying measures, financial and fiscal incentives.

31 geothermal doublets in Paris basin and 18 in Aquitaine basin were operating in 2006. This represents a total thermal power of 200 MW with an annual output at 1000 GWh and 130,000 flats or equivalents connected to geothermal district heating.

At the present, more than 30 projects are currently studied with geothermal target in the Dogger reservoir but also using shallower aquifers in Lower Cretaceous. The realization of these new plants, in the coming years, is subject to energy policy decisions.

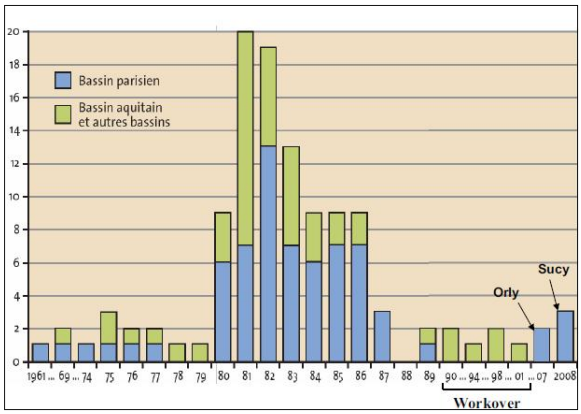

Figure 2: Deep drilling in both Paris basin and Aquitaine shows a restart of the activity since 2006 (BRGM-ADEME)

2. DESCRIPTION OF THE RISK GUARANTEE SYSTEM FOR SHALLOW GEOTHERMAL RESOURCES

The guarantee system for shallow resources is named AQUAPAC; this system is in place for 25 years. The exploitation of shallow resources was increasing in the eighties and AQUAPAC was created to cover the geological risks due to uncertainties of the drilling's results for shallow groundwater wells. It concerns plants using heat pumps of more than 30 KW (not for individual housing) and based on two complementary mechanisms as described in the following.

The Research Guarantee (RG): this system is built following the same frame as STR for deep drilling. It covers the risk of insufficient resource regarding to the expected production flow rate and failure of injection at the same level. In France, the water extracted in a reservoir needs to be injected in the same aquifer. The amount of the covered cost includes the drillings, the pumps, and the surface equipments including heat exchanger minus the subsidies if any. The fee to be paid is equal to 5% of the investment. The maximum covered amount is 115 K€

The Long Term Productivity Guarantee (LTPG): this covers the risk of decrease or deterioration of the resource and the equipment during the exploitation. The fee is paid annually for 10 years and represents 4% of the total cost of the installation assuming an annual depreciation of 10% by year of exploitation. LTPG has duration of ten years. The fund is managed by SAF-Environnement and the decision of allocation is taken by an ad hoc committee composed of ADEME, EDF (Electricité de France), BRGM and SAF-Environnement. The insurance guarantee schemes proved to be successful overcoming many obstacles for the deployment of geothermal energy. Main barriers that AQUAPAC overcomes are psychological (geothermal energy is a basic choice for the long term) and financial (the guarantee system can encourage the banks to offer loans).

This fund as for deep drilling insurance procedure remains a tool to support the motivated actors but appears clearly not sufficient to double or triple the number of installations in the next ten years.

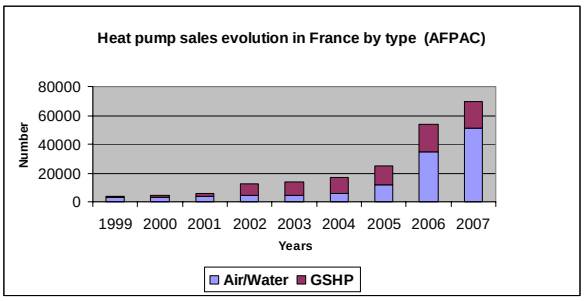

Figure 3: Heat Pumps sales shows that the quick growth measured in 2006 and 2007 is mainly related to HP using ambient air and not heat from the earth (Outlook 2008. EHPA (European Heat Pump Association)

3. NEW MEASURES TAKEN THE LAST YEARS

The last incentive now in place and well known by the public at large is of fiscal nature, it has been created for all renewable and energy savings realized in private housing. It consists of the deduction up to 50% of the investment for this kind of investment from the yearly income tax. It explains the big development of air/air HP which can be installed easily everywhere in France at a reasonable price even if the energy efficiency of these system is poor and causes problem for electricity peaks of consumption.

Another measure has been adopted after years of fighting carried out by the Association of the Geothermal plants Owners (AGEMO) to obtain a reduced VAT at 5, 5% which was already applied to gas long time ago, giving a commercial advantage of 14, 1 % with other fossil fuel and coming back to a normal competitiveness with gas which is the main competitor in district heating plants. This reduced tax is limited to district heating networks which are utilizing renewable energy for more than 60% to feed the network. This measure taken in 2006 will be modified soon to downgrade this percentage at 50%. This reduced VAT is one of the main reasons for restarting of drilling deep doublets in the last two years.

4. FEED IN TARIFFS

In France, nearly 80% of the electricity comes from nuclear power plants with no CO_2 emission. The feed in tariffs for this energy has been always difficult to put in place. Nevertheless, it do exist for renewable but not under the same conditions. For geothermal the actual price of geothermal electricity for sale to EDF (July 2006) is of 0, 12 €ct/KWhe with possible additional 0, 03 in case of valorization of the residual heat. This French tariff has to be compared with the tariff in force in Germany, where the obligatory buying price of a geothermal KWhe is of 24ct€. Another anomaly, is linked to the fact that every renewable has a different feed in tariff (i.e. for solar 35ct€ and at 55ct€ if included in the building).

Following a study conducted in 2004 by BRGM, France (excluding overseas islands) is the second country in EU after Hungary and offering in terms of EGS potential seven times the possible development in Germany. In theory this enormous potential even exploited at 2% of its full capacity would allow to build 10 GWe of power plants.

This potential is tremendous. The negotiation with MEDAAT (Ministère de l'Ecologie, de l'Energie , du Développement Durable et de l'Aménagement du Territoire) which began beginning of 2009 will normally set a correct tariff asked to be at the minimum level of 22 ct€ per KWhe.

Short term zones for development are Limagne and Alsace and about 10 projects (type Landau-Soultz) are being developed. The net installed power could reach 50 MWe easily. For the long term to 2030, the cost reduction of the equipment and the series effect could allow to reach a power of 500 MWe in France.

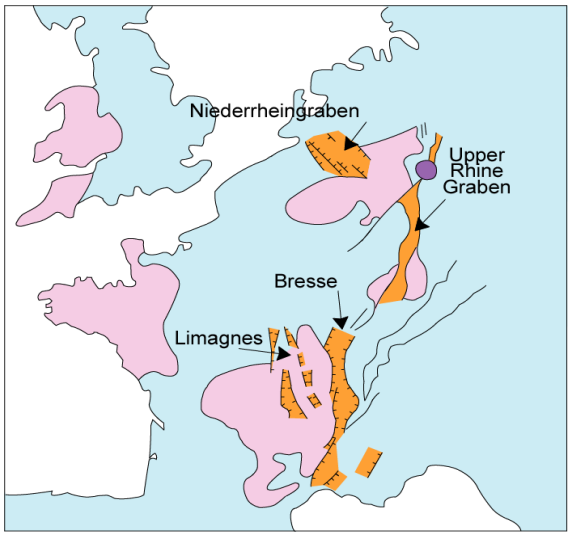

Figure 4: In orange the western European grabens in EU which represent the best target for EGS plants (BRGM)

5. COMING ACTIONS

The COMOP (Comité Opérationnel des Energies Renouvelables) of the Grenelle de l'Envrionnement has calculated that the deep geothermal energy (geothermal reservoir deeper than 200 m) would produce 5, 8 GWh in 2020, representing an additional production of 4,3 GWh corresponding to an increase of about 390% in 14 years. To attain the target, the Heating Fund should ensure the simple principle that the subsidies granted will guarantee a selling price of the geothermal MWh with a discount of 5% compared with other energies in competition for the same district heating network or for a single installation requiring the use of a deep geothermal doublet.

5.1 Description of the System for Deep Geothermal Resources, EGS and HDR

To realize this objective the following cases will be eligible to this fund: Doublet or triplet of drillings associated with an existing DH or a district heating network to be created; the drilling of an injection well, in Aquitaine, where there is discharge of the geothermal water in the environment; other specific cases such as realization of doublets in a zone poorly documented regarding aquifers and their resources and transformation of an existing oil and gas well.

The corresponding subsidies will be allowed for new plants at a level of 60% of the eligible costs, which correspond to 170 - 300 € per MWh annually produced. For other plants the subsidy will be limited to 40% of the total cost of the construction. These numbers are indicative and should be confirmed by the Heating Fund supervised by ADEME. The support will implicate to become a subscriber of the guarantee fund (Short and Long Terms).

To have a strong control regarding the geothermal MWh produced during the first year of operation, the subsidy will be distributed in three terms: 50% at the contract signature with ADEME, 30% at the completion of the plant and 20% after two years of operation. ADEME will oblige to reimburse up to 50% of the subsidy if the real geothermal production is lower than 50% of the expected savings. For this purpose, the owner will have to install a validated automatic measurement installation, including counters for temperature, flow rate, pressure and a full monitoring of the geothermal installation.

5.2 Description of the System for Shallow Geothermal Resources

For Shallow geothermal installation the COMOP target is 3 GWh in 2020. Shallow geothermal system addresses to two different types of installation: heat pumps using aquifer and ground source heat pump systems (GSHP). These types of installations are used to provide heat during the heating season but reversible systems allow also cooling or refreshing in summer.

5.2.1 Heat Pumps Using Shallow Aquifers with a Doublet

This type of plant valorizes the thermal potential of groundwater resources down to about 200m depth, with temperature in between 12 and 20°C. The plant can cover the needs for heating, cooling and production of sanitary hot water. To take into account the investment of a doublet, this technique is well adapted to medium and big size buildings, such as offices, hospitals, hotels, commercial buildings and greenhouses (area from 2000 to 25000 m^2).

The lower installed power to be supported is 50 KW for the heat delivery by the HP. The obligations are: injection of the water into the same aquifer, a COP of the heat pump up to 4 (using the European standard EN 14511), the installation of heat counters and a monitoring system.

The diversity of the project imposes a customized instruction of each proposed installation. Anyway, ADEME expect a support of 40 % of the investment costs including engineering. A calculation shows that this amount correspond to a subsidy of 350 to 850 € per KWh installed (Méthode de calcul du niveau d'aide du Fonds Chaleur Renouvelable - April 2009).The subsidy will be paid in three terms: 50 % at the contract signature with the HF, 30% when the installation has started and 20% after one year of operation and track records to prove that the geothermal yearly output is as expected.

5.2.2 Ground Source Heat Exchanger

This system proposes the unique advantage to be installed everywhere even there is no water in the ground. A U-tube made of polyethylene is introduced in a small diameter drilling up to 200m deep. After cementing it, heat can be recovered while circulating tap water in a closed circuit. The two main advantages of the system are: no maintenance costs and a life span of the installation up to 50 years if constructed following the state of the art. Usually the average output of one meter of tube is of 30 to 60 Wh. A normal installation has about 10 to 30 borehole in France and the buildings which can benefit are: housing for retired people, small public buildings, offices and industrial installations.

The lower installed power to be supported is 30 KW for the heat delivery by the HP, with a COP of the heat pump up to 3, 7 (using the European standard EN 14511) and the installation of heat counters plus a monitoring system. The subsidy will cover about 60% of the supplementary investment cost compared with a conventional installation.

As for HP using aquifers, the subsidy will be paid in three terms: 50 % at the contract signature with the HF, 30% when the installation has started and 20% after one year of operation and track records to prove that the geothermal yearly output is as expected.

6. EXPECTED GEOTHERMAL DEVELOPMENT T0 2020 - 2030

The insurance tool has been reactivated for deep drilling to produce heat, for supporting very deep drilling to produce electricity even in poorly well known zones. Shallow drilling and vertical borehole exchanger are also taken into account in he new Heat Fund. The tax system for DH network gives a competitive advantage to geothermal. Subsidies are at a level which allows building new plants with internal rate of return sometimes lower than 5 years. All these parameters should give a strong impetus for geothermal energy development in France not only for heating but also for cooling as well as electricity generation. The following figures could be envisaged in parallel with the figures produced by EGEC (European Geothermal Energy Council).

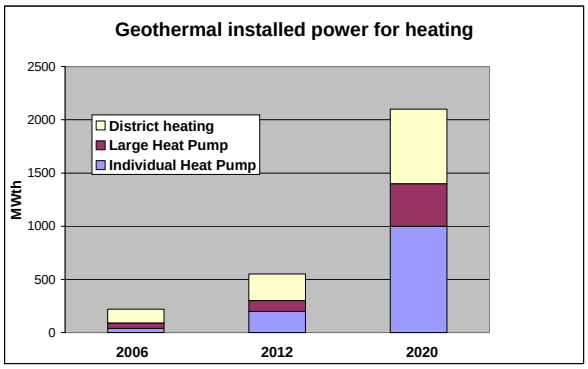

Figure 5: French geothermal installed thermal power prognosis for 2020

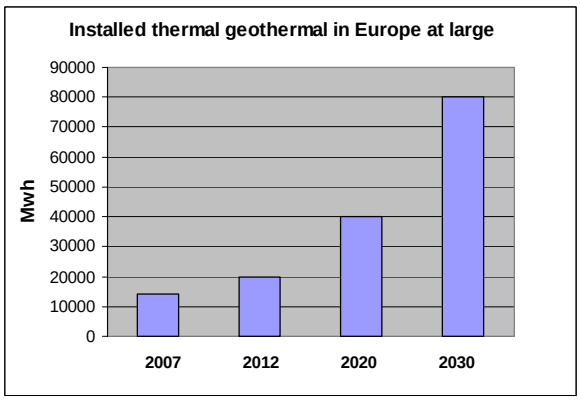

Figure 6: Europe geothermal installed thermal power prognosis for 2030 (EGEC Brussels Declaration – February 2009)

The main part of the development has been achieved by multiplication of GSHP systems in the last years and this trend will continue. But the target to achieve will be attained only if deep geothermal projects restart strongly and quickly. New wells have been drilled, one new doublet in Orly (2007) to counter balance an abandoned plant due to exploitation problems, a well in Sucy en Brie (2008) to

replace an old one and new doublets in Aubervilliers and Orly airport (2009).

If we compare the expected development in France and Europe at large (including Iceland, Turkey, Ukraine…) we can see that the development between 2012 and 2020 is expected to double in Europe and multiplied by a factor of 2,5 in France. This development should be normally dominated by deep drilling doublet replication because each new plant represents about 10 MWh installed.

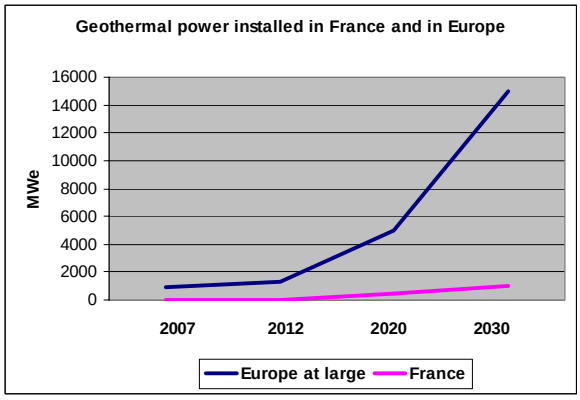

Figure7: Comparison between installed geothermal power for electricity generation in France and Europe at large (2007 to 2030)

For electricity generation, the comparison between Europe and France shows that even assuming a multiplication by two times of the feed in tariff, the development will be small.

For power production, the concept of Enhanced Geothermal Systems (including the classical Hot Dry Rock idea) is going to add a tremendous increase to the potential. Innovative power plants permitting the production of electricity using water temperature in the order of 100°C or below will also gain importance.

In that case, the installation of larger plants based on several wells in cluster becomes crucial to reach the geothermal power targets.

CONCLUSIONS

For heating and cooling (more than 50% of the annual energy consumed annually in France) the recent orientation of French policy (following the Grenelle de l'Environnement) built the adequate supports to boost the development of renewable and in particular geothermal energy, which will promote a restart as strong as in the eighties. Regarding the electricity generation the tool kit is not sufficient at the moment to predict a quick and strong development compared to other countries of the European Union.

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