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French Financial Incentives to Promote Geothermal Heat

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ABSTRACT

Within the framework of the European environmental commitments (reduction of the greenhouse gas emissions, increase of the share of renewable energies in the energy mix and reduction of energy consumption), France carries out an ambitious support policy for renewable energies, including geothermal energy. In this favorable context, geothermal heat is thus expected to be multiplied by 5 between 2006 and 2020 whereas the general objective for renewable heat is a multiplication by 2.

Since the end of the 2000s, following the outcome of the national debate "Grenelle de l'environnement", several support schemes were set up in the geothermal energy sector, like for example subsidies for investments and guarantee systems for the mitigation of the geological risk.

So this paper aims to present the French data updated since WGC2010 in particularly the last significant results achieved with three major incentive schemes: the Renewable Heat Fund and the guarantee systems covering geological risk for shallow and deep aquifers.

The Renewable Heat Fund has been put in place for the funding of operational projects in tertiary, collective buildings or agricultural/industrial process and is driven by the following principle: to reach a renewable energy sources heat price at least 5 % lower than conventional heat.

Its implementation by 2009 contributed to developing geothermal district heating projects such as in Paris basin, and shallow geothermal operations with heat pumps of a higher 50 kW power. The assessment at the end of 2013 shows that nearly 300 operations have been subsidized thanks to this program; it represents a renewable energy production of more than 913 GWh/year and a total aid of 75 M€.

The other component of the geothermal energy financial support is the existence of guarantees for the geological risk:

- "AQUAPAC": It is intended to the ground water heat pumps operations and it has guaranteed approximately 30 operations per year since 2010,
- The "Geothermal Guarantee Fund" has been abounded for the operations of deep geothermal energy with direct use of heat.

These guarantees are used to strengthen the development of geothermal energy.

Reflections are currently on going for the creation of guarantee funds for geothermal power stations in order to sustain the emergence of this sector which has all the key skills and actors in France to implement successfully this kind of project.

1. INTRODUCTION

France disposes of a large diversity of geothermal resources, especially low-energy resources, mainly exploited for direct uses or with geothermal heat pumps; She has also the great opportunity to exploit high-energy resources for power generation in its Overseas Departments and experiments EGS in Soultz-sous-Forêts.

Along with these plentiful geothermal resources, France leads a proactive policy in favor of renewable energy sources to meet national and European environmental objectives. The major significant measures are detailed in the following chapters.

2. THE RENEWABLE HEAT FUND

2.1 Description

Major commitment of the national debate "Grenelle de l'Environnement", the Renewable Heat fund was set up in France by the finance law 2009-2011 voted in November 2008. It aims to develop the production of heat from renewable energy sources such as biomass, geothermal, solar thermal, biogas and district heating networks ... in tertiary, collective buildings or in agricultural/industrial process.

The management of this fund was entrusted to the French Environment and Energy Management Agency (ADEME). It is dedicated to the funding of operational projects, under the following principle: to reach a renewable energy sources heat price at least 5 % lower than conventional heat. For that, an economic analysis is conducted for each project in order to determine the level of subsidy. This fund was granted 1.2 billion € for the 2009-2013 period, magnifying by an important factor the public money allocated to renewable energy sources heating.

2.2 First Results on 2009 – 2013 Period

After five years of implementation, the total budget for 2009-2013 brought to the Renewable Heat Fund amounted to 1.112 M€ i.e. an amount close to 1.2 M€ announced. As seen in the following table, more than 2 900 projects have been sustained for a production of 1 362 kToe /year.

Table 1: Assessment of the Renewable Heat Fund for all Heat Renewable Energy Sources from 2009 to 2013.

2009 – 2013 Renewable Heat Fund balance for all renewable energy sources				
	Projects number	ADEME subsidy (in M€)	Toe/year	Subsidy ratio (in €/Toe) over 20 years operation
2009	361	169	195 651	43,1
2010	699	263	334 039	39,4
2011	811	248	291 081	42,7
2012	574	231	299 000	38,7
2013	466	206	242 500	42,5
2009 – 2013 TOTAL	**2 911**	**1 118**	**1 362 271**	**41,0**

For the geothermal energy sector, the operations eligible to the Renewable Heat Fund include deep geothermal installations (low energy geothermal installations) and ground water and ground source heat exchangers using heat pumps (very low energy geothermal installations). By extension, operations of heat recovery on sea water, waste water and mining water enhanced by a heat pump are also considered.

The following bar graph (Figure 1) presents the geothermal position in the use of the Renewable Heat Fund in terms of subsidized over the 2009 – 2013 period.

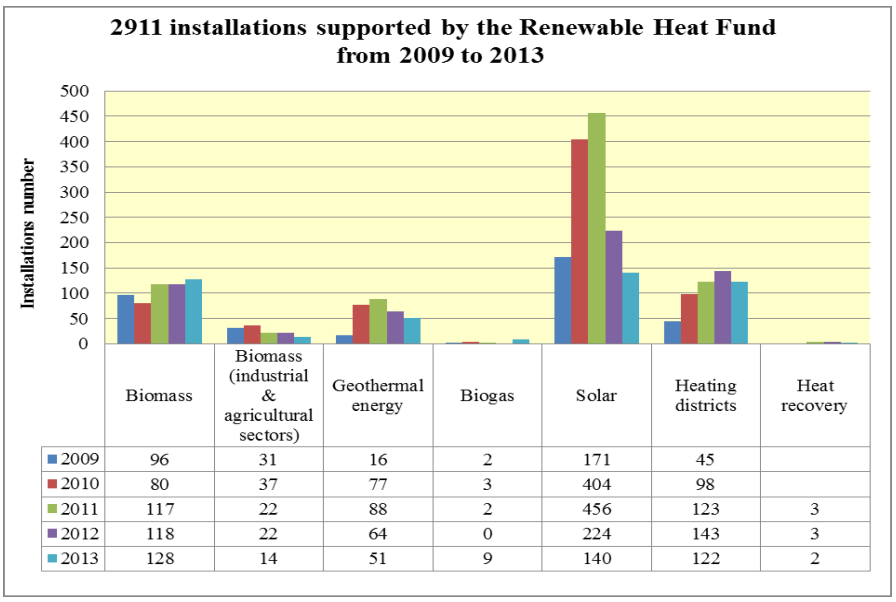


Figure 1: Evolution of the number of projects supported by the Renewable Heat Fund from 2009 to 2013.

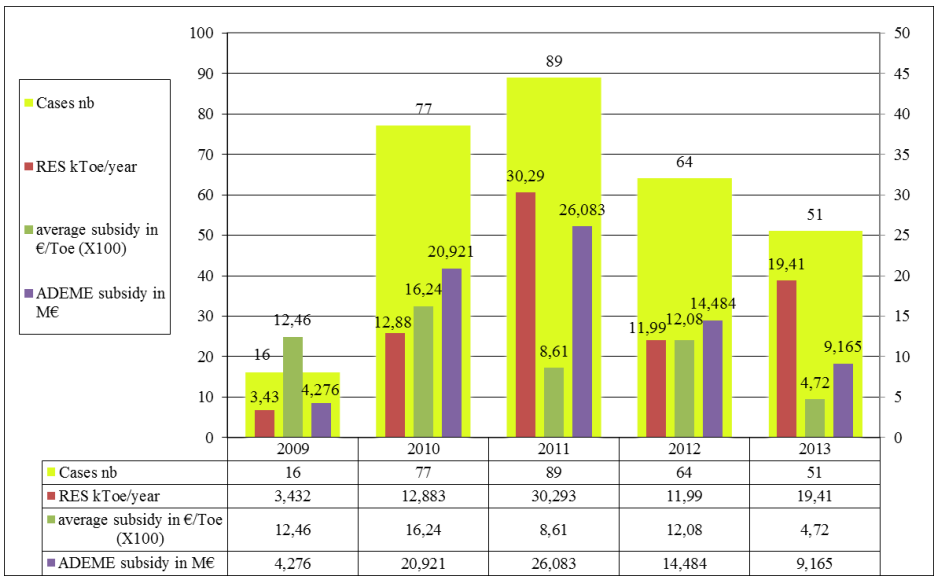
The graph here below shows the Renewable Heat Fund balance for the geothermal sector between 2009 and 2013 (Figure 2). The different bars represent the projects number (in yellow), the renewable energy production (in red) and the subsidy amount (in blue). The evolution of the average ratio expressed in €/Toe (in green) is also highlighted as it emphasizes the economic optimization work carried out by ADEME instructors.

Despite a further decline in the number of projects supported the last two years, the Renewable Heat Fund balance still remains positive for the geothermal sector. Indeed, for a lower number of projects supported compared to the previous years, the average subsidy ratio (in €/MWh/year) decreased significantly showing a continuous improvement in the efficiency of public incentives to renewable energy sources.

However, these results are to be modulated according to the technologies considered, namely low geothermal energy operations and very low energy geothermal operations such as shallow groundwater heat pumps, waste water and sea water heat pumps and ground sources heat pumps. These latter have the highest production cost and logically a greater subsidy ratio.

In contrast, deep geothermal operations (with or without heat pumps) have reduced their average cost. Only 4 to 5 low energy geothermal projects are yearly supported by ADEME. They generate nearly 90% of Toe for the geothermal energy sector whereas they involve a subsidy level representing 55% of the total subsidy amount granted to all geothermal technologies.

The number of cases followed by ADEME in the last five years of Renewable Heat Fund implementation allows nowadays for further study and analysis. Thus, for each of the technologies mentioned above, various indicators available have been assessed: subsidy, renewable energy produced and capex versus power, surface area building, etc.



	2009	2010	2011	2012	2013
Cases nb	16	77	89	64	51
RES kToe/year	3,432	12,883	30,293	11,99	19,41
average subsidy in €/Toe (X100)	12,46	16,24	8,61	12,08	4,72
ADEME subsidy in M€	4,276	20,921	26,083	14,484	9,165

Figure 2: Evolution of geothermal energy projects from 2009 to 2013 through the Renewable Heat Fund.

Sometimes, it is difficult to establish clear correlations between technical parameters and economics given the specificities of funded projects: variable access to the geothermal resource, different uses (heating/cooling/hot water), specific consumption in kWh/m² and various types of buildings ... However, trends can be identified and exploited by the ADEME instructors for new cases assessment.

2.3 Comparison with 2020 Environmental Targets and Prospects

As shown hereafter (Figure 3), the 2020 target (in red) set to 5.5 Mtoe/year versus 2006 will require a further increase of heat production from all renewable energy sources.

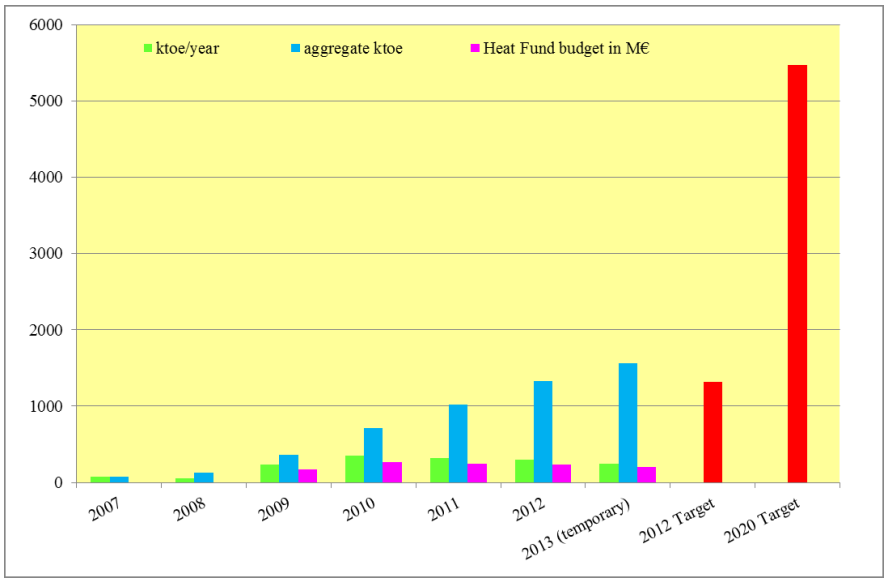


Figure 3 : Evolution of Renewable Energy Sources production versus 2012 and 2020 environmental targets.

This will need proportionate financial resources to achieve it. The current budget level of the Renewable Heat Fund does not achieve the national targets for 2020 as roughly 600 ktoe/year should be generated from 2014 versus 243 ktoe in 2013.

In this situation, geothermal energy could actively contribute. Since 2009, the Renewable Heat Fund has (re)boost geothermal sector mainly in district heating networks, tertiary and collective buildings sectors. Indeed, the number of operations subsidized has

quadrupled in the years 2010-2011 to decrease at a steady pace around 50-60 cases per year in 2012 and 2013. In the meanwhile, renewable heat from geothermal energy has increased.

Even so significant efforts are focused on design optimization and plants monitoring as well as improving the effectiveness of public subsidy, the 2020 objectives defined in the "Grenelle de l'Environnement" Round Table will be limited. The continuous development of geothermal energy will still rely also on communication and training of professional actors.

3. THE RISK GUARANTEE SYSTEM FOR SHALLOW GEOTHERMAL RESOURCES

3.1 Description

The guarantee system for shallow resources is named AQUAPAC and is in place for 30 years. The exploitation of shallow resources was increasing in the eighties so 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.

(1) The Research Guarantee (RG)

This system 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 140 k€.

(2) 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 (Société Auxiliaire de Financement) and the decision of allocation is taken by an ad hoc committee composed of ADEME, EDF (Electricité de France), BRGM (Bureau de Recherches Géologiques et Minières) 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).

3.2 AQUAPAC Results from 2000

The AQUAPAC process allowed to collect information of very low energy geothermal installations with more than 300 files assessed since 1985.

Table 2: Breakdown of geothermal operations submitted to AQUAPAC gurantee.

AQUAPAC	Research Guarantee	Long Term Productivity	TOTAL
Number of assessed cases from 1st January 1985	304		304
Number of operations with subscribed guarantee	222	73	295
Number of operations with an admissible damage	45	6	51
Number of operations under guarantee at the end of 2013	17	13	30

This follow up allowed to set up in statistics about AQUAPAC guarantee amounts granted in the Research Guarantee context. i.e. aquifer depth, geographical location and exploitation flowrate. This statistical analysis started in 2011 and was completed with 2013 data. These data allow the AQUAPAC committee to better evaluate the coming projects. Robust correlations have been found between the amount of covered cost in RG (i.e. drilling cost) and depth drilling (Figure 4).

In Paris basin (blue trend line): guarantee amount (€ HT) = 483 x depth drilling (m) + 39 299

In other French regions (red trend line): guarantee amount (€ HT) = 608 x depth drilling (m) + 9 978

For flowrates greater than 70 m^3/h, the drilling cost is increased by 20 %.

A specific AQUAPAC website was created in 2012 to share easier data files between the members of the AQUAPAC committee. This runs from a sharepoint application and facilitates data files storage (preliminary studies, report drilling, etc.).

4. THE RISK GUARANTEE SYSTEM FOR DEEP GEOTHERMAL RESOURCES

4.1 Description

The risk guarantee system for deep geothermal resources was creating in 1981 by the French Industry Ministry. The first period (1981 – 2008) allows developing more than 50 geothermal productions for district heating. It has been reactivated in 2006.

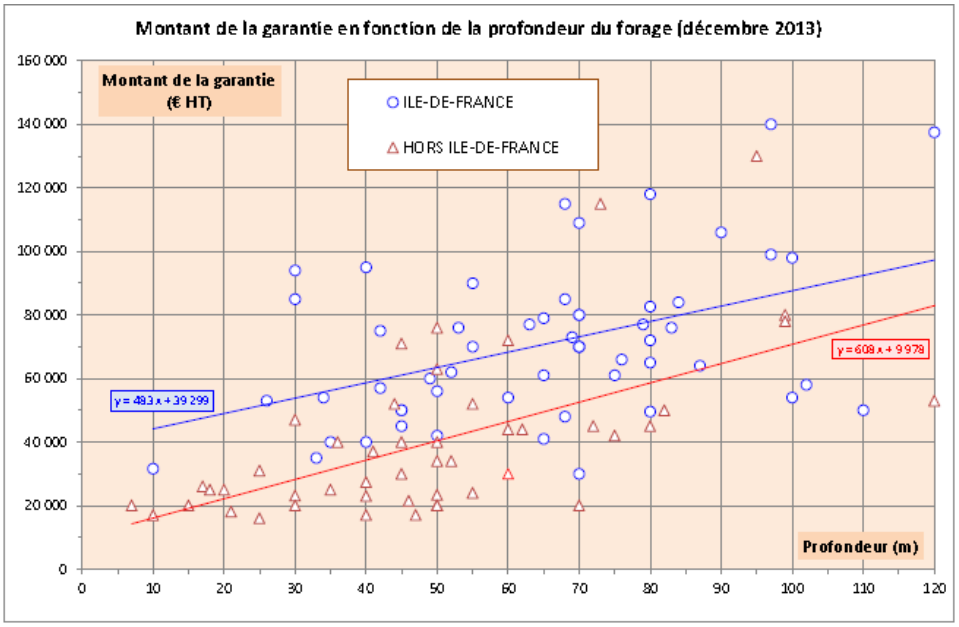


Figure 4: AQUAPAC correlations – guarantee amount versus depth drilling (Jean-Claude Martin BRGM 2013).

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.

(1) The Short Term Procedure (STP)

The Short Term Procedure (STP) 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 is of paramount importance for the project profitability (Figure 5). STP insurance is used to secure the project's profitability in spite of the geological model's uncertainties.

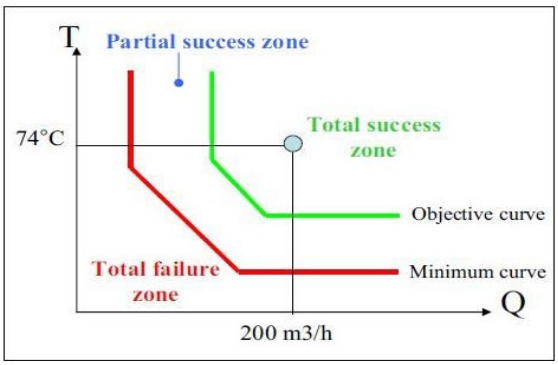


Figure 5: Diagram showing the definition of success for the STP procedure (Bélzègues-Courtade BRGM Nov 2008).

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 initial payment is between 3,5% and 5% (it depends on the geological risk) of the costs which are covered and the level of compensation is 65% of the eligible cost (total cost of the first well – subsidies + over costs due to unforeseen events during drilling works). It can reach a maximum of 90% with the complement of the regional council.

For a normal Dogger geothermal well in Paris basin (deviated well at 1800 - 2000 m) the full cost is about 4 - 5 M€ per well. The insurance mechanism is based on success-failure curves and different sums are granted according to the degree of success of the project.

(2) The Long Term Procedure (LTP)

The Long Term Procedure (LTP) 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. LTP 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. LTP insurance is used for securing long term profitable exploitation, covering the risks of drilling exploitability's degradation. The conditions for subscript to the LTP 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 lower profitability), 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 Auxiliaire 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.

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.

4.2 Results from 2000

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 were connected to geothermal district heating.

Since 2008 and at the end of 2013, 28 projects (new or rehabilitation plants) benefited from the STP procedure, 26 in Paris Basin, one in Aquitaine and the last one in Alsace for an industrial plant. 6 operations subscribed to the LTP procedure. At the end of 2013, more than 200,000 flats or equivalent are connected.

At the present, several 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.

5. CONCLUSIONS

The two insurance funds (for shallow and deep aquifers) remain very interesting tools to support the motivated actors but appear clearly not sufficient to double or triple the number of installations in the next ten years. Hence, in order to develop further renewable energy sources and in particular geothermal energy, these systems have been maintained for the next few years.

Regarding the Renewable Heat Fund, this was also renewed in 2014 and will be strengthened from 2015 with a higher budget level and simplified instruction procedure.

In parallel, the French electricity sector started to emerge with especially EGS sites in metropolitan France and with more classical projects in Overseas Departments (such as the Bouillante power plant in the Caraibean zone). A reflection is undergoing with French industrial actors (GEODEEP: The French geothermal cluster for heat and power), ADEME and public support to develop specific guarantee funds dedicated to geothermal electricity. These new systems could be operational mid 2015.

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