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## Investigations into GSHP development in France

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### ABSTRACT

At the beginning of 1980s ground water heat pumps were being developed for both the individual houses and small groups. It has been a major failure which resulted from the fall in energy prices, and a bad perception of heat pumps due to a too fast development, based only on energy cost and poor quality of machines and fitters, that led to many breakdowns and poor quality of heating

Current objectives to reduce greenhouses gases combined with uncertainties in fossil fuel are now restarting the Heat Pumps market in France.

Since 1997, on the impulsion of EDF, supported by ADEME and BRGM, the heat pump industry has taken a new start.

Market growth has intensified since 2005; this market attracts new contributors because of very strong demand that sometimes is difficult to fulfil by existing actors

In this context, the goal is to have a controlled development of the market, based on quality.

This paper considers the tools set up in France for promoting, accompanying and to secure the Ground Source Heat Pumps (GSHP) market: organization of the heat-pump sector, implementation of a quality policy, technical support, financial support, communication and information, research activities

### 1. INTRODUCTION

Historically, France experienced a first attempt to develop geothermal heat pumps in the 80's, in the context of the oil crisis. The program launched at this time in order to develop heat pumps and reduce the oil consumption was finally, after a promising start, a major failure and led to a lack of interest and confidence in heat pump solutions. The main reasons of this failure were :

- The development of the market was too fast and only based on the energy costs. When the price of oil finally decreased, many people re-consider the pertinence of this solution and ecological awareness was not in the air...

- The heat pump actors were not well prepared. Quality problems with the machine and its installation, and the lack of qualified professionals for maintenance, led to many breakdowns and a poor quality of heating. This resulted in a bad perception of heat pump solutions.

- The chosen target, heat pump combined with boiler in existing dwelling, was a technically complex one. The heat pump community was not well prepared to address it.

After this first attempt, heat pumps installations in France were only a few hundred per year during around 10 years.

Since 1997, after an initial impulsion of EDF<sup>1</sup>, supported by ADEME<sup>2</sup> and BRGM<sup>3</sup>, the geothermal heat pump solutions are coming back. Learning from the past, the focus has been set on quality and easier technical solutions, in new buildings. This new start is indeed fed by the energy prices increase and the rising of ecological awareness, but it is also mainly the result of 10 years of actions and measures to overcome the barriers to the development, and to perpetuate the market. The main actions taken in France to secure the market can be classified in the following way:

- Organization of the heat-pump sector
- Implementation of a quality policy
- Technical supports
- Financial supports
- Communication and information
- Research

### 2. ORGANIZATION OF THE HEAT PUMP SECTOR

ADEME, BRGM and EDF have helped to organize the market by contributing to heat-pump distribution, financing demonstrators, R & D programs, and informing the public.

#### 2.1 A growing market

Market growth has intensified since 2005 (fig.2). This growth is mainly fuelled by the price increase of hydrocarbons, the tax incentives accorded by the French government, and increasing ecological awareness. The Heat Pumps market for heating (and cooling) is growing fast but is still small with regards to boilers with estimated sales of 700 000 units in 2007; that means that the possibilities of the market are still very big.

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<sup>1</sup> EDF : the biggest French electricity company

<sup>2</sup> ADEME : French Environment and Energy Management Agency

<sup>3</sup> BRGM : French Geological Survey

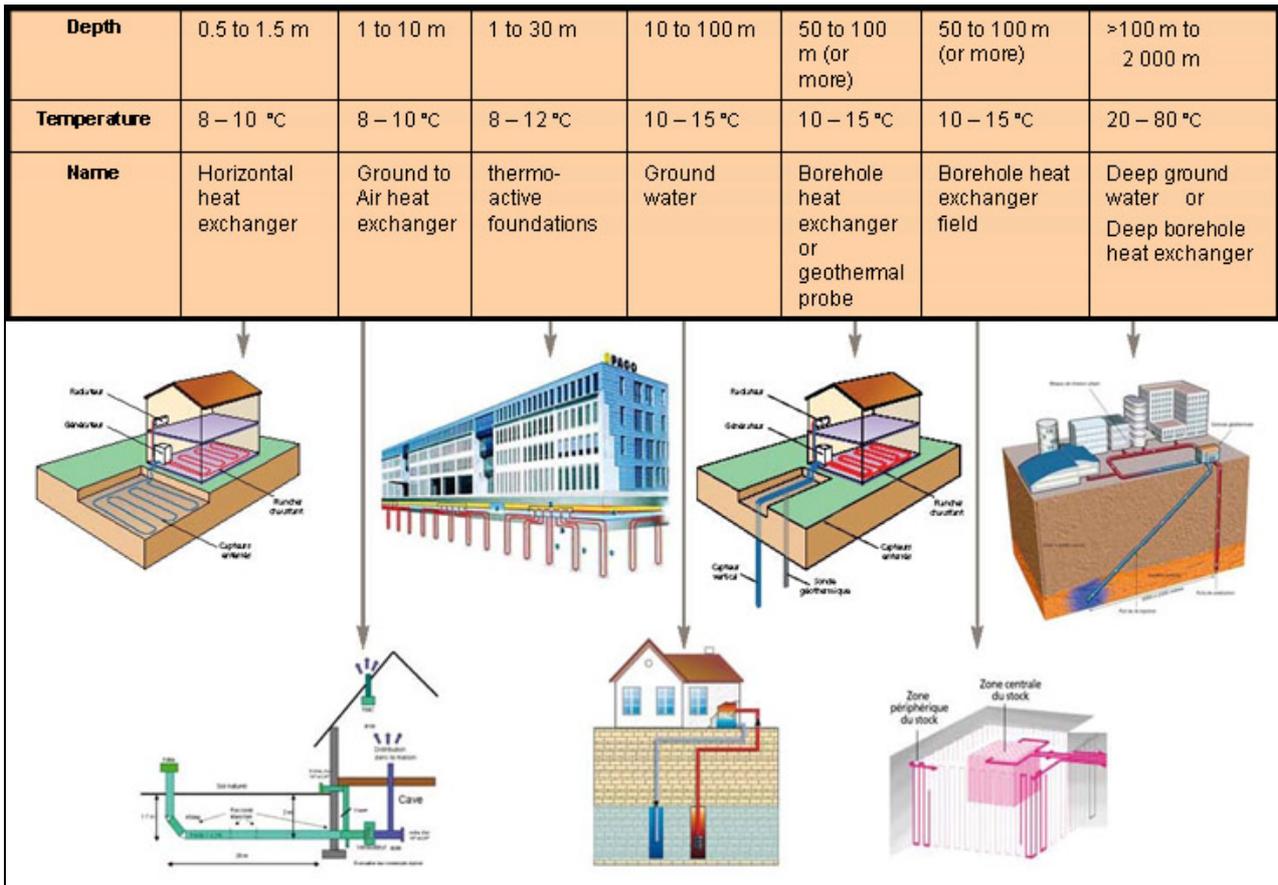


Figure 1: Main ground heat extraction systems developed in France

	2003	2004	2005	2006	2007	2008
Ground Direct / Ground Direct + Ground Direct / Water	5 400	6 800	7 800	9 600	9 600	7 900
Water / Water	3 600	4 900	5 400	8 850	9 000	11 530
<b>Total GSHP</b>	<b>9 000</b>	<b>11 700</b>	<b>13 200</b>	<b>18 450</b>	<b>18 600</b>	<b>19 430</b>
Air / Water	4 700	5 600	12 000	35 050	51 000	133 080

Figure 2: Heat pumps sales since 2002 until 2008 (data from AFPAC)

Concerning Geothermal Heat Pumps (GHP) also called Ground Source Heat Pumps (GSHP), different ground heat exploitation system have been developed in France (fig.1)

Sales of GSHP heat pumps are mainly for installations in new dwellings and over 90% are individual installations with a installed power between 5 kW to 20 kW.

Air-to-water heat-pump sales are booming (fig.2) because of the demand for existing dwellings, in which they are easier to integrate with a lower capital investment than GSHP ones.

This market attracts new contributors because of very strong demand that sometimes is difficult to fulfil by existing actors.

## 2.2 A heat-pump association

A heat pump association called AFPAC<sup>4</sup> (standing for French Association for Heat Pumps) has been created in 2002. This association is gathering all the contributors to the heat pump industry, going from the manufacturers to the fitters. Its purpose is to promote the use of heat pumps for heating and cooling, with a strong focus on quality.

The creation of AFPAC was a very powerful tool to promote the technology in France. It has provided a "place" to discuss about heat pumps and to develop a promotion politic in coordination with all the contributors to the sector. AFPAC is the dedicated "spokesman" for heat pumps, particularly when dealing with the government. It was for instance instrumental in creating tax cuts for heat pumps.

AFPAC is a member of the European Heat Pump Association

<sup>4</sup> AFPAC : Association Française pour les Pompes à Chaleur



Figure 3: Quality device of the AFPAC

### 3. IMPLEMENTATION OF A QUALITY POLICY

The purpose of the quality promotion is obviously to avoid reproducing the mistakes made in the past, but also to develop a durable market by keeping the public confidence in heat pump solutions. The important point in implementing this quality approach is that it must be led by the heat pump sector itself to be sustainable. This is why ADEME, BRGM and EDF have always tried to implicate and to encourage as much as possible the professionals in their attempt to implement quality. Every action is thus concerted with AFPAC to be shared with all the actors of the heat pump sector in France. Since 1997, different quality tools have been developed:

Quality label for machines: NF PAC

Quality charter for fitters: QualiPAC

Drilling-quality charter : QualiForage

Normes & Standards

#### 3.1 Quality label for machines: NF PAC

NF PAC is a non-mandatory quality certification which purpose is to attest that a machine respects commitments defined in European standards and a specific frame of reference. In the frame of reference, additional specifications have been added, such as performance measurements at other operating points, test conditions for machines not covered in EN 14511 (direct expansion machines) and minimum COP.

NF PAC is a sign of quality for the customers. It is awarded by AFAQ (French Quality Insurance Agency).

NF PAC is a first step toward a certification at European level (not yet possible as direct expansion heat pumps are not covered in the standards). For this reason, it has been designed to be "euro-compatible", and coherence with other label such as DACH or Eurovent has been checked.

Through laboratory's tests and through audit of the factories the NF PAC label certifies

- . COP
- . Thermal power
- . Acoustic power

This label thus allows to compare the performances of machines.

#### 3.2 Quality charter for fitters: "QualiPAC"

This charter is based on the observation that the fitting of the heat pump is one of the main key to a successful system. Experiences from measurement campaigns have underlined this fact. Furthermore, in France, apart a minimum registration for handling fluids, there are no mandatory technical skills needed to become a heat pump fitter. This can lead people, attracted by the expansion of the market, to start in this business without being aware of the high technical skills necessary. Customers not being able to distinguish between professionals or opportunists, some counter-references could damage the opinion on heat pumps.

For these reasons, AFPAC has been developing since 2002 a charter for fitters who want to be identified as professionals committed in quality. This charter, elaborated in cooperation with all the actors of the sector has been deployed in the first half of 2007. The charter is a complete quality system including:- 10 commitments of the fitters with regard to the client, including the necessity to proceed to a true thermal sizing study of the building to evaluate the needs.

- Admission and exclusion conditions to the charter well defined, such as minimum skill levels and the obligation to submit to controls of the installations realised.
- A training course. This training course is composed of 3 different levels following the experience of the fitters. A fitter applying to the charter has to demonstrate that its technical skills are good by submitting to a test, or has to follow the training course.
- The supply of tools such as a sizing software, and technical guides defining the rules of heat pump system design and fitting.
- A quality checking system including on-site randomly selected controls.
- A communication plan including information to the public and the professionals, leaflets, websites, press releases, etc.



Figure 4: 5 of the 10 commitments of the QualiPAC fitters

#### 3.3 Quality charter for drillers: "QualiForage"

This initiative aims at supervising the market of Geothermal Heat Pumps on vertical heat exchangers (probes) thanks to:

- the implementation of a "quality standard", with a reference specifications for the realization of probes according to the rules of the art

- the promotion of an optimal brand image of the vertical geothermal probe

The purpose of this charter is also to enable the public to identify the drillers involved in a quality approach. The drillers have to respect several rules defined in the charter.

These rules are:

- Technical: How to design and build a borehole heat exchanger properly? How to organise the construction site respecting security rules and the environment?
- Administrative: What are the responsibilities of the different persons involved in the project? What are the commitments with regard to the clients?
- Juridical: What is the legal framework to follow?
- To have signed a ten-year assurance with the mention of geothermal probes

The drilling companies sign a commitment letter to follow the rules defined in the charter. They have to adopt the work methodologies and to submit themselves to control.

In return they benefit from the communication campaigns of ADEME, BRGM and EDF and they are clearly identified by the public as drillers engaged in quality. The list of the drillers involved in the charter can be consulted on the common website of ADEME and BRGM on geothermy ([www.geothermie-perspectives.fr/](http://www.geothermie-perspectives.fr/)) and on AFPAC website ([www.afpac.org](http://www.afpac.org))



Figure 5: QualiForage technical documents

Qualiforage is supported by a set of technical documents (fig. 5) providing information on borehole heat exchangers. The main information and supports included in the technical documents are:

- Regulatory framework + technical support
- Ten-year guarantee
- Training for drillers
- Administrative preparation of files
- Controls on sites

The good implementation of the geothermal probe conditions the performance of the whole installation of heating. *QualiForage* guarantees the respect for the rules of the art for:

- the sizing of the probes, in function of the nature of the ground and presence or not of ground water, to meet correctly the needs of heating (and/or cooling)

- the respect for the minimal spacing between 2 probes to avoid the frost of the ground

- the technical conditions of realization (adapted technique of drilling, of implementation of tubes and of the cementation)

- the test in - situ of the watertightness and airtightness of the probes

The main objectives of this Quality charter for drillers is to :

- Increase quality standard
- Develop the sector in coherence with the EU objectives

### 3.4 Standards & Regulation

Evolutions of the French geothermal regulation are necessary to take into account the fast development of Ground Source Heat Pumps. At the present time, legal formulations are not well defined for Borehole Heat Exchangers (BHE), nor for Ground Source Heat Pumps (GSHP) in a general way. Horizontal ground heat exchanger (usually < 1.5 m depth) are even not mentioned in the legal framework

Nevertheless, things are improving and two standards has been edited in 2007 for ground water and geothermal wells:  
Norme AFNOR FD X10-999

Norme AFNOR NF X10-980

A new standard is furthermore in preparation for vertical heat exchangers. Its first objective is to propose a technical and informative document easy to read for owners, fitters or drillers.... It clarifies the limits of services and the transfer of responsibilities between the operators.(heat pump fitter, driller, contracting body,...).

The second and more technical objective of this standard is to clarify the quality of required cementation of the well. Indeed, in France, the vertical heat exchangers must be necessarily cemented on all the height of the well for reasons of environment and protection of the groundwater.

## 4. TECHNICAL SUPPORTS

### 4.1 Free access to the available geological data

All the available public geoscientific data (geological, hydrogeological and environmental datas, etc.) are accessible and visualisable through the InfoTerre portal, which provides access to georeferenced information produced by the BRGM and other organisations and to a wide range of online services.

- . geological maps, logs and sections,
- . drill-hole data base including borehole logs,
- . groundwater and mineral data,
- . etc.

All the data is available in digital format on an interoperable web server (<http://infoterre.brgm.fr>).

#### 4.2 Decision-making tools for the installation of heat pumps using groundwater

In several regions of France GIS (geographical Information Systems) are available for decisions makers ; They can evaluate the local feasibility for ground water geothermal heat pumps and decide if they could invest the project

The Geological GIS Supply data on the local ground water geothermal potential to all partners. It provides objective technical data on the regional superficial hydrogeology (with multicriteria analysis) and guides for operators on administrative, economic, and technical aspects.

They are mainly dedicated to medium to large scale ground water heat pumps , for buildings of the service sector (office blocks, hospitals, Shopping centres, hotels, etc.)

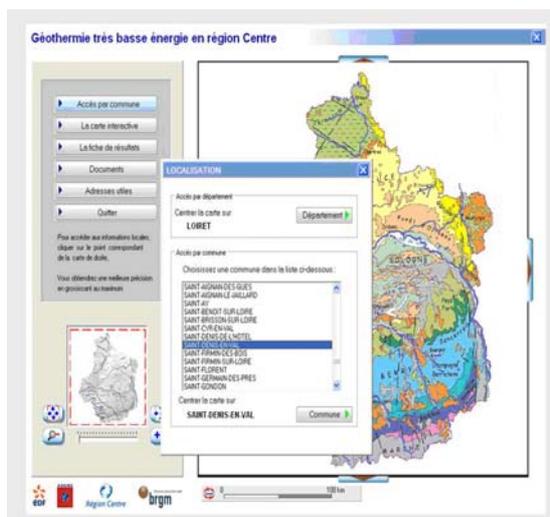


Figure 6: Example of GIS for regional geothermal groundwater resources, available on CD-Rom or Web site



Figure 7: The program to develop GIS for regional geothermal groundwater resources (Available on : [www.geothermie-perspectives.fr](http://www.geothermie-perspectives.fr) )

#### 5. FINANCIAL SUPPORT

To activate the development of the market, some financial incentives have been created in France at national level and in some cases at regional or local level.

##### 5.1 Income-tax cut

Through discussions with AFPAC, the French authorities have implemented in 2005 a tax cut of 50% for heat pumps. The principle is to give a reduction on the income-tax of taxpayers who have installed a heat pump as their main heating system. The amount is calculated as 40% of the price of the machine, excluding workforce costs, provided it has been fitted by a professional and the COP is greater than 3.3. It is applicable to all technologies of heat pumps (excluding air to air) and even if someone's incomes are not enough to pay tax, the money equivalent to the tax cut is given as a subvention.

This measure is very important for the heat pump market because it reduces the return on investment of heat pump systems, which is usually longer than the one of the more widespread fossil fuel heating systems.

This measure has increased the growth of the market and has also transformed it. Usually, the heat pumps sales were made for new buildings (around 96% of the sales). The income-tax cut, combined with increase of fossil energy prices, have ignited the existing dwelling market. This change benefits mainly to air-to-water and air-to-air heat pumps, because they create less disturbance than the over technologies on the landscape around the dwelling.

##### 5.2 AQUAPAC-Geological Risk insurance for ground water heat pumps

AQUAPAC is a guarantee against geological risk due to uncertainty of the drilling results for ground water when used for energetic purposes. This insurance system is for medium to high size ground water Heat Pumps projects (>30kW). This insurance system was created by ADEME, BRGM and EDF in the 80' and reactivated during 2000s. It is dedicated to heat pumps using ground water with well depth lower than 100 m. Its principle is to propose to the client a double guarantee covering two risks:

- A "seeking guarantee" covering the risk of an unsuccessful drilling, in terms of absence of water or of insufficient flow in the aquifer.
- A "durability guarantee" covering the risk, over 10 years, of a drying up of the well or of accidents on hardware, linked to an evolution of the well.

The aim is to enable the client to take an insurance at a small cost and thus to help him to overcome his reluctance to chose this type of solution.

AQUAPAC is based on a guarantee fund allocated by ADEME and EDF. The client has to pay a guarantee fee proportional to the cost of the system but this fee is small with regard to a traditional insurance.



**AQUAPAC**  
**Fund guaranteeing**  
**ground water supply to a heat pump**

- Unsuccessful drilling
- 10-year guarantee of water supply
- Heat Pump > 30kW
- Depth < 100 m

**Figure 8: The AQUAPAC technical document**

Possible local supports from the regional or local council are possible: in some areas where local council wants to promote GSHP there is and additional support for ground heat exchangers works..

**6. PUBLIC INFORMATION**

One of the barriers to the development of heat pumps in France is that it is not a heating and cooling solution widely known, especially from the general public. This has two consequences:

- First, people not knowing this solution are not considering it when it is time to choose a heating and cooling system.
- Second, people have a very bad knowledge of heat pumps and thus are more vulnerable to sellers who promise them that everything is possible with heat pumps.

To inform the public, ADEME in cooperation with AFPAC and BRGM has developed some information tools:

- Leaflets on heat pumps systems.
- Active presence with mock-up on renewable energy shows.
- About 350 energy counsellors are working on the French territory to give some energy efficiency advice to a large public.
- Information courses are organised to help them promoting efficiently heat pumps solutions.
- Information on heat pumps is provided to energy engineers of ADEME working in the 26 countryside offices. The engineers through their contacts with local authorities are able to promote heat pumps.
- Information on heat pumps is also provided through websites: [www.ademe.fr](http://www.ademe.fr) ; [www.afpac.org](http://www.afpac.org) ; [www.geothermie-perspectives.fr](http://www.geothermie-perspectives.fr)
- Technical documents and training courses

As there are no official technical skills necessary to work in the heat pump sector, it is necessary to disseminate as much

as possible the technical rules of designing and fitting heat pump systems. The aim is to make them shared and used by professionals already working in the heat pump sector, but also for the new ones starting in the business.

For this purpose, some technical guides have been developed, or updated, and are distributed by AFPAC or other professional organizations.

A training course for heat pump fitters has also been developed. It is accessible through the quality charter QualiPAC for fitters, but is also accessible for people who do not want to enter in the charter.

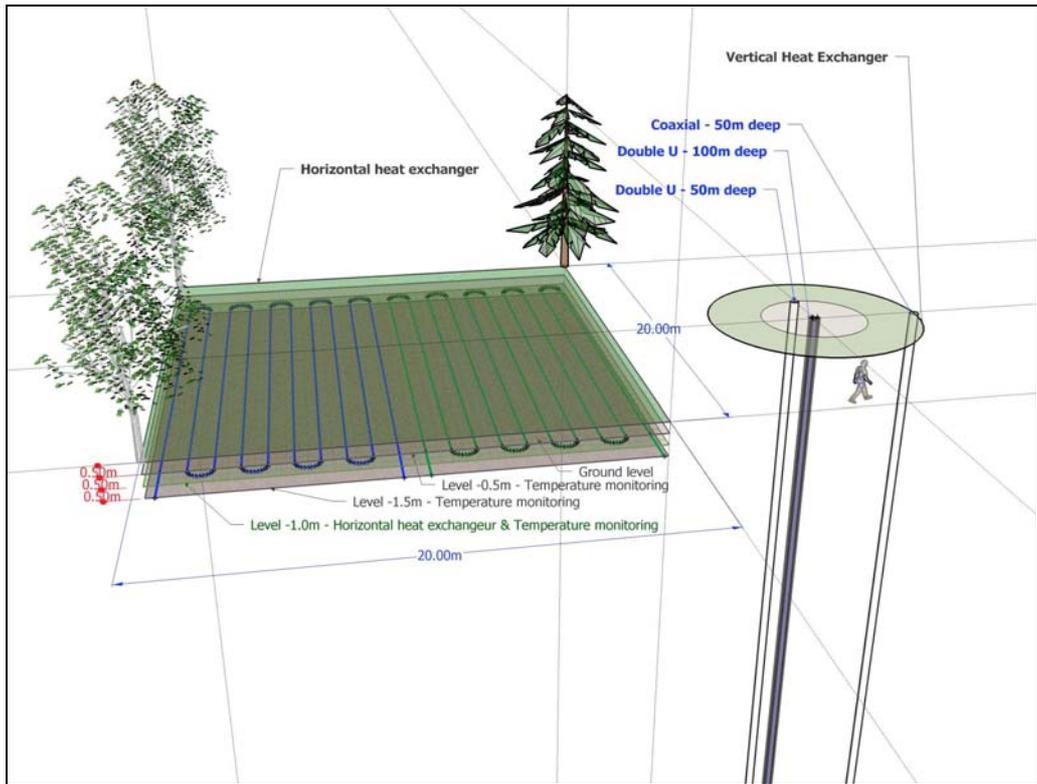
**7. RESEARCH**

BRGM and the Council for the Centre Region have created a joint venture setting up an experimental site for the testing of underground heat exchangers for GSHP. The main elements of this experimental platform were built in 2007 and 2008, and thermal systems for simulation of heating or cooling needs has been installed end 2008.

(description is given in paper n° 2929)

The objectives of the platform are:

- to Describe the functioning of heat exchangers, to integrate them better into the definition of the system and to encircle better the domain of functioning ( energy, environmental and economic optimum) . Describe the influence of the geological parameters on the performances,
- to Investigate conditions of functioning as frost of the surrounding ground better know to where we can go without degrading the long-term performance,
- to study the impact of ground heat exchangers on the environment: temperature (interference between installations) , stability and balance, chemistry , bacteriology,
- storage of heat with study of the incidence of the annual heating and/or cooling cycles,
- estimate annual average COP (directly representative of the invoice), connected to all the factors of systems (basement, HP, building, weather report, etc) ,
- perspective of certification of the installations,
- develop new concepts of heat exchangers, such as less intrusive Ground Heat Exchangers, and decrease of the investments,
- validate the concepts, verify and optimize their performances and determine the markets of application (climate, size, urban context, etc.),
- use the platform as a tool of testing and demonstration; this site will provide opportunities for staff training and publicizing professional activities.



**Figure 9: The experimental platform – Concept**



**Figure 10: The experimental platform - Sight of the wooden technical buildings**

**8. CONCLUSION**

The developpement of GSHP in France seems now to be on a good path, through all the different actions to promote quality and to organize the sector. The purpose is now to perpetuate the growth and to make the different quality tools either mandatory, by using regulations, or unavoidable, if they become so well implemented that GSHP actors could not play without them.

ADEME and BRGM are joining their efforts in order to activate the development of geothermy in France. This is of great importance as geothermy could be one of the major contributor to reach the Kyoto targets.