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Geothermal Resources in France - Current Situation and Prospects

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ABSTRACT

The exploitation of geothermal resources in France has seen several phases:

- a major development phase at the beginning of the 1980's with, in particular, more than 70 geothermal district heating systems operating in the Paris area and, in 1987, launch of the European Deep Geothermal Energy Programme of Soultz-sous-Forêts,
- a period of withdrawal during the 1990's marked by very little new activity and public support being geared essentially towards the Soultz-sous-Forêts Deep Geothermal Energy Programme,
- a boost in activity since 1998 following the Kyoto Agreement, and the decision taken in France to resume an active policy for energy management and the development of renewable energies.

Furthermore, since the introduction of the European electricity directive, France, under the influence of Ademe, is seriously considering its position on geothermal energy, which could play a key role in reaching the objectives to reduce greenhouse gas emission. With this in mind, several studies have been launched by Ademe, many of which are in partnership with BRGM, so as to define the optimum conditions for boosting activity of low-enthalpy geothermal resources with a high exploitation potential.

INTRODUCTION

Since 1998, geothermal energy in France has been concentrated on four main sectors:

Geothermal district heating systems

The thirty or so systems still in operation persevered notably due to a public-support policy for the connection of new clients. The measures adopted enabled some 10,000 additional dwellings to be linked up to the systems, providing a total of approximately 170,000 connected dwellings.

Geothermal Heat Pumps (GHP)

The market has been undergoing regular and significant expansion for the past few years due essentially to the impetus from EDF (French Electricity Board) and Ademe (French Environment and Energy Management Agency), and dynamic industrial influence. The objective for 2010 is that one out of five new single-family houses be equipped with geothermal energy, i.e. some 40,000 units per year.

Electricity production in the French Overseas Departments

A new 11 MW power plant is now in operation at Bouillante in Guadeloupe, raising the site's total capacity to 15 MW. In the Martinique and La Réunion islands, geothermal exploration programmes are planned to be launched in the near future concerning zones identified as having potential during prospecting surveys on-going since 2000.

Deep geothermal energy at Soultz-sous-Forêts

Construction of a scientific pilot plant module is underway since 2002. The pilot, comprising a three-well system bored through granite to a depth of 5000 m, is expected to come into operation during 2006. Over the coming years, these activities should continue in a sustainable manner, following the implementation of the French Energy Law in 2004. This law, which establishes the structure for the future French energy policy, assigns renewable energies – including geothermal resources - an important role and, a priori, the necessary resources to allow their real development.

This document presents the situation of geothermal resources in France and its prospects in the medium term.

1. FRENCH GEOTHERMAL RESOURCES

France disposes of several types of geothermal resources.

Low-energy resources – developed for thermal applications primarily located in the two major existing sedimentary basins: the Paris Basin (for which Paris is the geographical centre) and the Aquitaine Basin in southwest France. The resources are found at depths between 600 and 2,000 m.

Other French regions also have high potential for low-energy resources, but the geological structures are more complex and the fields much more localized (Hainault, Bresse, Limagne, etc.).

France also possesses high-energy resources that are potentially exploitable for electricity production. These are located essentially in its Overseas Departments (the volcanic islands of the Antilles - Guadeloupe and Martinique – and the Indian Ocean – La Réunion).

Finally, the entire French territory has a good supply of surficial water-bearing strata that can be exploited using heat pumps.

Since the end of 2002, a project for updating Metropolitan France's resources has been underway, led by the BRGM (French Geological Survey) with the cooperation of Ademe. The aim of this project is to finalize a new methodology for the inventory of geothermal resources (COPGEN).

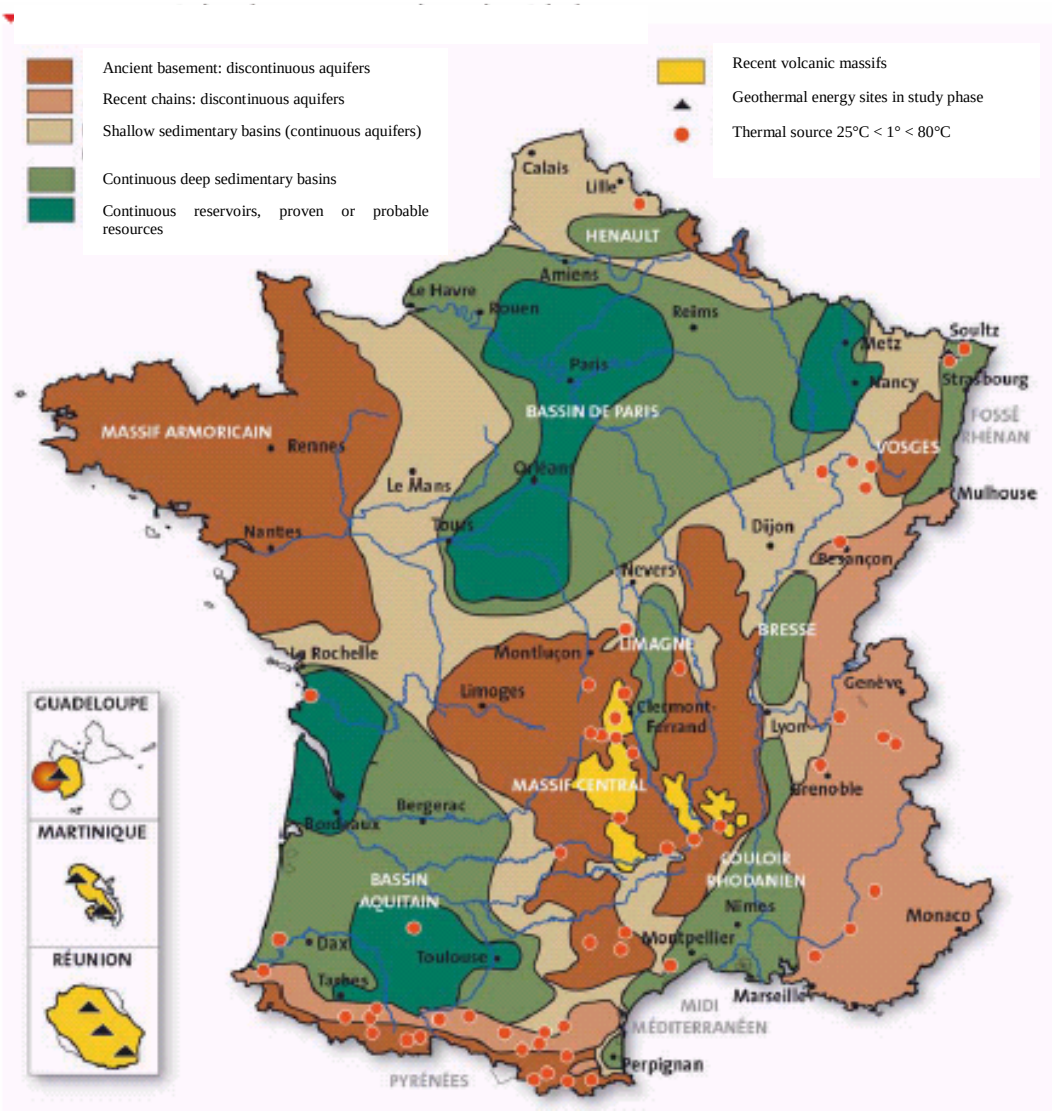


Figure 1: Geothermal Resources in France and their geological setting

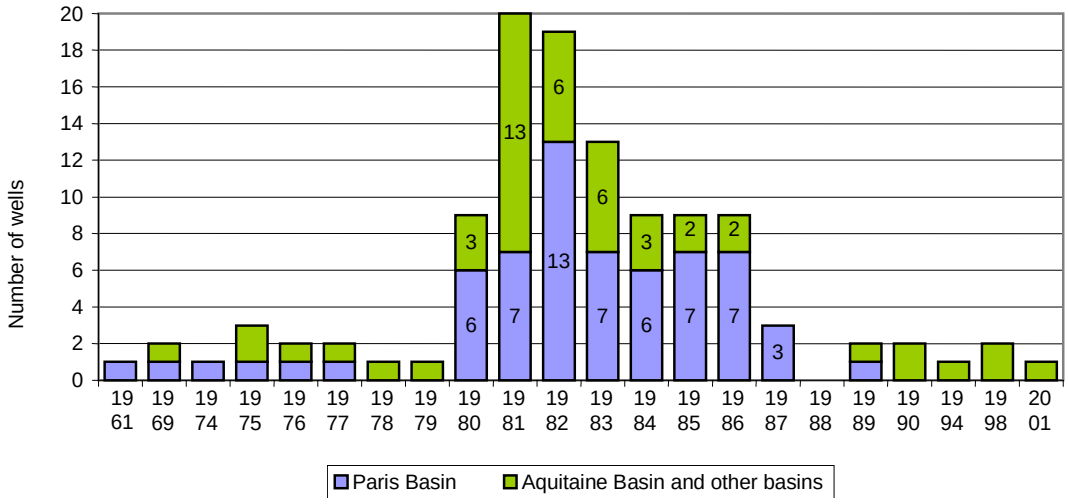


Figure 2: Annual evolution of drilled or rehabilitated wells

2. THE DEVELOPMENT OF LOW-ENERGY RESOURCES

2.1. Situation

The nature of the existing resources has led France to favour thermal applications of geothermal resources.

To this end, 112 deep exploration wells (drilled wells or rehabilitated existing wells) have been created since 1961, 97 of which were finally brought into operation, mainly between 1980 and 1987, as shown in the following histogram. At present, **65 geothermal production plants** (installations with single, double and triple wells) are in operation. These correspond to **60 geothermal operations** *sensu stricto*.

Approximately a third of operations have been discontinued, due to technical, economic or financial problems.

Most of the plants are located in the Paris Basin, followed by the Aquitaine Basin.

Almost half of operations concern district heat networks, which are essentially in the Paris region where they serve on average 4,000 to 5,000 LUEs (Living Unit Equivalents). Other installations serve heating systems for fish-breeding installations, horticultural greenhouses, swimming pools or aquatic leisure complexes.

2.2. Energy and environmental assessment

Together, all these operations represent an average annual saving of 1,265 effective GWh, equal to approximately 130,000 toe of fossil fuel serving in the region of 166,000 LUEs. The annual tonnage of CO_2 emissions avoided is estimated at just over 400,000 tons.

2.3. Main characteristics of geothermal heat networks in the Paris region

Since 1998, just over half of the existing heat networks in the Paris region (17 out of 29) have been equipped with gas cogeneration plants, essentially for economic reasons, by virtue of a particularly attractive repurchase rate paid by EDF (French Electricity Board).

The overall electric power of these units totals 122 MW. During winter 2001-2002, they produced 384 GWh of electricity and 358 GWh of heat.

Although, initially, these cogeneration plants were installed to the detriment of geothermal resources – since the heat produced by cogeneration generally takes priority over geothermal resources during the winter months - they led the operators to engage upon an active policy for connecting networks to new subscribers, and were actively supported in this approach by the Authorities (who awarded a 400 € grant per ton of carbon saved). This policy for extending networks therefore made it possible to limit, in a progressive manner, the reduction in geothermal energy use that was attributable to the installation of cogeneration plants.

Technically, the plants have reached a high level of performance. The average rate of availability, for all operations over the last three years, has been estimated at 94.7%. This rate of availability reflects the significant progress made in the profession to ensure that installations are reliable.

Finally, we can note that the average rate of geothermal energy coverage for the group of 29 networks is at approximately 60%, and up to 72% for those plants without cogeneration.

Table 1: Breakdown of operations (>100 toe) by geography and usage

	Paris Basin	Aquitaine Basin	Other regions	Total
District heat networks	29	5	-	34
Fish breeding, greenhouses, etc.	-	4	6	10
Swimming pools, aquatic leisure complexes, etc.	-	9	3	12
Heating for buildings (non-network)	2	-	2	4
				60

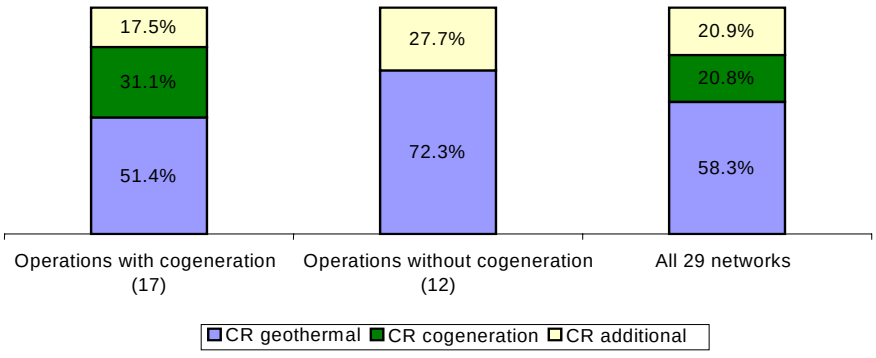


Figure 3: Geothermal coverage rate (weighted average) for the Parisian geothermal heat networks

3. THERMAL APPLICATIONS IN BUILDINGS AND GEOTHERMAL HEAT PUMPS

The market of geothermal heat pumps for heating buildings has seen great developments over the past few years in France, following the trend of the other European countries and North America.

In 2003, the number of units sold, essentially to equip new single-family houses, was approximately 9,000; in comparison with the 700 installations sold in 1997.

To give an idea of scale, approximately 180,000 new single-family houses are built in France every year; there is, therefore, a real development potential.

Table 2 shows the evolution of the market in 2002 and in 2003.

Contrary to the majority of European countries in which they are installed, most of the geothermal heat pumps sold on the French market – that is over 90% - are of the horizontal closed-loop ground-source type (which explains the high number of Direct Expansion Heat Pumps).

This is due to historical reasons (the presence of small French companies that were already marketing this type of equipment at the beginning of the 1990s) and economic reasons (the competitive cost of investment compared with fuel or propane heating solutions).

Vertical closed-loop ground-source systems were little marketed in France up to the end of the 1990s (due to the lack of French expertise in matters of installation, and to the high cost of investment). Nevertheless, this market is beginning to develop thanks to action taken by professionals; water drillers are gradually being trained, with the support of the BRGM, to implement plants in accordance with good engineering practice. There are now approximately forty trained drilling companies.

Table 2: Evolutions in the heat pump market within the residential sector in 2002 and in 2003

	2002	2003	Progression
Direct Expansion	4,500	5,400	+ 20%
Brine/Water and Water/Water	3,200	3,600	+ 12%
Air /Water	4,400	4,700	+7%
Total	**12,100**	**13,700**	**+ 13%**

Figure 4: Map of drilling companies committed in the EDF-Ademe vertical closed-loop ground-source approach

Ultimately, the vertical closed-loop ground-source market seems to show the best potential in terms of progress, not only for single-family houses but also for larger-scale buildings. A number of new building projects have seen the day since 2000, such as office blocks, collective residential complexes and retirement homes, and should serve as examples for new projects.

The expansion of the geothermal heat pump market in France is linked to several factors:

– EDF's approach in favour of these heating solutions. As a result of action undertaken by EDF, the market was in a position to implement a programme, between 1997 and 2000, for allocating premiums to individuals equipping their homes with such systems,

– the presence of dynamic small companies (manufacturers), which are commercially aggressive and in a position to respond to the demand,

– the interest shown by Ademe towards these systems, which could contribute, on a national scale, towards reducing the growth of the electricity demand, increasing the portion of renewable energies in play, and reducing the quantities of greenhouse gas emissions.

On this account, since 2001, private individuals who equip their houses with ground-source heat pumps benefit from public aid in the form of tax credits.

The concern of Ademe and EDF is, however, to supervise the development of this market so that it progresses in a constant and regular fashion and does not become unmanageable. To do so, a support policy has been implemented gradually since 2000 that puts quality first (structuring of the sector, grouping of the professionals within a non-profit organisation, minimum performance thresholds required for products, quality charter for installers, information-communication).

4. ELECTRICITY PRODUCTION IN FRENCH OVERSEAS DEPARTMENTS

Due to their volcanic environment, the French Overseas Departments - Guadeloupe, Martinique and La Réunion – represent, for France, prime candidates for geothermal electricity production.

At present, projects have made the most headway in Guadeloupe - in the Caribbean islands - on the site of the town of Bouillante, with the rehabilitation in 1995-1996 of the Bouillante 1 double-flash power plant (still operating), the creation of a new power plant (Bouillante 2) between 1999 and 2004, and a project that started in 2003 concerning a new power plant, Bouillante 3.

The objective is that geothermal resources should cover nearly 20% of the electricity consumed in Guadeloupe with an economically profitable, permanently available, and non-polluting base supply.

The successful rehabilitation of the Bouillante 1 power plant and the positive results of a research programme conducted in 1998 - aiming to deepen the knowledge of the Bouillante field – led Géothermie Bouillante S.A.– a joint company owned by BRGM and EDF to begin, in 1999, the study and implementation of a new project, Bouillante 2.

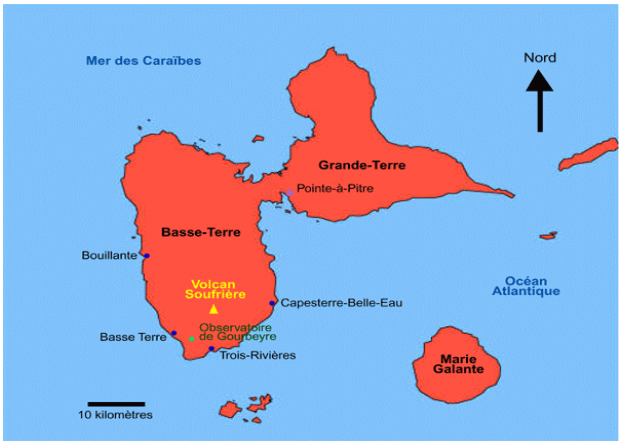
This project was designed on the basis of three new production wells designed to supply a 10 MW electric power plant.

The location for the drilling operations was selected on the basis of extensive research conducted in 1998 and local constraints linked to the increasing urbanization of the town of Bouillante (this small municipality of 3,000 inhabitants has been expanding regularly over the past few years due to tourism).

The decision was finally made to use an accessible area located above Bouillante 1, approximately 400 m away as the crow flies (see map below).

Three deviated wells were drilled in order to intersect, at depth, the faults that produce the geothermal fluid. The drilling works lasted five months, from December 2000 to April 2001, and produced extremely positive results, with the wells yielding far more steam than even the most optimistic forecasts.

These results therefore led to the creation of a new power plant (Bouillante 2), equipped with a 10 MW electric single-flash unit. Installed next to Bouillante 1, Bouillante 2 was commissioned in 2004



Guadeloupe

Bouillante Bay

Figure 5: Creation and implementation of Bouillante 2 (1999-2004)

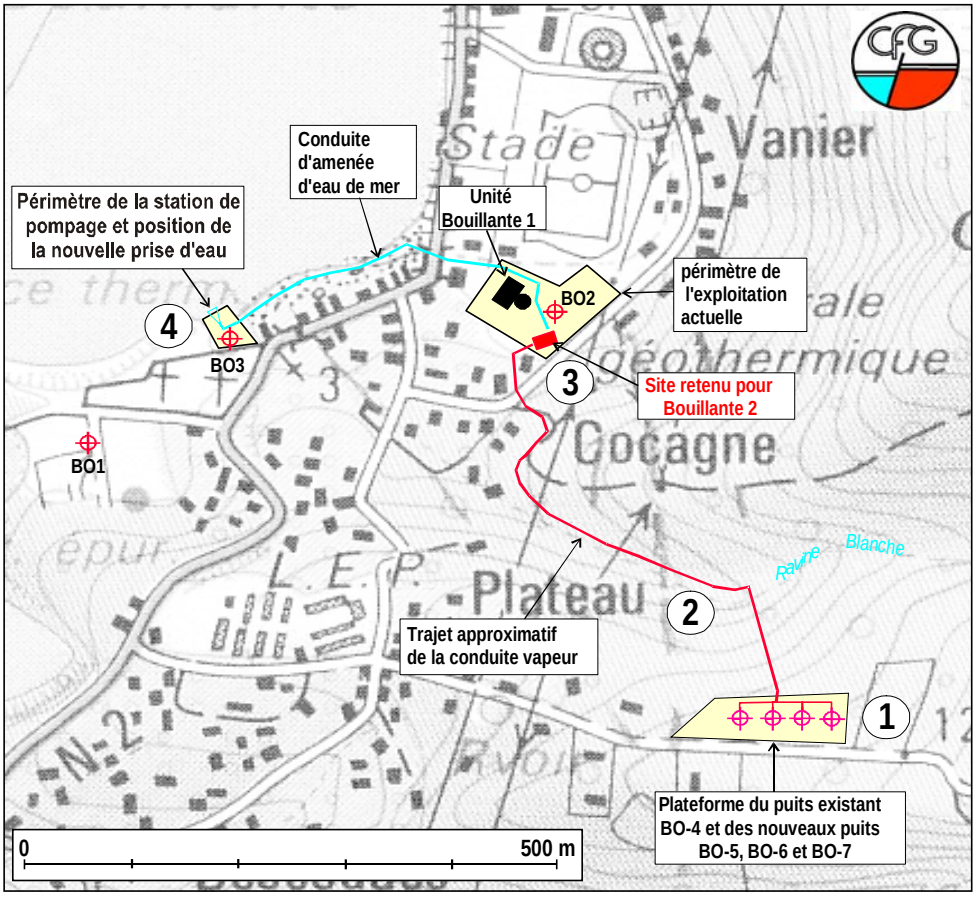


Figure 5

Figure 6: Steam supply lines at Bouillante 2

This project started in 2003 and aims to exploit part of the geothermal reservoir located on the northern edge of Bouillante bay, approximately 2 km from the Bouillante 1 and 2 site. Good indications have been found offshore and onshore in this area, in particular a major tectonic structure. These constitute a prime target and merit investigation by drilling.

Table 3: Main characteristics of the geothermal energy plants at Bouillante

Bouillante 1	Double-flash power plant Nominal power installed: 4.7 MW Depth of wells: 350 m Temperature: 250 °C
Bouillante 2	Simple-flash power plant Nominal power installed: 10 MW Depth of wells between 1,000 and 1,150 m Temperature: 250 °C
Bouillante 1 and 2	Bouillante 1: 30 GWh/year Bouillante 2: 72 GWh/year Rate of availability: approximately 90% Overall energy contribution: ~ 9% of Guadeloupe's consumption in electricity

Situation in Martinique and La Réunion

Operations have not made as much progress in these two other Overseas Departments.

In Martinique, an exploration campaign led in 2001 near Fort-de-France, with the drilling of three slim-hole wells, revealed the presence of a medium - to low-enthalpy reservoir (80°C). Further exploration operations have been underway since 2003 in the north and south of Martinique, and have indicated favourable areas. Since 2000, work has been carried out in La Réunion including a synthesis of previous work conducted in the 1980's, and a geophysical survey (MT) in specific areas, in order to identify a suitable area for future geothermal energy prospecting operations.

5. DEEP GEOTHERMAL RESOURCES WITHIN FRACTURED ROCK

The scientific pilot plant at Soultz-sous-Forêts

Since 1987, France has been committed, beside Germany and the European Union, to deep and fractured rock geothermal resources. Highly encouraging results were obtained from research conducted at Soultz-sous-Forêts (Alsace) in the east of France. This resulted, in 1999, in the decision to implement a scientific pilot plant designed to demonstrate the feasibility of the concept of deep geothermal resources.

The design of this pilot requires the drilling of three wells 5,000 m deep, with a central injector well and two deviated production wells located one on each side of the injector well. The two production wells recover the injected fluid, which is heated during its circulation in the stimulated fractured environment. The surface fluid is re-injected by the injector well once its calorific contents have been exhausted.

The pilot plant was designed for a capacity requiring a loop of 30 to 50 MW of thermal capacity (electric power installed 5 to 6 MW).

The 1999-2004 period was dedicated to preparing and building a deep reservoir heat exchanger (wells and stimulation tests), which was completed successfully in 2004.

The 2004-2007 period will be dedicated to long-term circulation testing between the wells in the deep reservoir heat exchanger and construction of the 5 to 6 MW plant. The main objective will be to determine the hydraulic productivity of the deep reservoir, evaluate its thermal productivity and work on its long-term management.

If the testing operations are conclusive, they should lead to the creation of an industrial prototype of 25 MW of capacity in 2010.

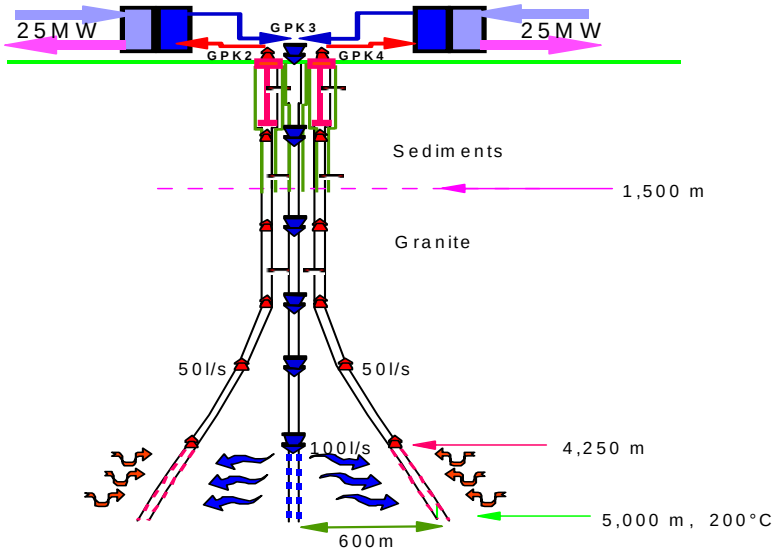


Figure 7: Flow diagram for the European pilot plant for deep geothermal system at Soultz-sous-forêts

Table 4: Soultz statistics

❑ 18 years of research
❑ 15 research laboratories involved and several hundred sub-contractor companies
❑ Three wells at 5,000 m depth (drilling of 20,000 metres, 60,000 m^3 of water injected in six major fracture stimulation phases)

CONCLUSION

Geothermal activities in France have increased significantly over recent years. In the 1980's, development was essentially focussed around district heat networks and thermal applications, but over the past few years, the ground-source geothermal heat pump sector has expanded to include electricity production. At the same time, the European programme for deep geothermal systems at Soultz-sous-forêts has taken on a new dimension.

This is the consequence of the energy policy adopted in France and Europe following the 1997 Kyoto treaty and aims to support more effectively the development of renewable energy resources.

The coming years should indeed confirm this trend.

In this context, the French Parliament voted for an Energy Law in 2004 with two important objectives :

i) to increase by 50% the production of renewable thermal energy to 2010,

ii) to reduce by 75% the current level of greenhouse gas emission to 2050.

To reach these objectives, the voted Law proposes that a proactive and highly active policy be led in matters of reduction in energy consumption throughout all activity sectors – in particular transport and construction sectors – favouring the development of renewable energy resources.

Not only does this Law fix a structure and objectives, but it also implements tools (notably of a fiscal or statutory nature) to support actions that have been undertaken in this area. For example, the implementation of a system of energy saving certificates is planned from 2005, imposing major energy suppliers to generate annual energy savings by investing in renewable energy sectors and energy control. A significant fiscal bonus is also offered to private individuals who equip their place of residence with a solar boiler or a geothermal heat pump or those who carry out renovation works to improve heat insulation, for example.

It is therefore highly likely, under this law, that new geothermal heat network operations will be underway in the very near future in the Paris region (there have been no new operations since 1987). We should also see significant developments in the geothermal heat pump market.

Furthermore, the Soultz-sous-forêts project is about to enter into the critical period that will reveal the long-awaited moment of truth.

TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY (Installed capacity)

	Geothermal		Fossil Fuels		Hydro		Nuclear		Other Renewables (specify)		Total	
	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr	Capac-ity MWe	Gross Prod. GWh/yr
In operation in December 2004	4,7	30		60 000	2 000	65 200	63 200	441 000		510*		566 000
Under construction in December 2004	10	72										
Funds committed, but not yet under construction in December 2004												
Total projected use by 2010												

* wind energy : 342 GWh/yr

TABLE 2. UTILIZATION OF GEOTHERMAL ENERGY FOR ELECTRIC POWER GENERATION AS OF 31 DECEMBER 2004

Locality	Power Plant Name	Year Com-missioned	No. of Units	Status[1)]	Type of Unit[2)]	Total Installed Capacity MWe	Annual Energy Produced 2004[3)] GWh/yr	Total under Constr. or Planned MWe
Guadeloupe	Bouillante 1		1		2 F	4,7	30	
	Bouillante 2		1	N	1 F	10	72	
Total			**2**			**14,7**	**102**	

TABLE 3. UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT
AS OF 31 DECEMBER 2004 (PARIS BASIN)

Locality	Type[1)]	Maximum Utilization					Capacity[3)]	Annual Utilization		
		Flow Rate	Temperature (°C)		Enthalpy[2)] (kJ/kg)			Ave. Flow	Energy[4)]	Capacity
		(kg/s)	Inlet	Outlet	Inlet	Outlet	(MWt)	(kg/s)	(TJ/yr)	Factor[5)]
Bassin Parisien :										
Alfortville	D	76	73	44			9,2	44	168,3	0,58
Bonneuil sur Marne	D	78	79,3	49			9,8	32	127,9	0,39
Cachan Nord & Sud	D	100	70	46			10,0	32	101,3	0,32
Champigny sur Marne	D	78	78	45			10,8	45	195,9	0,59
Chelles	D	78	69	40			9,5	32	122,4	0,41
Chevilly Larue + L'Hay les Roses	D	155	72,6	43			19,0	65	253,8	0,42
Clichy Sous Bois	D	50	71	44			5,6	20,5	73,0	0,41
Coulommiers	D	64	85	61			6,4	36	114,0	0,56
Créteil	D	84	78,9	50			10,2	67	255,4	0,80
Epinay sous Sénart	D	70	72	49			6,7	67	203,3	0,96
Fresnes	D	70	73	46			7,9	37	131,8	0,53
La Courneuve Nord	D	55	58	40			4,0	32	76,0	0,58
La Courneuve Sud	D	50	56	40			5,5	35	73,9	0,70
Le Blanc Mesnil Nord	D	49	66	40			5,3	19	65,2	0,28
Le Mée sur Seine	D	38	72	52			3,2	34,5	91,0	0,91
Maisons Alfort1	D	84	73	50			8,1	58	176,0	0,69
Maisons Alfort2	D	72	74	54			6,0	36	95,0	0,50
Meaux Beauval & Collinet	D	113	75	46			13,7	37	141,5	0,32
Meaux Hopital	D	36	76	51			3,8	45	148,4	0,67
Melun l'Almont	D	72	72	42			9,0	45	178,1	0,62
Montgeron	D	61	72,5	45			7,0	27,5	99,7	0,45
Orly 1 & 2	D	98	75	49			10,7	35,5	121,7	0,36
Ris Orangis	D	52	72	53			4,0	35,3	88,5	0,70
Sucy en Brie	D	55	78	50			6,5	23	84,9	0,59
Thiais	D	70	76	46			8,8	37	146,4	0,53
Tremblay en France	D	76	73	46			8,6	52,5	187,0	0,69
Vigneux sur Seine	D	67	73,2	44			8,2	45	173,3	0,55
Villeneuve Saint Georges	D	97	76	45			12,6	34	139,0	0,35
Villers le Bel	D	64	67	40			7,3	30	106,8	0,37
TOTAL		**2 112,0**					**237,5**		**3 889,3**	**0,58**

TABLE 3.bis UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT
AS OF 31 DECEMBER 2004 (other French Basins)

Locality	Type[1]	Maximum Utilization					Capacity[3]	Annual Utilization		
		Flow Rate	Temperature (°C)		Enthalpy[2] (kJ/kg)			Ave. Flow	Energy[4]	Capacity
		(kg/s)	Inlet	Outlet	Inlet	Outlet	(MWt)	(kg/s)	(TJ/yr)	Factor[5]
Autres bassins:										
Dieuze	F	31	31	20			1,4	18	26,1	0,58
Lunéville	B	42	25	15			1,8	2,5	3,3	0,06
Nancy1 - Thermes	B	39	45	29			2,6	5,8	12,2	0,15
Bresse										
Montrevel en Bresse	B	17	32	20,1			0,8	8,8	13,8	0,52
Languedoc										
Montagnac	F	10	30	20			0,4	8	10,6	0,80
Lodève 1	G	10	30	20			0,4	5,6	7,4	0,56
Lodève 2	G	10	52	20			1,3	5,6	23,6	0,56
Pézenas	F+B	53	38	20,1			4,0	30,5	72,0	0,58
Limagne										
Aigueperse	G	17	43	20			1,6	10	30,3	0,59
Bassin Aquitain										
Argelouse/Sore	G	42	48	18			5,3	15	59,4	0,36
Bordeaux Benauge	B	55,5	42	30			2,8	0,1	0,2	0,00
Bordeaux Stadium	B	36	34	26			1,2	5	5,3	0,14
Merignac - BA 106	D	67	52	40			3,4	37	58,6	0,55
Mios le Tech	F	55,5	73	30			10,0	27,5	156,0	0,50
Mont-de-Marsan 1	D	70	60	54			1,8	60	47,5	0,86
Mont-de-Marsan 2	D	17	56	44			0,9	9,7	15,4	0,57
Saint Paul les Dax 1	D+B	42	47	22			4,4	28	92,3	0,67
Saint Paul les Dax 2	H+B	8,5	60	30			1,1	4	15,8	0,47
Blagnac1	B	8,5	55	28			1,0	3	10,7	0,35
Nogaro 2	F	50	51	27			5,0	36	114,0	0,72
Jonzac 1	D+B	8,5	60	30			1,1	5	19,8	0,59
Jonzac 2	B	17	58	26			2,3	10,3	43,5	0,61
Total		**706,5**					**54,4**		**837,6**	**0,49**

TABLE 4. GEOTHERMAL (GROUND-SOURCE) HEAT PUMPS AS OF 31 DECEMBER 2004

Locality	Ground or water temp.	Typical Heat Pump Rating or Capacity (kW)	Number of Units	Type[2)]	COP[3)]	Heating Equivalent Full Load Hr/Year[4)]	Thermal Energy Used (TJ/yr)	Cooling Energy (TJ/yr)
Bassin Parisien								
Maison de la Radio	27		2	W			62,00	70
Bruyères le Châtel	34			W			21,00	
Châteauroux	34		3	W			61,00	
Bassin Aquitain								
Bordeaux Meriadeck	52			W			13,00	
Gujan Mestra	25			W			8,30	
Hagetmau	32			W			11,50	
Pessac	48			W			66,00	
Blagnac 2	60			W			26,00	
Lorraine								
Nancy 2	30			W			26,00	
France	15	5	1 000,00	V			104,00	
TOTAL							**398,80**	**70,0**

TABLE 5. SUMMARY TABLE OF GEOTHERMAL DIRECT HEAT USES AS OF 31 DECEMBER 2004

Use	Installed Capacity[1)] (MWt)	Annual Energy Use[2)] (TJ/yr = 10^{12} J/yr)	Capacity Factor[3)]
Individual Space Heating[4)]			
District Heating [4)]	243,4	4030,3	0,51
Air Conditioning (Cooling)			
Greenhouse Heating	12,6	120,7	0,30
Fish Farming	20,8	309,3	0,47
Animal Farming			
Agricultural Drying[5)]			
Industrial Process Heat[6)]			
Snow Melting			
Bathing and Swimming[7)]	15,1	266,6	0,38
Other Uses (specify)			
Subtotal	**291,9**	**4726,9**	
Geothermal Heat Pumps	**16,1**	**468,8**	
TOTAL	**308**	**5195,7**	

TABLE 6. WELLS DRILLED FOR ELECTRICAL, DIRECT AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1, 2000 TO DECEMBER 31, 2004 (excluding heat pump wells)

Purpose	Wellhead Temperature	Number of Wells Drilled				Total Depth (km)
		Electric Power	Direct Use	Combined	Other (specify)	
Exploration[1)]	(all)					
Production Experimentation	>150° C	2				5
	150-100° C					
	<100° C					
Injection Experimentation	(all)	1				
Total		**3**				**5**