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Manual for implementing sustainable support schemes for GEODH

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Executive summary / key messages

- Support schemes are crucial tools of public policy for geothermal to compensate for market failures and to allow the technology to progress along its learning curve. By definition, they are temporary and shall be phased out as this technology reaches full competitiveness;

- Geothermal heat technologies are heading for competitiveness, but support is still needed in certain cases. Financial support schemes should be adapted to the level of maturity of markets, notably in emerging markets and where a level-playing field does not exist.

- Innovative financing mechanisms should be adapted to the specificities and the maturity of geothermal technologies;

- In addition, there is a need for an in-depth analysis of the heat sector, including about the best practises to promote geothermal heat, the synergies between energy efficiency and renewable heating and cooling, and barriers to competition.

- A Geothermal Risk Insurance Fund is seen as an appealing public support measure for overcoming the geological risk. As costs decrease and markets develop, the private sector will be able to manage project risks with, for example, private insurance schemes, and attract private funding;

- Innovative support schemes have to be developed on the regional level too. Based on a better knowledge of the local ecosystem, such support schemes respond more quickly and effectively to the regional environmental targets;

- Whatever the support scheme, it has to be set up on a long-term basis to offer enough visibility to GeoDH project developers;

- Alternatives to public investment have to be found; the development of third party financing is essential. To reach this aim, it is important to increase the communication about the profitability of GeoDH projects in order to encourage private investment.

Introduction

The geothermal energy source is free, but the upfront investments to use it are significant. The higher upfront-costs of geothermal district heating (DH) can be compensated by much lower operating costs, but only if a sufficiently low 'cost of capital' can be reached, that is to say if the risks can be properly managed. Therefore, innovative solutions for financing projects have to be found to overcome this challenge.

Over the last years Member States have been using a wide range of public policy mechanisms to support the development of geothermal technologies. These can be distinguished between investment aid (capital grants, loans – including from EU Structural Funds, risk insurance) and operating aid (price subsidies, e.g. feed-in tariffs or premiums, renewable energy obligations with green certificates, and tax exemptions or deductions on the purchase of goods).

Against this background, combination of financing schemes and incentives can be a key point for the economic success of projects. Regarding the economic factors and price construction of geothermal energy for heat generation, see Annex 2.

A special focus is set on the geological risk insurance mechanisms that guarantee the presence and the quality of the resource. This could be a key aspect to overcome existing difficulties.

When this important parameter has been overcome, in some cases there is still a need for a comprehensive enabling framework in order to make geothermal competitive against fossil fuels (as long as the final price of the latter does not fully reflect the real costs to society).

Different innovative support schemes have therefore been identified and will be described in this document. The first to be described has been developed by the European Investment Bank (EIB) in collaboration with the Aquitaine Region and a cluster of banks. Secondly Third-party financing models will be presented: one developed by the Ile-de-France Region, and one developed by a private company "KYOTHERM". Finally, this document will provide an analysis other four relevant financial European support schemes in Hungary, United Kingdom, Germany, and France.

Why should public funds be used to support the geothermal industry and interfere with the market?

The primary objective of financial incentive schemes is to compensate for market failures and unfair competition. They are also intended to favour the deployment of a given technology by creating a secure investment environment catalysing an initial round of investment and thereby allowing the technology to progress along its learning curve. Hence, support schemes should be temporary and can be phased out as this technology reaches full competitiveness in a (then) complete and open internal market where a level playing field is fully established.

Today, however, market conditions in the EU heat sector prevent geothermal from fully competing with conventional technologies developed historically under protected, monopolistic market structures where costs reduction and risks were borne by consumers rather than by plant suppliers and operators. The internal market is still far from being perfect and transparent. Firstly, in many countries electricity and gas prices are regulated, thus they do not reflect the full costs of the electricity and/or heat generation. Secondly, the conventional sectors still receive many subsidies. Thirdly, there is lack of market transparency, including lack of information provision to customers and tax-payers, and clear billing.

Support measures for geothermal technologies are therefore needed to favour the progress towards cost-competitiveness of a key source in the future European energy mix and to compensate for current market-failures.

Support schemes and EU State Aid regime

Any kind of support, when granted by Member States need to be compatible with EU State Aid rules. As far geothermal district heating technology is concerned, the most important pieces of legislation in this field are the following:

- *Guidelines on State aid for environmental protection and energy 2014-2020(2014/C 200/01)*
- *Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty*

The conditions under which public support is compatible with the internal marker differ for operating and investment aid.

Regarding operating aid for renewable heat, according to Paragraph 3.3.3.2 of the Guidelines, it is compatible with the internal market if the following cumulative conditions are met:

- *the aid per unit of energy does not exceed the difference between the total levelised costs of producing energy ('LCOE') from the particular technology in question and the market price of the form of energy concerned;*

- *the LCOE may include a normal return on capital. Investment aid is deducted from the total investment amount in calculating the LCOE;*

- *the production costs are updated regularly, at least every year; and*

- *aid is only granted until the plant has been fully depreciated according to normal accounting rules in order to avoid that operating aid based on LCOE exceeds the depreciation of the investment.*

Regarding investment aid, the table overleaf summarises eligible costs and maximum aid intensity for geothermal heat and district heating infrastructure (%of eligible costs) compatible with the internal market:

	Notification threshold	Eligible costs	Intensity aid compatible with the internal market		
			Small enterprise	Medium-sized enterprise	Large enterprise
Aid for environmental studies		The eligible costs are the costs of the studies.	[70] %	[60] %	[50]%
Aid for renewable energies **Aid for cogeneration installations (only to high efficient CHP – see para 13**	EUR 15 million per undertaking per investment project	The counterfactual is a conventional power/heat plant with the same capacity in terms of the effective production of energy.	[65] %, [100] % if bidding process	[55] %, [100] % if bidding process	[45] %, [100] % if bidding process
DH infrastructure	EUR 20 MIL for DH network		65% [100]% if bidding process	[55]%	[45]%
			To the aid intensities mentioned above may be increased by a bonus of [5]% point in regions covered by Article 107(3)c or by a bonus of [15]% in regions covered by Article 107(3)a Treaty up to a maximum of 100% aid intensity.		

1- Risk insurance scheme: an absolute prerequisite

1.1 Why is it so important ?

Analyses of investment costs and risks underline that the financing of the exploration phase of a geothermal project is an important, if not the most important barrier to development (Fig. 3). During the exploration phase, the risk is high while the costs are already significant as, for example seismic data has to be purchased or seismic investigations have to be conducted. One of the largest obstacles for investment in deep geothermal systems is that the presence and quality of the resource is not fully proven until the first exploration well is drilled. On the other hand exploration wells have a relatively low success rate (20-60%) To establish a comparison, in oil and gas exploration a success ratio of 20% is considered as rather good taking into account that the geophysical campaign carried out before (with associated huge cost) allows a much better prognosis of geological conditions, which is not the case in geothermal exploration. Only if the flow rate and temperature fulfil the expectations of the investor (i.e.. profitability), can it be determined that the project will achieve its objectives.

An unsuccessful drilling is an important risk that has to be taken and to be paid. Drilling costs are significant and can represent a non-negligible part of the overall project costs, however have to be financed somehow.

As a consequence of the fairly low number of deep geothermal projects, geothermal developers struggle to find insurance (public or private) schemes with affordable terms and conditions for the resource risk. Depending on the maturity of the market, governments can step in by funding public or public/private risk mitigation schemes.

In this context, it is worth mentioning the proposal to establish a pan-European risk mitigation scheme in order to facilitate the pooling of the resource risk among geothermal projects. In particular, the GEOELEC project has put forward concrete suggestions for governance and structure of a European Geothermal Risk Insurance Scheme (EGRIF)[1],

In the short-term, however, national and regional schemes adapted to market development represent the most concrete option. The following sections summarise the functioning of the main national risk mitigation schemes in force in Europe and that could easily be replicated in other EU countries.

1.2. The French risk insurance model

The mining risk is present at the start of a project, even in areas which are geologically well understood; there is a question over whether the right amount of hot water can be produced at an acceptable cost. Figure 1 matches the probability of success during all the phase of a project.

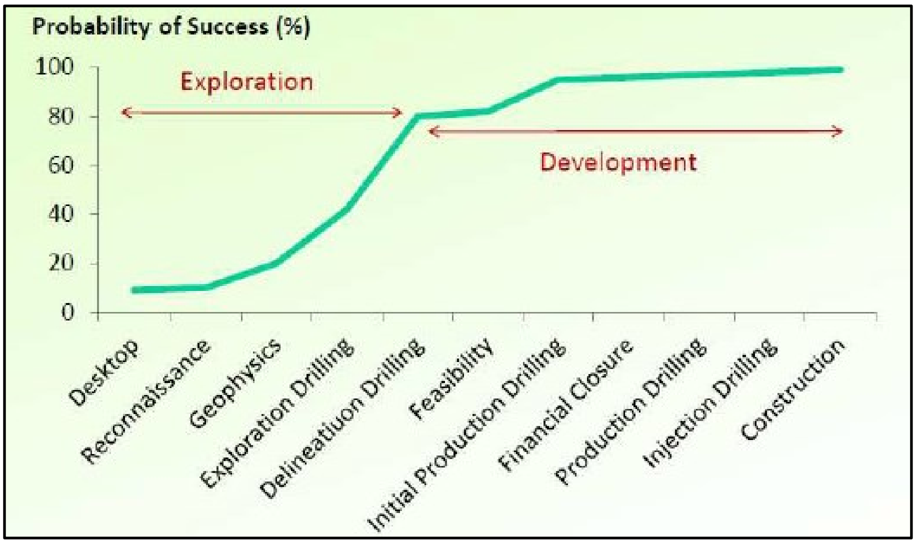


Figure 1: Variation of risks at different phase of a geothermal project (Source GEA 2008)

The French risk insurance system differentiates between two types of risks. The first one is the risk during the drilling phase of not obtaining geothermal resource matching the flow rate and

[1] See GEOELEC report on risk insurance for more details. Available at www.geoelec.eu/library.

temperature requirements, assuring the profitability of the planned operation (Short Term Risk - STR). The second one is the risk of seeing this resource, when it exists and is developed, naturally decreasing or depleting before the payback of the equipment, as well as the risk of damage affecting the wells, the material and the equipment of the geothermal loop during the development period ('Long Term Risk – LTR').

1.2.1. Short term risk (STR) insurance principles (Fonds SAF)

If the district heating network thermal characteristics are known**,** financial forecasts depend on *expected* main geothermal parameters: Temperature (T) and Flow rate (Q). These parameters are extrapolated from general geological models made by*:*

- Oil and gas companies,

- The French geological survey (BRGM)

- And data from former deep water and/or geothermal wells

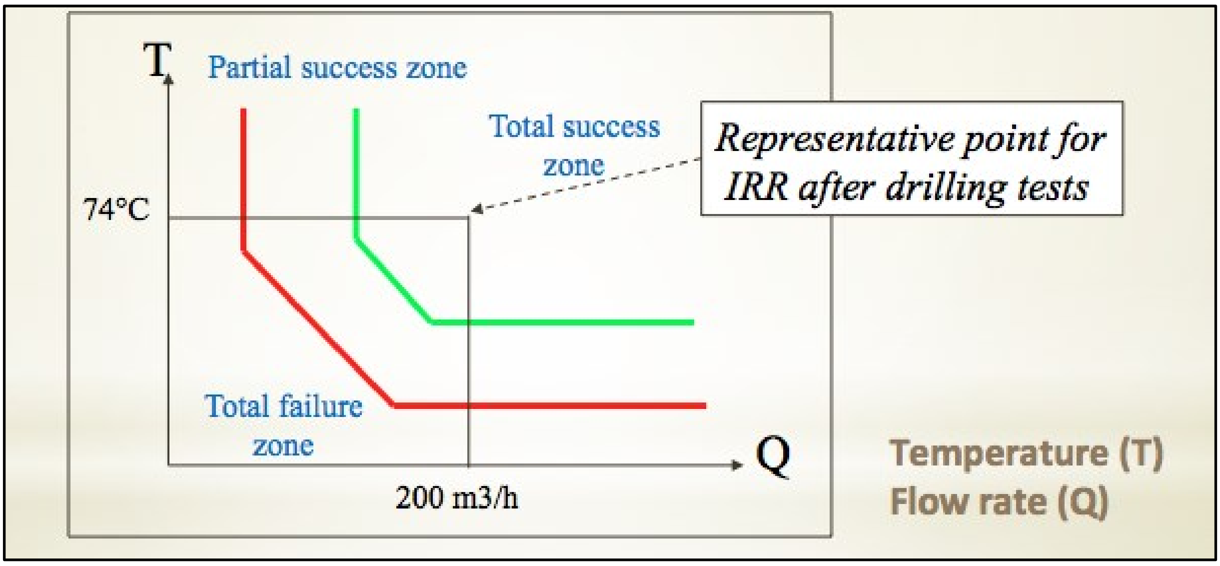


Figure 2: Success-failure economic curves

The conditions of subscription to the STR insurance are the following:

- Acceptance of the technical and financial form by the had-hoc Geothermal Committee
- Payment of 1.5% of the covered costs
- Maximum indemnity of 90% of the eligible costs (effective supported costs minus subsidies)
- The balance of the fund is partly ensured by public funds (State and ADEME)

1.2.2. Long term risk (LTR) insurance technical principles (Fonds SAF Environnement)

After a doublet has been set, the geothermal characteristics are known, but their long term behaviour, as well as long term effects on wells and reservoir, is unknown. The two mains risks are: the decrease of temperature and/or flow rate and a possible severe corrosion and/or scaling in wells. The LTR insurance is used for securing long term profitable development in respect with depreciation calculation.

The conditions of subscription to the LTR insurance are:

- Acceptance of rule of good technical practice and respect of the regulation
- First 15 years period: payment of 3.2 % of covered costs
- Second 10 years period: payment of an annual 10 to 12 k€ contribution

The balance of the fund is partly ensured by public funds (State and ADEME).

1.3. The German risk insurance system

To cover the risk of not finding adequate resources, the German Federal Environmental Ministry (BMU) has developed a risk mitigation instrument focused on geothermal drilling projects. The instrument is focused on the drilling phase of projects with at least two deep drillings that will be connected to a surface plant. It provides a loan with identification clause (in case of unsuccessful drilling) and redemption grant. The loan can be combined with a redemption grant for accrued costs for stimulation. This leads to higher interest rates during drilling. It is managed by KfW Bankengruppe.

Description of the financial instrument *(source: GEOFAR)*

Project phase where the financial instrument tackle

Beneficiary

– Small and medium-sized private commercial enterprises that fulfil the 'SME' criteria of the EC

– Private companies that are majority owned by municipalities

– Municipalities, local authorities, special purpose vehicles (SPV), non-commercial investors

– Large companies can be funded in special cases proving the eligibility of the investment

Investors are just eligible if they are at the same time the operator of the plant.

How the amount of financial support is calculated

The financing share is up to 80% of the eligible drilling costs including the investment for stimulation measures with a maximum loan of 16 Million Euro per drilling project. The instrument foresees two financing models:

Financing model A:

There is a 100% indemnity loan for up to 80% of the eligible investment. The indemnification clause is awarded at proven non-discovery after successful drilling up to the execution of adjusted stimulation measures. The exact definition of non-discovery is set in the loan contract.

Financing model B:

A partial debt relief[2] amounting to the exact loan payment for adjusted and executed stimulation measures will be additionally granted. This gives the investor more certainty in the investment. The indemnification clause will be discharged after proven and KfW approved non-discovery to 100% from the liability for the repayment of outstanding loans. The credit institutions will be committed to discharge the debtor for the case of non-discovery for 100% of repayment of outstanding loans. The claim on indemnification runs out after the first approved discovery of the drilling project. The money will be paid out in partial amounts after a call-off plan that will be set in the loan contract.

The paying-off starts after the two grace start-up years with equal quarterly payments. Overpayment is only possible in special cases, where after consultation with the KfW the loan can be paid off completely or partly on a payment of a prepayment penalty. A combination with other funding instruments is possible if:

–A Maximum 80% of eligible costs are financed by public funding with the remaining 20% covered by the investor, with risks.

– Compliant with EU State aid rules.

According to the analysis of financial instruments in Germany described in the GEOFAR project, the loan term is up to 10 years with a maximum of two grace start-up years. The investor has to apply for the instrument over his bank, which choice is free. The KfW conducts the loan over the bank to the investor, not directly. The application for the instrument has to comply with certain minimum standards. The project will be checked according to the technical and economic feasibility of the drilling project including the operation phase, the types of collateral, and the existence of all necessary official licenses. Additionally a qualitative certificate on geological and geophysical studies and the thermal capacity has to be provided. For the application, the following documents have to be provided:

- Statement on the solvency of the applicant
- Technical Report of the drilling plan including development concept and description of the requirements on thermal capacity of the drilling and conceivability on the loan amount
- Project study including geological studies and development concept
- Independent certificate for the benchmark of the conclusiveness of the project study
- Official licences for the drilling and execution of the tests
- Certification of the qualifications of project management, drilling company, and service provider
- Display of a feasible plant concept/heat-use concept
- Economic calculation for the whole project phase

[2] A Debt relief is the partial or total forgiveness of debt, or the slowing or stopping of debt growth, owed by individuals, corporations, or nations.

Only applications that provide documents and information on all the above-mentioned points will be checked. The check and the statement on approval or rejection of an indemnification is subject to the KfW in consultation with the Munich RE AG. The KfW can forward the provided documents for each case to the BMU on request. The KfW or a subcontractor steadily monitors the progress of the drilling.

The latest inputs coming from the German developers demonstrate that even though this Fund was very well designed it has been unsuccessful, due to the fact that KfW has sub-contracting the management to an intermediate private bank. The risk adverse banking culture has led to impossibly high demands for details and guarantees being placed on applicants and no projects have so far been insured.

1.4. The Dutch risk insurance system

The Dutch geological guaranty scheme is managed by the Agentschap of Netherlands (Dutch National Agency for innovation, sustainability and international business & cooperation), Energy and Climate division. It is a post-damage guarantee based on a national fund with a State budget of 43.35 M Euros. A Premium of 7% of the maximum guaranteed amount is charged.

The beneficiaries are public and private developers based in the Netherlands. This insurance is dedicated to the heat production and operation of one or two ‘drillings’ (wells deeper than 500 meters). It coverst the short-term geological risk that there will be lass thermal capacity than expected. Eligible costs include drilling and test costs. Subsidised costs are not covered.

The coverage ratio takes into account up to 85% of eligible costs. The ceiling is 8.5 M Euros and 15 M Euros for a deep pilot project (however, at the moment, no deep project has been contracted).

Additional coverage by commercial insurance companies is possible, but the developer has to bear at least 5 % of the risk.

Regarding the eligibility criteria, the developer must provide a technical report (including analysis of the local geology), and a legal and financial feasibility study.

He must comply with schedules: the drilling must start within 6 months after guarantee approval, be completed within 1 year after guarantee approval and lead to the application of geothermal energy within a 2 years period.

The developer has to respect reporting and disclosure obligations.

Complete applications are evaluated in order of receipt. TNO (Netherlands Organisation for Applied Scientific Research) has an advising role, both in the application phase and in the assessment of results. The guarantee scheme is operated through tenders. The first opening took place in 2009. A fourth tender is foreseen for 2014 and some improvements are expected including a longer opening of the tender and extension of the budget.

The risk mitigation scheme was launched by the Ministry of Economic Affairs in 2009 through the regulation SEI (Risico’s dekken voor Aardwarmte).

After the first tenders, the scheme is deemed to have been crucial in helping projects get started by the state guarantee of the geological risks.

The scheme is considered as a transparent and objective benchmark for the market and officials expect that more private insurance companies will enter the geothermal market.

2- Support schemes: Investment and operation aid

This chapter looks at a number of support schemes put in place in European countries (France, Hungary, Germany, and United Kingdom), and covering geothermal and/or district heating. The objective is to identify best practices which can possibly be replicated in other EU countries.

a) Investment aid:

2.A.1. An innovative support scheme with the EIB : a banking collaboration with the Regional Aquitaine Council

2.A.1.1.Objectives of the Aquitaine Region:

To promote renewable energies, the Aquitaine Region (in the South-West of France) set up an innovative financial tool based on “subsidies loan”. This project was contracted between the European Investment Bank and three regional French banks (Banque Populaire, Caisse d’Epargne et le Crédit Agricole).

The Aquitaine Regional Council has decided to strengthen further its commitment to defining political measures in favour of energy efficiency and renewable energies. After a previous voluntary climate action plan adopted in 2007, the Regional Council renewed its engagement through the vote of the 'Climate Aquitaine Challenge', a new energy territorial climate plan, on 19th of December 2011. This report has to be considered as the regional roadmap until 2014 with actions established for all directions of the Regional Council.

This commitment takes place in the general framework set up by the Region: to go beyond the objectives defined by the 'Grenelle de l’environnement' to reach a below 30% reduction of greenhouse gas emissions, 30% of energy efficiency improvement and 32% of renewable energies in the final energy consumption,doubling current levels.

For this reason, the regional council has decided to reinforce its action plan to promote energy savings and the decentralised production of renewable energy in order to support regional actors and notably through a better access to reasonable financing mechanisms.

Given the difficult economic context, having the possibility to benefit from financing conditions which are more advantagious than those commonly proposed on the market represent a real supplementary factor of attractiveness to these projects.

To promote both the decentralised production of renewable energy based on solar, wind, biomass, geothermal, and methanation operations, as well as energy efficiency in buildings projects, the Aquitaine Region received support from the EIB to finance up to maximum 50% of the investments foreseen in the 2012-2015 Aquitaine Region support scheme thanks to the release of a line of credit up to a maximum amount of 150 million euros.

This line of credit will be made available to the Partners Banking Cluster who will bring complementary financing of 150 million euros.

The main objective of this scheme is to facilitate the financing of of renewable energy production projects in the Aquitaine Region carried out by individual entrepreneurs, legal entities under private or public law (in particular companies, societies, associations, farming businesses, public institutions or similar, local authorities, semi-public companies, social landlord) or bu1ildings energy efficiency carried out by same people. Despite the legal evolutions and the economic context, projects are still being launched. We estimate that nearly 2 million euros are engaged in the projects referred above.

To reach these ambitious objectives, the Aquitaine Region has set a regional plan in favour of energy efficiency and renewable energies, entitled ‘Positive Energy Aquitaine’. This plan aims at identifying issues and difficulties to over to ensure a real development of these industries: financing, training, social acceptability, etc.

In the same way, to improve the conditions proposed to very small and small and medium sized companies, the Aquitaine Region in collaboration with OSEO, in the frame of the Guarantee Aquitaine Fund will intervene to guarantee 50% of the total amount of complementary loans (outwith EIB loans) allocated to developing projects in renewable energies operations and energy efficiency.

As a result, all local authorities, and leganl entities under private or public law or similar (named the “Borrower”) will be able to ask to benefit from financing via the Partners Banking Clusters, whose profile will be adjusted to the operational characteristics and to the best financing conditions, taking account of the backing from EIB resources provided their are consistent with the eligibility criteria of the EIB.

2.A.1.2. Principles of the contract :

The contact model is based on the following frame.

- Aquitaine regional Council: Alain ROUSSET as President

- European Investment Bank: Philippe De FONTAINE VIVE CURTAZ as Vice-President

- Two banking groups untitled "Partners Banking Clusters"

1) Aquitaine Region "Caisse regionale de Crédit Agricole" group

2) Aquitaine&Poitou-Charentes "Caisse d'Epargne" group

Having regard the deliberation N° 2011.2694.SP on 19 December 2011 of the Aquitaine Region plenary approving the regional plan in favour of energy efficiency and development of renewable energies through a partnership with the EIB,

Having regard the call of proposals launched by the Aquitaine Region to the banks in order to finance projects of decentralised renewable energy production and projects linked to energy efficiency in Aquitaine Region,

Having regard the final offer of the Cluster composed of the "Caisses regionales du Crédit Agricole d'Aquitaine" (Caisse régionale de Crédit Agricole Mutuel d'Aquitaine, la Caisse régionale de Crédit Agricole Mutuel Py

rénées Gascogne, la Caisse régionale de Crédit agricole Charente Périgord et Crédit Agricole SA) being mandated by the Cluster to ensure the relation with the EIB,

Having regard the final offer of the Cluster composed by "Banque Populaire Aquitaine Centre Atlantique and "Caisse d'Epargne Aquitaine Poitou-Charentes,

Having regard the deliberation N°2012.1924.SP of the Aquitaine Region plenary Commission on 22 October 2012 approving the present Protocol,

Having regards the decision of the EIB Board of Directors on 25 September 2012.

-This type of financing facilities represent many advantages such as:-

- Very long-term maturity loan

- Good financial conditions because of the "A.A.A" rating of the EIB

- Strong capacity of replication because of the involvement of the European Investment Bank.

2.A.1.3. The first concrete impacts on the developments of GeoDH projects

-To made the Guarantee Aquitaine Fund and its intervention conditions available to the complementary loans allocated by the Partners Banking Clusters together with the EIB to the Borrowers belonging to the VSB&SME category for the financing of projects in renewable energies operations and energy efficiency. Loans will be the matter of the Partners Banking Clusters, but the guarantee demands will be the subject of an OSEO's decision in the Guarantee Aquitaine Fund frame. (guarantee conditions in Annex 1)

- To put in place a steering committee composed of Partners Banking Clusters, OSEO, and EBI representatives, of independent experts and the Region that will meet once per year and also at the midway point (end of 2013).

- To provide, when required, a complementary support to the 'Borrowers' regarding its energy and fight against the climate change policy;

- To disseminate on the regional level in particular, the existence of the financial mechanisms linked to the Protocol;

- To make the promotion through a dedicated media plan of the collaboration between the EIB and Partner Banking Clusters.

2.1.4.Technical eligibility criteria

- Project of renewable energies and energy efficiency

- Project will be carried out by individual entrepreneurs, legal entities under private or public law (in particular companies, societies, associations, farming business, public institutions or similar, local authorities, semi-public companies, social landlord)

- Individual are not involved in the protocol;

- Projects will have to meet the EIB technical eligibility criteria that are specified in a special convention between EIB and the banks.

The eligible projects can be financed in this frame until their commissioning or the complete achievement of the works and investments.

2.A.2. Structural Funds in Hungary: The Environment and Energy Operational Program 2007-2013: *(Source: Transenergy project)*

The Environment and Energy Operational Program 2007-2013 is owned by the Ministry of National Development, while the managing authority is the National Development Agency, National Environment and Energy Centre.

The EEOP has 7 priority areas out of which 2 are related to geothermal: Priority 4: Increase the use of renewables (396 million EUR) and Priority 5: Energy efficiency (386.5 million EUR).

The overall targeted program indicators (by 2015) are:

- renewable energy utilisation (electricity and heat): 29.3 PJ/year
- renewable-based electricity production: 937 GWh/year

- reduction of GHG emission: 1400 kt/year
- saved energy (due to increased efficiency): 2.7 PJ/year

The target groups of the program are SMEs, larger companies, non-profit organisations, private companies, companies operating from the state-budget (typically municipalities). Priority area 4 dedicated to Renewable Energy aims at increasing renewable energy utilisation:

- to contribute to the enhancement of security of supply,
- to the decrease of import reliance,
- to fulfil the environment and climate protection policy related goals,
- to implement operational support (among others) for geothermal electric and/or thermal energy generation and the utilisation and heat pump systems.

The following projects were financed between 2007 and 2011:

- -KEOP-4.1.0. (Support of heat/power generation from renewables): 3 projects, total support: 2, 53 million €
- KEOP-4.2.0. (Local heat and cooling supply from renewable sources): 10 projects, total support 14.87 million €
- KEOP-4.7.0. (Subsidy of the preparing and developing activities of the geothermal based heat and electricity producing projects): 2 projects, total support 2.08 million €

The EEOP programme is the most efficient and major supporting scheme for geothermal projects in Hungary. The experience was that the lack of prove of own resources, guarantees and elongated licensing procedures were the main problems during the period of contracting, while in the period of project implementation itself, mostly the changes in the technical content of execution, and the not sufficient proofs of performances caused delays.

2.A.3. – Third party financing specialised

The banking system alone cannot finance geothermal DH projects. The main risks of Geothermal DH projects are usually:

- Geothermal resource risk, in terms of capacity (MWh), duration (years) and operational costs
- Demand risk (MWh) from the clients of the district heating network

The banks are unable to bear these risks, so they have to be structured and transferred to other parties. The banks need a partner to ultimately bear and manage the remaining risks.

Energy service companies and municipalities are often unable to be this partner banks are looking. forEnergy service companies / utilities can have a good understanding of geothermal DH risks, however operators are "service companies" with a high cost of capital (>10 % IRR). Investing in the geothermal DH project is value destructive for them and costly for the end users. According to Ben

Warren, who works in environmental finance at Ernst & Young, “Utilities simply don't have the capital to allocate to endless volumes of renewable energy investment".

Municipalities have limited financial resources and are often unable to take more debts. They do not have the technical expertise internally to asses and manage the risks efficiently. In addition, they are not supposed to enter directly in the energy market with the current EU anti-competition law.

2.A.3.1. Francilian Region scheme - "SEM Energies Posit'IF"

Description:

The project consists in establishing a Société d’Economie Mixte – SEM (a public-private mixed status often used by French local authorities to manage urban development projects that is increasingly used to support energy operations). The SEM allows public authorities to keep control on the political objectives while benefiting from private management capabilities and co-funding. This initiative has been supported by ClimAct regions, INTERREG IVC and the European Regional Development Fund.

Energies POSIT’IF would :

- Deliver expertise (feasibility studies prior to building retrofitting or RE projects)
- Offer support to Project Management, or even ensure it through delegation
- Act as an operator integrating energy performance contract management, trading of white certificates and implementation of EE and RE projects.
- Guarantee energy performance after execution of works
- Develop finance engineering related to this kind of operations. The main targets are : collective housing (both private and small public social housing operators), public buildings and energy production projects led by local authorities and their partners.

Context and rationale

The action has two distinct objectives :

1- Accelerate and increase investments in buildings retrofitting in the Ile-de-France region (12 million inhabitants)

The purpose of Energies POSIT’IF1 is to allow stakeholders of collective housing to engage more massively in thermal retrofitting by providing them with funding and technical advice. This will be done by establishing contractual frames combining third-party financing and an energy performance guarantee. The revenues of this new regional energy operator will come from energy cost savings through extra rent revenue or expenses from owners or tenants. Revenues would also come from soft loans, subsidies, fiscal exemptions (tax abatement) or white certificates. The objective is to compensate for the lack of private investments through public funding, but with a guaranteed return on investment. The thermal retrofitting market is largely dominated by private sector offers that tend to focus on high margins and short payback energy saving components. Collective housing has therefore been neglected, even though it is predominant in Ile-de-France.

2- Stimulate investments in renewable energies (heat and green electricity)

The rise in the number of initiatives, especially in photovoltaic and wind power solutions can be explained by the development of offers by private operators under a favourable feed-in tariff framework. There is an increasing political will to enhance public control of these projects, together with an interest in taking a part of the financial benefit from this profitable and growing sector, and in parallel to extend its support to other renewable energy sources of high social value while having a lesser financial profile attractiveness. Energies POSIT'IF will be a third party investor, mainly backed by public regional funding (i.e. funds from the Regional Council and public local authorities including municipalities of the region). The financed projects will be for example the development of district heating networks using either biomass or geothermal sources. In the case of geothermal, it is clearly devoted to boost the development of the deep Dogger aquifer to feed district heating network having an annual capacity of a minimum of 50 000 MWh thermal. The concept of establishing a semi-public company came from a study launched by the Caisse des Dépôts – CDC (the French public development bank which is also the biggest French social housing operator) to assess the market development perspectives of large scale thermal retrofitting investments through third part financing mechanisms. The action fits into the Territorial Climate & Energy Plan of Ile-de-France region.

The creation of such an operator is also expected to:

- Enhance coherence and ensure balancing between retrofitting and RE projects.
- Make a quantitative step in the roll-out of regional climate and energy policies, by overcoming some of the limits related to public subsidies (limited funds, windfall effects etc.).

Implementing structure and partners –governance

The Regional Council as main sponsor has been in charge of establishing the company in close collaboration with other public and private shareholders: local authorities, CDC, financial bank and insurance companies. A close dialogue has also developed with energy-related organisations.

Financing and Costs

The regional budget allocated to the design, and capitalisation of Energies POSIT'IF is 15 M Euros. The finance & governance scheme is under discussion. The goal is to reach self-sustainability.

Human resources devoted to the fund is of 2.5 full time employes (FTE) provided by environment departments of Regional Council and Caisse des Dépôts et de Consignations.

2.A.3.2. KYOTHERM business model: applications in France and in Germany

Since geothermal DH projects are so capital intensive, a lower cost of capital means directly a lower cost for each KWh produced. Reaching a lower cost of capital however requires a proper risk allocation and management and a long term perspective for investors. Third party 'infrastructure' financing specialized in geothermal energy and DH has two main benefits: it is an 'infrastructure'" asset class investment, and it is technically specialised in such type of asset so that it can properly manage the risks.

The 'infrastructure' asset class:

Third party infrastructure financing has emerged in the United States and Australia, to finance low risk assets like Highways, Bridges or other big civil works infrastructure. In such scheme, a low cost of capital is reached thanks to relatively low risk business models (passive infrastructure, tolling or utilisation fees revenues,etc.), a clear risk allocation with operating companies, and long term investors like pension funds or insurance companies, looking for returns on a long term basis (20/30 years) through stable cash flows[3]. The low risk profile enables banks to finance up to 80/90% of the project, while equity financing (10/20% of the project) is provided ultimately by pension funds or insurance companies. The weighted average cost of capital (bank loan + equity) can reach as low as 6-7 % IRR[4] per annum. Today all the major infrastructure projects in Europe or the United States are financed through this type of project financing. This type of financing is however unpractical for geothermal DH projects because of the significantly higher risks and the absence of technical and industrial expertise to properly structure and manage the risks.

The benefits of specialised investors with an 'infrastructure' business model:

Geothermal DH projects have a business model similar to traditional infrastructure assets: there is a significant upfront investment, but the operating costs are then low and the cash flows can be relatively stable and secure, if and only if the risk are correctly managed.

To take an example: Ferraris are powerful and have high performance, but they need to be properly steered, otherwise an accident can happen. The same applies to geothermal DH: they can bring a big deal of advantages to the community, but the worst is always possible.

The main benefits of specialised investors in geothermal energy infrastructure are:

- Contractual and technical expertise to structure and manage the specific risks of geothermal DH projects. It is useful to note that many bankruptcies related to geothermal DH projects of the 80's are related to surface issues instead of sub-surface issues, so the expertise in DH projects in general should not be underestimated: level and sustainability of heat demand, price formula, public concession management, etc. The specific risks of geothermal drilling and well operation are also important: permitting, geo-engineering, well maintenance and operation, etc.
- Financial and insurance expertise to structure and secure bank financing, for at least 60-70% of the total capital expenditure. France has a very good insurance system with SAF-Environment, that makes much easier for banks to take part in the financing of such projects, with a good leverage (debt / equity), relatively low interest rates and a long term debt maturity (> 15 years if possible).
- Socially Responsible Investing (SRI) in renewable and community projects means better financing conditions for the equity financing (20-30 % of the capital expenditure): longer payback time, lower cost of capital and acceptance of higher risks-return profiles.

Legal and financial scheme:

The legal and financial scheme is of major importance to structure and allocate the project risks. Such risk allocation depends on each project and should often be 'tailor-made' for each type of

[3] Pension funds or Insurance companies usually invest in long term government securities, but the yields have significantly decreased while the risks are higher.
[4] Internal Rate of Return : similar to a yearly return

project (public or private concession, existence of dedicated insurance policies for geothermal resource risks, innovative or already well known geothermal drilling, etc. However there are some similarities for each project that are presented below:

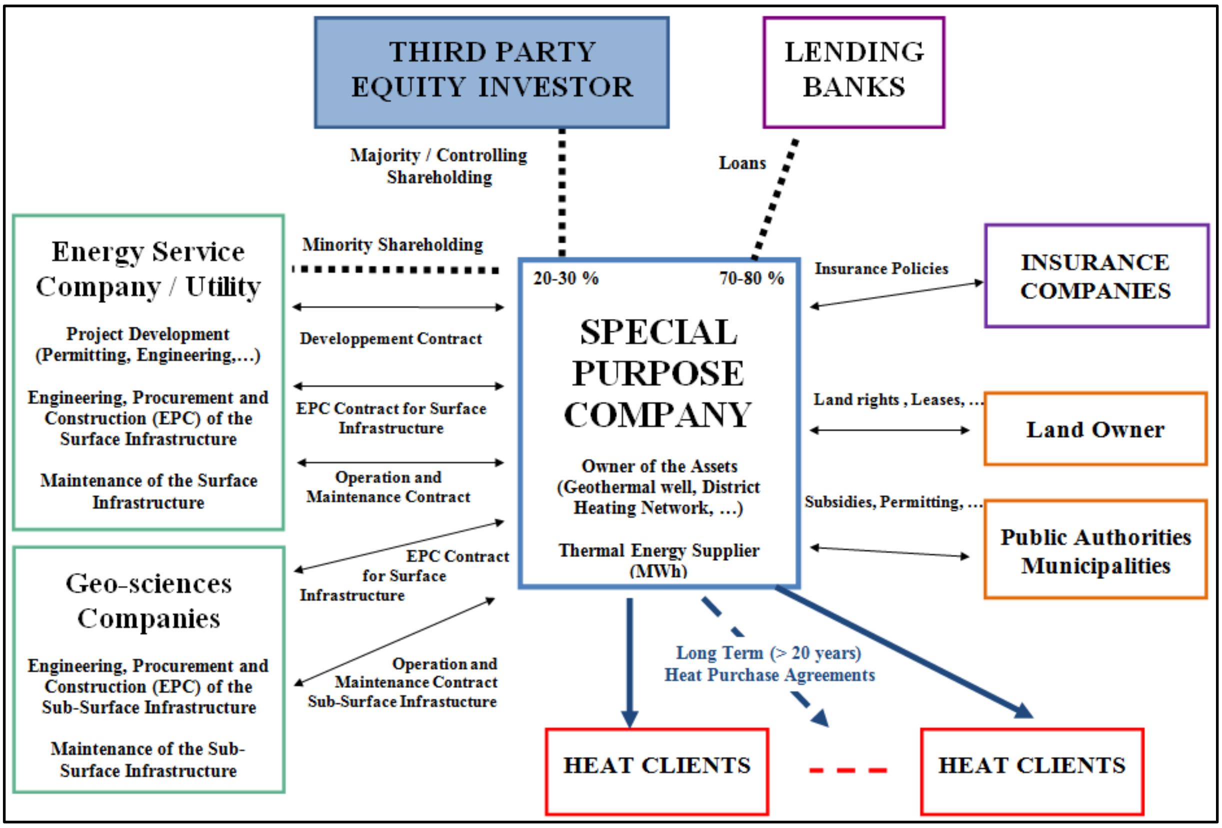


Figure 3: Legal and Financial framework example. (www.kyotherm.com/en/ (specialised investor in geothermal and DH projects))

This framework can work either in public or in private concessions.

A Special Purpose Company (SPC), financed by the third party equity investor (20-30% of total investment cost) and by bank loans (70-80 %), is created to centralise the assets, rights and operational contracts. This SPC signs long term (> 20 years) Heat Purchase Agreements with end users (Public Buildings, Housing Associations, etc.), with a fixed charge (‘capacity charge’) linked to kW of capacity subscribed, and a variable charge (“consumption charge”) proportional to KWh supplied. This SPC also signs ‘turn-key’ Engineering, Procurement and Construction (EPC) Contracts as well as Operating and Maintenance (O&M) Contracts for both the geothermal well (sub-surface) and the district heating network (surface infrastructure). Energy Service Companies / Utilities can sometimes have the role of Prime Contractor for both surface and sub-surface infrastructures, so Geo-Companies are subcontractors of the Energy Service Company / Utility and there are only one EPC and one O&M Contract with the Special Purpose Company. The SPC has insurance policies (civil liability, damage, geothermal resource risk if possible, etc.) with insurance companies. The SPC also secures land rights, permitting and subsidies with the Land owners and Public Authorities or Municipalities.

2.A.4. Germany

Germany is often cited as a good example in Europe, showing how much the financial supportive tools can contribute to the high growth rate of renewables in a country with moderate natural resources. The support system summarised here is based on Gassner (2010) and Imolauer et al (2010).

The Renewable Energy Heat Act:

The Renewable Energy Heat Act (EEWaermeG), which entered into force in 2009, is a first step towards utilising the potential offered by the use of renewable energy sources to heat buildings. It obliges building developers to source a minimum percentage of the energy requirement for heating and hot water from renewable energy sources. The minimum percentages for each type of energy are set down in law such that no particular technology is favoured. The minimum percentage can also be achieved by combining different types of energy. Particularly efficient thermal insulation can also be used as an alternative. The obligations of the EEWaermeG only apply for new buildings. However, the German federal states can also oblige the owners of existing buildings to use renewable energy sources. For example, a regulation in Baden-Wuerttemberg requires that at least 10% of the heat requirement must be supplied via renewable energy sources when the heating system in an existing building is replaced. It is too early to evaluate whether the EEWaermeG promotes leads primarily to the use of individual shallow systems, and to what extent it supports classic centrally sourced district heating networks that can be supplied with geothermal heat. In addition to EEG and EEWaermeG that intend to increase the utilisation of renewable energy sources without state subsidies, direct state support is also available in Germany. This provides state subsidies for the construction of geothermal heating stations, district-heating infrastructure and for shallow geothermal systems.

Market Incentive Programme (MAP)

As a recent addition, state support is now available to cover drilling and exploration risks. (See 1.3.) The measures are grouped in a so-called Market Incentive Programme (MAP) that consists of multiple modules tailored for each type of renewable energy and specific use aspects. It is established in Directives of the Federal Ministry for the Environment on the Promotion of Measures for the Utilisation of Renewable Energies in the Heat Market. These directives are adjusted on an annual basis.

The MAP contains three different modules for promoting deep geothermal energy.

- Pure geothermal heat generating systems are eligible for a repayment subsidy of up to € 2 million for construction and expansion, and up to € 2.5 million per borehole. Systems which also generate electricity, or which generate electricity only, are excluded because they are seen as sufficiently subsidised via the feed-in tariffs as laid out in the EEG. Thus the MAP incentives take the place of the EEG subsidies for pure geothermal heating stations.
- The drilling and exploration risks can be covered both for electricity generation systems and for pure thermal use. Deep boreholes with special technical drilling risks may be granted a repayment subsidy of 50% of the additional expenses above the planned figures, maximum euros 1.25 million. In order to cover the exploration risk, a new, separate credit programme has been on offer since February 2009. The operator receives a loan to finance up to 80% of the drilling costs. If previously defined yields are not reached, than he is released from repaying the loan the subsidy module was developed in cooperation of the German Federal Ministry for the Environment with the insurance industry. Guarantees for drilling and exploration risks are subject to strict application conditions and comprehensive audits of individual cases. Independent experts evaluate the exploration risk and the overall economic viability of the project is examined before granting the loan.

- A further subsidy module is the promotion of district heating infrastructure, which is supplied with heat from renewable energy sources. Subsidies of up to € 1.5 million can be awarded for infrastructures powered by geothermal energy. The funds are applied for via the respective principal bank and awarded by the state Reconstruction Loan Corporation (Kreditanstalt für Wiederaufbau, www.kfw.de). Eligible applicants include municipalities, legally dependent municipally-owned enterprises, special purpose associations, small and medium sized enterprises (SME), large enterprises in cases of special funding eligibility, as well as private individuals and private foundations that use the produced energy solely to meet their own needs. The financing share is up to 100% of the eligible net investment costs. The KfW can grant a maximum loan amount of usually EUR 10 million per project.

Bullet loan to support research projects:

In addition research is also supported in Germany: for demonstration projects in Heating & Electricity & Cogeneration, a demonstration programme has been set by the Federal Ministry of Environment (BMU). The programme provides bullet loan with interest subsidy (KfW) and in special cases investment subsidy. For the bullet loan with interest subsidies the amount of financial support can be up to 70% of the fundable costs without a limit. An investment subsidy for up to 30% of the fundable costs can be applied for in exceptional cases. National and international private companies, mainly public sector dominated companies, municipalities, municipality associations; owner operated municipal enterprises, administration unions and county administrations can apply.

2.A.5. France : the Renewable Heat Fund

2.A.5.1. The first step results : 2009 - 2013

District heating allows on the one hand an optimum valorisation of biomass, geothermal energy and also heat recovery, and on the other hand, local authorities to deal significantly with energy issues, from production to users. By 2020, the objective is to reach an average rate of 50% of renewable & waste heat.

The Fund, which is not restricted to geothermal can finance feasibility studies, thermal response test, shallow drilling, deep drilling, geo-physics, pumping, testing etc. The maximum percentage of eligible funding is 30% but, as shown in the table below, ADEME aid represents 18% in 2012 for deep aquifers

- 1,2 million euros for the 2009-2013 period -
- Projects using renewable heat in the collective housing, tertiary and industrials sectors.
- Objective: Economic competitiveness of installations using renewable heat
- Deep geothermal energy: installations with or without district heating

During the first phase of the Fund, 182 geothermal energy projects have been financed, representing more than 50 000 TOE/year of fossil energy saving. The table 2 below shows that the average support rate for 64 new geothermal plants was of nearly 19% and correspond to annual energy production of about 12 000 toe.

Type	Operation	Project investment	ADEME support	TOE / year	Cost €/TOE	ADEME support in €/toe during 20 years	ADEME Support rate
Deep aquifer	**3**	**37 546**	**6918**	**8 692**	**4 320**	**796**	**18%**
Shallow aquifer	**18**	**4864**	**1346**	**884**	**5 502**	**1522**	**28%**
BHS	**30**	**10 609**	**2403**	**506**	**20 979**	**4753**	**23%**
Waste and sea water	**13**	**24 269**	**3817**	**1909**	**12 712**	**1999**	**16%**
Total	**64**	**77 288**	**14 484**	**11 991**	**NA**	**NA**	**18,7%**

Table 1: **Heat fund results for the year 2012**

2.A.5.2. New rules established in 2013

After 3 years of application, the R.H.F. is considered as a good tool and should be extended until 2014. The new amounts allocated to the R.H.F. are not precisely known but in 2014 the budget is expected to be stable compared to 2013 at 220 million euros/year.

Nevertheless, the current allocated budget won't be sufficient to reach the 2020 objectives. French actors are expecting a progressive increase to 800 M€/year in 2020.

The graph below shows the relative part of geothermal energy in the French energy mix from 2006 to 2012 and the prognosis for 2020.

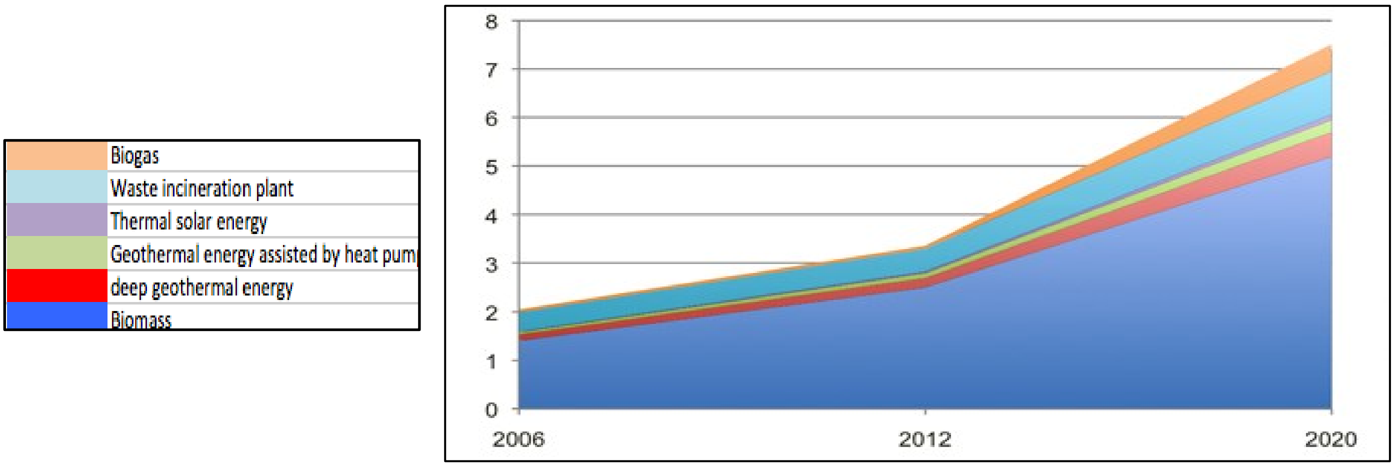


Figure 4 **MTOE/year of renewable and heat energy recovery**

Project eligibility:

The support allocated to district heating is an investment aid. It is dedicated to the "distribution" part of the network in addition to the support given to the renewable energy "production" part.

Renewal and repairs of the network are not eligible.

The utilisation of the Renewable Heat Funds aid for district heating is hampered by:

- The district heating has to be supplied by a minimum of 50% of renewable and waste heat.
- The extension energy needs have to be covered by minimum 50% of an additional production of renewable and waste heat.

Regarding the extension of district heating, that could be sometimes spread over time depending on the decisions of potential users; the project owner can choose whether he wants to benefit from Renewable heat fund aid or from the Certificates of energy savings. The same project cannot combine both schemes.

For extension/creation projects which are urgently needed but not forecast and not able to respect the 50% level of renewable and waste energy at the time the application is submitted for the first part of the work, the applicants will have to present the district heating development master plan by 2020.

This master plan will include:

- The client's engagement with associated delay. (< to 5 years)
- Investment of heating production to reach the minimum 50% rate of Renewable energy
- The planned timetable with the duration of the works.

If this engagement is not fulfilled, the financing convention stipulates a refund of the ADEME aid.

Conditions of eligibility for district heating:

Investigation fill would include documents and studies in particular the realisation of a "district heating blueprint" for extension projects. Three criteria are required to be fulfilled:

Technical criteria:

In the case of a district extension; minimal trenches length will be 200m and will contribute to a minimum valorisation of 25 toe/year of renewable energy (-> 290MWh/an).

Projects cumulating several extensions of less than 200m are not eligible.

To optimise district energy performance, a special consideration must be given to the temperature conditions in compliance with buildings to be heated, highest 'delta T°C flow-return' and lowest temperatures will have to be reached if connected to districts with, in particular, low energy buildings'.

Economic criteria:

Aid will create a positive impact for the end user: this impact will be subject to quantified commitments from the candidate and known by the local authority. The aim is that the local authority controls the economic advantage from subscriber to final user.

Regulatory criteria:

- Facilities must respect regulations in place, in particular norms: NFE 39 001 à 004 ; NFEN 13941 ; NFEN 253 ; NFEN 448, NFEN 488, NFEN 489 and Paper 78 (CCTG)
- Supported district heating will be energy efficient and will respect minimum performance criteria for heat production facility described in the European Commission Decision 2007/74/CE.
- Facility will be in compliance with urbanism documents.
- District heating will be equipped with an energy calculator for each delivery points as mentioned in the Grenelle 2 Law of 12/07/10.

Specific criteria

Case N°1: District extension already supplied by 50% of renewable and recovery energy.

In this case, operation will be in compliance with at minimum one of the following conditions:

- Existing renewable energy production system disposes of a capacity reserve enabling an additional production equivalent to minimum 50% of the planed extension uses.
- Existing renewable energy production system disposes of a capacity reserve enabling an additional production equivalent to minimum 25% of the forecast extension uses and global rate of renewable and recovery energies of the entire district heating should be, after extension, superior to 70%.

Case N°2: District extension supplied by less than 50% of renewable and recovery energy, in connection with a new investment of renewable & recovery energies production or of recovery heat valorisation:

In this case, the planed operation reaches a 50% minimum rate of renewable & recovery energies on the entire district, including extension.

<u>Case N°3: Creation of a new district heating (production and distribution)</u>

In that case, investment should lead to a minimum 50% renewable & recovery energies part in the production.

Calculation of the subsidy: (Annexe 2: Deep geothermal sector: instruction sheet)

<u>Aid for district heating</u>

Maximum aid rate for district heating (AR) = 55% of the district investment with an aid celling limited to an Euro per linear meter of trench value as described in the following table.

Type of district heating system	**Nominal diameter of DH pipes**	**Support in €/ml of trenches**	**Maximum support is 55%**
High pressure (Stream, over-heated water…)	All diameter	1800	990
Low pressure (hot water) Nominal diameter for pipes is (ND).	ND 300 and more	900	495
	ND 150 to ND 250	710	390
	ND 80 to ND 125	520	286
	ND 65 and less	450	248

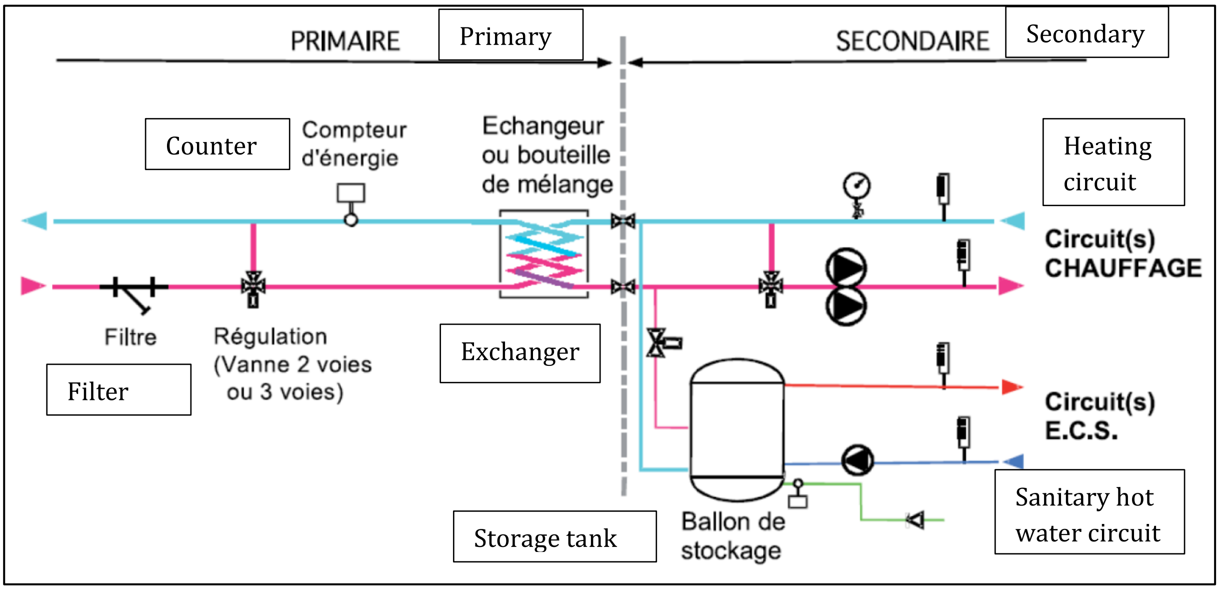
The maximum aid rate might be diminished regarding all the file elements and the way they define the technical, economic and environmental relevance of the district.

<u>Elements taken into account in the eligible expenditures:</u>

	Eligible	**Non eligible**
Production	-Pump that supplies the district heating and its connection -Regulation/electrical connection of the DH	Heat Pump, boilers, primary production units, Primary distribution, production in the technical unit
Road construction, Civil engineering/trench	- Penetration works at the exit of the boiler - trenches opening - valve chambers - civil works related to buried piping systems - repair works, road repairs	Main works in the heating production building or house
Hydraulic distribution	-Buried pipe linear meters -Auxiliary equipment	Piping system ahead of pumping distribution network

Under-stations	Civil work across buildings Primary district until exchanger - Accessories and regulations of DH for the primary side of the exchanger - Primary energy sources counter - Exchanger	-Secondary district heating downstream from the heat exchanger Secondary district modifications useful in the buildings - Ascension pipes
Supervision **Remote management**		-Computer stations, screens, -Licences, hardware, software, - Programming, remote view

Limit between primary (geothermal) and secondary circuit (treated tap water)



b) Operational aid

2.B.1. Certificates of energy savings

There is a scheme with tradable Energy Certificates and an obligation for energy suppliers to promote energy efficiency to their clients. Non-compliance leads to penalties.

This tool, established in 2006 is maturing, and has strong potential in 2015.The objective is for 660 000 GWh cumac from 2015 to 2017 (cumac which is the unit of measurement for Energy Savings Certificates, is accumulated and updated final energy in kWh over the life of the product). This represents an amount of energy that has been saved thanks to energy saving operations).

The main contributors to this scheme are the companies working in the transportation sector as can be seen in the following table. In 2014 the price of 1 MWh cumac was 4 €, consequently the 3 year plan will to put on the market more than 2,5 Billion euro available to support district heating schemes and geothermal wells, which are eligible.

For example, for a GeoDH project in Ile de France based on the Dogger reservoir and a network feeding about 6 - 7000 thousand dwellings, the amount of ESC which could be sold to finance the project is about 2,5 million euros which is comparable to the subsidies given by the Heat fund managed by the ADEME.

In the framework of the article 3 or the European Directive on energy efficiency, the ESC will normally contribute to 1/3 of the support to lower the final energy consumption from 150 million TOE to 131 in 2020.

Type of energy	***Percentage***	***GWh cumac***
Transport fuel	*45%*	*297 000*
Electricity	*27%*	*178 000*
Gas	*15%*	*99 000*
Heating oil	*11%*	*73.000*
District heating	*2%*	*13.000*

Table 2 Energy mix regarding the use of ESC during the 3rd Period (Source French Ministry of Environment and Energy - December 2013)

2.B.2. United Kingdom: the RHI **(Source: www.gov.uk/renewableheatincentive/)**

Overview

The Renewable Heat Incentive (RHI) helps businesses, the public sector and non-profit organisations meet the cost of installing renewable heat technologies. The types of heating covered by the scheme are:

- Biomass
- Heat pumps (ground source and water source)
- Geothermal
- Solar thermal collectors
- Biomethane and biogas

The RHI is compose of the sub-schemes: the non-domestic, launched first and described here, and the non-domestic, only launched in spring 2014..

Eligibility

To be eligible for the scheme:

- The equipment must be installed in England, Scotland or Wales on or after 15 July 2009
- The equipment installed must be new and of a certain size or 'capacity'
- The equipment and installer must have Microgeneration Certification Scheme (MCS) or equivalent certification The equipment must use liquid or steam to deliver the heat
- The equipment must be used to heat a space or water - or for carrying out a process where the heat is used within a building. The equipment can't be used to heat a single home (though a combination of homes sharing a heating installation might be eligible – e.g. a block of flats)

Public grants can't be used to buy or install the equipment. Projects which have received National Lottery funding are ineligible unless it was received between July 2009 and November 2011 and has been repaid.

Sources and technologies

- Solid biomass - including solid biomass contained in municipal solid waste

- Ground-source or water-source heat pumps

- Deep geothermal

- Solar thermal collectors

- Bio-methane injection and biogas combustion (except from landfill gas)

Extra rules

There are some extra rules for certain heating types; Ground- and water-source heat pumps must have a 'coefficient of performance' (COP) of at least 2.9

Available funding

Payments are spread over 20 years, every 3 months and are made per kilowatt hour (kWh). The payments depend on:

- The type of technology you install
- How much energy the installation can produce (its capacity)

- How much energy is used

3- Conclusions and recommendations

3.1. Risk insurance scheme: an absolute prerequisite

Securing peak production in a doublet system is key to the financing of a Geothermal District Heating project. The risk is very high for the first well, lower for the second, and is very low during the exploitation phase when a loop full test has been completed in between the production and injection well.

Two existing insurance schemes are the French, which has been in operation for 30 years, and the Dutch, which has been in operation for two years. They are quite similar, controlled by state bodies with no interference with the private market. The French system has facilitated the development of more than 60 projects in 30 years (an average 2 per year) and the Dutch more than 10 in 2 years. The German example, on the contrary, shows that even if the scheme is establish is promoted by the state via KfW (see annex 3), the presence of the private sector which was contracted to manage the scheme and provide the insurance, has proved unsuccessful.

The recommendation is to follow a mutually beneficial system without ambition to make profit with a strong involvement of the state. One key obstacle to this kind of insurance is the assets required at the beginning; around 50-100m Euro are required at EU level, enough to fund 20 deep wells. Such a fund should be comparable to the EGRIF suggested in the GEOELEC report.

3.2. Dedicated financing facilities: investment and operational aids

If the geological risk is covered, many different systems could be used to finance the project. Firstly, the use of Energy Saving Certificates which are based on fossil fuel taxations in order to subsidise the development of both energy savings and renewable projects is proposed.

The second more attractive option is to give to GeoDH projects soft loans which can upgrade strongly the business plan of a normal project. Generally, decreasing the interest rate by 1% reduces the payback period by two years. The advantage of this instrument is that it could be installed at regional level, country level, or a European level through an adapted banking scheme.

3.3. Relevant support schemes

Looking at the (sometimes successful) support schemes that have so far been put in place, it seems that they are all too complicated to support the development of geothermal district heating widely. For GeoDH using mainly hot water at a temperature that could be valorised by simple heat exchange (more than 50°C), the solution appears simpler because these projects, implying drilling at a minimum of 1000m[5] and requiring some million euros of investments, can be treated individually.

The simpler the rules of a scheme the more efficient, and easier to manage and control it will be. Consequently a fixed amount of eurocents per KWh produced per year appears as the best approach to be promoted in the EU. Finally, an additional subsidy per kilometre of district heating to be constructed could be also useful when there is no distribution system in place.

[5] This is valid for the whole EU but for some limited areas with geological anomalies like in Tuscany, Italy.

Annexes:

Annex 1 : Analysis of economic factors and price construction of geothermal energy for heat generation

1) Economic factors determining investment

Six main factors have been listed in the GEOFAR project: the projected revenue flows, the cost of investment, the discount rate, the growth prospects rate, the volatility rate, and the subsidy or premium to ensure immediate investment.

The appropriate values for each one of those variables has to be evaluated in order to establish a baseline projection of the investment path.

- **Projected revenues flows**

Heat-generating geothermal plants have a record of reliable continuous operation. Therefore, variation in revenues derives, mainly, from variation in output price. In electricity generation the price could be very flexible, in heat generation where gas is the main competitor the fixed price is moving slowly.

- **The cost of investment**

This variable is determined by engineering studies. In terms of economics, it is important to recognise that the total cost for a geothermal project is disbursed in three distinct stages. These are: the initial exploratory studies and feasibility studies of a diagnostic nature. The cost is of about 0.1 - 0.5 million Euros. If they are successful, the project proceeds to the first well drilling, costing between 4 and 8 million Euros. If this stage is successful, the project proceeds to the building stage costing between 4 and 8 million Euros depending of the site location and depth of the geothermal reservoir.

It is clear that the most critical stage is the drilling stage. It requires a large investment with a possible partial or total failure. Moreover, the risk is of a technical nature. There is no way this risk can be mitigated by the ordinary financial tools available to a project operator. The only way to know the cost of the drilling stage is to do the drilling.

The problem is known in the extractive industries and their experience shows that high-risk venture capital investors cannot provide significant financing. The most productive approach is to pool the risk by building big companies that own many projects and can compensate for the failure of some projects with resources drawn from other projects that are successful.

- **The discount rate**

The rate shows the preference of an investor (including public entities in their capacity as investors) for very important and very controversial figure in any discussion, theoretical or practical, of investment.

One approach is to set it exogenously to reflect the preferences of the investor for present over future enjoyment. Another approach suggests setting it following the signals of the financial markets. In the last two to three years the turmoil in the financial markets has shown serious weaknesses in this approach. However, one must accept that over the long-term, such as the one considered for investments examined in this report, financial markets will operate and provide credible signals. Then the discount rate will be determined by taking the risk-free rate of interest and adding a risk net premium.

Capital Assets Pricing Model suggests that well-diversified investors need only earn a rate of return that reflects the risk that they cannot reduce by spreading their investments over many projects in different sectors of the economy. Thus, they are supposed to cover their macroeconomic risk, the risk they can do nothing about. The rate of return on investments in energy is weakly correlated, if at all, with the market rate of return. Thus, in times of normally functioning capital markets, one should expect to find investors in energy projects that would be willing to earn a rate of return close to the risk-free rate of interest. If one is willing to assume complete futures markets in energy for long periods (over 10 years), then the discount rate should be set at the risk-free rate of interest. Most analysts would think this is unrealistic. Still energy is actively traded in financial markets, so this argument gives an indication as to the value of the discount rate.

With financial markets not functioning, the correlation of returns in all classes of assets is nearly perfect. In that case, the discount rate must be set at a rate equal to the market rate of return. This rate is hardly constant. The researchers' findings of historical rates as high as 8% (real) cannot be used in this instance, since it has been calculated mostly from data obtained in periods of normal operation of financial markets. So, on this argument, too, one must end up with a discount rate close to the risk-free rate.

The graph in the following figure 1 shows the spot risk-free rate for public-sector entities borrowing in euro. The data are nominal, but the prospective inflation as measured and perceived by the financial markets does not seem to be significant. Thus, the real risk-free rate of return cannot show a significantly different picture.

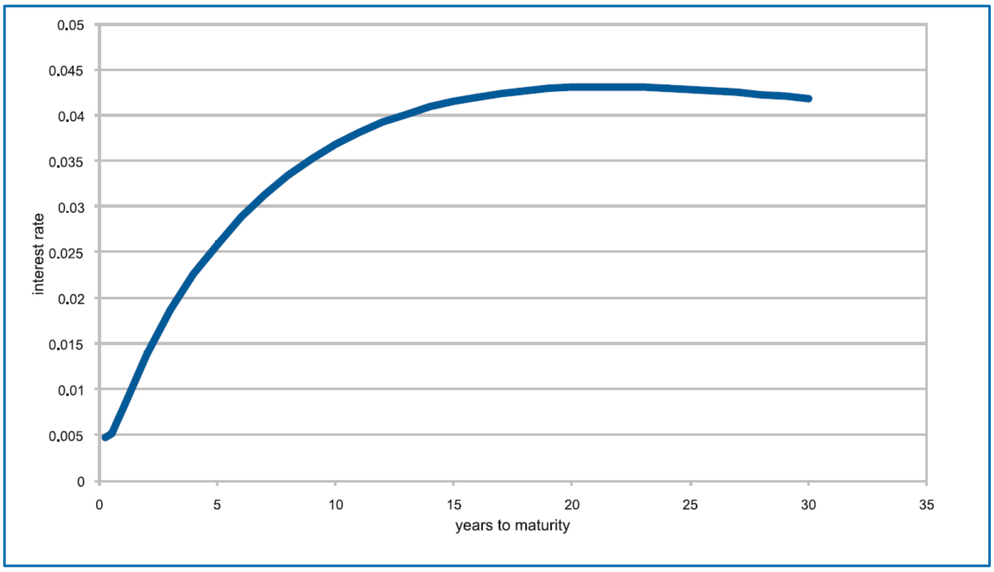


Figure 5: **Euro yield curve (2009 European Central Bank)**

On the basis of the data and the discussion above, the preferred value for the discount rate that this analysis proposes is 5%. It will be shown later on in this section of the report that the choice of this value is critical and if, in reality, the true value turns out significantly different, the findings can be very severely weakened.

To illustrate, we consider the example taken in GEOFAR project with 30 million € geothermal plant. All other variables being equal (growth prospects 2%, volatility 6%), passing from a discount rate of 5% to 4% raises the subsidy warranted for immediate investment from 24 million Euros to 35 million Euros.

- **The growth prospects rate**

As the analysis so far has shown, this is a very significant variable and one rarely taken into account. Its measured average value of real growth of around 2% over the last 35 years cannot be a basis for a safe prediction over the next 15 or 20 years.

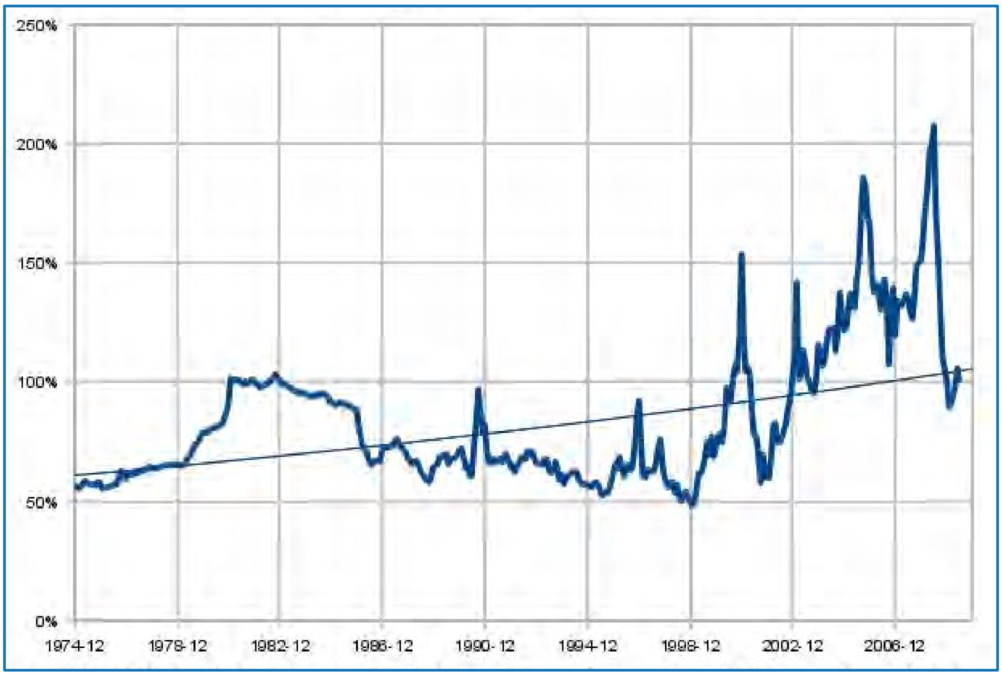


Figure 6: **Relative price of primary energy**

One should rather base a prediction on the assumption that public policies to restrain emissions from the burning of fossil fuels will drive the cost of generating energy from those sources higher and higher over the years. In the absence of a major technological breakthrough, one should be confident that such a scenario is indeed the most likely outcome. As in the case of the discount rate, an illustration of the effect of the choice of the particular value for this variable shows that passing from a growth prospects rate of 2% to a rate of 2.5% raises the subsidy warranted for immediate investment from 24 million Euros to 34 million Euros.

- **The volatility rate**

Volatility is an important variable for the short term. High output prices lead to spurts of immediate investment in the expectation that high prices will persist, as indeed they often (but not always) do for certain periods. In the longer term, high volatility means that extreme price movements in one direction at a certain point are likely to be cancelled out by strong price changes in the other direction at a later point. Thus, annual volatility of 26% per year, as observed in the price of primary energy in the last 36 years, is transformed to a total volatility of around 3% for a project that will run for 15-20 years.

However, an arithmetically correct value of 3% appears too rosy in view of the fairly strong turbulence observed in the real, as well as in the financial, markets. This study will propose a value of 6%.

Passing from a volatility rate of 3% to 6% raises the subsidy warranted for immediate investment in our former example from 21 million Euros to 24 million Euros.

- **The subsidy or premium to ensure immediate investment**

This review of the market variables that determine investment in geothermal energy show that immediate investment in geothermal energy requires support at a level significantly beyond the one that is presently available through feed-in tariffs for electricity generation.

It is for the public authorities to judge whether the environmental and other benefits of geothermal energy warrant increasing the feed-in tariff for this type of project by the equivalent of about 80% (discount rate 5%, growth prospects rate 2% and volatility rate 6%) over its present level.

This is a fairly high level of support. It is high in absolute terms and in terms of the support provided for most (though not all) alternative forms of renewable energy.

We start by observing that the risk-return characteristics of the project are quite different for the three stages of our example. Once the exploratory and drilling stages are completed, the building stage is much less risky. In fact, a private investor who would be given the opportunity to invest 20 million Euros in the building, and receives a feed-in tariff of 90-96 Euros/ MWh would earn around 9-10% per annum on the 20 million € invested. If that investor financed two-thirds of this investment with debt, as it is common practice for such investments, the return on equity can rise to 20%. This observation leads us to the conclusion that a feed-in tariff, such as is already available in the wealthier Member States of the European Union, is sufficient to attract investment for the building and operation stage of a geothermal electricity-generating plant, if only the exploratory and drilling stages are completed.

It also follows from the observation above that the cost of supporting our example geothermal plant need not be as high as we had calculated previously. Even if the public authorities chose to provide a 100% subsidy to the exploratory and the drilling stage, the cost would be 11 million Euros, although a 100% subsidy is generally considered to be inappropriate and incompatible with EU state aid rules. In practice, a ceiling of 75-80 % has been found to work much better. So the maximum subsidy that the public authorities should consider for the exploratory and drilling stages for our example geothermal project is 9 million Euros.

2) Extension to the heat-generation option

The analysis so far has been illustrated by means of a geothermal plant producing electricity only. What about the case where that plant would only produce heat or produce jointly electricity and heat (CHP project)?

The option to produce heat does not change the basic arguments calling for substantial support from public financing sources to speed up investment in geothermal energy.

Heat generated by geothermal plants can be fed into local district-heating networks or into industrial processes that require low/medium temperature heat. Energy in the form of heat cannot be transferred over long-distances, so the price cannot be very high. Besides, domestic heat is not needed in constant amounts throughout the year, so investments in it take longer to pay back. The capital costs and the environmental benefits from generating heat from geothermal energy are about one fourth of the corresponding costs and environmental benefits from generating electricity from geothermal energy. The benefits are greater when high temperature resources is used for both heat and power than when it is used for heat alone. A programme of geothermal development, committing a fixed amount of funds with risk-tolerance, may discover any proportion of electricity-capable geothermal resources. The higher the proportion, the higher the financial and environmental returns of the programme will be.

Of course, this extra growth comes at a price. Electricity-generating geothermal plants are significantly larger and more expensive, on average, than heat-generating geothermal plants. Even more importantly, the risks in building and operating them over a number of business cycles are correspondingly larger.

So, investments in heat generation alone cannot deliver a strong growth thrust to the geothermal energy sector. Even so, they have several advantages, such as:

- Local payback in exchange for local support for deep drilling,
- They complement existing district-heating networks offering an alternative to other fuels
- They can be combined with smaller binary cycle (if economics allow) electricity-generating plants to bring up the utilisation of the reservoir to the maximum
- Partial recovery of costs for failed drilling for a geothermal power project
- May be a useful complement to regional and local economic development programmes with positive effect on employment and the viability of public infrastructure.
- They raise public awareness to the benefits of geothermal energy to a broader section of the public

In the future, heat may account for 25-30% of new geothermal investments. The consensus of expert opinion indicates that the investment in heat need not be granted extra support, but should not be excluded from public geothermal energy support programmes. Focusing exclusively on large-scale efficient projects has proven to be a risky strategy. Developing more numerous, if less efficient, plants is often more expedient and can even be economically efficient, if the current economic climate of high public debt and low economic growth persists in the medium term.

Of course, disbursing that much money over so many projects, whether for electricity generation or heat generation, will require a proper administrative and control mechanism. Such a mechanism is presented in the sequel of the present document. To complete this analysis, one must consider two further classes of barriers to the development of geothermal energy.

3) Generation costs of heat using geothermal energy

This section deals with the structure of heat generation costs when using geothermal energy. Due to the immense variation of conditions for each geothermal energy project it is impossible to have a basic calculation for all geothermal energy projects generating heat. Nevertheless, the following pages shall demonstrate how the costs of such a project could be calculated and which parameters are the most important for the realisation of such a project. This will be done by firstly defining the basic conditions affecting the heat generation costs and secondly by developing theoretical projects in order to show economic viability.

- **Factors determining heat generation costs**

The main parameters for each geothermal energy project are the following: Geological framework, Economic conditions, and demand.

Although at first glance there are only a few parameters determining the heat generation costs it is still difficult to assess the profitability of a geothermal energy project in a general way as for each project the demand structure, the geological structure, the costs of capital and the existing geological data differ.

Nevertheless, the structure of heat generation costs will be calculated by integrating basic assumptions and setting standard parameters for a standard project. Figure 7 shows the factors determining costs for the generation of heat in a geothermal energy project.

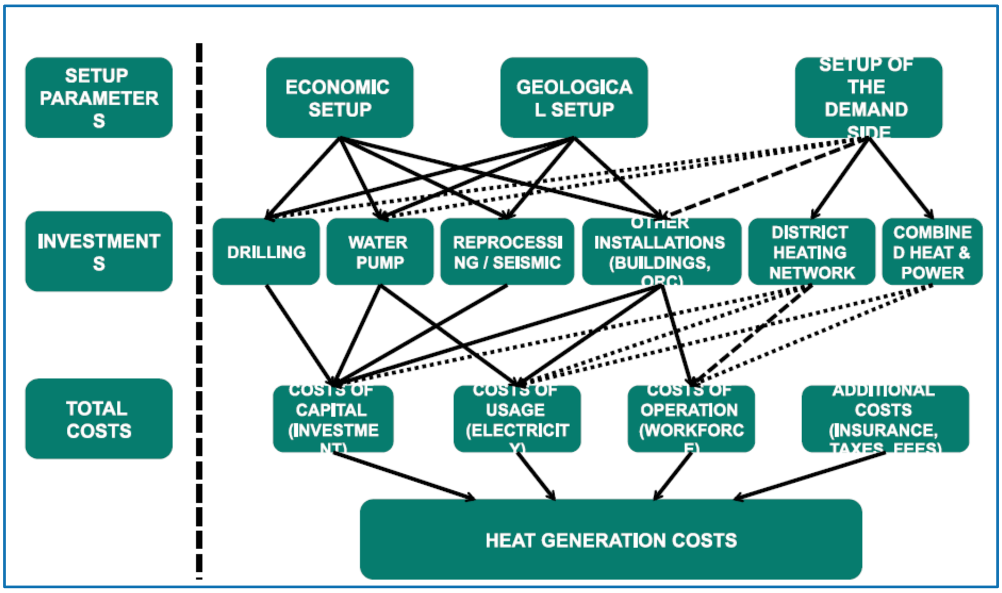


Figure 7 **Factor determining heat generation costs**

The figure above shows that the setup of the demand side plays a very important role in determining the investments such as the drilling of boreholes, the size of the water pump, installation of buildings, the installation of a district heating network and the installation of a power plant's components such as the ORC or a turbine. The divisor for any heat generation costs calculation depends critically on the 'useable' heat of the geothermal energy resource.

As every location has different conditions concerning its demand side which has to be examined in a pre-feasibility study, it is not possible to consider these factors in a basic heat generation cost calculation. Thus, it will be assumed that all the heat and power generated will be delivered to the customers.

Moreover, many costs are equal to those of a conventional heat generation installation. Therefore, the costs for a district heating network and special installations will not be included in the calculation. In addition, having in mind that every country uses individual laws, the additional costs for taxes and fees will also be excluded. Thus, the calculation will take into consideration the following costs: Costs of capital (investments for drilling, water pump, substation), costs of depreciation (can also be considered as costs of capital), costs of operation (electricity needed for pumping and ancillary equipment), and costs for maintenance.

In addition to these costs, if a geothermal plant is not connected to broader heat or electricity of other energy networks, a gas-fired or coal-fired power plant has to be connected to the geothermal plant in order to be able to cope with peak loads. The costs for this power plant are not included in the calculation as it has to be built both in the case of a geothermal plant and in the case of a gas-fired thermal power station.

For the calculation the following assumptions were made: assuming that the geothermal energy provides the base load energy for district heating, all of the generated heat will be delivered to the district heating network and therefore the total hours of the plant will be 8.000 (hours/year)

No revenues will be calculated as the focus is only on the heat generation costs. The period under consideration is 30 years of operation; the loan will be repaid within 30 years. The depreciation time of the drilling is 50 years, the depreciation time of the substation is 30 years, and the depreciation time of the pump is 3 years. The interest rate will be 7.5%.

Three basic sample projects were calculated and analysed. The installed capacities of the projects are: 10, 15 and 20 MWth, figure 8 shows the heat generation costs of each project. The figure illustrates that these generation costs are stable for the next 30 years. Moreover, the generation costs decrease over time- a trend that is the exact opposite in the forecasted prices for fossil fuels. This is because of the lower costs for the loan which fall over time.

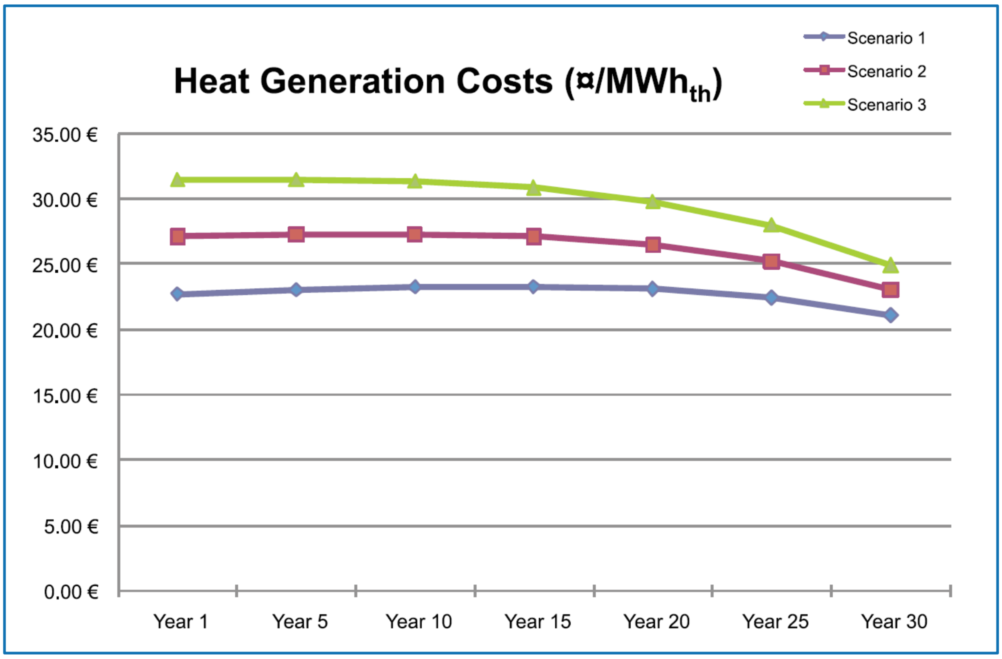


Figure 8: Heat generation cost of the 3 different plants

These already low costs are further reduced in net terms because they also generate revenues from the issuing of CO2 emissions certificates. Due to the assumption of generating and delivering 8.000 hours of heat per year the heat generation costs are lower than in other cases.

The higher costs of scenarios 2 and 3 derive from the high depreciation costs due to the higher drilling costs as the investment sum for the drilling of boreholes. Larger scale plants can afford to drill somewhat deeper, although generally drilling costs increase exponentially with depth.

Figure 9 illustrates the shares of each cost pool (interest, depreciation, maintenance and operation). One can observe that the costs for interest are very high and make up to 35% of the whole heat generation costs. Notably the largest project, which has the highest interest costs, shows the highest share of borrowing costs. At the same time, the biggest project has the smallest share of operating and maintenance costs. These facts point out the possible cost reductions due to economies of scale of geothermal projects. (Economies of scope in the form of co-generated electricity are also possible in large-scale heat generating plants, although they are not being taken into account in the present calculation). Therefore, reducing the financing costs of geothermal energy projects is the main variable to control so as to reduce heat generation costs.

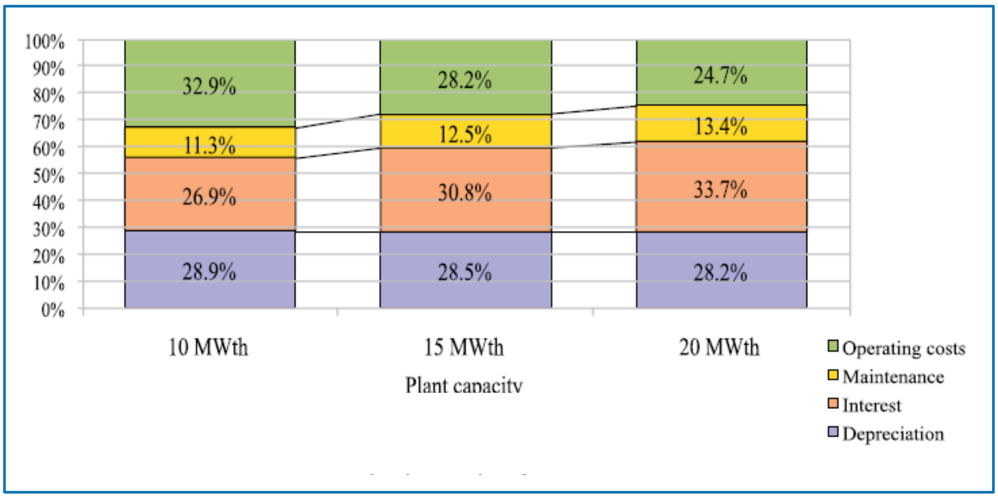


Figure 9: **Ventilation of heat generation costs per plant capacity**

Looking at the allocation of heat generation costs of a 10 MWth geothermal power plant, the biggest share of the heat generation costs derive from the operating costs for the electricity to feed the water pump. The costs for the interest of the loan and for depreciation also play a major role in the cost setup of this scenario. When looking at scenario 2 a slightly more equal distribution of the costs for electricity (operating), for depreciation and interest can be observed. In this scenario the interest costs account for the highest share, due to the large capital investment expenditure and to the debt required to finance it. Nearly one third of the total heat generation costs for a geothermal energy project of 20 MWth derive from interest charges.

In contrast to heat generation by fossil fuels, the highest proportion of geothermal heat energy costs is made up the by the costs of financing such a project. In order to examine the leverage effect of the financing conditions of heat generation costs, a sensitivity analysis on interest rates will be conducted by looking at scenario 2. The interest rates for the loans used in the analysis are: 5%, 7, 5% and 10%. The figure 6 shows the sensitivity of the sample project with capacity of 15 MWth and illustrates the heavy influence of financing costs on the viability of a geothermal energy project.

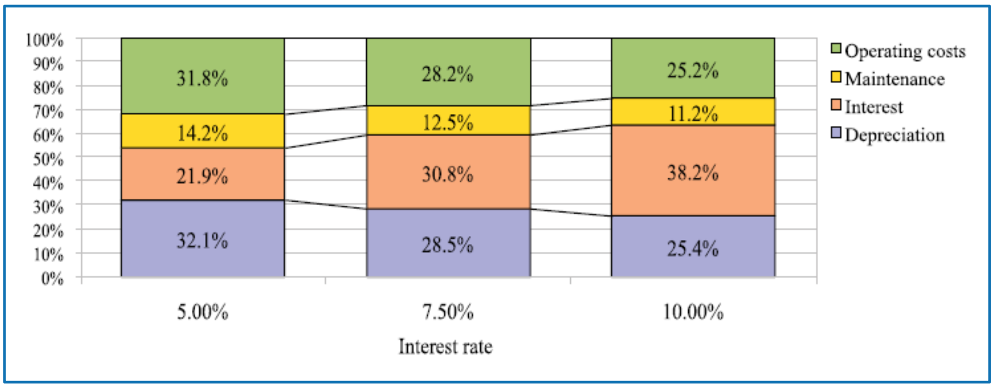


Figure 10 **Structure of heat generation costs and sensitivity to interest rate**

It also suggests that for those projects one of the major problems is the lack of financial support by financing banks as the banks will charge higher interest rates due to the high risks in the early stages of geothermal energy projects. As soon as interest rates reach a certain level, it is no longer profitable to carry out a project. In some cases, a project developer will even not be able to find any financing banks and thus the project will not be carried out. The difference in the heat generation costs between the calculations at an interest rate of 5% to one with 10% can be as high as 30%.

This results in the need of financial support from public sources for geothermal energy projects in the early project phases due to the high risk effect.

4) Comparison of the heat generation costs/prices[6] of geothermal/fossil fuels

Deriving an average cost of generating heat from fossil fuels in Europe is not easy, because of the high proportion of the operating costs, which account for approximately 60% of the total costs. The prices for fossil fuels are very different from country to country and are very volatile. For example, in Italy, the prices of light fuels are 120% higher than those in Luxembourg, due to high taxes for light fuels in Italy. In the case of gas prices, the gap between the highest priced country, Denmark, and the country with the lowest prices, Romania, is about 215%.Due to the high differences in the costs for fossil fuels in each EU country a comparison of the heat generation costs is nearly impossible. Nevertheless, the Fraunhofer Institute for Environmental, Safety and Energy Technology carried out a study for Germany comparing the heat generation costs between fossil fuels and geothermal heat plants delivering heat to district heating networks. In that study, the correlation of heat generation costs with the increase in prices of fossil fuels is monitored and compared to that of geothermal energy. Operating costs for both geothermal and fossil-fuel heat generating plants ultimately depend on the price of primary energy, but the primary energy of geothermal plants is not entirely dependent on fossil fuels.

[6] For the purpose of this section, the term price" includes levies and taxes, including varying CO2 price.

Thus, in the case of ever-increasing fossil fuel prices, fossil fuel plants will see their operating costs rising much more rapidly than the costs of geothermal plants.

The figure 11 illustrates the results of the study and it clearly highlights the advantages of geothermal energy when assuming an increase in prices for fossil fuels compared to the fuel prices in 2006.

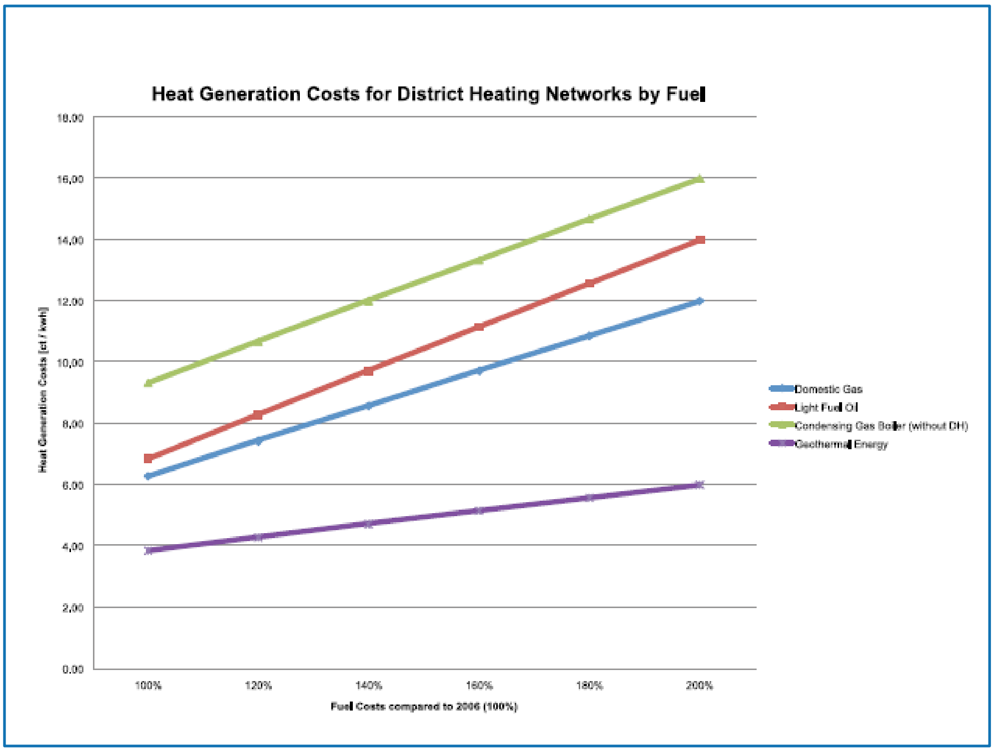


Figure 11 Comparison of geothermal heat generation costs/prices with oil and gas

The heat generation costs of geothermal energy are low in absolute terms due to the assumption of a high rate of utilisation of geothermal energy, up to 8,760 hours per year. This cost advantage in absolute terms is not based solely on the technical suitability of geothermal energy, but also on its economic characteristics, that is on its low variable costs and its high fixed costs. The cost advantage in absolute terms is additional to the relative cost advantage of geothermal power, in case primary energy prices rise rapidly.

Annex 2: Deep geothermal sector: instruction sheet

Project context

General characteristics presentation:

- Presentation of the project leader and the main actors (surface and underground engineering companies, drilling companies, others stakeholders etc.),
- Project description (location, new or existing installation, number of buildings and/or housings concerned by the project, corresponding surface, types of use),
- Respect of conditions of eligibility,
- Energetic studies realised (Pre-feasibility study, underground studies, preliminary design, final design),
- Provisional schedule of the works

Useful thermal requirements

- List of buildings with useful heating & domestic hot water requirements, before and after energy saving scheme (if buildings already exist)

Buildings	Buildings surfaces (m2)	Domestic hot water quantity (m3/an)	Useful thermal requirements (MWh/an)	Energy saving scheme	New useful thermal requirements (MWh/an)

For existing building(s): copy of invoices linked to energy consumption of the previous year.

Definition of the geothermal solution characteristics

Technical characteristics	Global power of the installation (kW)	
	Geothermal power plant (kW)	
	If creation of a district heating, length of the district in meter 2	
	If extension of a district heating, length of the district in meter 2	
	Production at the outlet of the geothermal power plant (MWh/an)	
	If implementation of heat pump(s), thermal power of the HP (kW)	
	Useful production at the outlet of the HP(s) (MWh/an)	
	Coverage rate of the thermal requirements provided by geothermal energy (in %)	
Additional energy	Sort of fuel (for example: gas, fuel etc.)	
	Annual consumption in energy at the boiler inlet (MWh PCI)	
	Efficiency of the backup boiler (%)	
	Price of the MWh PCI (pre-tax price) (boiler inlet)	
Operational charges	P1 HTVA	
	P’1 HTVA	
	P2 (staffing costs included) HTVA	

	P3 HTVA	
Investments	Civil engineering (pre-tax price)	
	Surface geothermal facility and accessories (pre-tax price)	
	Underground geothermal facility (drilling, pumps etc.) and accessories (pre-tax price)	
	District heating (trenches and sub-stations) (pre-tax price)	
	Heat Pump, when appropriate	
	Engineering (pre-tax price)	
	Others (to be specified)	

(1) P1: cost of furniture of fuel(s)
P'1: cost of electricity used mechanically to ensure the functioning
P2: cost of services, follow up of the installation, maintenance and others costs
P3: cost of facilities and heavy equipment renewal

Definition of the reference solution characteristics

Reference solution: classical solution that would have been set up or maintained to provide the same thermal uses if the foreseen project has not been selected.

District heating	If district heating exists, length in meters (A+R)/2	
Energy 1	Sort of fuel (for example: gas, fuel etc.)	
	Annual consumption in energy at the boiler inlet (MWh PCI)	
	Price of the MWh PCI (pre-tax price) (boiler inlet)	
Energy 2	Sort of fuel (for example: gas, fuel etc.)	
	Annual consumption in energy at the boiler inlet (MWh PCI)	
	Price of the MWh PCI (pre-tax price) (boiler inlet)	
Operational charges	P1 HTVA	
	P'1 HTVA	
	P2 (staffing costs included) HTVA	
	P3 HTVA	
	Civil engineering (pre-tax price)	
	Boiler and accessories (pre-tax price)	
	District heating (pre-tax price)	
	Engineering (pre-tax price)	
	Others (to be specified)	

(1) P1: cost of furniture of fuel(s)
P'1: cost of electricity used mechanically to ensure the functioning
P2: cost of services of carrying, of maintenance, taxes, and others costs
P3: cost of facilities renewal

Technical description of the installation

The project leader will present a synthesis of all the components of the facility justified by the results of the thermal uses study.

Description of the counting installation and of the renewable production readout

The project leader will precise the thermal production counting method based on the deep geothermal operation in accordance with ADEME technical specifications.

Financing plan

Candidate will detail which type of financing package has been foreseen for the project (Own funds, loans, leasing, third financing body etc.) and the organisation of the actors on legal and financial levels.

Origin	Amount (pre-tax price)
Own funds	
Subsidiaries: Renewable Heat Fund Region FEDER Other (to be précised)	
Loan	
TOTAL investment	
Loan rate	
Loan duration	
Loan annuity	

Annex 3: The German Federal Ministry for Environment, the KfW Bankengruppe and Munich Re promote deep geothermal drilling in Germany (February 25, 2009).

The German Federal Ministry for the Environment, the KfW Bankengruppe, and Munich Re are launching with immediate effect a new credit programme for the expansion of geothermal power in Germany. Together, they are making available a sum of €60m for the financing of deep geothermal wells. The programme is designed in particular to minimise the productivity risk of the projects.

The high drilling costs are the main deterrent to potential investors in deep geothermal projects due to the risk of not making a find in the depths of the earth. The commercial use of deep geothermal heat for the generation of heat and/or electricity depends to a decisive extent on the availability of sufficient volumes of water at sufficient temperatures. Investments often exceeding €10m for each project are at risk. The support scheme launched by the Federal Ministry for the Environment, the KfW Bankengruppe, and Munich Re is intended to distinctly reduce the productivity risk for investors.

The plan specifically involves KfW loans for deep geothermal wells being granted by way of commercial banks. Up to a maximum of 80% of the costs that qualify for a subsidy will be financed in this way. If no find is made, the investor will be released from having to repay the remaining loan amounts as soon as the project is declared a failure. The productivity risk of each deep geothermal project and hence the question whether it qualifies for support will be examined prior to the loan being granted.

Besides the usual loan interest, the subsidised loans also contain a “risk loading” for the productivity risk. In addition, one-off fees must be paid when the loan is applied for and when the loan contract is signed. In return, the investor receives an expert assessment of the deep geothermal project and technical support before and during the drilling phase.

“Deep geothermal energy offers great opportunities for a climate-friendly and cost-effective supply of electricity.

With more financial support being provided for geothermal plants in the market stimulation programme and the amendment to the Renewable Energy Sources Act that has been in force since 1 January, we have again improved the general conditions for this technology. The new credit scheme will ensure a further reduction in the risks encountered by operating companies. Incidentally, this cooperation is a good example of how, even in times of financial crisis, politicians and private companies can pull together on climate protection in view of the great economic opportunities it presents,” said Sigmar Gabriel, Federal Minister for the Environment.

“The KfW Bankengruppe is committed to the principle of sustainability. The exploitation of domestic renewable energy sources in the form of deep geothermal energy is important with a view to climate protection and sustainable energy supplies.