Geothermal ERA-NET

Financial Instruments and Funding of RD&D

and

Geothermal Projects Barriers and Opportunities

December, 2016

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Table of Contents

1. Foreword

The overall objective of this activity is to improve the synergies between different players in the field of geothermal utilisation and improved funding in R&D and project financing, to strengthen European geothermal development for economic opportunities, energy security and mitigate climate change.

A better understanding of the financial landscape is beneficial to all stakeholders in defining the barriers and recommend practical solutions, e.g. to prioritise in future joint calls, increase investments and growth of geothermal projects in Europe.

A regular RDD&I knowledge exchange between all geothermal stakeholders will enhance cooperation and lower non-technical barriers for joint projects and ultimately yield subsequent joint programming and ERANET-style funding instruments.

The Joint Activity "New Ways of Working" goals is to improve in the working practice of national funding institutions and the collaboration with their European counterparts.

The main process focus of this activity is to
- Analyse the financial instruments that are available and how they operate – and map the operational structure of the different national funding bodies, including policy and funding rules in R&D and industrial projects.
- Highlight the main barriers and opportunities, and how these instruments can more easily work together.

The focus of the work was to achieve knowledge regarding the various national research policies related to geothermal energy in European countries.
- Present and discuss the handling of national research funding workflows starting at funding opportunity announcements, grant applications, evaluation processes, and award processes.
- Share experiences on strengths, weaknesses, opportunities and threats of national funding programs vis-à-vis the national need – with recommend policy option.

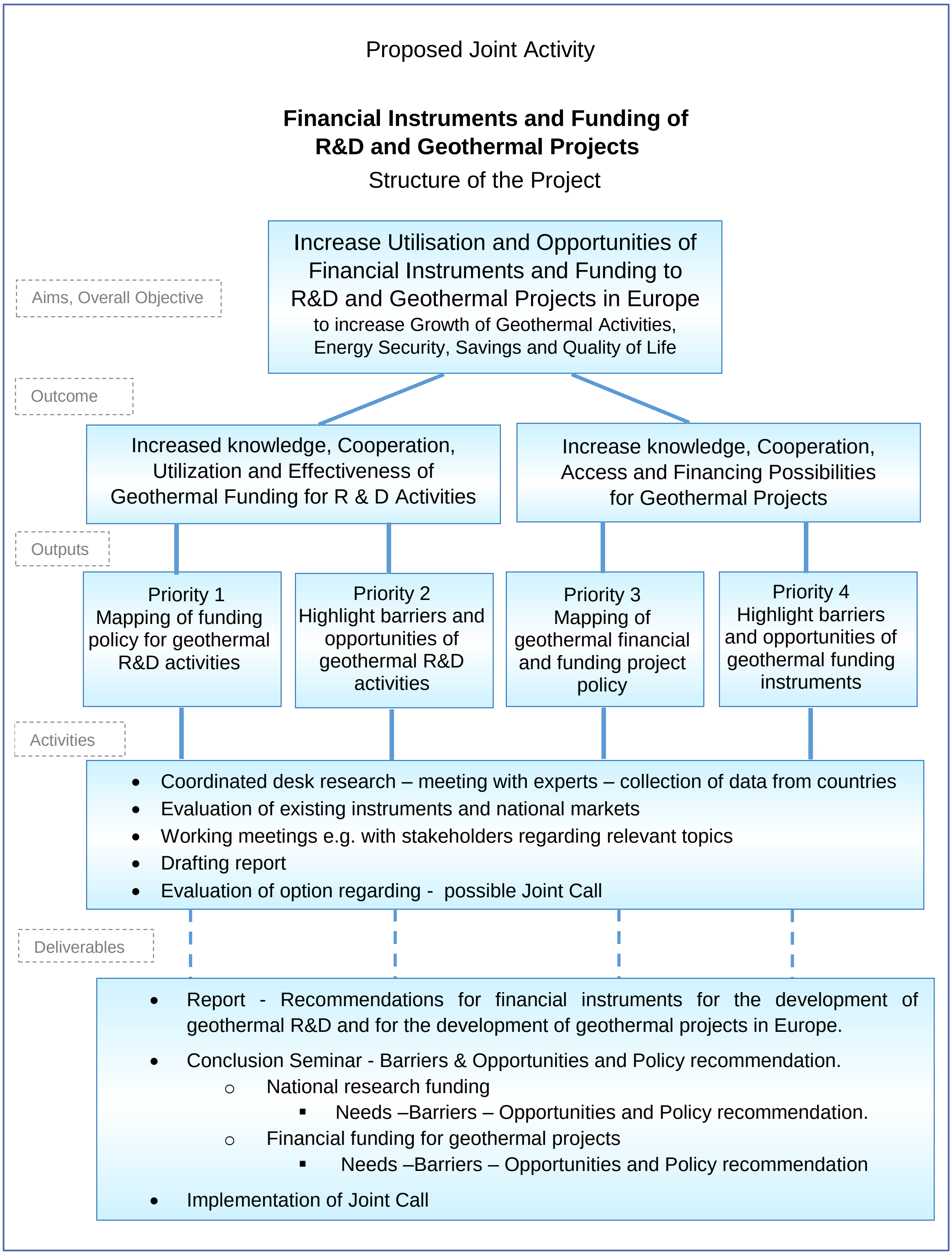
Mapping of current financial framework and instruments for geothermal business projects, challenges and policy options and opportunities.
- Attract more financing for geothermal projects - and more innovative financial solutions to finance geothermal projects which are capital intensive and risky on early stages.
- Increase the awareness of country, regional and local decision-makers on geothermal potential projects and its advantages to strengthening European geothermal development for economic opportunities, energy security and mitigate climate change.

The main instruments for the work were as follows:
- Coordinated desk research, meeting with experts and collection of data from countries.
- Sending our questionnaires to countries.
- Evaluation of existing instruments and national markets
- Working meetings e.g. with stakeholders on necessary instruments and topics.
- Seminar - Financial Instruments and Funding of RD&D and Geothermal Projects in Brussels highlighting on Barriers & Opportunities and Policy recommendation.
  - National research funding:
  - Financial funding for geothermal projects.

A steering committee was established, which implemented the tasks done and its member were: Iceland/Rannis Sigurdur Bjornsson, Iceland/OS Baldur Petursson and Switzerland Gunter Siddiqi.

Other participants were: Netherlands Ramsak/Breembroek, Portugal Mathilde Cunha, Germany Stephan Schreiber, Slovakia Igor Kosic, Hungary Annamaria Nador, Turkey Kaan Karaoz, Italy Adele Manzella and Slovenia Andrej Lapanje.

The layout / planning of the work on this report is described on this picture.



The ultimate goal of the ERA-NET is to develop transnational joint activities ensuring that results from the analysis of national RD&D programs are used. As funding agencies and governmental administrations, the ERA-NET Geothermal participants can be one of the lead drivers towards European cooperation.

This report is a result of one of these joint activities, called New Ways of Working, whose goal it is to look at the working practices of national funding institutions and the collaboration with their European counterparts.

The objectives of this study are to analyse the funding schemes available to research, development and demonstration (hereafter RD&D) and the financing of projects of geothermal energy within the participating countries of the ERA-NET geothermal cooperation.

The aim is to strengthen European geothermal development for economic opportunities, energy security and mitigate climate change. A better understanding of this financial landscape is beneficial to all stakeholders in defining the barriers and recommending practical solutions.

The content of this report has been brought together by member countries through questionnaires and a seminar in Brussels.

The questionnaires had two main topics, one regarding financing of geothermal energy RD&D and one on financing geothermal energy projects. Data mentioned in this report stem from the questionnaires completed by the member countries, unless otherwise indicated.

Support schemes are important tools for the development of public policy, especially for geothermal energy so as to compensate for market distortions and failures and to allow the technology to progress along its learning curve. Support schemes should nonetheless be temporary and be phased out as the technology reaches full competitiveness.

It has thus been suggested that a *European Geothermal Risk Insurance Fund* (EGRIF) would be an attractive public support measure for overcoming the financial barrier due to the geological risk involved in utilizing geothermal energy. As costs decrease and markets develop the private sector will be able to manage project risks with, for example, private insurance schemes. In some cases, the level of support appears to be much lower than the one given to other renewable technologies at the same stage of maturity.[1]

[1] EGEC report

2. Executive Summary

In this report we make a distinction between funding of research, development and demonstration (hereafter Funding of RD&D) and funding of industrial and/or public utility projects (hereafter Financial Instruments). The report is based on a survey between the partners of the Geothermal ERA-NET, other deliverables of the ERA-NET and public reports on Geothermal activities. Other players have not been consulted directly.

As perhaps was to be expected the responses are very varied and unique to each country. Geothermal is not high on the agenda by most partners and statistics on geothermal as part of renewable is scarce.

The results of the survey are presented, but a Power Point presentation has been made which constitute the main body of the report (link to the power point)

2.1 Geothermal RD&D - Main Findings and Key Recommendation

Funding of RD&D:

- ✓ Mostly funding is allocated by public competitive funds.
- ✓ In many cases there is more than one fund applicable for a category of research.
- ✓ However, one fund can also be applicable to more than one type of category of research.
- ✓ Occasionally there is funding dedicated to geothermal energy research however mostly there is not.
- ✓ Funding is mostly national, and only a few countries have the possibility of funding foreign parties.

Barriers and opportunities to RD&D:

- ✓ A lot of barriers are mentioned in regards to geothermal energy research
- ✓ In all categories; technological, economical, commercial, organizational and political - Most in technological and political
- ✓ Opportunities were also mentioned by all participants, both already established ones as well as future ones. Ranging from awareness-rising to the potential of collaboration between stakeholders.

Key recommendations

- ✓ Amount of funding is not enough. More unified plan and cooperation between national and European stakeholders.
- ✓ Look at the market and try to see what particularities are needed for the market. Role of public authorities is important there.
- ✓ Being able to speak with a single voice, and communicate the opinion of the geothermal industry. > PRGeo?
- ✓ Strengthening the organization. Bring together academia and industry. Position the sector as a one that can provide reliable affordable technology.
- ✓ Geothermal is a very broad sector. Need to create better links between these sectors.
- ✓ Stick to the geothermal roadmap. Funding by national programme owners with an add-on from EU and the Industry.

2.1 Geothermal Projects - Main Findings and Key Recommendation

Improved deployment of geothermal energy will require increase investments that cannot solely rely on public funds. Therefore, the engagement of the private sector is crucial.

However, financial barriers to develop geothermal power projects in Europe still persist and need to be overcome through public support at the beginning of geothermal development. An ideal scheme from the (private) project developer's point of view is for public authorities to finance the exploratory and preferably also the pre-feasibility phases of geothermal development; investors would take over.

Conclusion

Conditions necessary for further growth of the utilization of geothermal energy, in general, fall into a few categories:

Financial: instruments that meet the challenges of high investments, uncertain success, long pay-back period for district heating systems.

Legislation/regulation: a need for adequate and transparent legislation. Lead time for permits should be reasonable. Regulation would ensure health, safety and environmentally acceptable project execution. Geological issues would be resolved by pooling knowledge of the resources, availability of relevant data, and knowledge of specific operational issues, such as re-injection (WP2 D2.1).

Public support schemes should cover different financial needs: R&D, demonstration, exploration phase to identify areas of interest, drilling/production phase (market conditions) (EGEC)

Risk guarantee/insurance. The fairly small number of geothermal power operations in the EU does not provide a sufficient statistical basis to access the probability of success – a prerequisite for commercially available insurance schemes. As a consequence, geothermal developers struggle to find insurance (public or private) schemes with affordable terms and conditions for the resource risk. In those circumstances and to spread the risk as broadly as possible, a European risk insurance system, may be a high-priority support instrument – ideally developed and instituted at the EU level. This instrument, in effect, would act in case of failure to find suitable geothermal energy reserves. Some proponents (EGEC) also wish for an insurance or guarantee scheme to be available during the production phase of a geothermal reserve. The EGRIF aims at alleviating the shortage of insurance policies for the resource risk and ease investments in geothermal power projects. The EGRIF should be first supported by public money; when mature this could be phased out and replaced by private schemes (EGEC).

Feasibility studies. An ideal scheme from the vantage point of private project developers would be for public authorities to finance the exploratory and preferably also the pre-feasibility phases of geothermal development; subsequently, investors would take over.

While conventional geothermal power is in a few regions of Europe already a competitive energy source, low-temperature systems and EGS are expected to become competitive within a few more years if substantial research, development and demonstration (RD&D) resources are allocated to those technologies (EGEC).

The types of financial incentives needed for electricity production from geothermal energy are: grants for first drilling, geothermal risk insurance, feed-in-tariff/feed-in-premium/premium.

Policy makers need to set the type and level of support according to the maturity of the technology and of the market. Therefore, the feed-in-tariff still appears to be the most appropriate mechanism to stimulate the market uptake of innovative technologies such as low temperature and EGS technologies (EGEC)

Technical barriers

- Lack of information on geothermal energy resources – regions, areas
- Lack of information on economic and technical data about the industry

Regulatory barriers

- Lack of national geothermal regulatory framework
- Bureaucracy – too long and complex – requests from authorities for licensing for exploration and drilling

Financial barriers

- Lack of financial risk funds / loans for geothermal exploration and first drilling
- Capital intensive for power production – less for district heating
- Need for new business models to make GeoDH more economic viable
- Limited and fragmented financial support
- Unfair competition with conventional sources

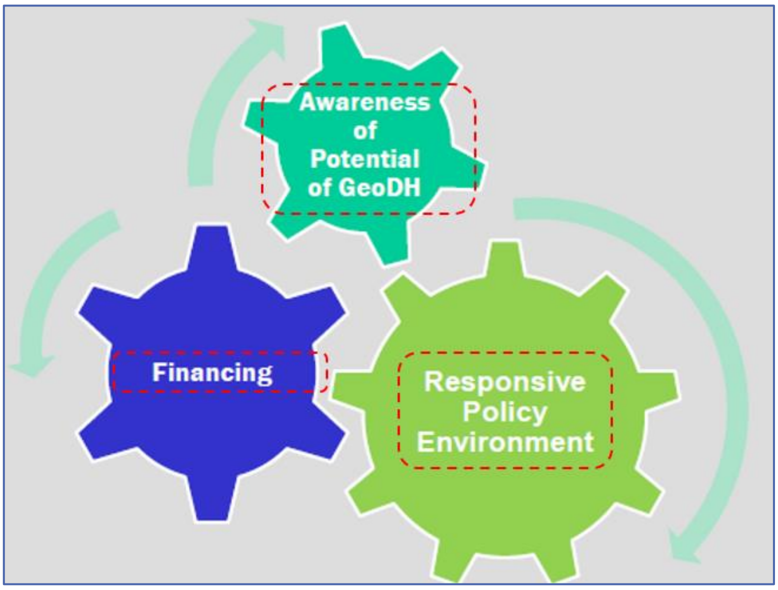
Awareness barriers

- Limited awareness within the industry and on national level – more activity is needed (ERA NET has raised the awareness – but more is needed on various levels)
- Negative view of geothermal in some areas / countries – due to lack of information

Recommendation

Awareness raising

- Link geothermal awareness raising with the risk of climate trend and concerns
- Geothermal programs and projects are valuable – fighting the climate crisis
- Geothermal options can create valuable economic, environmental and climate opportunities
- Increased awareness within the industry and on national level – more activity is needed
- Focus on special groups / regions, national level and EEA/EU level



Financial barriers

- More financial risk funds / loans for geothermal exploration and first drilling
- Develop new business models to make GeoDH more economic viable
- Better financial support
- Equal competition with conventional sources

Better Policy Environment

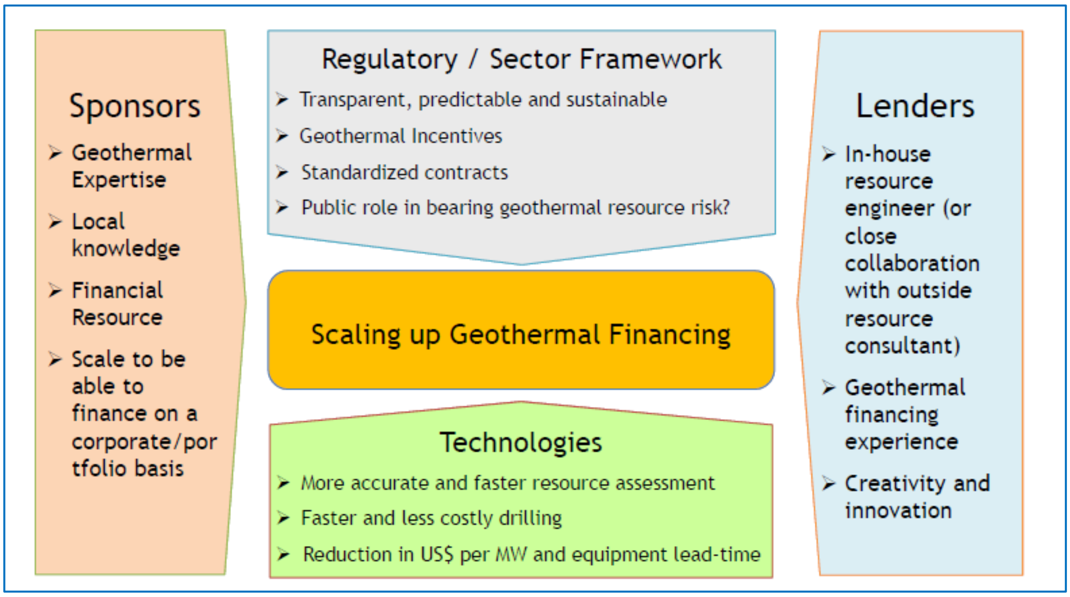
- Better national geothermal regulatory framework
- Simpler and faster process on geo. licensing for exploration and drilling etc.
- More information on geothermal energy resources – regions, areas
- More information on economic and technical data about the industry

Success for the geothermal sector in the concerning countries is not only based on geothermal resources, but also on these factors for competitiveness.

The competitiveness model can be used in many different ways to increase competitiveness and growth of companies.

One possibility is to use the enclosed model to analyse the seven main framework conditions in the geothermal sector;

1. Authorities and regulation (unclear vision).
2. Geothermal resources.
3. Scientific & technical factors.
4. Companies, management, expertise - industry, clusters assessment (lack of cooperation).
5. Education & human factors.
6. Access to capital.
7. Infrastructure and access to markets, sectors and other clusters.
8. Access to international markets and services, and finally.



One of the main elements of the Geothermal ERA NET – was to link together industry, policymakers and research.

Although no formal assessment has been done on the results of this program - there are several indicators that the cooperation has already resulted towards – more cooperation, policy coordination, economic benefits, **more geothermal funding to geothermal RD&D and projects**, economic benefits, better environment, mitigate climate change and more quality of life – **both within individual member countries, and within relevant EU bodies as well.**

The Geothermal ER NET project itself – have therefore been important contributor towards better funding of geothermal R&D projects – as well business projects – as cooperation, policy coordination and awareness building is important element regarding better funding of geothermal projects.

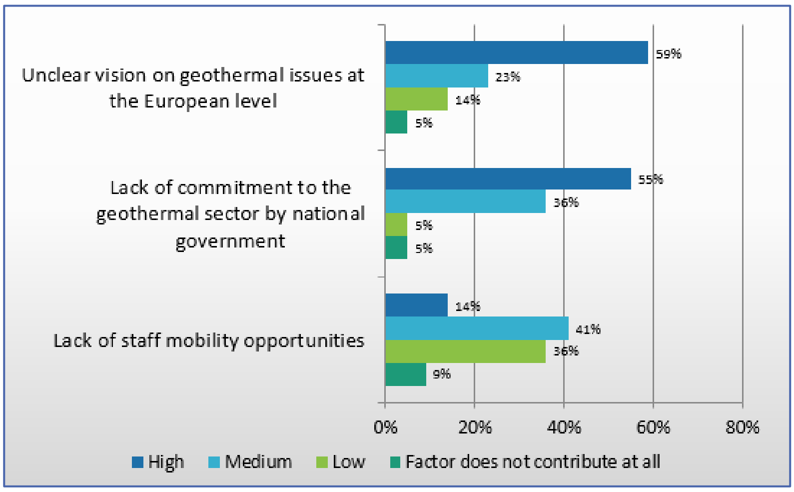
3. Framework of the Geothermal Sector – some Key elements

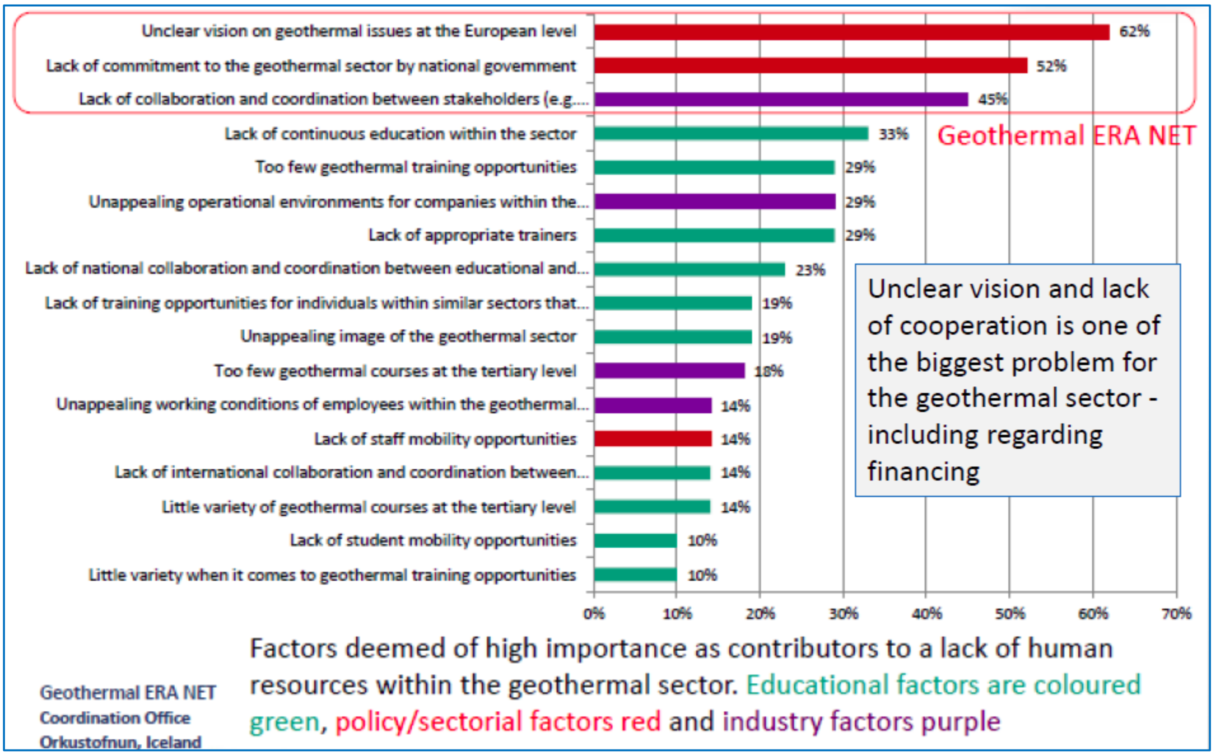
3.1 Status and Vision of the Geothermal Sector

To evaluate the financial framework of the geothermal sector and the barriers and opportunities, the first step is to understand the situation and the general financial framework for the geothermal industry in Europe.

In general, geothermal is not very high on the agenda of participating countries.

In a survey conducted under WP 6.2 of ERA Geothermal it is clear that there is a considerable political barrier in exploiting geothermal (ref. picture), besides the technological and financial barriers. The vision is unclear and there is a lack of commitment in the sector.



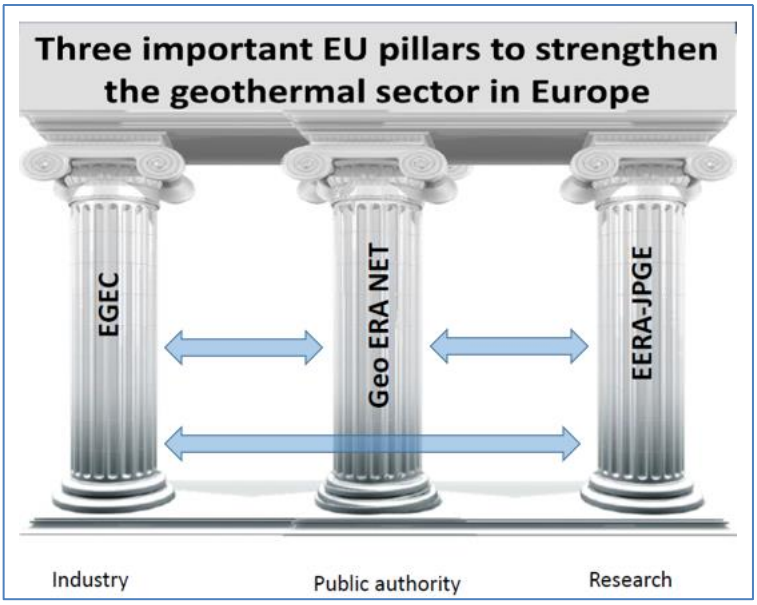


From the survey following elements can be highlighted:

- In many countries, the geothermal sector has a lower visibility and lobbying strength than other sustainable energy sectors.
- It is thus not surprising that many countries report problems in getting projects going, especially related to financing the projects.
- There are quite a few different issues that lead to financial barriers for geothermal energy in regards to the private sector.
- Unclear vision and lack of cooperation is one of the biggest problem for the geothermal sector – including regarding financing of projects.

3.2 The Status and Cooperation within the Geothermal Sector

Depending on the financial buffers of a typical company investing in geothermal, the investment cost may be an issue. The geological risk is another issue, especially in areas and at depths where there are few wells. In all participating countries, there are policy instruments in place to support geothermal energy utilisation. R&D efforts are generally supported, but in some countries there are also instruments to address the geological risk in the form of soft loans or guarantee funds. Also, most participating countries have a feed-in-tariff in place, for renewable energy production [2]



In the ERA NET Newsletter 2015, the ERA NET Coordinator, Guðni A. Johannesson, made a following statement.

"*It is now 3 fruitful years since the birth of the Geothermal ERA NET program in 2012. Important milestones have been reached, and various activities have taken place, e.g. several working groups and reports evaluating different aspect of the geothermal sector as a step towards policy recommendation and implementation of joint activities.*

The focus of our work has been among other on following elements.

- *Exchange information on the status of geothermal energy.*
- *Lay groundwork to create a European Geothermal Information Platform.*
- *Highlight barriers and recommend practical solutions.*
- *Communicate with principal stakeholders and enhance public awareness on the added value and benefits of geothermal scientific and policy issues.*
- *Increase transnational collaboration in research training and mobility.*

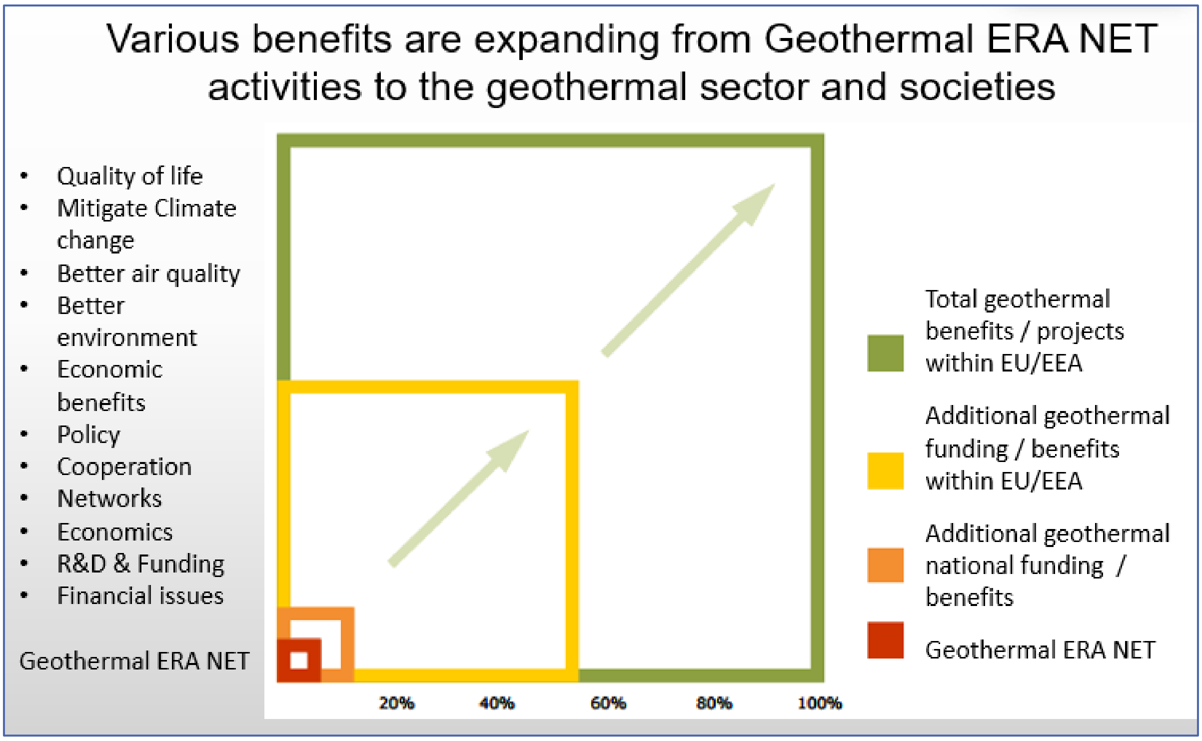
The program is one of the three important EU pillars to strengthen geothermal sector and its development. It will provide various opportunities and future joint activities in terms of development of geothermal energy and cooperation between partners at pan-European level.

***One important element of the Geothermal ERA NET is to link together the geothermal industry pillar, the research pillar and the policy pillar by increasing cooperation and consultation between those pillars and stakeholders to strengthen geothermal assessment and policy recommendation**. ERA NET vision is to minimize the fragmentation of geothermal research, build on European know-how and know-who to utilize geothermal energy and to framework large opportunities in the utilization of geothermal energy".*

As can be seen from this – on of the important factors within the ERA NET process was to ***"link together the geothermal industry pillar, the research pillar and the policy pillar", as*** the industry was struggling with - unclear vision and lack of cooperation.

Such a situation – is one of the main barriers to successful access to finance – both for geothermal RD&D and projects – both on European level and national level – specially in those countries where the problem is greatest. The ERA NET was therefore already in the beginning – focusing on the biggest problem for the geothermal sector – including regarding financing of projects.

[2] WP2 D2.1 & 2.3



One of the main elements of the Geothermal ERA NET – was to link together industry, policymakers and research.

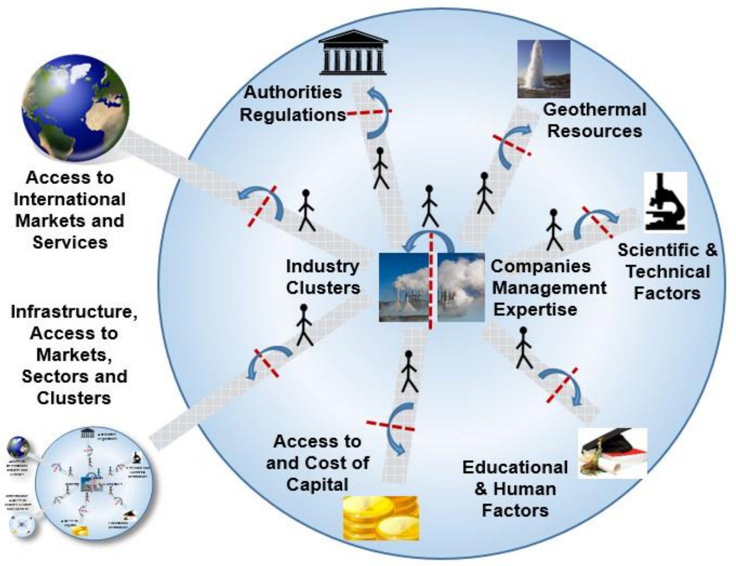
Although no formal assessment has been done on the results of this program - there are several indicators that the cooperation has already resulted towards – more cooperation, policy coordination, economic benefits, **more geothermal funding to geothermal RD&D and projects**, economic benefits, better environment, mitigate climate change and more quality of life – **both within individual member countries, and within relevant EU bodies as well. The Geothermal ER NET project itself – have therefore been important contributor towards better funding of geothermal R&D projects – as well business projects – as cooperation, policy coordination and awareness building is important element regarding better funding of geothermal projects.**

Value	Activities – benefits in general	ERA NET	National	EU / EEA
Policy coordination	Better quality policy and success	Relevant	Relevant	Relevant
Cooperation on different topics	More national and international activities	Relevant	Relevant	Relevant
Building networks information cooperation	More networks Working with additional bodies like EU bodies, IEA, Eurostat, IGA, etc.	Relevant	Relevant	Relevant
Economic benefits	Economics of scale & more competitiveness	Relevant	Relevant	Relevant
RD&D & Technical benefits	More projects & funding	Relevant	Relevant	Relevant
Financial issues	Better understanding of Geo funding - better funding	Relevant	Relevant	Relevant
Climate contribution (CO2) Quality of life	Less CO2 – better environment – more Geothermal Projects - less pollution - reducing climate risks – raising quality of life	Relevant	Relevant	Relevant

3.3 Competitiveness of the Geothermal Sector

When analysing the financial framework and recommending formulating policy recommendations for the geothermal sector, the enclosed model of 8 factors of geothermal competitiveness, challenges and opportunities, was used to highlight the key elements for policy recommendations and options in the concerning countries. [3]

Figure 3.2.1. **Competitiveness of the Geothermal Sector**



Source: Sölvell & Lindquist 2012, Amended, B. Petursson, National Energy Authority, 2014

Success for the geothermal sector in the concerning countries is not only based on geothermal resources, but also on these factors for competitiveness.

The competitiveness model can be used in many different ways to increase competitiveness and growth of companies.

One possibility is to use the enclosed model to analyse the seven main framework conditions in the geothermal sector;

1. Authorities and regulation (unclear vision).
2. Geothermal resources.
3. Scientific & technical factors.
4. Companies, management, expertise - industry, clusters assessment (lack of cooperation).
5. Education & human factors.
6. Access to capital.
7. Infrastructure and access to markets, sectors and other clusters.
8. Access to international markets and services, and finally.

By evaluating these seven factors of the geothermal competitiveness in the concerning country, it is possible to highlight the key weaknesses and strengths of the frameworks conditions as a base for the formulation of a better competitiveness financial policy for the geothermal sector; to increase competitiveness, growth, jobs, productivity and quality of life.

All these basic factors and elements is important to have in mind – when evaluation of the **Financial Instruments and Funding of RD&D and Geothermal Projects and Barriers and Opportunities**

1. Authorities and Regulatory Factors

- Design regulation specific to the promotion of direct uses of geothermal energy
- Publicise the characteristics and benefits of geothermal energy for regional development
- Promote cooperation with international organisations

2. Geothermal Resources

- Improvement of geothermal regulation
- Improvements for data analysis of reservoirs in regions

[3] Petursson, Baldur, Solvell & Lindquest,2014, 2012

3. Scientific and Technical Factors

- Promote relationships with industry
- Promote alliances with research centres and educational institutions for the formation of specialised human resources

4. Companies, Management, Expertise – Industry Clusters.

- Promote alliances with research centres and educational institutions for the formation of specialised human resources
- Promote cooperation with IFI for financing, donor support and consulting
- Organize workshops and conferences to improve knowledge on geothermal energy
- Identify geothermal energy-related productive chains

5. Educational and Human Factors

- There is not enough support for the generation of the human resources needed for the geothermal industry
- Creating seminars and specialized courses on the different stages of a geothermal project and adding them to the existing
- engineering degrees
- Give the personnel technical training to participate in the different stages of a project
- Implement programs for technical development

6. Access to, and Cost of Capital

- Promote additional access to financing geothermal projects – domestic and international
- Increase access to capital by providing capital to exploration and test drilling and DH networks e.g. soft loans or donor grants,
- to lower the risks at the beginning of projects

7. Infrastructure, Access to Markets, Sectors and Clusters

- Promote training in the banking system for the development of financial mechanisms specific to geothermal energy
- Awareness; organize workshops & conferences to improve knowledge of geothermal energy
- Increase the available knowledge about opportunities and benefits of geothermal resources

8. Access to International Markets and Services

- Support international cooperation in area of geothermal knowledge, training and service
- Promote international cooperation with IFI and donors on finance, grants and funding
- Support international consulting cooperation on various fields of geothermal expertise

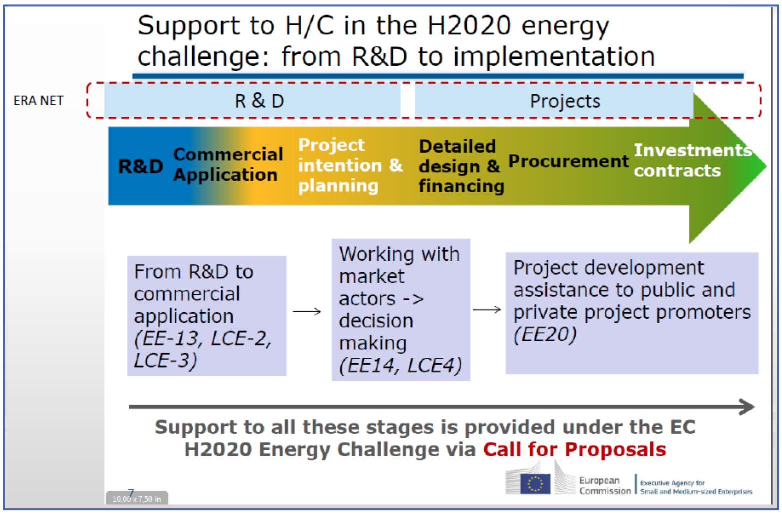
4. Financial Instruments and Funding situation of Geothermal Research, Development and Demonstration

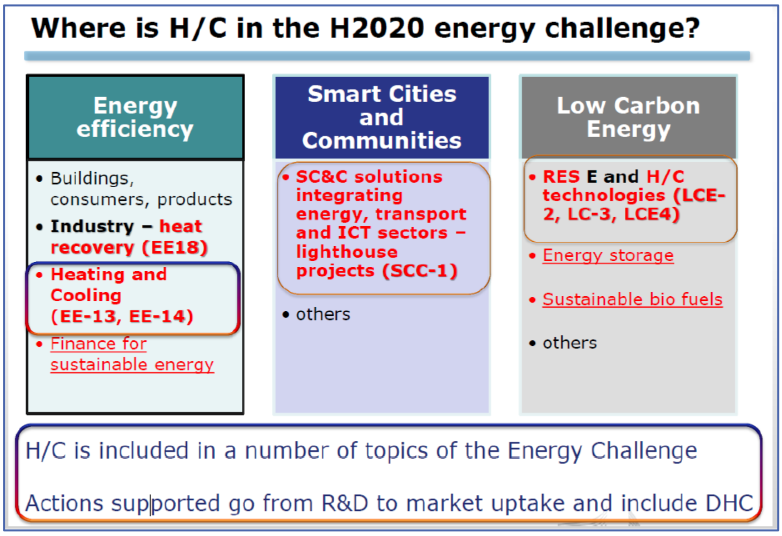
First half of the questionnaire was directed at getting a more in depth view of the financial instruments and funding situation for Geothermal RD&D. Recent European Commission's documents point out how crucial it is to invest in new renewable technologies and to improve existing ones through RD&D. Member States have spent €4.5bn on renewable energy RD&D over the last 10 years, with the EU spending €1.7bn. At the same time EU R&D funding allocated to geothermal energy during the Sixth and Seventh Framework Programme until March 2012 amounts to 29.4m. It is therefore clear that geothermal is, among those technologies experiencing technological progress, the one receiving the smallest amount of financial support despite all the advantages it provides to the energy system, such as stabilisation. It seems however that gathering financing for geothermal RD&D and the early stages of projects has been made more difficult since the market turndown in 2008.[4] [5]

In the study the participating agencies were asked to provide a general map of the funding situation for different RD&D activities, as well as highlight barriers and opportunities of geothermal RD&D in their country.

4.1 Funding for research

In order for any geothermal project to get started a substantial research must be performed beforehand. The funding of RD&D is especially important to the geothermal energy sector as feasibility studies on the viability of a geothermal site are necessary.





RD&D related to geothermal energy can be divided into subcategories. Thus the questionnaire asks not only about RD&D but rather about free fundamental research, oriented fundamental research, application oriented fundamental research, prototype development, pilots and demonstration as well as about market-driven innovation and research. The answers given from the participants are very varied yet show a certain pattern in funding of RD&D activities. Instead of analysing the answers to each category, themes and patterns that run throughout the answers are commented upon.

It is clear from the answers that the funding bodies of geothermal RD&D are in most cases public funds. Often there are more than one fund applicable to each category yet at the same time one fund can span many topics in some cases. The allocation of funds seems to be competitive in most cases, but quite often there seems to be no specific budget allocated to geothermal RD&D. However, in certain participating countries there is some funding dedicated to

[4] NREL Guidebook to Geothermal Power Finance
[5] EGEC

geothermal activities mentioned in regards to application oriented fundamental research, prototype development, pilots and demonstration as well as market-driven innovation and research. Private funding of geothermal competes with funding of other renewable energy sources that might have shorter turnover than geothermal ones do and thus be more appealing to private funding.

4.2 Possibility of transference of funds to European partners

As geothermal energy only has limited human resources international cooperation is vital to its success as well as in order to minimise expenses by using knowledge already formed in one place at a different one. It is therefore quite important that such RD&D cooperation can be funded. In the current system though some participating countries have no possibility of funding foreign partners, as their funding is in general only national. Transnational projects are still possible even though funding is often limited to the national partner. Some funding for joint international projects is still available, there are even specific funds for international cooperation in certain fields in some countries. However, funding for international cooperation is in some cases bound to certain nationalities of the foreign partner. One country still stated that funds were available to foreign entities, if they could justify how the activity would benefit the country.

Barriers of Geothermal RD&D

The role of the EU and national policy-makers in setting the most favourable climate for investments is crucial to geothermal energy. This means that a number of specific barriers need to be removed so as to involve new developers and groups of investors. Some financial factors that have been mentioned as barriers in other reports are; lack of access to private funds, poor knowledge of the deep subsurface over large parts of Europe, the length of project development.[6] It was therefore important to ask the participants to comment upon barriers to geothermal energy in their country. The questionnaire asked participants to highlight barriers of geothermal RD&D in regards to technological, economical, commercial, organizational and political barriers.

There were quite a few different technological barriers mentioned by the participants. Most notable are those relating to missing equipment suitable for geothermal energy and exploration. This can be seen as a result of the lack of competition in the making of new technology in geothermal energy, as industrial RD&D projects are waiting to be funded as there seem to be no suitable platforms yet. Therefore, much of the missing funding for technological advancement in the field is covered by national agencies.

Economical barriers mostly relate to the relatively few numbers of companies that are focused on geothermal energy. Most of which are small to medium sized and can thus often only realize singular projects. Research is thus driven by academia rather than the commercial market. To the market the high upfront cost of projects and research is a barrier to geothermal energy and thus there is a difficulty getting projects started. There is a clear potential present within the bodies of companies to prepare projects with partners, either academia or foreign firms. The lines are still not properly drawn for working partnerships in order to fulfil the requirements of an RD&D project nationally and internationally.

There are fewer **commercial barriers** mentioned than either technical or economical ones. Mostly standard intellectual property rights (IP) approaches are mentioned as barriers. It is clear that the market for geothermal RD&D is very small, especially as companies would very much like to be able to start projects without the necessary preliminary research.

The organizational barriers to geothermal RD&D were the timespan for project development, which is very long. A better management among researchers was also mentioned as a barrier.

The last topic participants were asked to comment upon was **political barriers** to geothermal RD&D. The most common theme found here is the focus of politics and politicians, which often is more on other renewable energies. When the focus is on geothermal energy it often lies on the negative aspects of it, which leads to a lack of public acceptance of the technique. There is a lack of political will towards geothermal energy, especially to invest. Finally, participants mentioned that proactive geothermal policy is missing.

[6] EGEC

4.3 Opportunities of geothermal RD&D

Participants were also asked to highlight opportunities of geothermal energy. In this section participants mentioned quite a few different, and very varied, opportunities where geothermal RD&D could succeed or has already done so.

- There is a high level of knowledge in academia.
- There is a large degree of internationalization.
- Opportunities lie in research and innovation funding that is available in most countries
- Operators are in general open to grant access to researchers.
- Information and data exchange could be enhanced.
- Consciousness-raising towards renewable energy. There is a lack of basic knowledge of geothermal energy and it should be introduced in schools and universities for better understanding and public acceptance.
- A "lighthouse"- project, a premium project, to show that geothermal energy is valuable and at the same time can be completed without too much going awry.
- Opportunity to show reliability to investors.
- Potential of companies regarding the technological abilities for conducting a RD&D project.
- There is R&D need for increased energy efficiency.
- Development of start-up community.
- A joint call gives an opportunity for realizing the geothermal potential by interactions with stakeholders and foreign partners.
- The potential and the current conditions of the companies for working together with academia and, especially, with foreign partners are at a sufficient level of ability for conducting collaborative RD&D projects in the area of Geothermal energy, as if platforms of partnerships act as effective interfaces.

4.4 Key recommendations

Risk insurance Funds for the geological risk already exist in some European countries. The geological risk, not to find an adequate resource or that the resource naturally declines over time, is a common issue all over Europe. Collaboration between Member States to remove it will allow them to save money. For this reason the establishment of a Geothermal Risk Insurance Fund at the EU level could insure deep geothermal projects all over Europe.[7]

And from the survey.

- RD&D funding for mapping of geothermal potential throughout Europe.
- Virtual pot can form the principle of funding in international projects. RD&D projects about geothermal energy will be funded if a joint call is realized within an international project, like Geothermal ERA-NET.
- Mutual virtual funds for international cooperation.
- Transnational agreements for intellectual exchange.
- Funds fully committed to the field of geothermal energy

At the workshop meeting in Brussels on October 5th 2015 the following recommendations were given to further emphasise the case.

- More funds fully committed to the field of geothermal energy are needed
- Mutual virtual funds for international cooperation, leaning on transnational agreements for intellectual exchange
- Bring academia and industry closer together
- Technological platform
- Awareness raising of geothermal energy

[7] EGEC

5. Financial Instruments and Funding of Geothermal Projects

Market conditions in the EU electricity and heat sectors 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 (EGEC).

While conventional geothermal power is already a most competitive energy source, low-temperature systems and EGS will become competitive within a few more years if substantial research, development and demonstration (RD&D) resources are allocated to those technologies (EGEC).

It has also previously been reported that financing of geothermal energy is lacking, both by earlier work of the ERA-NET geothermal as well as work by other organizations such as the European Geothermal Energy Council (EGEC). In order to realise the full potential of geothermal energy to the benefit of European economies and citizens alike it needs increased and dedicated support now. With the accelerated deployment of geothermal energy and added requirement for investments, it is clear that it cannot solely rely on public funds. Hence, the engagement of the private sector will become increasingly more crucial.[8]

It is also clear that geothermal projects are a less attractive option than other renewable energy technologies in ways that make obtaining financing more challenging. It is especially the significant investment required to find and prove the geothermal resource, an activity akin to oil and gas exploration, which is unique to geothermal among renewable energy resources. This facet substantially changes the power project's level of certainty in its early stages as well as the development time required relative to other renewable energy resources.[9]

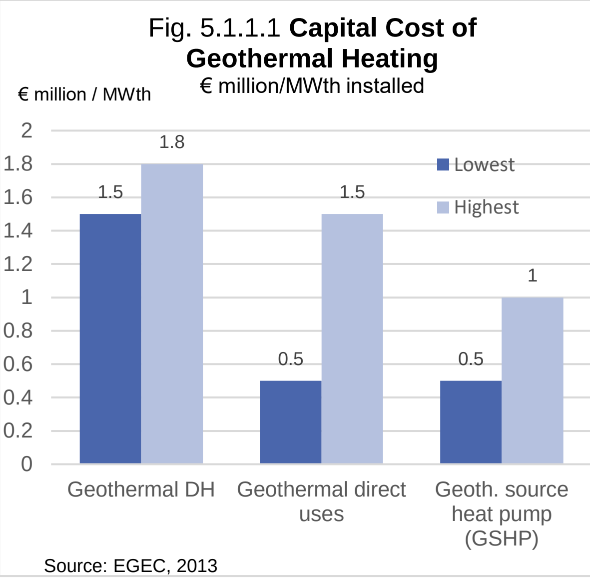
[8] EGEC report

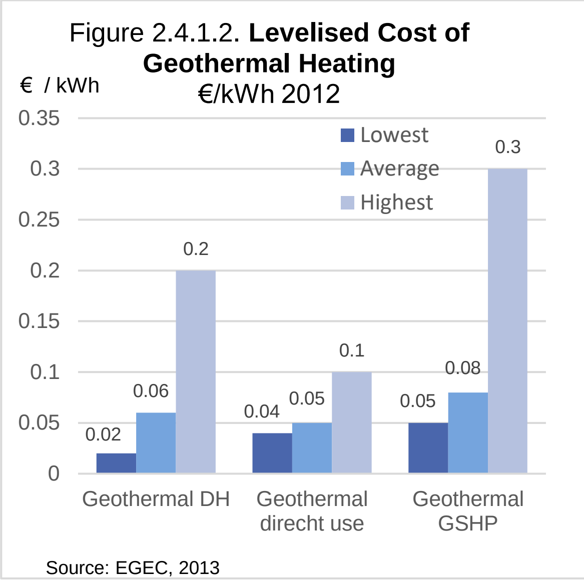
[9] NREL Guidebook to Geothermal Power Finance

5.1 The Geothermal Structure

5.1.1 Geothermal District Heating – Cost Structure

In most cases, geothermal district heating projects face the same issues as geothermal power plants. Furthermore, geothermal heat pumps can also be considered as a capital intensive technology in comparison with other small scale applications. (EGEC, 2013).





Geothermal heat is also important and competitive for district heating, where a resource is available, especially where a district heating system is already in place. Geothermal heat can also be competitive for industrial and agriculture applications. Geothermal heat pumps can also be profitable, in comparison with fossil fuel heating systems.

Geothermal heat may be competitive for district heating where a resource with sufficiently high temperatures is available and an adaptable district heating system is in place. Geothermal heat may also be competitive for industrial and agriculture applications (greenhouses). As geothermal heat pumps can be considered a mature and competitive technology, a level playing field with the fossil fuel heating systems will allow phasing out any subsidies for shallow geothermal in the heating sector.

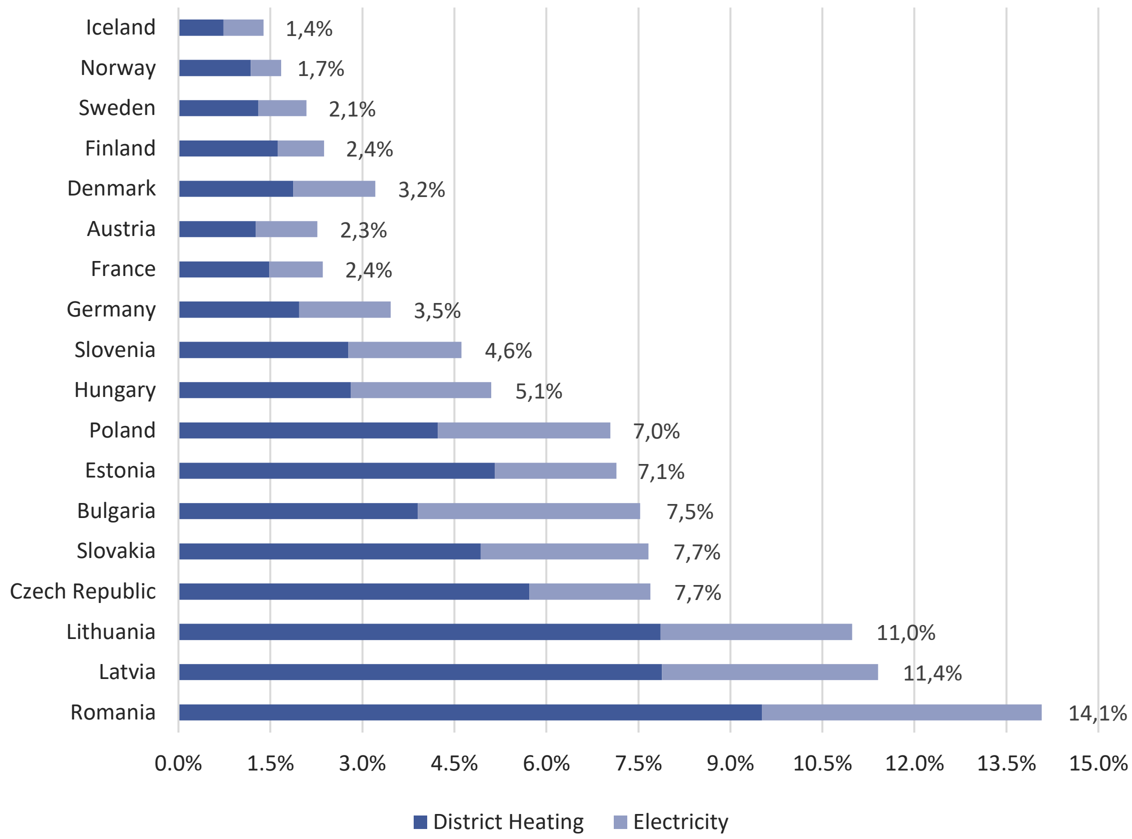
In many cases, geothermal district heating projects face the same issues as geothermal power plants, the need of capital and risk mitigation is therefore also valid for this technology. Moreover, notably because of the drilling, geothermal heat pumps can also be considered as a capital intensive technology in comparison with other small scale applications. Geothermal heating and cooling technologies are considered competitive in terms of costs, apart from the notable exception of EGS for heating.

In addition, an important barrier for both electricity and heating and cooling sectors is the unfair competition with gas, coal, nuclear and oil, which is the primary reason justifying the establishment of financial support schemes for geothermal.

If we look at the proportion of annual's salaries of people for buying district heating and electricity for 100m^2 household in Europe, we can see that Iceland is paying the lowest proportion for both district heating and electricity, and Romania is paying the highest.

The risk characteristics of a geothermal heating project are different depending on the three stages of the projects, which are: 1. Exploration, 2. Drilling, and 3. Building, which is less risky.

Fig. 5.1.1.2 **The Proportion of Annual's Salaries of people for buying District Heating and Electricity for 100m² Household in Europe**



Source: Orkustofnun Data Repository: OS-2016-T006-01

In a calculation presented in a GeoDH paper from 2014, it is estimated that, *“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 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.”* (Christian Boissavy, 2014).

It is therefore an important element of a geothermal heating project that there are options and possibilities of support from public authorities towards the exploration and the drilling stage of such a project. In the above mentioned paper it is recommended that the support should cover 75%-80% of the exploration and drilling cost if the project fails. This is especially important due to the risk of test drilling. In Iceland for example, the test drilling for such projects can be refunded by the Energy Fund if the test drilling is not successful. On average the electricity generating geothermal plants are considerably larger and more expensive than heat generating geothermal plants and the risks (investment & operation) for electricity generating geothermal plants over longer period of time is therefore larger. Regarding heat generating geothermal plants, the benefits are greater when high temperature resources is used to generate both heat and electricity than when it is used for heat alone.

The geothermal heat production has several advantages, such as:

1. Economic opportunity and savings.
2. Improvement of energy security.
3. Reducing greenhouse gas emissions.
4. Harnessing local resources.
5. Reducing dependency on fossil fuels for energy use.
6. Local payback in exchange for local support for deep drilling.
7. They complement existing district-heating networks offering an alternative to other fuels.
8. They can be combined with smaller binary cycle (if reservoir and economics allow) electricity generating plants to bring the utilisation of the reservoir to the maximum.
9. May be a useful complement to regional and local economic development programmes with positive effect on employment and the viability of public infrastructure.
10. They raise public awareness for the geothermal energy to a broader section of the public
11. Improving quality of life based on economic and environmental / climate benefits.

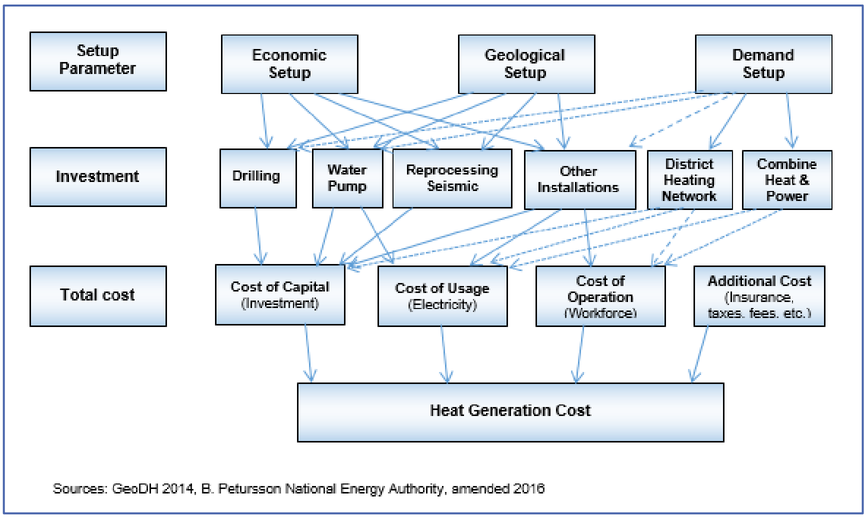
It is difficult or impossible to present standard costs of geothermal district heating projects, as the cost vary between regions and variable conditions. Nevertheless, the costs of such a project can be estimated, based on the most important parameters for the understanding of the individual projects, by:

- first defining the basic conditions affecting the heat generation cost,
- secondly by developing theoretical projects in order to explore economic viability.

Key factors for geothermal district heating projects are:

- geological framework,
- economic conditions and
- demand.

Fig. 5.1.1.3. **Cost Structure of Geothermal Heat Generation Project**



Although it is difficult to estimate the profitability of such projects, the cost for each project can be based on the demand structure, the geological conditions, the costs of capital and the existing geological data, as is shown in figure, 2.4.3.2.

The demand aspect plays an important role in defining the project and the investments e.g. drilling, size of the water pump, buildings, district heating network and a power plant's mechanisms. In addition, the evaluation of heat production costs depends on the geothermal energy resource. It should also be noted that many of these cost elements are the same as for a standard heat production installation.

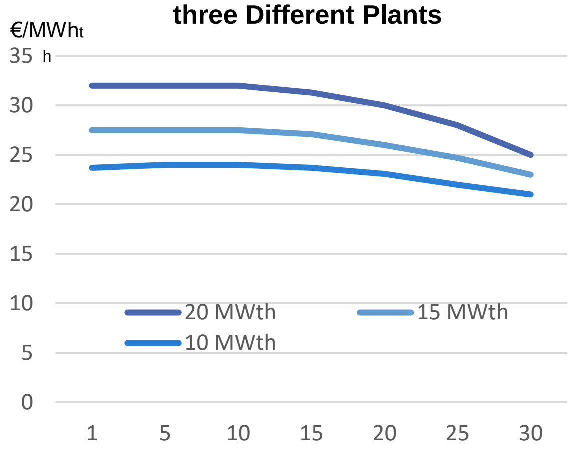
However, due to the fact that every location has different demand conditions, it is not possible to incorporate these factors in a general heat production cost calculation. Moreover, many costs are equal to those of a conventional heat generation installation. A paper for GeoDH from 2014 presented a calculation estimating the cost of a geothermal heat production project. The calculation was based on the following costs elements:

- capital cost (investments for drilling, water pump, substation, depreciation),
- operational cost (electricity for pumping & equipment, maintenance).

However, in addition to these costs, geothermal heat generation plants have to be connected to a network of plants using other energy sources, like a gas-fired or coal-fired power plant to be able to cope with peak loads. That kind of cost is not included in the project example that will be described in figure 5.1.1.4.[10]

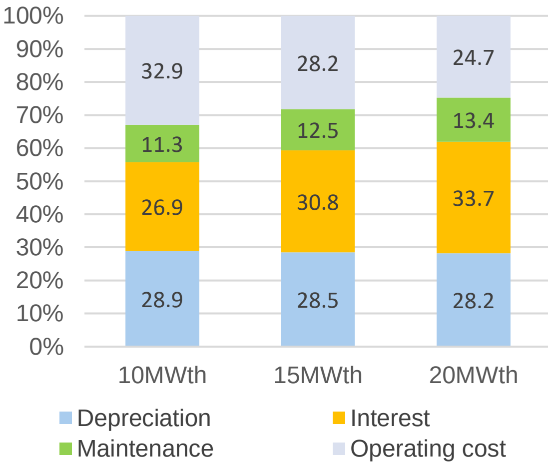
Calculations on geothermal heat generation cost carried out for GeoDH in 2014, involved three projects 10, 15 and 20 MW_{th} as shown in figure 5.1.1.4. It is interesting that the figure illustrates that the generation cost is stable for a period of 30 years, (due to lower costs of capital over time), which is opposite to the trend for forecasted prices for fossil fuels. Higher cost for 15 and 20 MWth projects than 10 MWth, is due to a higher capital cost in form of interests due to more expensive drilling.

Fig. 5.1.1.4. **Heat Generation Cost of three Different Plants**



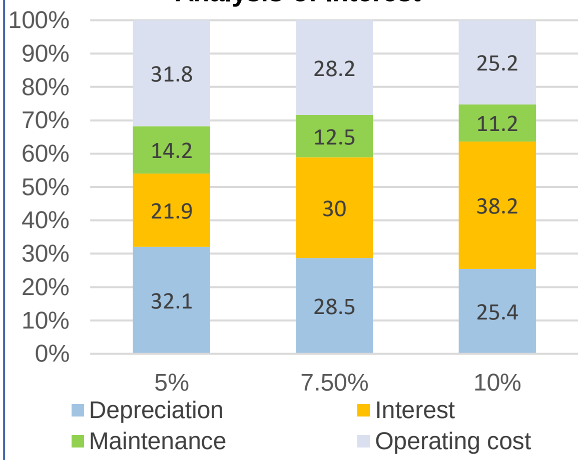
Sources: GeoDH, 2014

Fig. 5.1.1.5. **Cost Structure of Generation Project Depending on Size**



Source: GeoDH, 2014

Fig. 5.1.1.6. **Cost Structure of a 15 MWth Project and Sensitivity Analysis of Interest**



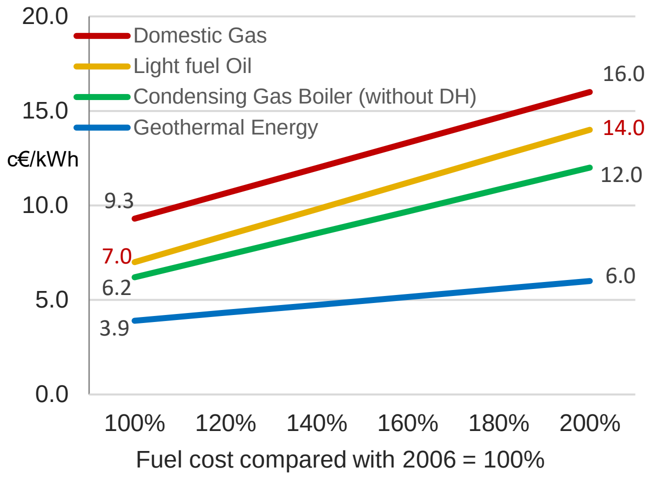
Source: GeoDH, 2014

As can be seen from figure 5.1.1.5, the cost structure is different depending on size of project, but for all projects the capital cost (depreciation and interests) is the biggest part of the overall cost, as this is a capital intensive sector. For the 10 MW_{th} case, the biggest single cost factor is operation coming from electricity cost to run the water pump. For the biggest project the largest cost factor is interest. As these projects are capital intensive, interest plays a major role regarding profitability, as can be seen for the sensitivity analysis in figure 5.1.1.6, where the 5% interests cost go from 21,9% up to 38,2% if the interests are 10%. Rates of interest are therefore one of the biggest risk factors.

[10] The geothermal generation heat project provides the base load energy for district heating, which will be delivered to the district heating network, total hours of the plant will be 8.000 hours/year. The focus will be on generation cost so no revenues will be calculated. Life time of the project is estimated 30 years of operation; repayment of loans is 30 years, depreciation off the drilling is 50 years, depreciation of the substation is 30 years, depreciation of the pump is 3 years and interest rate will be 7,5%. The costs for a district heating network and special installations, as well as taxes and fees, are not included.

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, (2006 prices). The study shows, that cost structure of generating heat from fossil has higher operating costs than geothermal which has higher fixed costs. Total heat generation costs of geothermal energy are low in absolute terms due to the high utilisation rate and low variable cost. During increase of primary energy prices, the total costs of generating heat from fossil fuels are rising more rapidly due to high variable cost, than from geothermal, as can be seen on figure 5.1.1.7.

Fig. 5.1.1.7. **Heat Generation Cost for District Heating Network by Fuel**



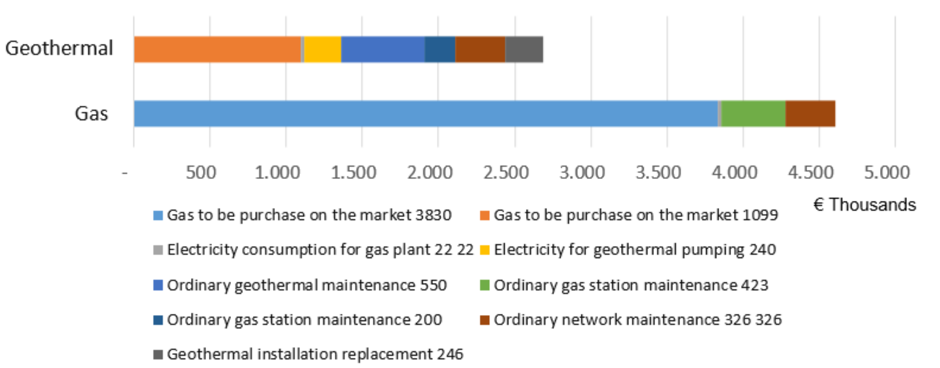
Source: GeoDH 2014.

Business Model for Geothermal District Heating and Gas
Cost Comparison – kWh Produced by Natural Gas and Geothermal Heat

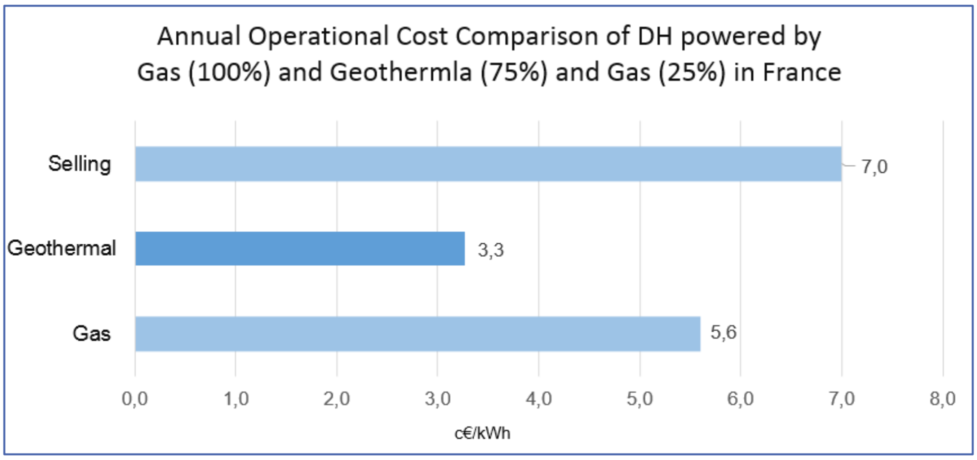
This business model is based on comparison between a district heating network using natural gas and a geothermal district heating network, in the Paris area, described in GeoDH paper from 2014. The project (geothermal doublet) has been running for 31 years. However, the geothermal water flow rate is decreasing. (GeoDH, 2014).

The key findings of this demonstrative example in France is that the actual production cost of the heat produced using 100% gas is about 5,6 c€/kWh for a final selling price to the consumer at 70 c€/kWh, all inclusive. However, the same kWh produced with a mix of natural gas (24,82%) and geothermal (75,18%) is 3.27 c€/kWh. The benefits and difference, which is 2,33 c€/MWh, will allow to finance the construction of the doublet. The annual production of the project is 81.980 kWh/ year with a turnover of 5,739 k€. The annual profit using geothermal is 1.918 K€.

Annual Operational Cost Comparison of DH powered by Gas (100%) and Geothermla (75%) and Gas (25%) in France



This profit will pay back the investment cost in 7,45 years, meaning that after 8 years the community will start to gain about 2 million euros per year, or it would be possible to lower the price of 2,33 c€/kWh and keep the profit as before (GeoDH, 2014). This demo example, shows the opportunities and economic benefit that may be gained from geothermal resources in combination with other energy resources in district heating.

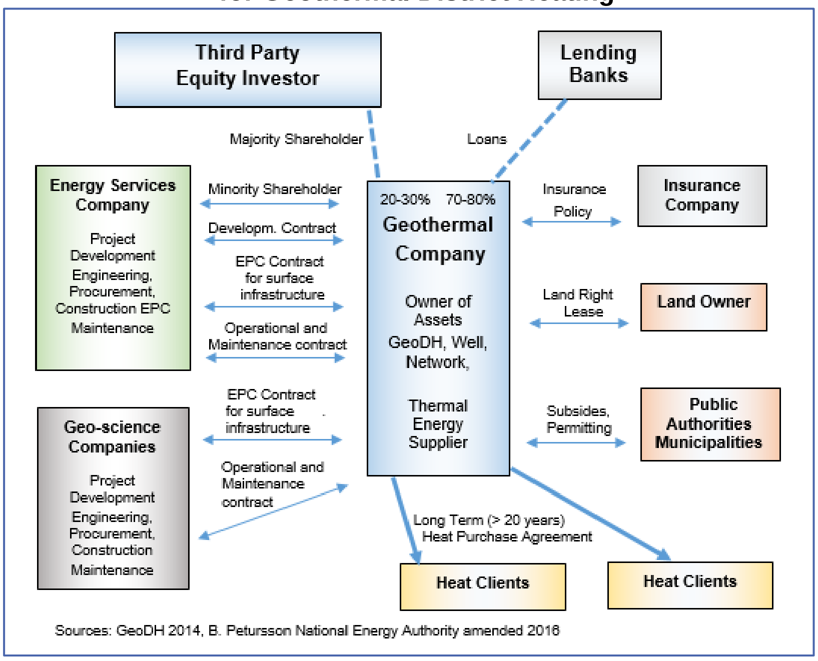


As can be seen from the case in France, the actual annual operational / production cost of the heat generated using 100% gas is about 4,6 M€ (5.6 c€/kWh) - but only 2,7 M€ (3,27 c€/kWh) with a combination of geothermal (75%) and gas (25%). The benefits and difference which is 2,33 c€/MWh will allow to finance the construction of the doublet – and the profit will pay back the investment cost in 7,45 years – meaning that after 8 years the community will start to gain about 2 million euros per year – or it would be possible to lower the price of 2,33 c€/kWh and keep the profit as before.

5.1.2 Geothermal District Heating – Legal Structure

Legal and financial structure and planning are main elements of geothermal district heating planning and risk assessment. However, risk assessments depend on each type of project which can be different based on location, regulation, technology, management, finance etc.

Fig. 5.1.2.1. **Legal and Financial Framework for Geothermal District Heating**

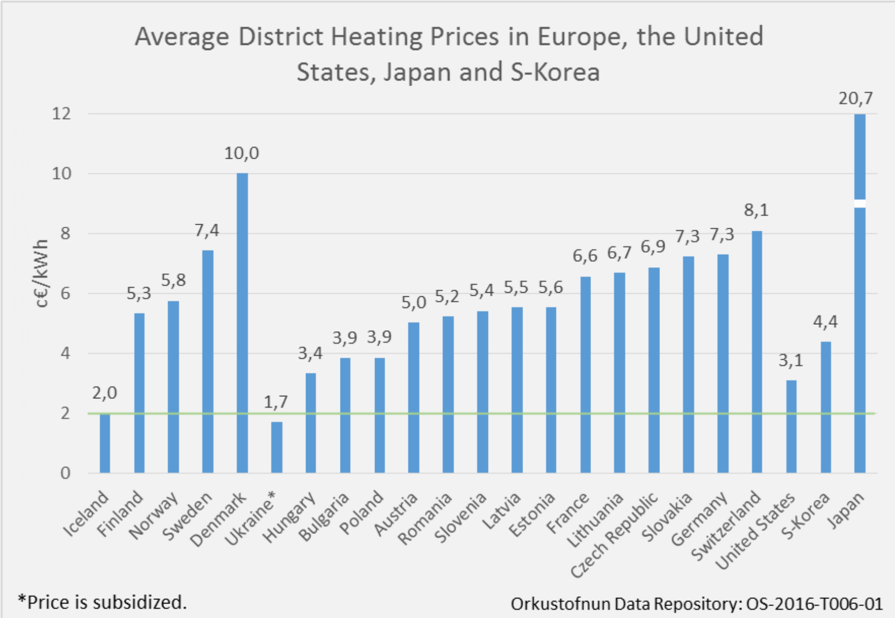


Nevertheless, there are also general similarities for such projects regarding legal and financial frameworks for geothermal district heating – as can be seen in enclosed figure 5.1.2.1.

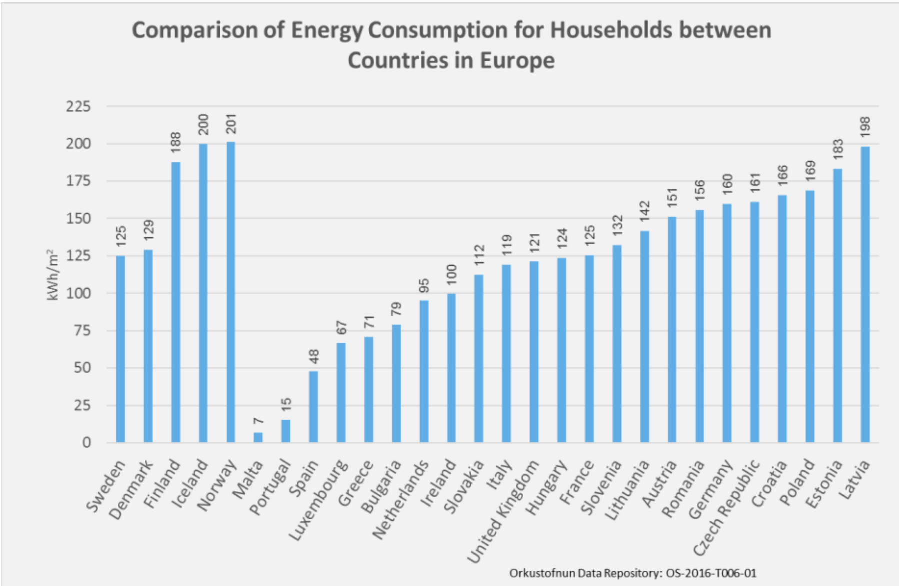
A Geothermal Company (GC) financed by the equity investor (20-30%) and by bank by loans (70-80%), is established to centralise the assets, rights and operational agreements. This company signs long term (>20 years), heat purchase agreements with end users with a fixed charge (capacity charge) linked to kW of capacity subscribed, and a variable charge (“consumption charge”) proportional to kWh supplied. The company should also sign key contracts regarding engineering, procurement and construction and operating and maintenance, for both the geothermal well and the district heating network. The company also has to have insurance policies (civil liability, damage, geothermal resource risk if possible, etc.). Finally, the company has to secure land rights, permitting and subsidies with the land owners and public authorities or municipalities. (GeoDH, 2014).

5.1.3 Geothermal District Heating – Price in Europe

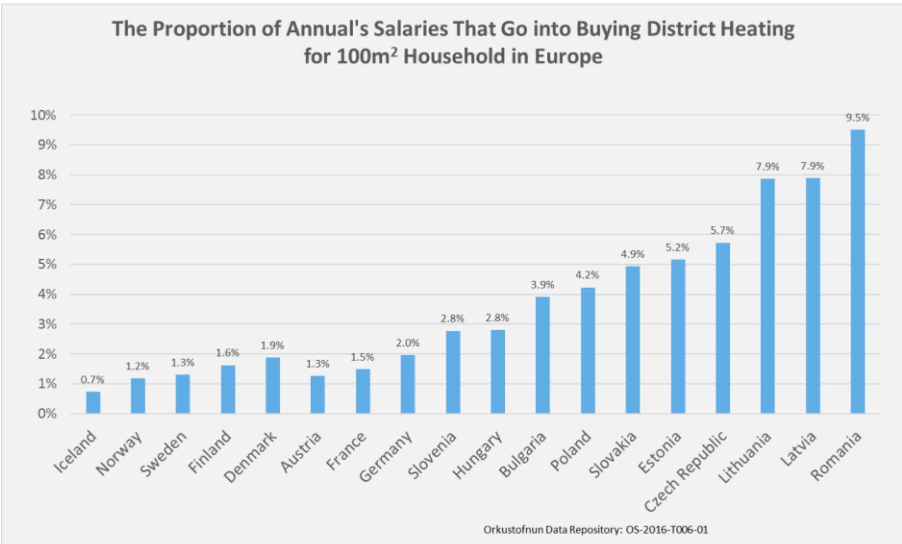
Average districts heating prices in Europe, Asia and USA are different. The lowest one is in Iceland 2,00 c€/kWh but the highest in Japan 20,7.



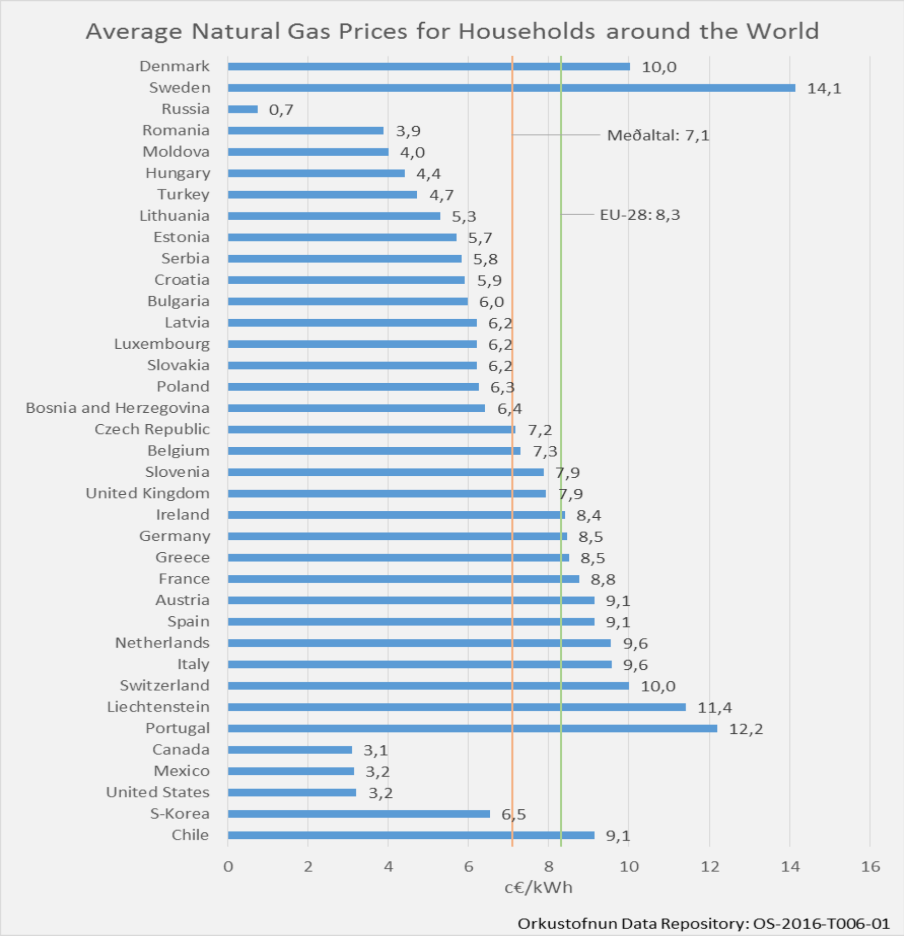
Energy use of households is highest in Norway, Iceland, Latvia, Finland and Estonia. All of these countries are in countries that are located in the north, and therefore rather cold countries.



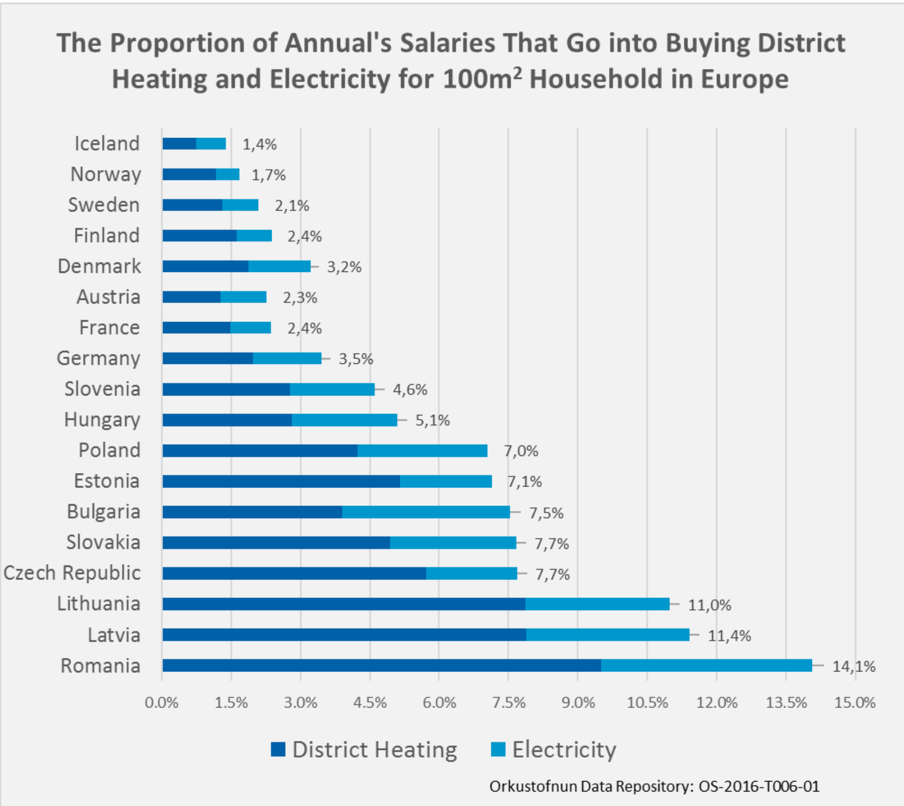
The proportion of annual salaries that go inti buying district heating for 100m² in Europe – is lowest in Iceland, Norway, Sweden, Austria, Finland, Denmark and Germany. The highest is in Romania, Latvia, and Lithuanian.



The average natural gas price differs also between countries, the highest one in Sweden, Portugal, Lichtenstein, Switzerland and Denmark. The lowest is in Russia, Canada, Mexico and USA.



The proportion of annual salaries that go into buying district heating and electricity for 100 m² – is the highest in Romania, Latvia and Lithuania. The lowest is in Iceland, Norway, Sweden, Austria, France and Finland.



5.2 The Questionnaire

5.2.1 General items

Second half of the questionnaire was directed at getting a more in depth view of the financial instruments and funding of Geothermal Projects. Previous reports have found that market conditions in the EU electricity and heat sectors prevent geothermal from fully competing with conventional technologies developed under protected, monopolistic market structures where costs reduction and risks were borne by consumers rather than by plant suppliers and operators.

The unfair competition with these conventional techniques like gas, coal, nuclear and oil, is one of the primary reasons for justifying the establishment of financial support schemes for geothermal. The Commission has pointed out that the main support instrument in place in the EU currently is feed-in-tariff, i.e. fixed and guaranteed price paid to the eligible producers of electricity from renewable energy sources.

The costs of capital for renewable energy sources investments observed in countries with established tariff systems have proven to be significantly lower than in countries with other instruments that involve higher risks for future returns on investments. It is clear that the more costs are competitive and markets mature, the less financial support is needed for geothermal projects. In coming years, the cost of fossil fuels is expected to rise, at the same time ensuring competitiveness and access to affordable energy for all is crucial, notably in difficult economic times. In this respect, geothermal energy can not only contribute to a decreasing in energy system costs (as it does not require additional system costs), but improve security of supply (it is available everywhere, 24 hours a day).[11] Capital costs for geothermal generation are higher than all other renewables and conventional technologies. They are also highly dependent upon the specific site and technology, as well as dependent on drilling, namely: the number of geothermal wells required and the depth of drilling.

In addition, **geothermal is associated with the geological risk**. The geological risk exists especially at sites with only partially known subsurface conditions. Project developers therefore have very little capability to manage the financial risk owing to the poor knowledge of the deep subsurface, lack of technological progress and high cost.

Legal aspects are also a factor such as the ownership of the underground resources, permits for exploration and exploitation of resources, requirements concerning public availability of geological data obtained during exploration and production. Geothermal may also fall under groundwater laws, environmental and building permits. And in case of electricity production regulations related to electricity production may be applicable. This brings uncertainty to potential investors and needs to be addressed.[12] [13]

The economic and financial crisis of recent times have also affected investment in clean energy. Whilst some countries such as Germany have maintained their level of financing, elsewhere financing geothermal projects has become more difficult. Geothermal energy is only a minor part of the energy mix in all ERA NET countries except Iceland and potentially Turkey as it is. However with the exception of Iceland, all countries within the ERA-NET geothermal have an ambitious agenda for an increase of the market for geothermal energy.[14][15]

The answers to the question of whether there is a possibility to be funded from abroad are quite varied. Majority of participants say that it is possible even though sometimes with limits. In Germany it is possible if the company has activities in Germany. While in Switzerland there is a possibility to be funded from

[11] EGEC
[12] EGEC
[13] WP2.1
[14] EGEC
[15] WP2.1

abroad but only Swiss companies can be funded. While Turkey and Hungary report there to be no possibility of being funded from abroad.

National Support for Renewable Energy Projects

Use of different support & policy instruments for electricity, heating & cooling		Germany	Hungary	Iceland	Italy	Portugal	Netherlands	Slovakia	Slovenia	Switzerland	Turkey	Ranking
Electricity	FIT	X	X		X				X	X	X	6
	Premium						X		X			2
	Quota obligation				X							1
	Investments grants		X				(x)	X	X	X	X	6
	Tax exemptions						X			X	X	3
	Fiscal incentives	X					X[1]					2
	Risk guarantee	X					X			X		3
	Auctions / tendering schemes						X					1
	Capacity markets											
	Renewable portfolio standards											
	Contracts for difference											
Direct use of geothermal energy for heating (e.g. district heating systems)	Investments Grants	X	X	X			X[2]	X	X	X	X	8
	Tax exemptions						X			X	X	3
	Fiscal incentives			X	X		X					3
	Premium						X					1
	Risk guarantee	X		X			X					3
	Auctions / tendering schemes						X					
	Capacity markets											
	Renewable portfolio standards											
	Contracts for difference											
Small heating and cooling applications (e.g. shallow geothermal heat pumps, etc.)	Investments Grants	X		X				X	X	X	X	6
	Tax exemptions						X			X	X	3
	Fiscal incentives	X		X	X		X					4
	Premium											
	Risk guarantee											
Emission	Emissions trading certifies	X	X	X			X	X	X	X		7
Other measures	(Please provide very short description),,,,											
National support for fossil fuels (oil, gas, coal)	Fiscal incentives for electricity generation	X	X					X				3
	Fiscal incentives for district heating	X	X									2

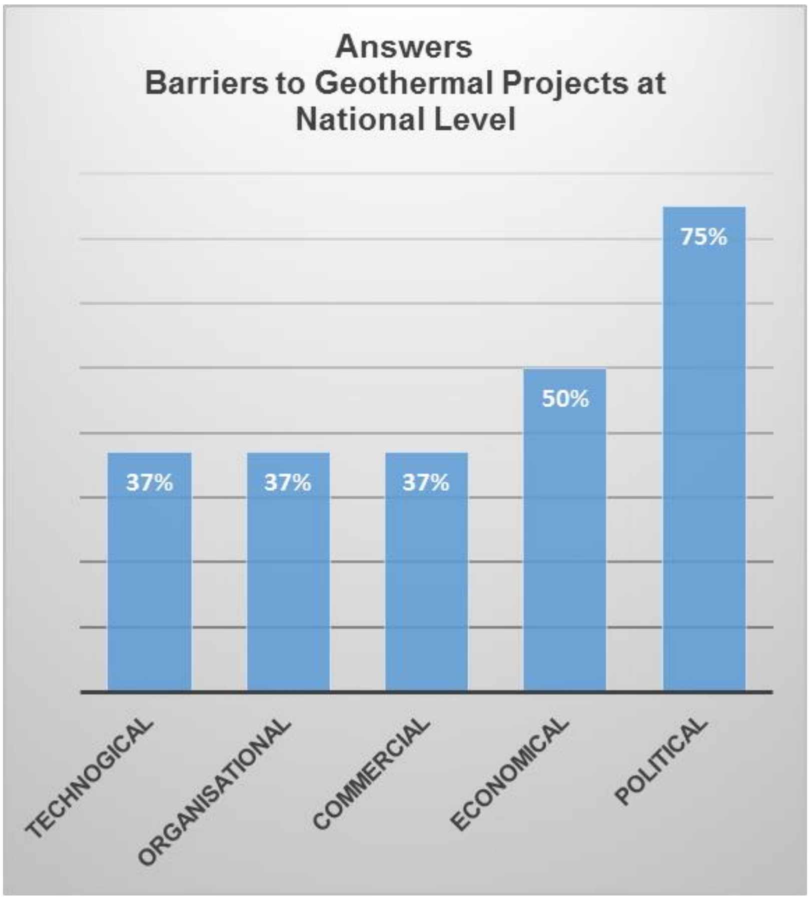
Sources: Geothermal ERA NET, 2015

5.2.2 Barriers to Geothermal Projects

There are not nearly as many barriers to geothermal energy projects mentioned as there were to geothermal RD&D. Couple of the participants mention only political barriers (Switzerland and Slovakia) and one mentions no barriers to geothermal projects (Turkey).

As with before when looking at barriers to geothermal RD&D the barriers were divided into five groups; technological, economical, commercial, organizational and political. It is clear from **Figure 5.6.1** that participants do not perceive as many barriers in regards to geothermal projects as they did in regards to geothermal RD&D. Looking at the overall responds to the question it is noticeable that political issues are seen as the most common barrier to geothermal projects.

Fig. 5.6.1. **Percentage of participants claiming there are barriers to geothermal projects.**



Technological barriers were only reported by Hungary, Germany and Slovenia. High risks avoid adequate credit opportunities, high drilling costs and upfront investment needed, no single national funding instrument for borehole drilling, lack of risk mitigation scheme.

Economical barriers were reported by exactly half of the participants. Project funding rate is low, for small companies it is often a problem to provide own resources. Financing schemes are often dependent on the private bank sector which is very reluctant in case of credits for geothermal projects. Lack of proper instruments for geothermal risk mitigation. To go beyond the market of (a cluster of) horticulturists, projects would need to heat city districts. However, financing of district heating networks is very difficult because of extremely long payback periods. Projects that cannot claim any innovation need to come up with 30% equity, which is to them a serious barrier. There is a debate going on, whether the government should establish a long-term guarantee for lasting production. This should lead to more appetite in banks to act as a financer. In Italy there are no dedicated calls on geothermal projects, except the fid-in-tariff schema for industrial projects.

Commercial barriers were fewer and simpler than economical barriers reported. No FIT for heat. There is a limited market for DH and the commercial gap between benefitting from geothermal and risk of failure is too wide and no instrument is available to overcome the gap. The geothermal market in Slovenia is highly undeveloped. In case of production stops, projects are extremely vulnerable, owing to their typical financial structure (horticulturists investing in their own installation). Projects have become more expensive over the years, since the demands on projects have changed.

Organizational barriers were reported by minority of the participants. Long approval procedure leads to long timespan until ROI. The geothermal researchers and developers are not organized in a Geothermal organization or cluster which will promote RD&D. the whole geothermal project is focus mostly on drilling and completion of the well, all other RD&D activities are deliberately ignored as unnecessary costs. Challenge is the efficient building-up of suitable skills.

Political barriers were reported by all participants who answered except for Turkey. A public funded successful demonstration project would relief the pressure on the financial market. Unwillingness to engage in what is seen to be industrial policy (i.e. the preference to build up an industry with governmental funds – cf. national champions of various European countries). There is political consent that geothermal energy should be supported, but the geothermal strategy on which support instrument could base on is not written. A certain unwillingness to have many specific measures for promotion of geothermal energy, other than other sources of renewable energy. Energy policy focuses on nuclear energy. Renewables and thus geothermal energy is not competitive with subsidized gas prices.

5.2.3 Opportunities of Geothermal Project

Participants were asked to highlight opportunities for geothermal projects. Quite a few opportunities were mentioned although much fewer than for geothermal RD&D.

- An intelligent funding can prove the advantages of geothermal energy to investors. Only possible if adequate proposals are delivered by the industry. At the moment it's going round in circles.
- New Operational Programme for the implementation of European cohesion policy in the period 2014-2020 will accelerate introduction of RES systems to produce heat by promoting the use of priority biomass, solar and geothermal energy as well as the exploitation of biomass CHP high efficiency and district heating systems, Incentives will comply with the requirements of Directive 2008/50/EC and the package of measures for cleaner air in Europe, in areas already introduced remote systems and air polluted brownfield areas will promote the construction of new individual systems on wood biomass. Funding about 2.000.000 EUR for geothermal district heating system is foreseen, but the drilling of geothermal boreholes is not eligible cost. The source has to be proven.
- Structural funds 2014-2020 on Energy Efficiency
- The demonstration programmes are relatively new (started 2014 and 2015). This introduces new concepts and new opportunities.
- 1509 funding programmes with flexible budget limits when joint call is realized
- Introduction of (geological) risk insurance
- Introduction of green-heat certificates
- Renewables for heating in Iceland is already saving up to 7% of GDP or equivalent 3000 US $ per capita per year

5.3 The Brussels Seminar – Presentations – Lessons Learned

JA NWW (New Ways of Working) Workshop, was held in Brussels October 5th, 2015. The theme of this workshop was "Financial Instruments and Funding of RD&D and Geothermal Projects – Barriers and Opportunities and Policy Recommendation". The overall objective of Joint Activity "New Ways of Working" was to improve the synergies between different players in the field of geothermal utilization and improved funding in R&D and project financing across national borders. It is also to strengthen European geothermal development for economic opportunities, energy security and mitigate climate change.

The task was also to mapping of current financial framework and instruments for geothermal business projects, challenges and policy options and opportunities to:

- Attract more financing for geothermal projects - and more innovative financial solutions to finance geothermal projects which are capital intensive and risky on early stages.
- Increase the awareness of country, regional and local decision-makers on geothermal potential projects and its advantages to strengthening European geothermal development for economic opportunities, energy security and mitigate climate change.

The first session at the seminar was on R&D activities in the ERA-NET countries, national research funding needs, barriers, opportunities and policy recommendation. The second session was on projects in the ERA-NET countries, national project funding needs, barriers, opportunities and policy recommendation.

Speakers gave presentation and after each session discussions among speakers and participants followed about priorities and next steps. At the meeting there were presentations from Unit B1 Energy, Executive Agency for Small and Medium-sized Enterprises (EASME), European Commission (Horizon 2020), DG CLIMA, EGEC, European Bank for Reconstruction and Development, ERDF, European Commission Regional and Urban Policy DG Unit G.1 – Competence Centre Smart and Sustainable Growth, presentations from Geothermal ERA NET Countries and the Icelandic Geothermal Cluster. The seminar, presentations and discussions, was important input to this report. Number of participants: 21

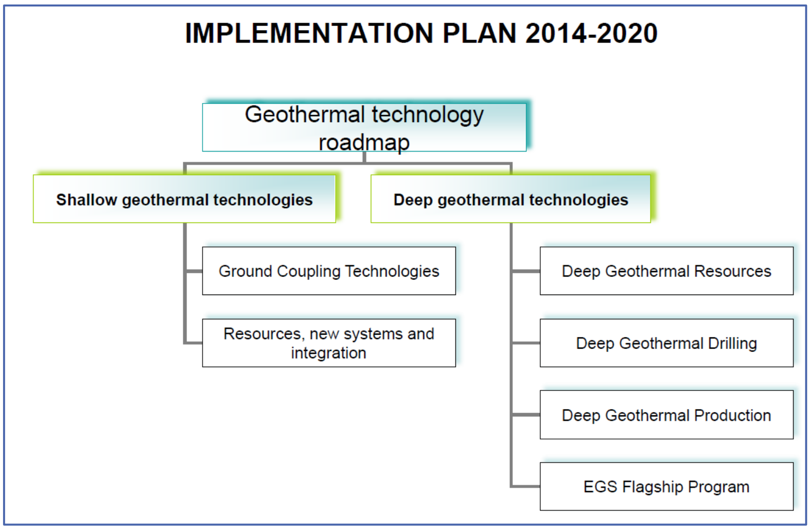
In following chapters – key elements in some presentations at the Seminar will be highlighted and more detailed information are also available at the Geothermal ERA NET website.

5.3.1. Financing Geothermal RD&D and Projects – Philippe DUMAS, EGEC

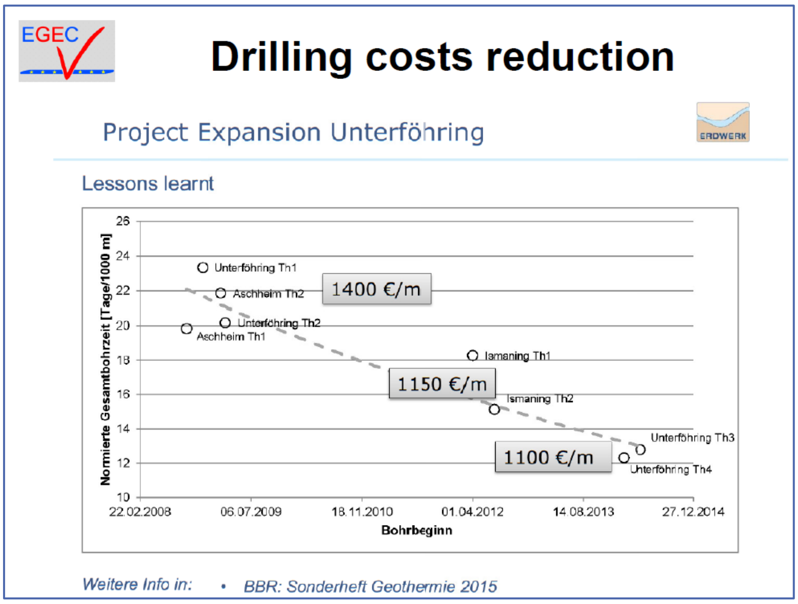
Some elements of geothermal competitiveness, technology challenges, and implementation plan can be sees on enclosed slides.

Technologic challenges in the sector depends on classifications.

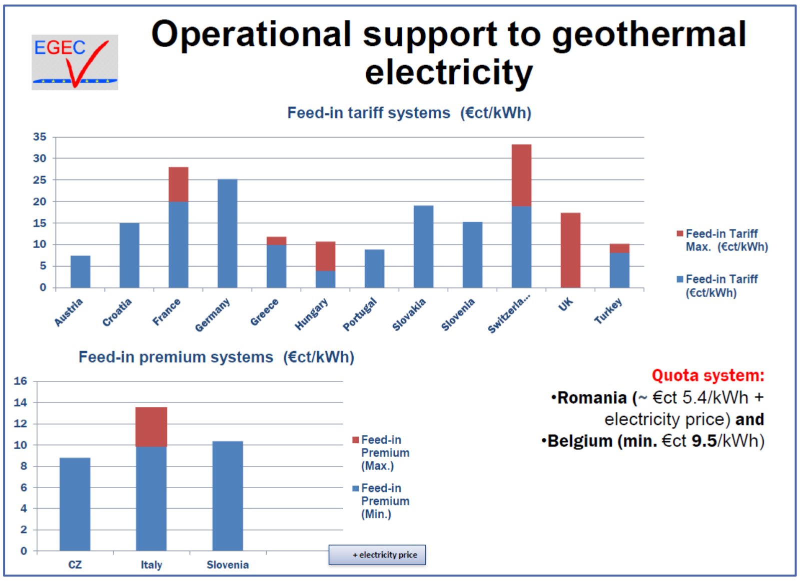
The implementation plan is classified into shallow and deep geothermal technologies.



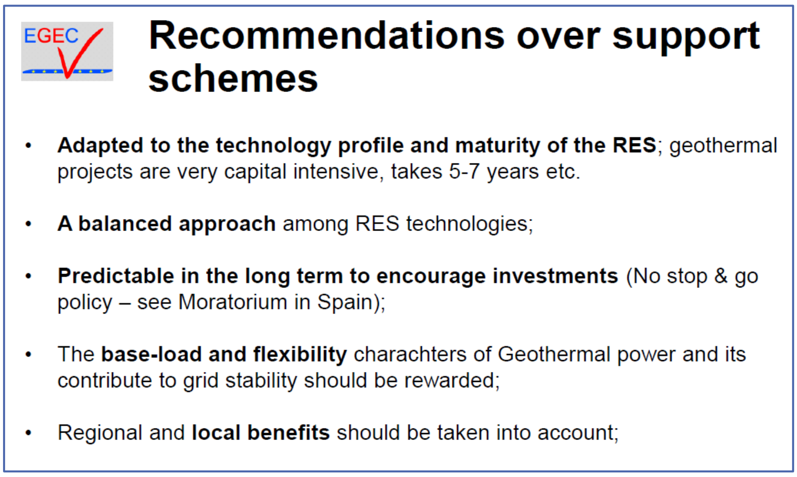
As can been seen geothermal drilling cost have gone down past years – increasing the competitiveness of the sector.



Operational support to geothermal in Europe is different between countries.



Geothermal Policy recommendations from EGEC



See more information:

http://www.geothermaleranet.is/publication/presentations/

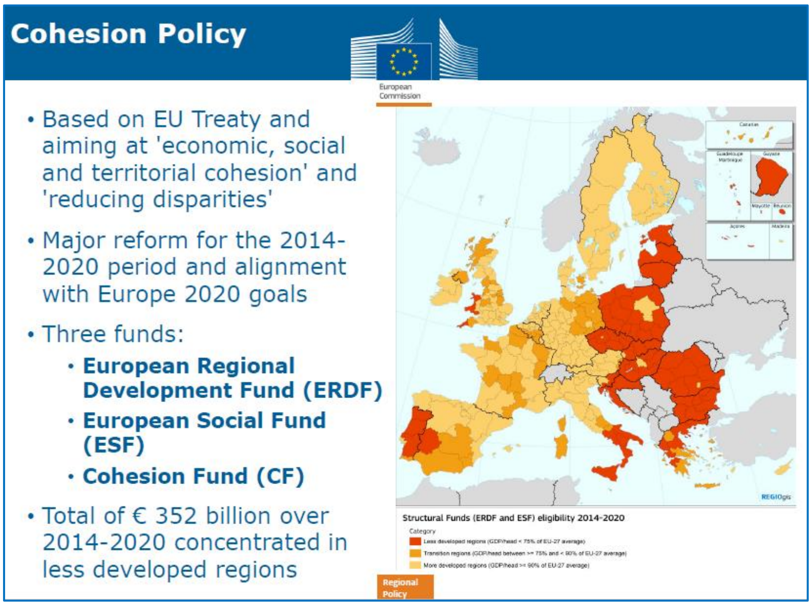
2015 - JOINT ACTIVITY NWW MEETING IN BRUSSELS, OCTOBER 5, 2015

Philippe Dumas, Secretary General EGEC

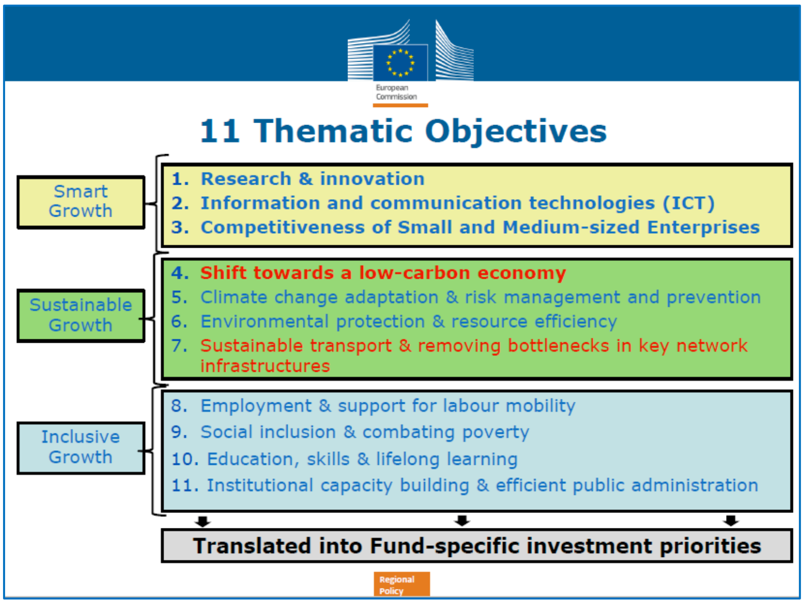
5.3.2. Cohesion Policy Investments in Sustainable Energy 2014 – 2020 – Maud SKARINGER, European Commission

There is substantial funding to energy related activities – within the EU Structural Funds.

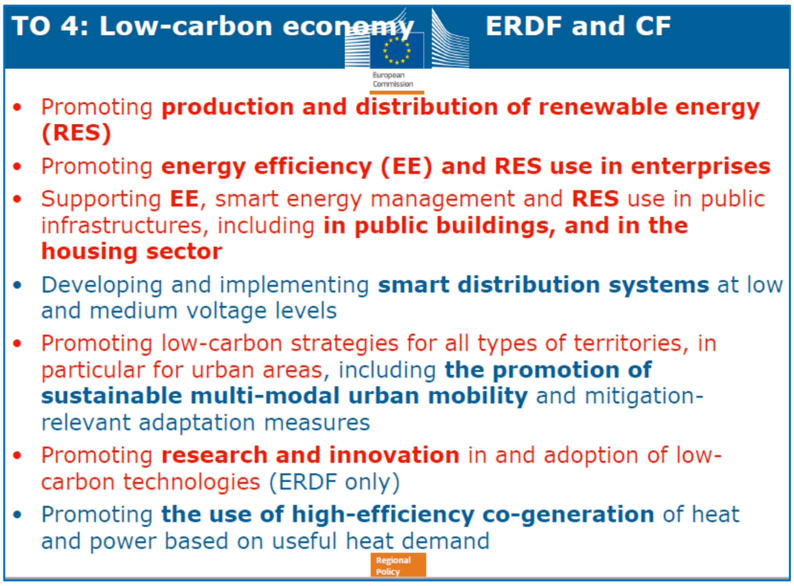
Total € 352 billion are available 2014 – 2020.



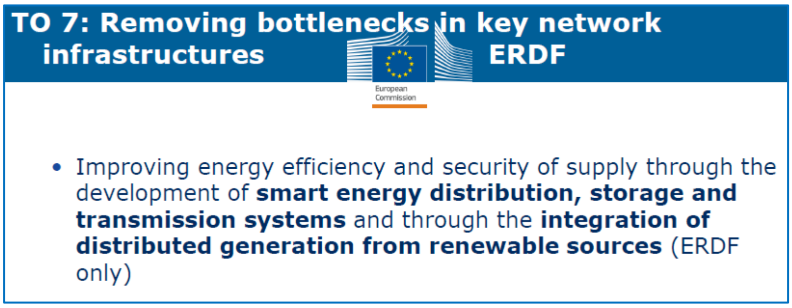
Sustainable growth is part of the program.



Low-carbon economy is part of the program



Several options are towards energy projects



Regional strategies are part of the options

See more information:

http://www.geothermaleranet.is/publication/presentations/

2015 - JOINT ACTIVITY NWW MEETING IN BRUSSELS, OCTOBER 5, 2015

Maud SKÄRINGER, Policy Analyst EC

5.3.3. The Role of the Private Sector in the Development of Geothermal Power – EBRD GPP Financing, Adonai Herrera-Martínez, EBRD

Financing mechanisms for exploration

European Bank for Reconstruction and Development

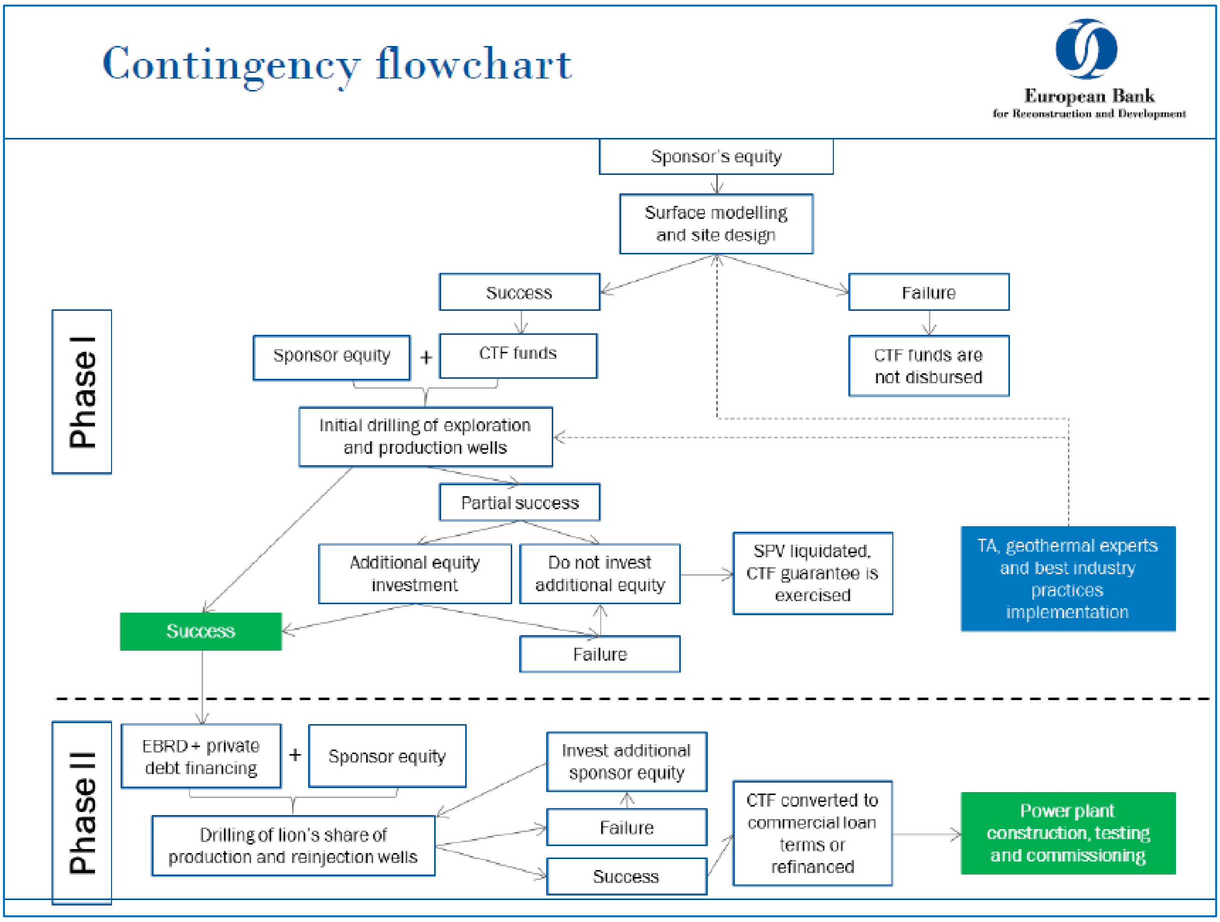
Illustrative Assessment of Leverage Capability by Policy

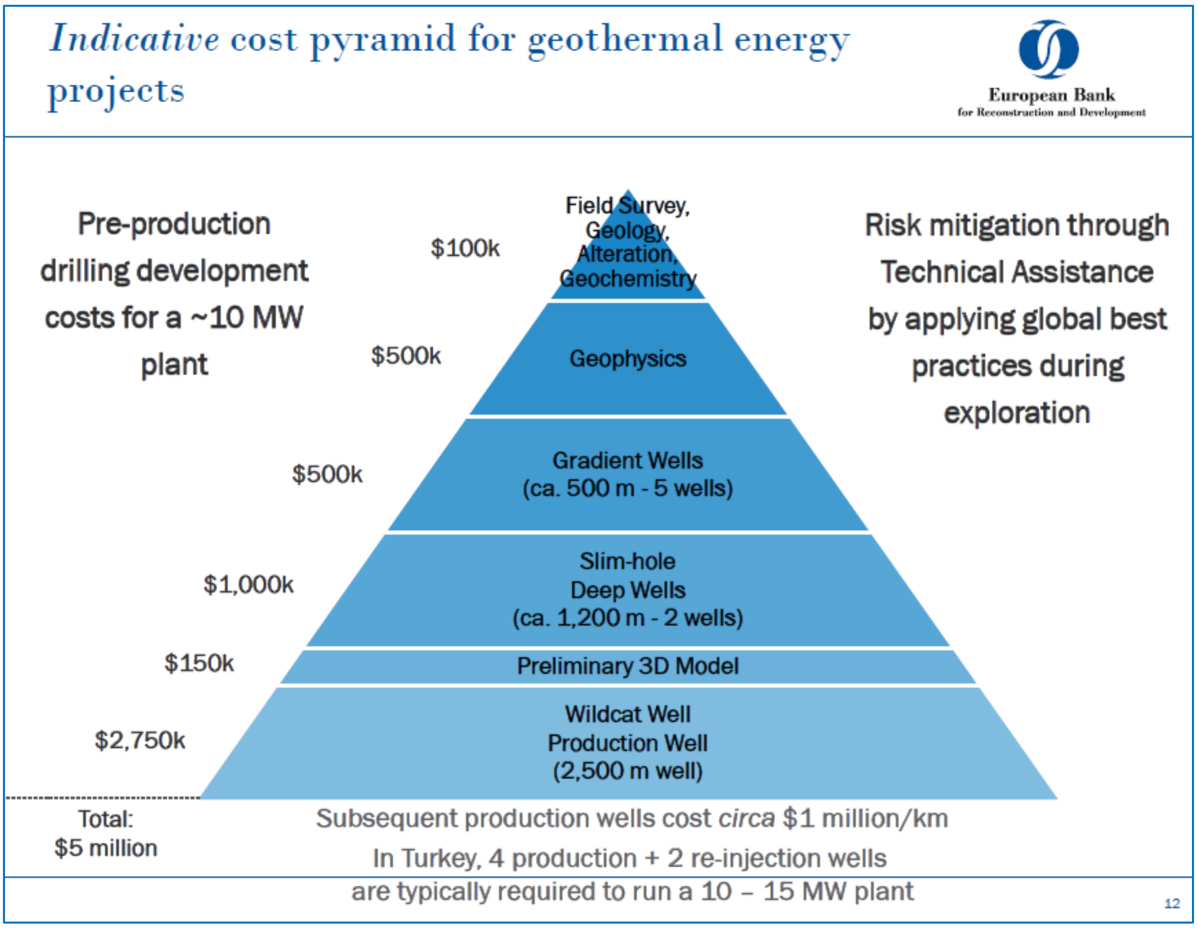
Low leverage	Medium leverage	High leverage	Very high leverage
Government-led exploration: government incurs full cost of exploration and investment forfeiture in the case of dry wells	**Lending support mechanisms**: interest from loans could help defray costs, provided that the default rate remains low	**Loan guarantee**: high leverage in the case of limited guarantee payouts	**Quasi-equity support** (concessional financing) at early stage Conversion to **commercial financing** for GPP construction
Grants and cooperative agreements: represent a liability in either the case of direct payouts or foregone tax income		**Drilling failure insurance**: high leverage in the case of limited claims	Use of **revolving fund** for concessional portion after 2 years

EBRD framework

1. *addresses the equity gap at early stage;*
2. *tackles technical risks by utilising global experts; and*
3. *uses fast turnover of concessional funds to enhance the leverage capacity of climate finance*

Adapted from Speer et al., 2014. "Geothermal Exploration Policy Mechanisms: Lessons for the United States from International Applications." The assessments of leverage provided here are general comparisons across the five policy types. Actual leverage will depend on the specifics of policy design.





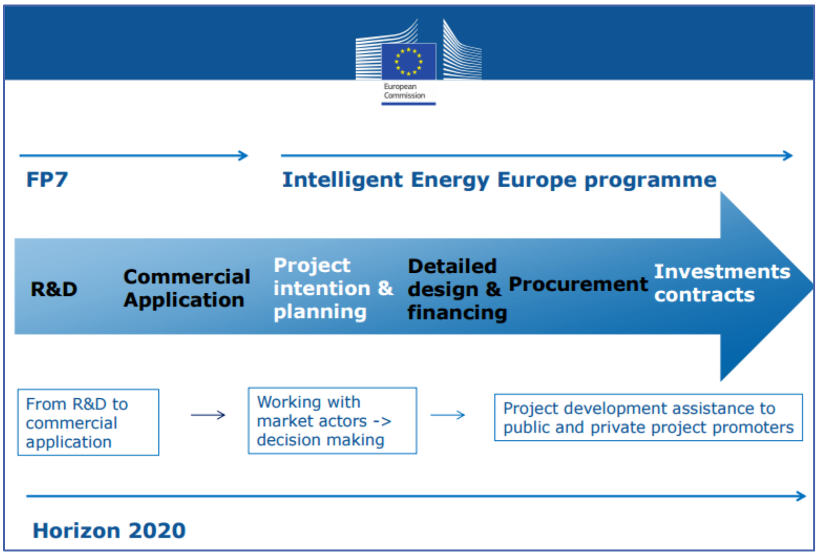
EBRD is providing several options regarding geothermal projects.

See more information:

http://www.geothermaleranet.is/publication/presentations/
2015 - JOINT ACTIVITY NWW MEETING IN BRUSSELS, OCTOBER 5, 2015
Antonio Aguilo Project Manager

5.3.4. Intelligent Energy Europe and Horizon 2020 programmes, Antonio Aguilo, European Commission

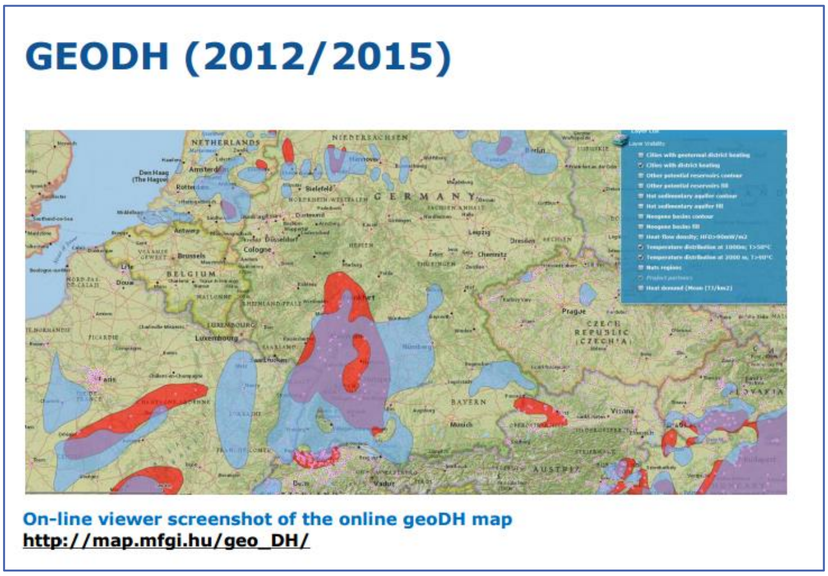
There are several funding possibilities to energy related activities – within the Horizon 2020.



GEODH is focusing on several activities.

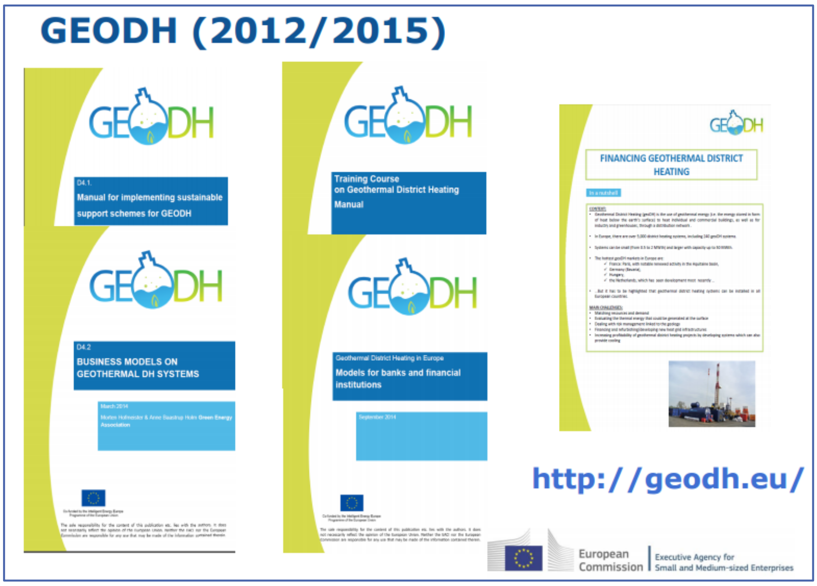
Here is an on-line information regarding geothermal issues on the web

https://map.mfgi.hu/geo_DH/



GEODH is making several reports and recommendations regarding the geothermal sector

http://geodh.eu/



The ReGeoCities project (01/05/2012 to 30/06/2015) worked on the integration of shallow Geothermal Energy at a local and regional level.

It examined and promoted best practices and an intelligent regulatory framework, supporting cities to reach their SEAPS and the 2020 climate and energy goals.

http://regeocities.eu/

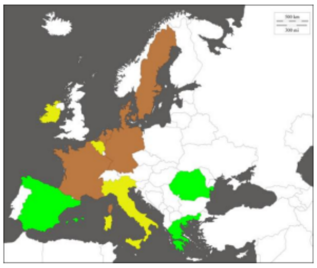
REGEOCITIES (2012-2015)

Objectives

- Remove administrative / regulatory barriers affecting the uptake of **shallow geothermal systems** at local and regional level

Outcomes

- **Transfer best practice** regulatory frameworks from mature to juvenile regions
- Develop a **common methodology for regulation** of shallow geothermal systems in cities
- **Training** developed on how to plan and regulate shallow geothermal systems **for policy makers and administrative staff** / officers in public administrations



Project CO: EGEC, Belgium
http://regeocities.eu/

European Commission | Executive Agency for Small and Medium-sized Enterprises

See more information:

NOT LEGALLY BINDING

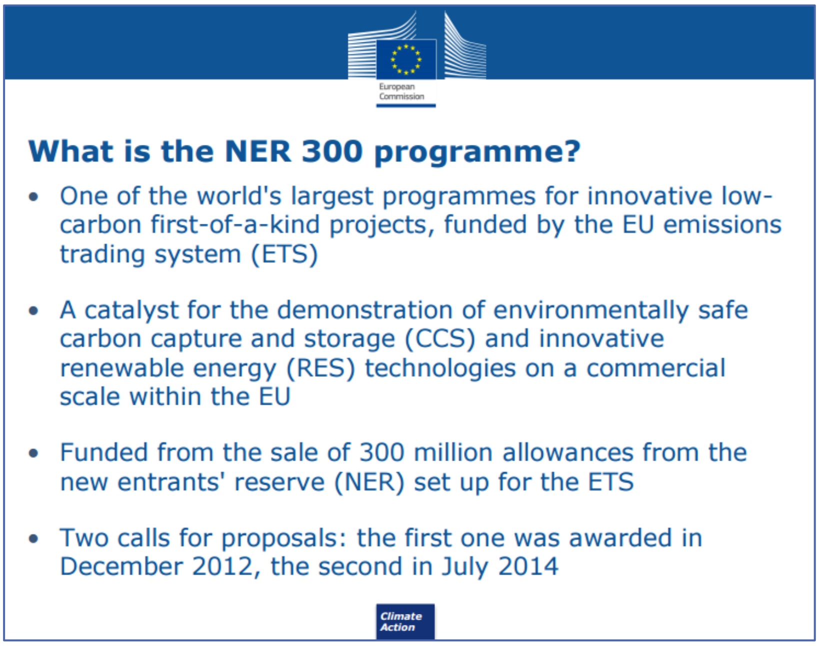
Code	EE Call 2016 Topics	Type	Budget (M€)	Deadline
EE-03	Standardised installation packages integrating renewable and energy efficiency solutions for heating, cooling and/or hot water preparation	IA	34	21 Jan
EE-04	New H/C solutions using low grade sources of thermal energy	RIA		
EE-05	Models & tools for heating and cooling mapping and planning	RIA		
EE-07	Behavioural change toward energy efficiency through ICT	RIA		
EE-08	Socio-economic research on consumer's behaviour related to energy efficiency	RIA		
EE-10	Supporting accelerated and cost-effective deep renovation of buildings	PPP	16	21 Jan
EE-17	Valorisation of waste heat in industrial systems	PPP		
EE-06	Engaging private consumers towards sustainable energy	CSA	30	15 Sep
EE-09	Engaging and activating public authorities	CSA		
EE-11	Overcoming market barriers and promoting deep renovation of buildings	CSA		
EE-13	Cost reduction of new Nearly Zero-Energy buildings	CSA		
EE-14	Construction skills	CSA		
EE-16	Effective implementation of EU product efficiency legislation	CSA		
EE-24	Making the energy efficiency market investible	CSA		
EE-25	Development and roll-out of innovative energy efficiency services	CSA		
EE-21	ERA-NET Cofund actions supporting Joint Actions towards increasing energy efficiency in industry and services	ERA-NET	5	15 Sep
EE-22	Project Development Assistance	CSA	8	15 Sep

http://www.geothermaleranet.is/publication/presentations/

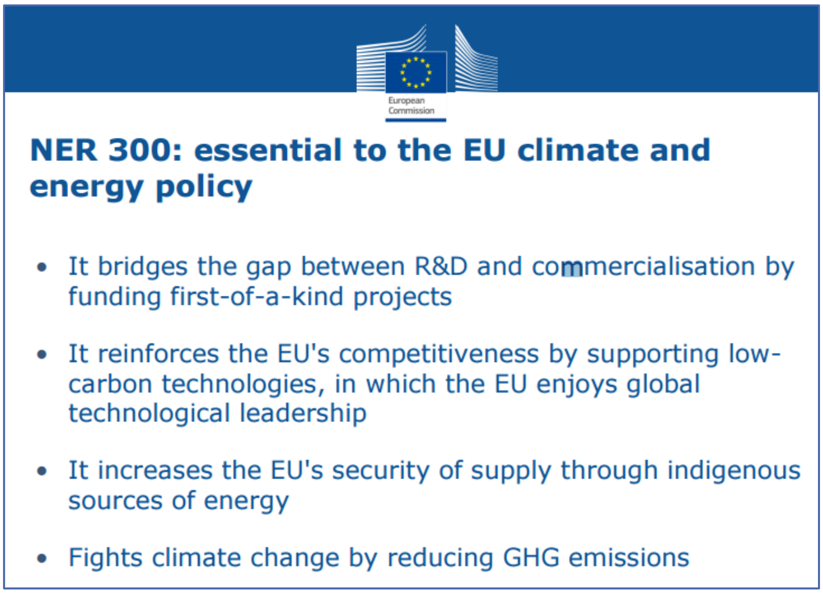
2015 - JOINT ACTIVITY NWW MEETING IN BRUSSELS, OCTOBER 5, 2015

Antonio Aguilo Project Manager, EC

5.3.5. Bringing low-carbon technologies to the market: the NER 300 program - Filippo Gagliardi, DG Climate Actions, European Commission



NER 300 bridges the gap between R&D and commercialisation



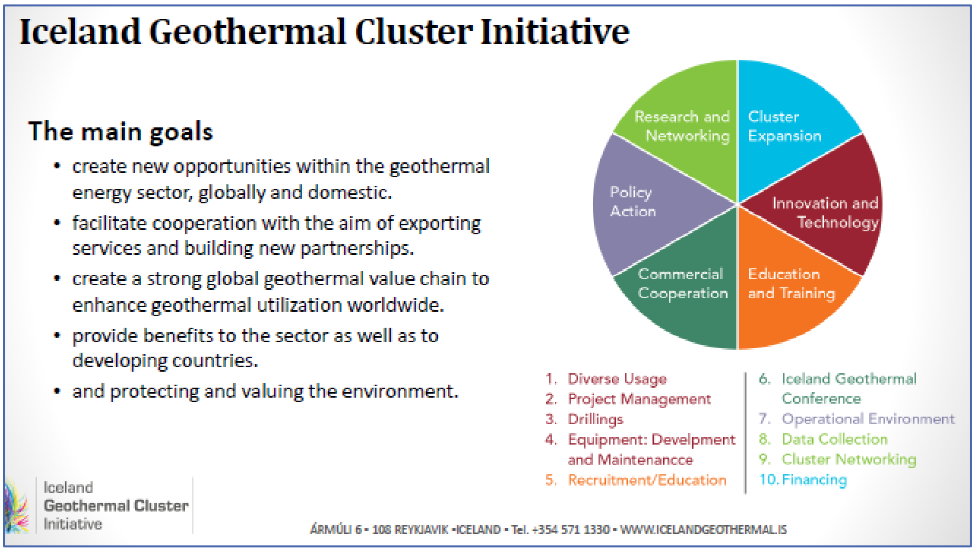
See more information:

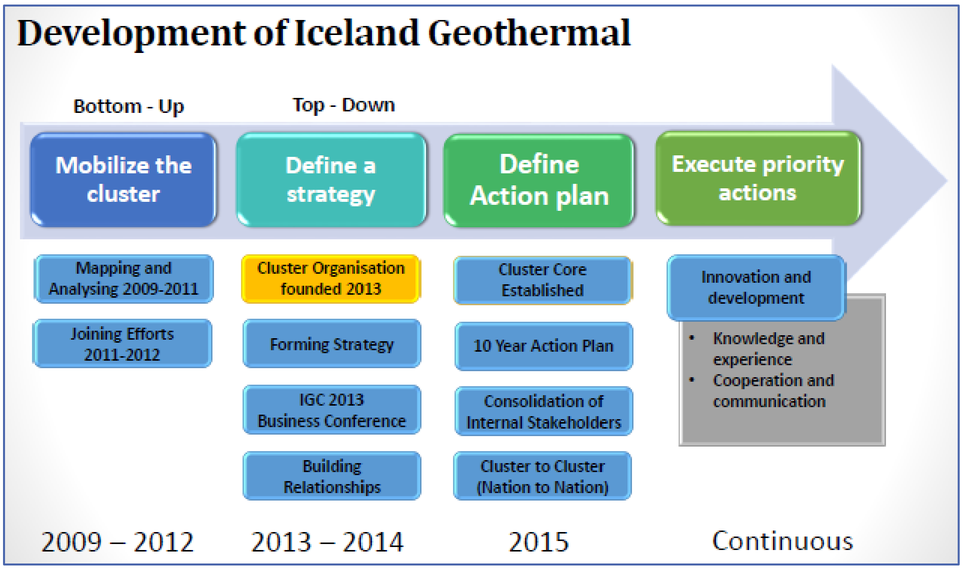
http://www.geothermaleranet.is/publication/presentations/

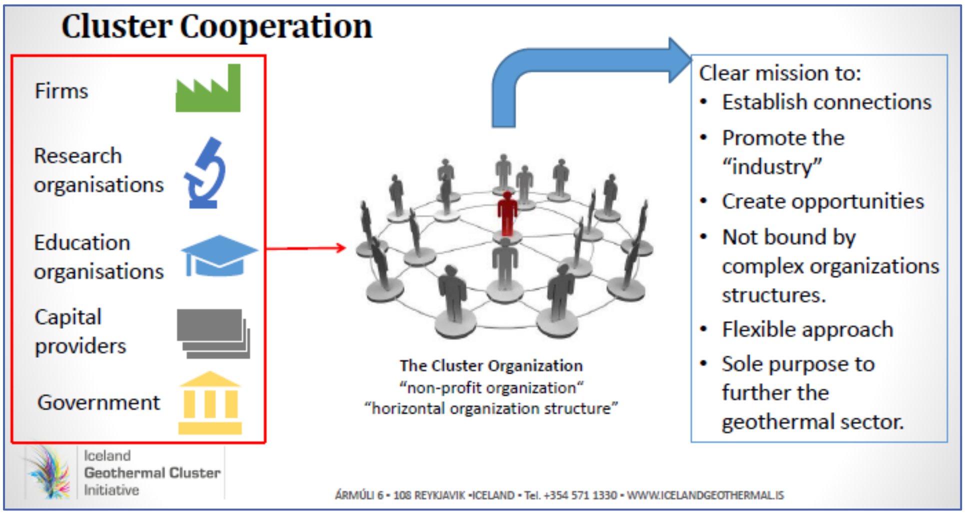
2015 - JOINT ACTIVITY NWW MEETING IN BRUSSELS, OCTOBER 5, 2015

Antonio Aguilo Project Manager, EC

5.3.6. The Geothermal Cluster – Cooperation between Companies, RD&D and financial Institutions, Viðar Helgason







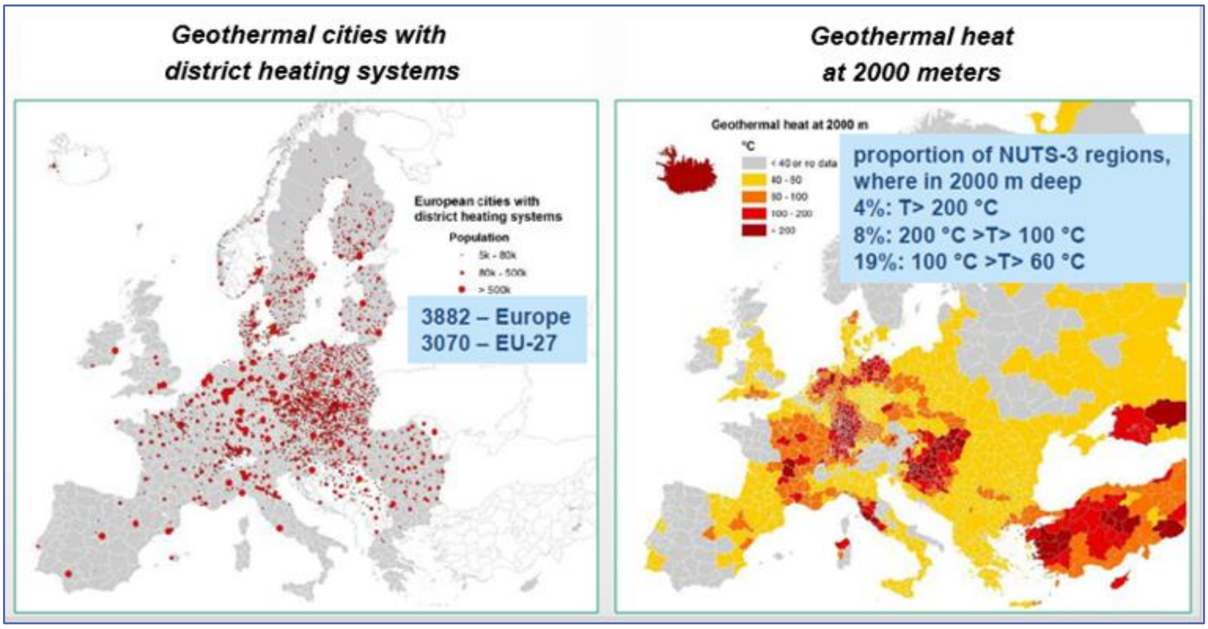
See more information:

http://www.geothermaleranet.is/publication/presentations/

2015 - JOINT ACTIVITY NWW MEETING IN BRUSSELS, OCTOBER 5, 2015

Viðar Helgason

5.3.7. European Cities with District Heating Systems – Geothermal Heat and EEA Grants

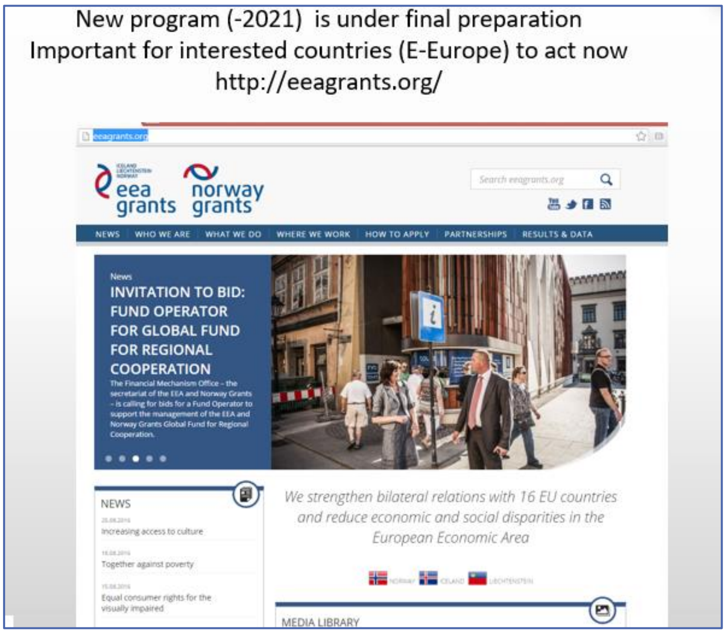


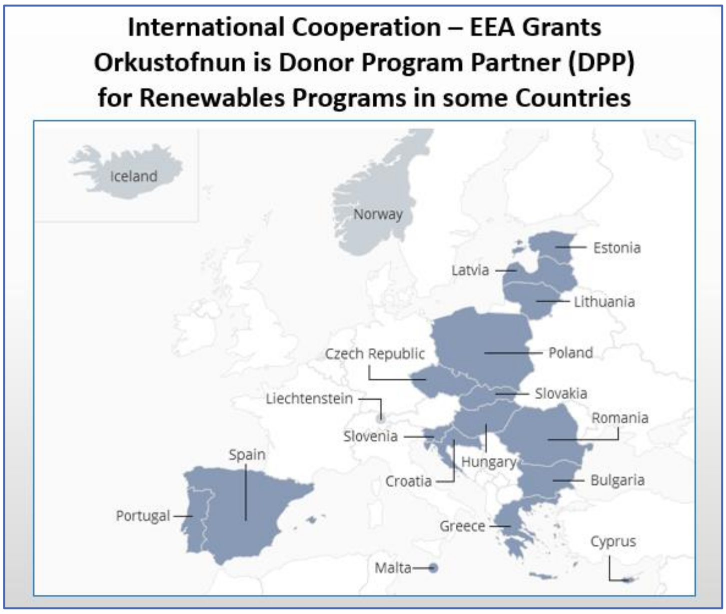
There are up to 500 European cities with district heating systems – and in several of those area there are geothermal resources – making it possible to connect the geothermal resources to those district systems.

The EEA and Norway Grants 2009-2014 provide funding to 16 EU countries in Central and Southern Europe and the Baltics. There are 32 programme areas within different sectors ranging from environmental protection and climate change to civil society and research.

All countries have different needs and priorities. Each country has agreed on a set of programmes with the donor countries based on needs, priorities and the scope for bilateral cooperation. For the EEA and Norway Grants 2014-2021, a total contribution of €2.8 billion from Iceland, Liechtenstein and Norway to 15 beneficiary countries has been agreed. The priorities for the 2014-2021 period reflect the priorities of the EU and aim to respond to the shared challenges facing Europe.

See further information.
http://eeagrants.org/



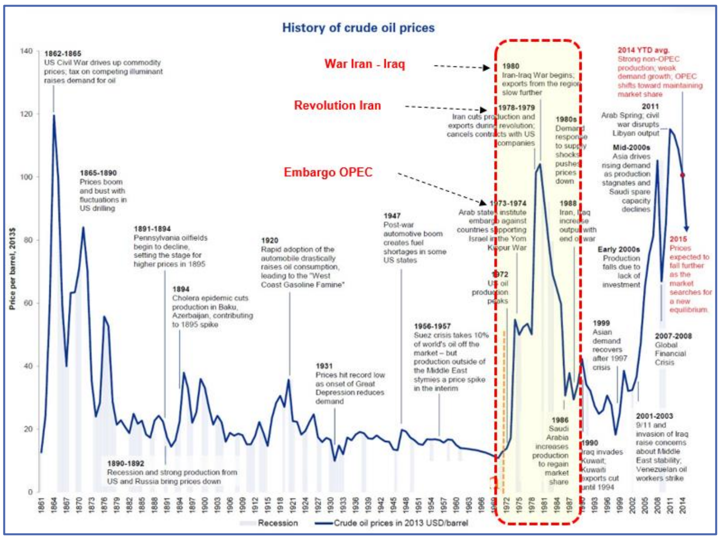


5.3.8. Iceland – Geothermal District Heating – Lessons Learned

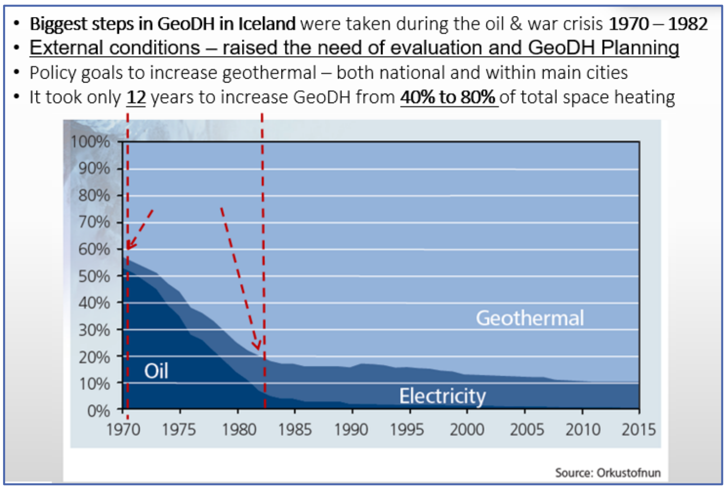
As Iceland has both long and successful record of district heating – a special focus will be on the lessons learned in Iceland in the report – as access to finance was a key element of the success in Iceland. In addition, special focus will be on – benefits of the geothermal policy in Iceland – both regarding economic factors as well as environmental and climate issues.

The beginning of the Geothermal Policy

When the oil crisis struck in the early 1970s, fuelled by the Arab-Israeli War, the world market price for crude oil rose by 70%. At the same time, close to 90.000 people enjoyed geothermal heating in Iceland, about 43% of the nation. Heat from oil served over 50% of the population, the remainder used electricity. In order to reduce the effect of rising oil prices, Iceland began subsidizing those who used oil for space heating. The oil crises in 1973 and 1979 (Iranian Revolution) caused Iceland to change its energy policy, reducing oil use and turning to domestic energy resources, hydropower and geothermal.

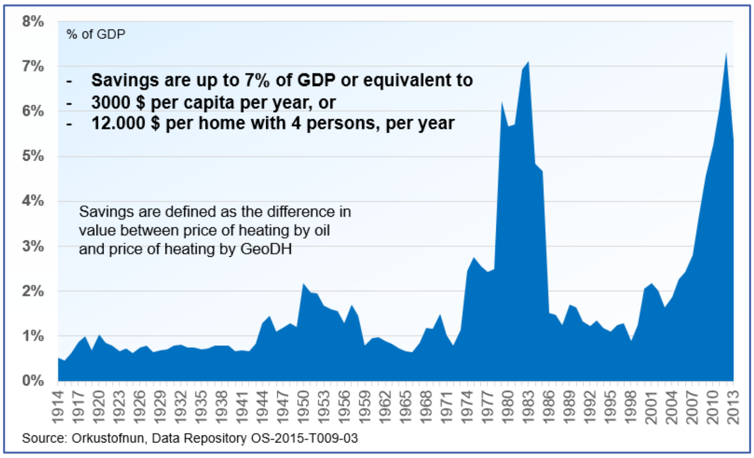


This policy meant exploring new geothermal resources, and building new heating utilities across the country. It also meant constructing transmission pipelines (commonly 10-20 km) from geothermal fields to towns, villages and individual farms. This involved converting household heating systems from electricity or oil to geothermal heat. But despite the reduction in the use of oil for space hea ting from 53% to 7% from 1970 to 1982, the share of oil still remained about 50% to 60% of the total heating cost due to rising oil prices.

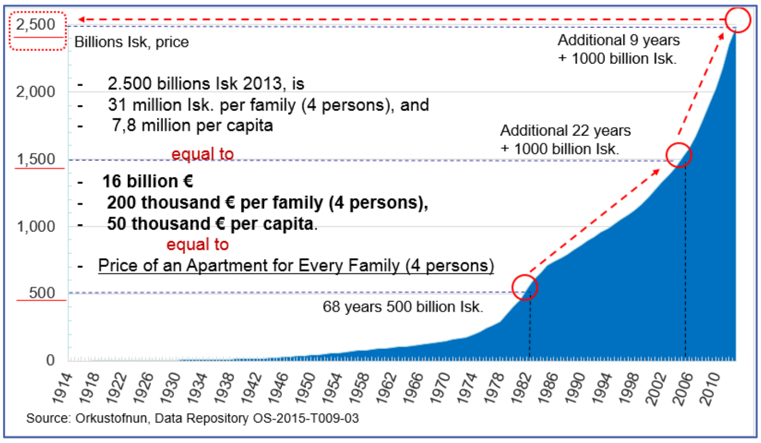


Benefits of using Geothermal Heat instead of Oil

The economic benefits of the government's policy to increase the utilisation of geothermal energy can be seen when the total cost of hot water used for space heating is compared to consumer cost if oil would be used, as shown in enclosed fig. The stability in the hot water cost during strong variations in oil cost is noteworthy. It is beyond dispute that the economic savings from using geothermal energy are substantial, have had a positive impact on the



currency account and contributed significantly to Iceland's prosperity, especially in times of need. The annual savings have been in the range of 1-2% of GDP for most years but rise to 7% in the period 1973 to 1985, and have been nearing that peak again in recent years. The 7% of GDP is equivalent to 3.000 USD per capita.

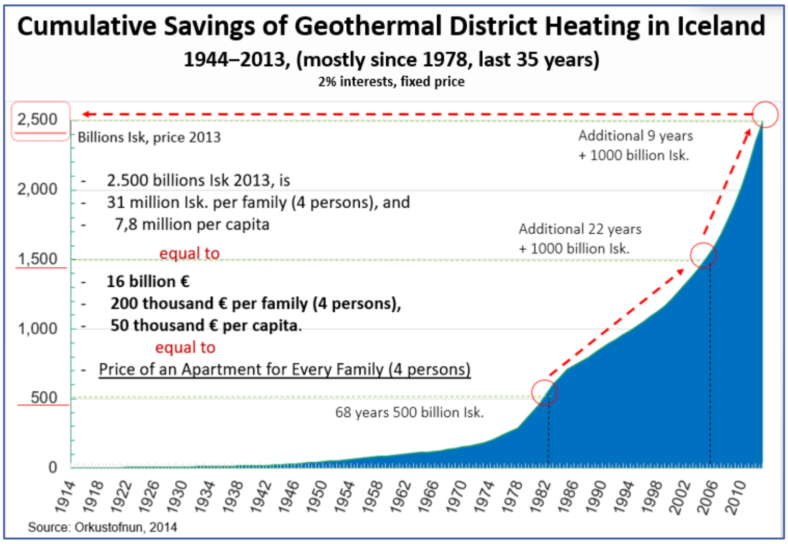


In recent years, the utilisation of geothermal energy for space heating has increased mainly as a result of the population increase in the capital area, as people have been moving from rural areas to the capital area. As a result of changing settlement patterns, and the discovery of geothermal sources in the so-called "cold" areas of Iceland, the share of geothermal energy in space heating is still rising. It is also possible to evaluate cumulative savings of geothermal district heating from 1914 – 2013, based on real price (fixed price 2013) and 2% annual interest rate**.** Based on these calculations, the overall savings is equal to 31 million ISK per family (€200.000), which is equal to the price of an apartment for a family (4 persons) in Iceland.

From 1982 – 2013 the majority of savings has happened after the geothermal district heating implementation and is about 2.000 billion ISK. This is equal to 64 billion ISK. (€412.000.000) per year, or 800.000 ISK (€5.160) per family, or about 70.000 ISK. (€450) per month per family, after taxes.

CO_2 Savings due to Geothermal District Heating

The use of geothermal energy for space heating and electricity generation has also benefited the environment, as both geothermal energy and hydropower have been classified as renewable energy resources, unlike carbon fuels such as coal, oil and gas.



The benefit lies mainly in relatively low CO_2 emissions compared to the burning of fossil fuels.

Since 1940 to 2014 the CO_2 savings by using geothermal district heating have been around 100 million tons, which is equal to saving of using 33 million tons of oil. In 2014 the geothermal district heating savings of CO_2 in Iceland was about 3 million tons of CO_2, or equal to 1 million tons of oil, equal to CO_2 bindings in 1,5 billion trees and 7.150 km^2 of forest.

CO_2 Savings due to Renewables in Iceland

If we look at the accumulated savings of CO_2 by all renewables in Iceland 1914 – 2014, that savings is about 350 million tons, mostly since 1944. That is equal to CO_2 bindings in 175 billion trees, or 850 km^2 of forest and is equal to 120 million tons of oil.

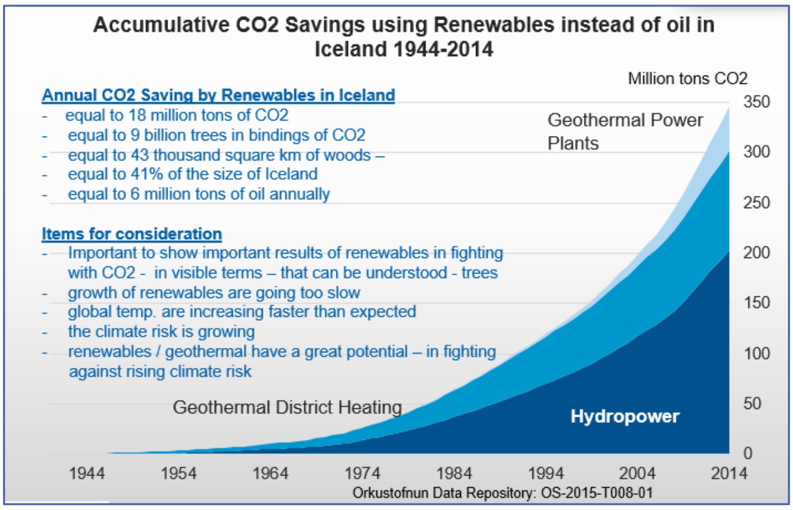
In 2014 the annual savings of CO_2 from renewables in Iceland was 18 million tons, equal to bindings of CO_2 in 9 billion trees, equal to 43.000 km^2 of forest – or equal to 41% of Iceland. It is also equal to 6 million tons of oil.

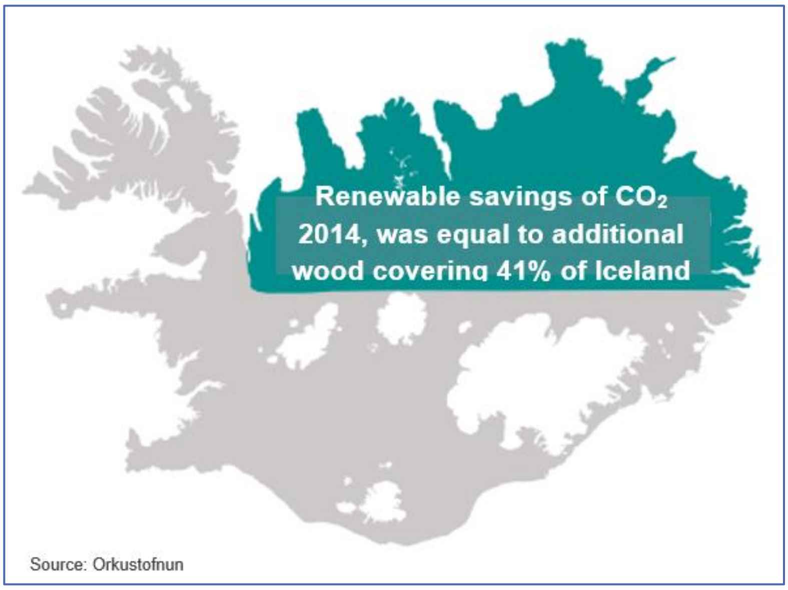
These saved tons of CO_2 have been an important contribution for mitigation of climate change, not only in Iceland but on a global level as well, as climate change has no border between countries or regions.

Geothermal District Heating in Iceland and the use of other renewables, contributes towards economic savings, energy security and reduction of greenhouse gas emissions.

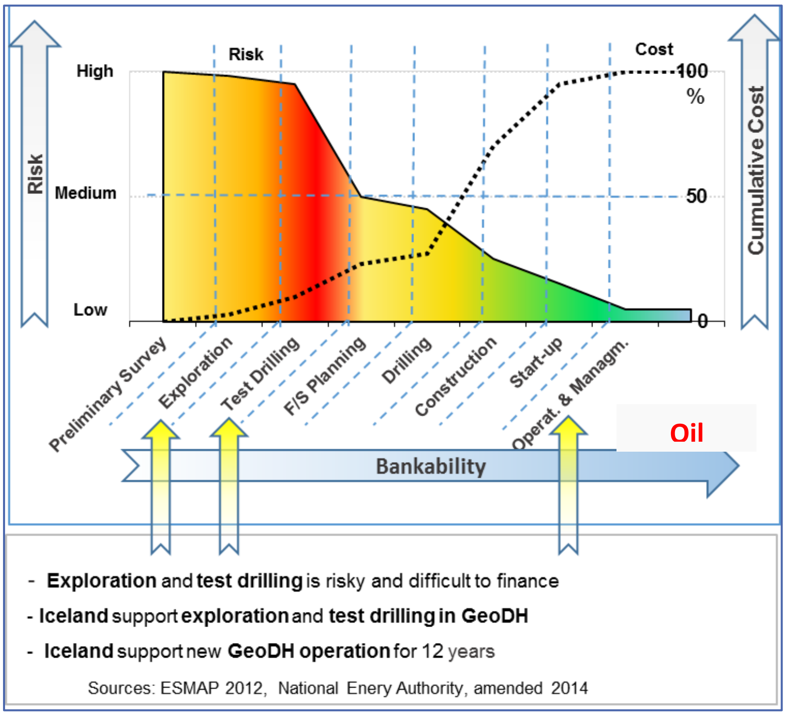
Public Support to District Heating

The national parliament approved an Act in 1953 on geothermal heating services in communities outside Reykjavik which permitted the State to guarantee loans up to 80% of the total drilling and construction cost of heating services. Further, to encourage the development, the State started a Geothermal Fund in 1961. The fund gave grants for reconnaissance and exploratory drilling carried out by the Geothermal Department of the State Electricity Authority and offered loans to communities and farmers for exploratory and appraisal drilling covering up to 60% of the drilling cost. If the





Risk, Bankability and Cost of a Geothermal Project



drilling was successful, the loans were to be paid back with highest allowed interests in 5 years after the heating service was up and running.

If exploratory drilling failed to yield exploitable hot water, the loan was converted to a grant and not paid back. In this way the fund encouraged exploration and shared the risk. Within the next 10 years many villages used this support and succeeded in finding geothermal water. In 1967 the fund was merged with the Electricity Fund and named the Energy Fund. The Electricity Fund had since the 1940s supported electrification and transmission in rural areas.

By 1970 about 43% of the nation enjoyed geothermal heating, while oil was used by 53% of the population, and the remainder used electricity. Space heating of residential buildings is subsidized by the state as shown in Figure 5.6.1. for those areas where geothermal based district heating systems are not reachable. The lump sum for 8 years of this state subsidization has been available to support home owners to transform to renewable heating (Act No. 78/2002). This has recently been increased by 50% to be equivalent of a 12 year lump sum. In addition, if the project receives other grants it will not effect in any way this lump sum payment. This has stimulated new geothermal based district heating systems to be installed, like in the town of Skagaströnd, operated by RARIK, in 2013.

Lessons learned from Iceland

- Important to recognize the importance of GeoDH for
  - economy (savings),
  - energy security and
  - mitigate climate change
- Important to lower the risk of projects in the beginning e.g. by supporting exploration and test drilling
- Importance for Financial Institutions to recognise opportunities within GeoDH

Lessons learned from Icelandic GeoDH Policy
Benefits of Geothermal District Heating

GEOTHERMAL ENERGY – Offers Major Opportunities

1. Harnessing Natural Resources
2. Economic opportunities and savings
3. Improve energy security
4. Reducing greenhouse gas emissions
5. Reducing dependence on fossil fuels for energy use
6. Improving industrial and economic activity
7. Developing the low-Carbon and Geothermal technology industry, and create employment opportunities
8. Improving quality of life

5.3.9. Awareness Raising - Climate Concerns and the Geothermal Support

I seem that there is a slow reaction time since, there are 21 years from the Kyoto meeting on climate change.

More awareness is needed, and link the need with available tools like geothermal contribution towards mitigating climate change.

It is important to highlight the climate risk, and bring it closer to people – in time and space.

Last 24 months there have been heat record every month around the globe.

In February the temperature was on average 1,35 degrees on Celsius, higher than 1951 – 1980.

In some areas like in N-America, Northern Europe and central Asia, the average monthly temperature increase was even 4–11,5º degrees C, far beyond the average 1,5 – 2 degrees on C.

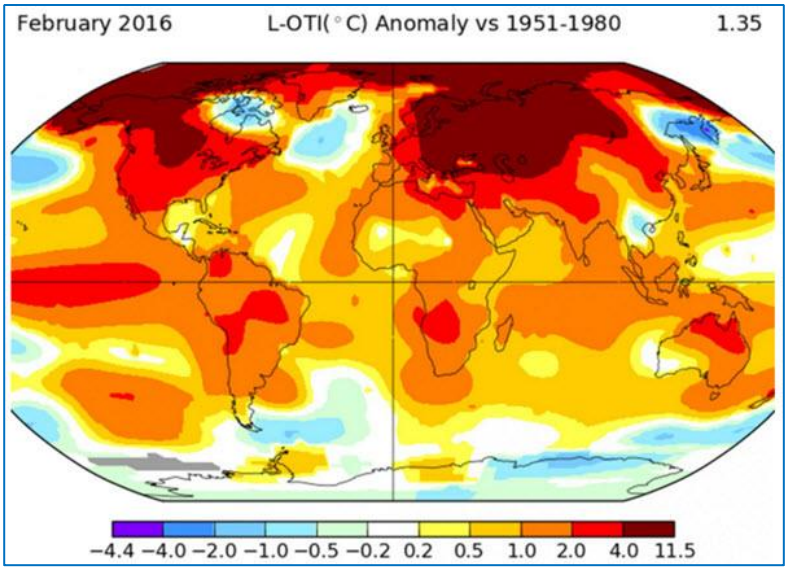
Due to this trend more regional consequences are foreseen – and therefore more action is needed – including in the area of geothermal.

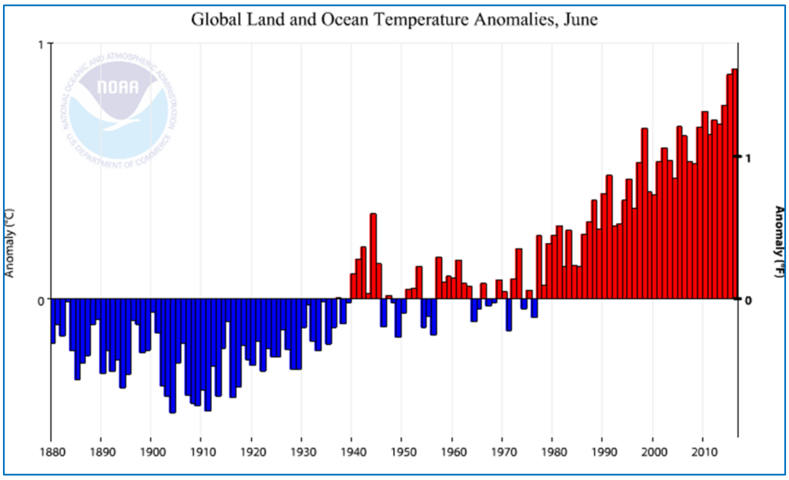
Climate change trend are also moving faster than expected, with higher temperature of air and sea and greater ocean acidification.

Increasing renewables are moving slowly – including utilisation of geothermal district heating.

There are great possibilities in Europe regarding geothermal district heating – but things are moving too slowly.

However, Geothermal projects con do more to fight the global CO2 / climate problem.





Sea-Level Rise Could Nearly Double Over Earlier Estimates in Next 100 Years

UMass Amherst, Penn State researchers model effects of melting Antarctic ice sheets

March 30, 2016
Contact: Janet Lathrop 413/545-0444

AMHERST, Mass. – A new study from climate scientists Robert DeConto at the University of Massachusetts Amherst and David Pollard at Pennsylvania State University suggests that the most recent estimates by the Intergovernmental Panel on Climate Change for future sea-level rise over the next 100 years could be too low by almost a factor of two. Details appear in the current issue of *Nature*.

The 100-meter terminal ice cliff of Helheim Glacier in Southeast Greenland, which is retreating rapidly. DeConto and Pollard say processes like this on Greenland could become more widespread in Antarctica if thick parts of the ice sheet at the ocean's edge begin losing their protective ice shelves. Photo: Knut Christianson, University of Washington

DeConto says, "This could spell disaster for many low-lying cities. For example, Boston could see more than 1.5 meters [about 5 feet] of sea-level rise in the next 100 years. But the good news is that an aggressive reduction in emissions will limit the risk of major Antarctic ice sheet retreat."

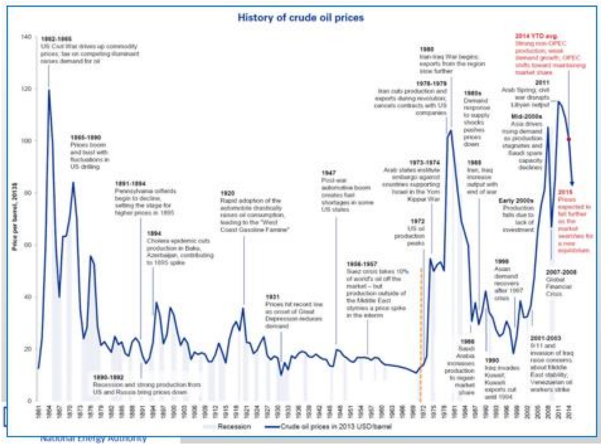
With mechanisms that were previously known but never incorporated in a model like this before, added to their ice-sheet model to consider the effects of surface melt water on the break-up of ice shelves and the collapse of vertical ice cliffs, the authors find that Antarctica has the potential to contribute greater than 1 meter (39 inches) of sea-level rise by the year 2100, and greater than 15 meters (49 feet) by 2500 if atmospheric emissions continue unabated. In this worst case scenario, atmospheric warming (rather than ocean warming) will soon become the dominant driver of ice loss.

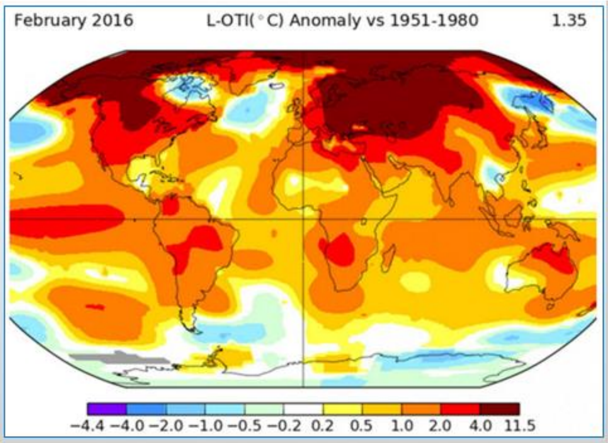
<u>Oil crisis</u>

–> very visible –> automatic awareness raising –> fast reaction time –> focus on economic issues –> economic balance fairly quickly –> no global environmental risk
-> geothermal contribution - did help many countries like Iceland to avoid economic problems of oil.

<u>Climate crisis</u>

–> difficult to see climate changes –> therefore very slow reaction time (22 years from Kyoto)
–> denial of problems –> very problematic and poorly managed awareness raising
–> globally very risky and urgent on all levels of societies (economic, social, envirom. etc.)
–> increasing risk of slow action and more damage and disaster than expected
-> geothermal contribution – can have valuable impact to mitigate climate change in many countries.





One area in Iceland – no rain - summer 2016

Floods in Iceland – autumn 2016

Lakes are shrinking in California recent

Forests on fire in California 2016

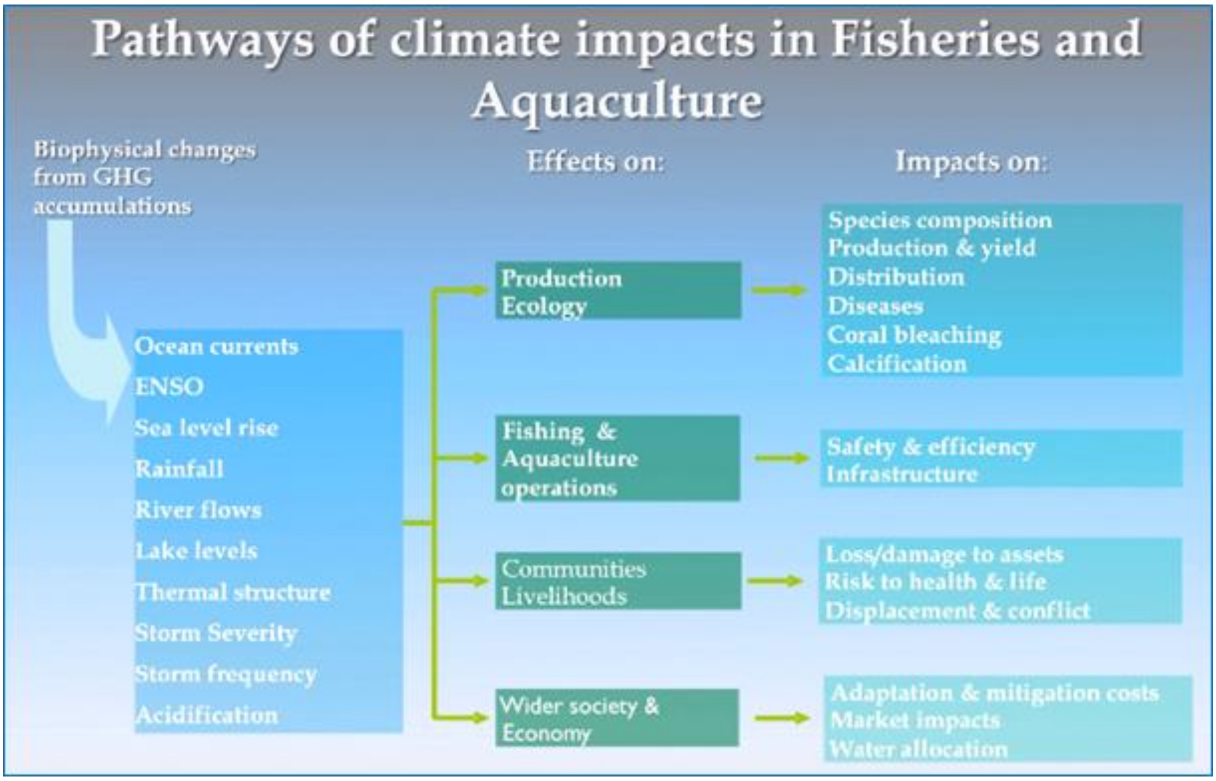
In recent years, extreme weathers have been increasing all around the word – and are already having tremendous affect, in various way – with serious consequences.

Floods in Germany June 2013,
damage 3 billion € - insurance claims

Floods in Paris 2016

Long Islands, New York “Frankenstorm”
Hurricane Sandy

Philippines 2013



We have passed the - point of no return - in the development of climate development. Therefore, the climate battle must be successful.

All renewables have a role in the battle – including various geothermal opportunities

Annex I

Proposed Joint Activity

Working Meeting

Financial Instruments and Funding of RD&D and Geothermal Projects

Barriers & Opportunities & Policy Recommendation

Hotel Bedford, Brussels
October 5, 2015

9:00 **Welcoming Remarks**

- *Mr. Guðni A Jóhannesson, ERA NET Coordinator Chairman of the meeting,*
- *Ms. Susanna Galloni, Research Programme Officer, DG Research & Innovation*

Session - R & D Activities in ERA NET Countries - National research funding Needs – Barriers – Opportunities and Policy Recommendation

9:20 **Main Conclusions from the Survey** – **the R & D Activities in ERA NET Countries Barriers & Opportunities,** *Mr. Sigurdur Bjornsson, Head of Science and Innovation Rannís, Iceland, and Mr. Gunter Siddiqi, Deputy Head, Swiss federal Office of Energy, SFOE, Switzerland*

9:45 **European Energy Research Alliance, EERA,** *Ms. Adele Manzella, CNR-IGG Italy.*

10:00 **EGEC the Geothermal Industry View**, **Geothermal Research in the EU** *Mr. Philippe Dumas, Secretary General, EGEC*

10:15 **Coffee**

10:30 **Energy efficiency in Horizon 2020 and projects of the Intelligent Energy Europe programme -** *Mr Antonio Aguiló, Project Advisor, Unit B1 Energy, Executive Agency for Small and Medium-sized Enterprises (EASME), European Commission***.**

10:45 **DG CLIMA (NER300***)* *Mr. Filippo Gagliardi, Policy Officer - Low Carbon Technologies, Innovation and Competitiveness European Commission (NER 300)*

11:00 **Roundtable Discussion – Speakers and Participants**

12:00 **Lunch**

Session – Projects in ERA NET Countries - National project funding Needs – Barriers – Opportunities and Policy recommendation

13:15 **Main Conclusions from the Survey** – **the Projects Activities in ERA NET Countries Barriers & Opportunities,** *Mr. Baldur Petursson, Specialist, Geothermal Market Analysis, Geothermal ERA NET Coordination Office, National Energy Authority, Iceland*

13:30 **Renewable Heating and Cooling**, *S***trategic Research Agenda and the Roadmaps** *Mr. Philippe Dumas, Secretary General, EGEC,*

14:00 **The Icelandic Geothermal Cluster, Narrowing Geothermal Cooperation between Companies, RD&D and Banks** *Mr. Viðar Helgason, Managing Director*

14:15 **European Investment Bank,** *Mr. Nadège HOPMAN, Energy Specialist – CCS & Geothermal, EIB - European Investment Bank*

14:30 **ERDF,** *Mr. Maud Skäringer Policy Analyst European Commission Regional and Urban Policy DG Unit G.1 – Competence Centre Smart and Sustainable Growth*

14:45 **European Bank for Reconstruction and Development,** *Mr Adonai Herrera-Martínez, Principal Manager, Energy Efficiency, European Bank for Reconstruction & Development, EBRD*

15:00 **Coffee**

15: 15 **Roundtable Discussion - Speakers and Participants**

16:00 **Summary of Discussions, Closing Remarks – Priorities and Next Steps**

17:00 **End of Meeting**

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