

International Cooperation on Geothermal Research Through the Geothermal ERA-NET

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ABSTRACT

The Geothermal ERA-NET is a cooperation instrument, supported by the European Commission. The aim is to deepen European cooperation on geothermal research at national and administrative levels and enable the integration of national research programs. It is a four years project led by Orkustofnun Iceland and in cooperation with partners from Iceland, the Netherlands, France, Switzerland, Germany, Italy, Hungary, Turkey and Slovakia.

Geothermal energy deployment requires the coordination of multi-disciplinary topics from earth sciences, engineering and commercial sectors, in order to optimise the geothermal resource characterization, development, operation and management. While the technological challenge is to create systems and technologies that will streamline and optimise the sophisticated and complex workflow that integrates the various topics, the logistical and organisational challenge is to create the units and the processes within the geothermal community and at a political level.

National geothermal energy programs developed mostly in response to specific local geothermal resources and conditions, national skills and competences and, importantly, along national goals that result from local conditions. This has led to the development of national/local RD&D value chains that are duplicated in various European countries. The fragmented nature of the geothermal industry and hence technology development has become a liability considering the vastness of the geothermal resource.

The Geothermal ERA-NET will take a prominent enabling role to assemble a fragmented picture and optimize geothermal research delivery. It is an ambitious initiative to foster cooperation and integration of geothermal research funding agencies in Europe and worldwide. It will identify key challenges and bottlenecks; define the actions to tackle them; establish the necessary investment levels; develop a strategy for prioritisation and thus an understanding of the optimal level of intervention from member states fostering geothermal exploitation and deployment.

The ultimate goal ensured by the analysis of national RD&D programs is the launching of transnational joint activities. Gaps will be eliminated and existing strengths will be enhanced by competitively awarded Europe-wide RD&D projects.

1. INTRODUCTION

This paper presents a description of the Geothermal ERA NET project, its objectives and structure, how geothermal renewables can contribute to increase the energy security and savings in Europe and are already saving large amount for the economy and citizens in the partners countries, the milestones, the, descriptions of the Geothermal ERA-NET partners and what has been achieved during the first 24 months.

The paper describes also national incentives and status of geothermal energy in participating countries, the work towards creation of European Geothermal Information Platform (EGIP), the work on interactive map to indicate Transnational Research Agenda and Programs, Analysis of Stakeholders on a National level and conclusions of the work so far and foreseen valuable opportunities and options.

2. HOW CAN GEOTHERMAL CONTRIBUTE TO INCREASE ENERGY SECURITY AND SAVINGS IN EUROPE?

Geothermal resources have been used successfully and economically in some locations in Europe where geological conditions are exceptionally favourable (e.g. Italy and Iceland), but they can play a much more important role at the European scale, if they can be economically exploited in other places.

Numerous projects in several countries (e.g. in France, Germany and Switzerland) have started to make use of this source of energy applying new approaches.

On top of the long term climatic challenges Europe is now looking at instability and limited security of the gas market and the countries are now feeling the urge to limit the dependency on gas and fossil fuels. Since a substantial part of the gas consumption is

used for direct heating of homes and domestic hot water the obvious choice is to develop methods to use renewable, carbon free sources for this purpose.

For regions with known access to geothermal energy such as the Pannonian basin and the Molassen stretching from Switzerland into Germany, have the possibility to tap the geothermal sources for energy that with good economy can replace gas use and be a game changer in improving the energy security, cost savings and mitigating climate change.

District heating can play a key role in this aspect. In the Nordic countries we have good examples where district heating provides means and the flexibility to utilise various sources of renewable energy from surplus wind power, biomass, waste heat from industries, heat pumps and geothermal. In Sweden we can follow how this has paved the way from 100% fossil fuel dependency to more than 80% renewable energy delivered by the district heating networks.

Many regions in Eastern Europe have district heating networks that have wide coverage but have severe technical problems due to inferior technology from the start and lack of maintenance. Individual customers have found it more economical and secure to provide heating and hot water from their own gas boilers which in turn has led to deteriorating economy for the district heating plant operation.

It is of high importance that necessary financing is provided to break this negative spiral. District heating systems are without comparison our most effective instrument to provide heating and even cooling with lowest possible CO₂ emission regardless of if we have access to geothermal energy or not.

The feed in tariffs system that has been the dominating instrument for enhancing use of renewable energy sources such as the sun or the wind have specific cost frame for certain technologies. Emerging subsidy systems that are technology neutral can operate in such a way that they give premium for delivered energy based on saved CO₂ emissions regardless of the technology used. Bidding rounds in competition such as in the Netherlands have shown that the use of geothermal energy can be very cost efficient compared to other conversion technologies when it comes to CO₂ savings per cost unit including capital cost and operation.

It is therefore important for policymakers and other stakeholders to recognise the great opportunity offered by geothermal heating for energy savings, as it is estimated that geothermal heating in Iceland in 2012 has saved 7% of GDP, equivalent to 3000 US\$ per capita, or 1 billion US\$ for the economy. It has also been estimated that renewables for heating and cooling could save EUR 11.5 billion per year within EU, improve the energy security and savings and mitigate climate change.

The framework of the Geothermal ERA-NET is the support of geothermal research in Europe, by encouraging and enlarging cooperation among energy agencies and ministries in Europe and make it possible for them to work on common goals towards utilising geothermal energy. Geothermal ERA-NET is different from other conventional research projects since in this case the grant is for cooperation and coordination of the research plan of the countries involved but not for direct research. The Geothermal ERA-NET is the first step towards a coordinated research in the EU through the so-called SET-Plan (European Strategic Energy Technology Plan).

The Geothermal ERA-NET aims to interact with international programs that foster cooperation in the areas of geothermal energy. In particular, some of the principal actors of the Geothermal ERA-NET (Iceland, France, Germany, and Switzerland) represent their countries in the International Energy Agency's Geothermal Implementing Agreement (IEA GIA) comprising 24 member countries and sponsors. The IEA GIA provides a platform to raise awareness and share knowledge on a wide range of activities related to the utilization of medium to high enthalpy geothermal resources. A more project oriented and focussed on Enhanced Geothermal Systems is the International Partnership on Geothermal Technology (IPGT) comprising the USA, Australia, Iceland and Switzerland. Like the IEA GIA, a few Geothermal ERA-NET actors (Iceland and Switzerland) are the government representatives in the IPGT's steering committee whose aims it is to coordinate RD&D activities in the IPGT countries.

The Geothermal ERA-NET addresses technical and non-technical (institutional, social and regulatory) issues, as long as they can be considered to be exclusively applied to the support of geothermal energy utilization.

A significant target is to complement the EERA Joint Programme on Geothermal Energy, whose aim is to contribute via research and development to the renewable energy targets for 2020 and beyond, in member and associated states. Coordination activities will focus on implementation of commonly agreed objectives and joint activities and funding of joint transnational research actions.

- To deepen the cooperation on national and administrative level
- Be an enabler for the integration of national research
- Development of agendas into a coherent European geothermal R&D programme

3. THE GEOTHERMAL ERA-NET OBJECTIVES AND STRUCTURE

The Geothermal ERA NET is a four years projects started on May 2012. Its aim corresponds to a strategic contribution to the European Action Plan "Energy Policy for Europe", speeding up the deployment of geothermal projects. Geothermal energy is a benign renewable energy source, which not only contributes to the overall goals of the European Action Plan (30% CO₂ reduction, 20% energy savings, 20% renewables and 10% bio fuels), but may also integrate intermittent renewable energies with its base load capacity. Countries participating in this ERA-NET were chosen on the basis of their ambitions to include geothermal energy into their goals for 2020 and 2050 on the reduction of CO₂ emissions.

The Geothermal ERA-NET focuses on the utilization of geothermal energy applications that involve direct heating and power generation, thus medium-high enthalpy resources and reserves. To ensure appropriate linkages to related R&D activities (renewable heating and cooling via ground storage heat pumps, power distribution and transmission) the interface with related ERA-NETs such as ERACOBUILD or SmartGrids will be maintained to avoid overlap.

3.1 Objectives

The overall objective is the mutual opening up of national research programmes and research infrastructures, and the development of joint activities. To reach this target, the detailed objectives that will direct this Geothermal ERA-NET are aimed to:

- Complete the preliminary work required to create a European Geothermal Database whose purpose it is to share information on legal and regulatory aspects, policies, measures, institutions, research projects and data.
- Exchange information on the status of geothermal energy, including national support schemes and RD&D activities and identification gaps.
- Recommend measures to strengthen European geothermal development in order to meet short-term targets according to National Renewable Energy Action Plans and future contributions to renewable energy supply.
- Foster synergies at regional and pan-European level by mobilizing competitive and non-competitive funds for research in a more coordinated way through joint activities.
- Achieve a critical mass to address cross-thematic research targets, thus enhancing cooperation and avoiding fragmentation.
- Define possible schemes and barriers for the joint activities and recommend practical solutions.
- Prepare and execute transnational funding activities, required agreements on themes of the planned projects and on all implementation and administrative issues concerned.
- Increase transnational collaboration in research training and mobility in geothermal research, improving human capacity building, by sharing of best practices, gap analysis and improve science development and collaboration.
- Gain a clear understanding of the principal stakeholders for a successful, Europe-wide coordination of publicly funded, national research, development, deployment and innovation programmes.
- Communicate with principal stakeholders and enhance public awareness toward the values and benefits of geothermal scientific and policy issues.
- Prepare the ground for the future formulation of a common European roadmap for geothermal energy technology research, development, deployment and innovation programme.

3.2. Structure

The project is divided into 7 work packages. Figure 1 illustrates how they relate to each other and the overall strategy of the work plan. WP 1 is the coordination work packages and ensures the smooth running of the project. The work performed in work packages 2, 4 and 6 concentrate on a bottom-up approach for the development of joint activities to be implemented in the second half of the project. This process starts with extensive exchange of information regarding national approaches, policies and initiatives supporting geothermal energy research. The information exchange facilitates common understanding among project participants about opportunities and barriers to future transnational research collaboration, setting the stage for other subsequent actions. The results from WP2 is followed up in WP4 where joint activities are defined and prepared with a clear aim to launch one or more joint calls for proposals in WP7. Special attention is given to issues of human resources and mobility in WP6 where joint interests and actions are being identified with a bottom-up approach and fed into WP7 for implementation.



Figure 1: The conceptual scheme of the Geothermal ERA-NET.

Work packages 3 and 5 supports the core activities during the entire project duration. WP3 prepares the establishment of a comprehensive geothermal information platform in order to share information necessary for developing joint research strategies, such as on legal and regulatory aspects, statistical data with principal parameters of geothermal energy utilization, institutions and on-going research projects. WP 5 on the other hand ensures efficient and structured collaboration with principal stakeholders in order to further reduce the fragmentation of transnational research activities and policies. These work packages continuously interact with WPs 2, 4 and 6.

4 THE GEOTHERMAL ERA-NET PARTNERS

The Project is led by Orkustofnun Iceland in cooperation with partners from Iceland, the Netherlands, France, Switzerland, Germany, Italy, Hungary, Turkey and Slovakia.

The Consortium represents National and Regional programmes from 10 European countries, giving the Geothermal ERA-NET the critical mass required for successful operations. All members have assigned senior staff to this ERA-NET and most of the representatives from the different partners have beyond their responsibilities for the home front programmes experience in international cooperation and ERA-NET's in particular



Figure 2: The geographic distribution of the Geothermal ERA-NET consortium.

The geographical balance of the Geothermal ERA-NET is quite good, stretching from the far North-West of Iceland down to the far South East of Turkey.

5 WHAT HAS BEEN ACHIEVED

During the first 24 months of the Geothermal ERA-NET the focus has been put on exchanging information on the status of geothermal energy utilization, including national support schemes and research, development and deployment (RD&D) activities and the creation of an inventory report on these activities. Emphasis has also been put on gaining an understanding of the principal stakeholders, including key industry players for a successful, Europe-wide coordination of publicly funded national research, development, deployment and innovation geothermal energy programmes. Great efforts have also been put on the preparation for a Joint European Data/Information platform called EGIP or European Geothermal Information Platform.

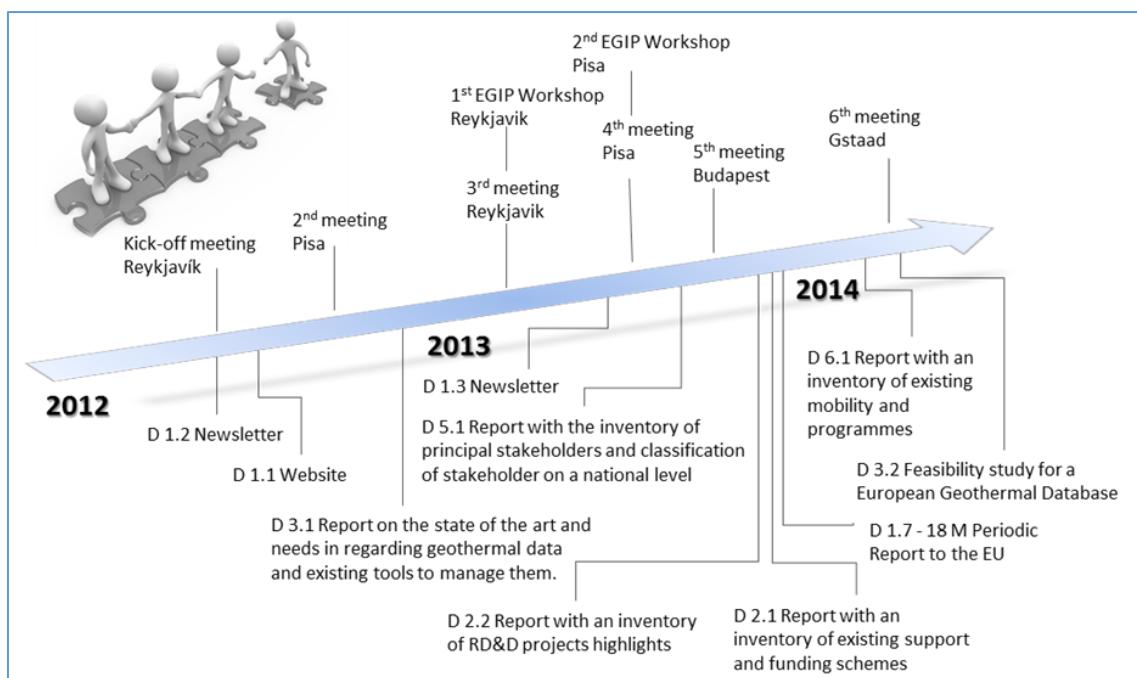


Figure 3: Achieved Deliverables and time distribution.

The consortium met 5 times in physical meetings and in addition had several telephone conferences on different issues. The first meeting was a kick off meeting that took place in Reykjavik Iceland in end of May 2012. Two times the consortium has met for annual meetings, first in Pisa, Italy in September 2012 and then in Budapest, Hungary in September 2013. Then there were two workshops organized within WP3, one in March 2013, focusing on geothermal database State of the art and needs and then another one in June 2013, focusing on the feasibility study for the geothermal database. In connection to the WP3 workshops the coordinator organized a general working meeting.

Now that the state-of-the-art of many issues has been defined, the next major steps in the Geothermal ERA-NET process is to identify research gaps and opportunities for joint activities within participating countries, to find common interests and discuss joint research agendas.

5.1 Information exchange on national incentives and status of geothermal energy

The collection of information on support and funding schemes, evaluation, monitoring and dissemination, and on RDD&D projects has been instrumented with two questionnaires, which have been discussed in the network before distribution. The questionnaires also covered the status of geothermal energy in the participating countries.

Geothermal energy utilization accounts for 68% of energy utilization in Iceland, and one could say that the potential that this energy source holds for this country is largely deployed. Italy also has a significant geothermal production, and ranks as fifth country in the world for geothermal electricity production. After Turkey, Iceland and Italy, Hungary is ranked at 4th place regarding installed geothermal direct use in Europe. For all other participating countries, geothermal energy is an energy source with potential.

With the exception of Iceland, all countries have an ambitious agenda for an increase of the market for geothermal energy. In all countries except for the Netherlands and Slovenia, this includes a significant growth in electricity production with geothermal energy. Up to 2020, the Netherlands will focus on direct use.

In all participating countries, there are policy instruments in place to improve geothermal energy utilization. This includes R&D efforts, and in some countries there are also instruments to address the geological risk in the form of soft loans or guarantee funds. Various participating countries have a feed-in-tariff in place for renewable energy production. In most cases this tariff is only applicable to electricity generation, but in France and the Netherlands there is also support for renewable (district) heating. The review also discusses other relevant issues, such as the availability of geological data, legislation and statistics.

As a second step within WP2, work has begun to identify technical and non-technical barriers and for geothermal development within the partner countries. This has been instrumented by collecting a “top 10” of barriers (as well as opportunities) from each partner country. A workshop was organized to discuss and cluster the results, and interestingly enough it all boiled down to about ten clusters, amongst others risk-mitigation, operational issues, and new/innovative concepts (the latter providing mostly opportunities). A similar exercise has been performed to identify RD&D gaps.

Other relevant issues, such as the availability of geological data, legislation and statistics, have been considered and compared among participating countries and joint activities to remove barriers for further market growth are going to be considered.

5.2 Towards a European Geothermal Information Platform

One of the objectives of the Geothermal ERA-NET is to complete the preliminary work required for the creation of a European Geothermal Information Platform (EGIP) with the purpose of sharing information on legal and regulatory aspects, policies, measures, institutions, research projects and data. EGIP’s overall target is to increase the share of potential geothermal energy users at an international level by improving knowledge and facilitating the retrieval of the basic information needed to establish geothermal projects.

Providers of a geothermal information system based on ICT (information and communication technologies) tend to differ in their conception of ideal data sharing and services, and hence each designs and builds its own information system independently. Scientists, operators and consultants organize and use geothermal databases, which contain underground data, provide maps (e.g. temperature and heat flow distribution) and are seldom accessible to the public.

Regional, national and European administrations produce, collect and organize regulations, documents, descriptions and maps of geothermal leases and permits, and energy production values. Information providers publish general information (e.g. definitions, terms) in the form of texts and figures. Manufacturers have their own advertising, none of which are included in a comprehensive picture of the geothermal world. Funding and insurance agencies require and organize all the information aimed at creating risk management and economic analyses of all proposed projects.

When available, these various databases and data-sharing systems are mostly based at a national level, provided in the local language, and are suitable for local or specialized applications.

5.2.1 The impact of creating EGIP

The increasing need for energy, both for electricity and thermal uses, has improved the potential market for geothermal energy applications. The trend toward globalization compounds the situation. As trade barriers between nations and regions are dismantled, information on resources, opportunities, regulations, prices and demand should become instantly and globally available. The



Figure 4: Impression of a result of the clustering workshop.

differences in data organization among different branches and languages are currently taken for granted. What EGIP does is to challenge the existing, taken-for-granted situation, and looks at the different segments as parts that can be aggregated into a unique higher-performing, less-fragmented geothermal information system.

The main aims behind the EGIP are to: i) reduce information fragmentation, ii) simplify data provision, iii) reduce project risks (economic aspects), iv) raise awareness about geothermal energy by providing an overview of its application at the European scale, and v) increase the focus on and investments in geothermal energy.

The primary EGIP customers are potential international energy users, such as international operators and funding agencies interested in launching new geothermal projects. However, the EGIP would be beneficial to any geothermal stakeholder and to respond to the increasing concerns of non-geothermal sector stakeholders that geothermal applications are too confusing and difficult to manage.

The EGIP is designed as a distributed system: each (national) data provider delivers its data according to a common standard data model and common services. Its development exploits INSPIRE European Directives for a common spatial data infrastructure, thus ensuring a coordinated effort at a minimum cost since each EU country will have to be INSPIRE compliant within the next few years. Creating an EGIP now that the INSPIRE directive are being implemented has several benefits:

- Guaranteed data interoperability: retrieval, viewing and access of information from partners/providers.
- Harmonized geothermal domain at a European level.
- Efficiency, data linked directly to national databases.
- Guaranteed ownership: data belong to and stay in the country they are related to. Each country decides what to share and what to keep private.
- Durability and maintainability, since this is information is directly related to national data sources.
- Economically viable, requiring only coordination with what each country would need to develop.
- Productivity, by covering all published data, long term

5.2.2 EGIP Basic Functions

The envisaged EGIP acts as a portal, where European geothermal information can be accessed, retrieved and queried using modern ICT technologies. In reality, it is a virtual entity, created through harmonized information. Indeed, the EGIP goes beyond pure data sharing: it also involves the way information and data are displayed, examined, and compared. The information included in the EGIP covers all the aspects related to geothermal energy: not only underground data but also information on the economics, regulations, national energy policies, energy production, energy demand, market requests, and social issues. All these issues represent the concept of geothermal knowledge, as outlined in Figure 4.

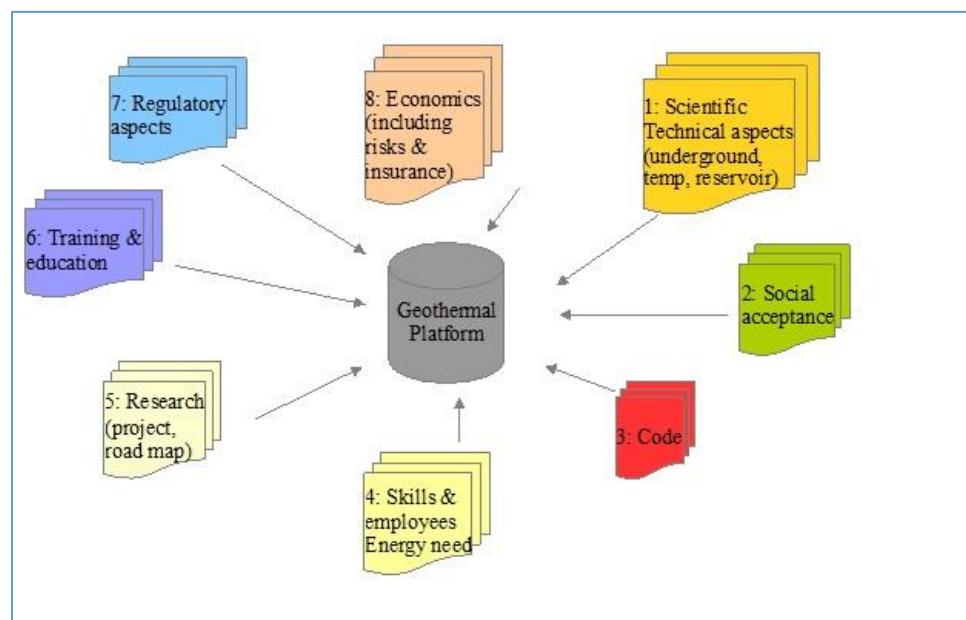


Figure 4: The eight topics covered in the information list that represents geothermal knowledge.

The platform would not be limited to statistically accessing and organizing information: the EGIP structure also aggregates and compares information. To be able to conduct in-depth surveys of geothermal knowledge, EGIP tools have to ensure, for example, browsing from a catalogue to a document and from a document to a table or map (see Figure 5).

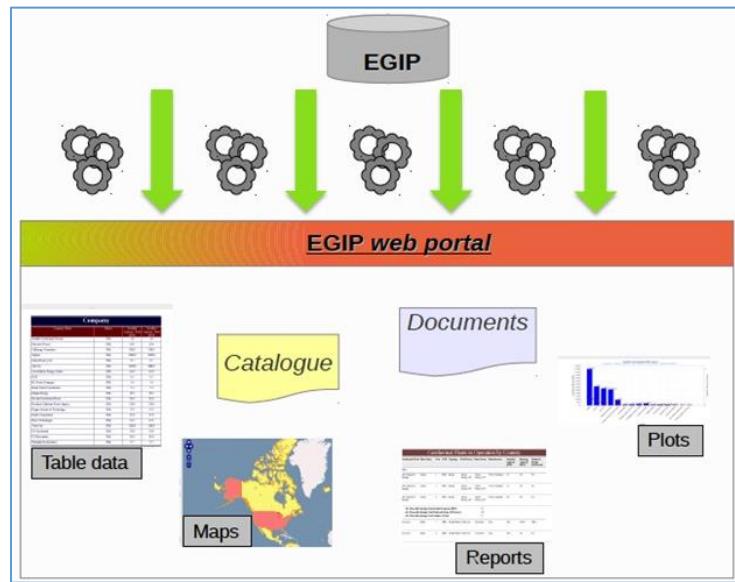


Figure 5: EGIP functionalities.

EGIP makes it possible not only to browse or query maps (e.g. depth temperatures for the whole of Europe or for the chosen areas) but also to obtain information in various aggregate forms such as charts, reports or tables that enable the geothermal information available in its database to be quickly surveyed and compared. Finally, through a catalogue tool (i.e. a search system based on keywords, countries and categories), the proposed EGIP provides all the electronic documents of geothermal interest.

5.3 Interactive map to indicate Transnational Research Agenda and Programs

WP6 of the GEOTHERMAL ERA NET addresses transnational researchers' mobility and a common approach in training of research talents as adequate human resources and capacity have to be in place to achieve targets in geothermal research. A coordinated approach to research has to be supplemented by idea exchange and the development of a trans-national approach to research training.



Figure 6: Locations of Schools with Geothermal Programs.

In order to identify areas of collaboration the Geothermal ERA NET mapped existing mobility and training programmes at national and European level. Special attention was given to the trans-national aspects of the programmes, i.e. if they are open to researchers of all nationalities. The results of the mapping is demonstrated on an interactive map which can be found under this link.

<https://mapsengine.google.com/map/viewer?mid=xd60TZthCCU.ktuAqcSJZv8I>

5.4 Stakeholder Analysis on a National Level

The Stakeholder Analysis aims at identifying and listing the main stakeholders and assessing their interest and attitude and how they are likely to impact / be impacted by the work of funding agencies and geothermal program owners. It is important to highlight the fact that the partners of the ERA-NET project, are affected by other national stakeholders. The collection of data of national stakeholders and the related analysis can be summarized as follows:

- The stakeholder lists and analysis differ strongly between countries. This is mostly related to the local availability of resources and energy demand.
- Depending on the local situation, the national RD&D has developed in different directions.
- Concerning the proposed actions there are some general findings which are valid for all partners.

Comparing the individual national stakeholder tables some conclusions with respect to stakeholder groups can be drawn irrespective of national specifics. Government and academic institutions are important and critical stakeholders. The level of interest by political stakeholders varies strongly among European country and political systems, but at least one member of federal, regional or local governments has very keen interest in advancing geothermal research, development and deployment. Frequently geothermal energy has a “champion” in government (e.g. members of parliament) who puts geothermal energy on the agenda. Frequently, geothermal energy is on the agenda because of long term potential and/or due to current project development and operations. There is also a correlation with project maturation; the more advanced geothermal energy project have been deployed, the more interest there is in project specific features, particularly where if project’s visibility or impact is high. In general governmental stakeholders express a need for high quality information regarding geothermal energy (status, development potential, achievements, strengths, weaknesses, opportunities and threats, in cases also highly specific information on individual projects).

Academia (including National Centers of Geothermal Competence, Geological Surveys) expresses a high level of interest in geothermal energy research especially where this research direction is already established. Very often, there is high degree of visibility with regards to state agencies and academia pursuing RD&D. Research organisations cover the entire value chain and Technology Readiness Levels with a strong bias towards RD&D oriented towards industry. There are highly vigorous programs, groups and entities across Europe and there is a trend that academia is “staffing up” to be able to deal with RD&D needs.

For obvious reasons, the power industry is highly important in those countries where high-enthalpy resources are already exploited or where a high potential is thought to be present. Industry, private companies appear of moderate importance. Interestingly the public does not appear to be a critical stakeholder. However, the public can very rapidly become a critical stakeholder whose desire it is to be informed with facts.

Public Funding Agencies (including the ERA-NET partner) are very keen to promote and grow RD&D activities in geothermal energy. In some cases, for political reasons, the attitude is expressed neutral. Most funding agencies require and seek information on R&D needs from fundamental research to industrial, market-driven applications (across all TRLs) to identify paths to commerciality and ultimately without subsidies. Interestingly, there is hardly ever any undifferentiated claim/need for “higher” budgets which may partly due to the fact that not all needs and RD&D paths are well-known.

In terms of private grant giving institutions, information is not widely available, but it appears that the power industry is in general very active with a very high interest and correspondingly appears to be inclined to fund RD&D. For obvious reasons the focus is very much project-specific and very much on applied RD&D. Links to technology roadmaps appear to be of high interest. .

All stakeholder groups, however, do require information, dissemination of knowledge (on various levels), need assistance in understanding how geothermal RD&D helps realize potentials and contribute to cost reduction. Often stakeholders are interested to learn whether and how national RD&D programs are coordinated both, at the national and international levels and to promote particularly international collaboration. The next step will be to extend the stakeholder listing and analysis to regional and European level.

6 CONCLUSION

The Geothermal ERA-NET participants’ primary role as governmental entities provides a unique opportunity to engage - with high priority and in concerted manner throughout Europe – principal stakeholders across the geothermal energy value chain ranging from grant-receiving members of the research community to industry actors that develop and deploy geothermal technologies. As funding agencies and governmental administration, the Geothermal ERA-NET consortium can be one of the lead drivers towards European cooperation.

A publicly available inventory of existing support and funding schemes will facilitate rapid identification of strengths, weaknesses, threats and opportunities across European programs. Primarily through access via the Geothermal ERA-NET website, the inventory will enable the sharing of good practices and emulation within other national programs. Sharing RD&D ongoing efforts and a gap analysis will identify needs that will be communicated at national and European program meetings and aid in setting annual/cycle program goals. Through progressive enlargement of the consortium to include other European countries, good practices are spread throughout Europe.

The development of stakeholder maps, communication strategies and their implementation plans ensures that national stakeholders are fully engaged – a task that is facilitated by the primary function of national Geothermal ERA-NET participants as grant-giving organisations.

A particular focus will be on engaging the European Commission and its administration in light of the patchy support for geothermal energy which – considering the breadth and multitude of possible uses – has been very limited in recent years (e.g. per Framework Programs an average of € 6 – 12 Million has been spent – a small fraction of the cumulative national programs). Bringing geothermal energy resources to market, however, is a European issue and hence needs significantly more focus and attention by the European Commission. The ultimate, long-term goal beyond this ERA-NET is that the European Commission and its administration will take up the role of champion of concerted geothermal energy development in Europe – similar to, for example, the European Commission’s uptake of Carbon Capture and Supply to manage European CO2 issues.

The ultimate goal of developing transnational joint activities ensures that results from the analysis of national RD&D programs are used. Gaps will be eliminated, existing strengths will be enhanced by competitively awarded Europe-wide RD&D projects. Again,

the role of the Geothermal ERA-NETs participants as, in the first instance, national, grant-giving organizations facilitates knowledge and availability of transnational funding and collaboration opportunities.

A particularly useful, “unifying” communication tool will be the preparation of a European geothermal energy action plan. The action plan helps national and EC administrators to identify key challenges and bottlenecks; define the actions to tackle them; estimate the RD&D investment levels needed; develop a model of prioritisation to optimally deploy scarce resources (human resources and capital) and ultimately develop the optimal level of intervention. The action plan will be widely shared and distributed.

At any appropriate stage of the implementation, the consortium will endeavour to make best use of the exploitable results of the project, in particular those with a commercial potential, through its own resources or other external services.

This may include proof of concept outside the laboratory; the identification of market potential and opportunities; the evaluation of competing technologies; the assessment of the cost for up-scaling from lab scale to industrial application; the development of a business plan; protection of intellectual property rights; etc.

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