

European cooperation on geothermal research through the GEOTHERMAL ERA NET

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ABSTRACT

In 2012, the European Commission has provided a financial grant to launch a GEOTHERMAL ERA NET and support its development for four years until October 2016. Research and innovation programme owners and managers from 11 European countries have joined the ERA NET under the leadership of Iceland's National Energy Authority, Orkustofnun, to realize the first steps of an integrated European geothermal energy research and innovation programme. Initial activities focused on exchange of information on national research and innovation ecosystems, identify shared goals, objectives, gaps, areas of necessary and unnecessary duplication. Subsequently, a number of Joint Activities of pan-European interest were established to learn how national funding agents collaborate and cooperate. Progress and added value in the joint activities – together with a shared vision that geothermal energy is crucial to Europe's sustainable development and competitiveness – has resulted in the preparation of a more extensive cooperation via an ERA NET cofund,

GEOTHERMICA. GEOTHERMICA will have at its core a joint call, an expansion of Joint Activities and is envisaged to run from 2016/2017 to 2020/2021. Thankfully, more European countries have indicated their willingness to join GEOTHERMICA.

1. THE ROLE OF GEOTHERMAL ENERGY TO INCREASE ENERGY SECURITY AND SAVINGS IN EUROPE?

1.1 Economic Benefits

Geothermal resources for power generation and direct use for heat supply have been used successfully and economically in some choice locations in Europe where geological conditions are highly favourable (e.g. Italy and Iceland, France), but they can play a much more important role at the European scale, if they can be economically exploited in other places. In recent years, the value chain of geothermal energy has expanded in some location to the provision of energy storage services and to some extent for revenues generated from credits for avoided greenhouse gas emissions.

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

1.2 Mitigating Climate Change

In addition to minimizing the adverse impact of climate change, Europe is also embarking on a path towards increasing its competitiveness in clean energy technologies, decreasing its dependence on fossil fuels - not in the least owing to political instabilities in Europe's neighbouring regions and an over-exposure to single foreign gas exporters.

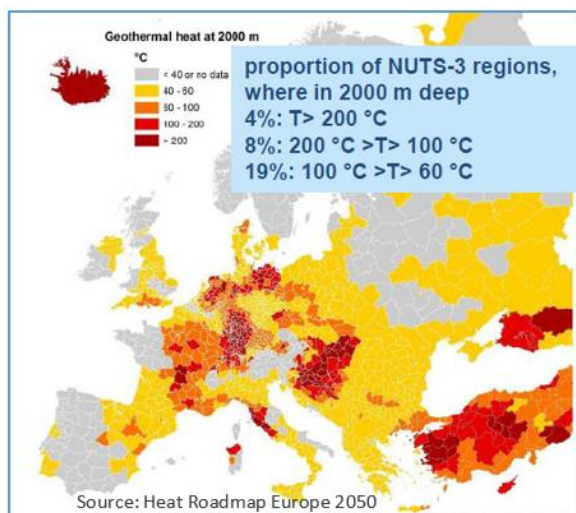


Figure 1: Identified geothermal heat resources by temperature at 2000 m depth by NUTS3 region.

This is well illustrated in the use of natural gas as a heating fuel; geothermal energy has the potential to significantly contribute to the substitution of natural gas (and oil, of course) in direct heating of homes and domestic hot water. Regions in Europe have a well-established geothermal resources (such as the Pannonian Basin of Central-Eastern Europe, the Paris Basin of Western-Central Europe and the Molasse Basin stretching along the northern rim of the Alps). The resource availability generates the possibility to tap geothermal sources for energy supply that are economically viable, and may replace fossil fuels (such as natural gas) thus improving energy security, cost savings and mitigating climate change.

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

1.3 Geothermal Opportunities Cross Europe

Many regions in Eastern Europe have district heating networks that have wide coverage but have severe technical problems due to outdated technology and issues related to maintenance. Individual customers have found it more economical and secure to provide heating and hot water from their own gas boilers; this

in turn has led to deteriorating commercial boundary conditions for operating district heating plants.

But, at the same time, functioning district heating systems are proven to be a highly effective instrument to provide heating and even cooling with low CO₂ emissions. Rather than viewing the levelized cost of electricity or heat, there is merit to instead address the system cost of providing energy to a broad customer base connected via a district heating and cooling network instead of individual customers acting on isolated needs (such as the desire to offset only patchy maintenance on «their» district heating network).

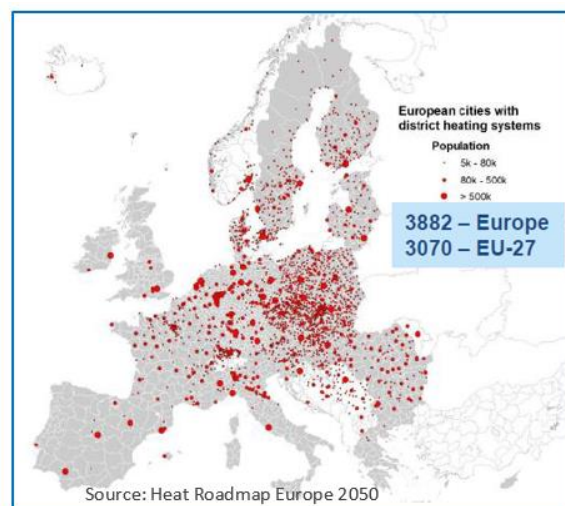


Figure 2: District heating systems in Europe by city size and for cities having more than 5000 inhabitants.

Feed-in tariffs together with legal obligations for renewable energy offtake, have in recent decades been the primary instrument to enhance use of renewable energy sources despite poor economics. Today, subsidy systems are being overhauled and, for example, emerging support systems attempt to introduce technology neutrality, operating by conferring a premium for delivered energy based on saved CO₂ emissions regardless of the technology used. Bidding rounds in such competitions, for example in the Netherlands, have shown that the use of geothermal energy can be much more cost efficient compared to heat derived from other conversion technologies, when it comes to CO₂ savings per unit cost and including capital cost and operation.

1.4 Savings Per Year in EU 11,5 billion €

It is therefore important for policymakers and other stakeholders to recognise the great opportunity offered by geothermal heating for energy savings. This offer can be vastly expanded if technology development and innovation lower the system cost thus vastly enlarging the geothermal reserves base. For example, estimates suggest that geothermal heating in Iceland in 2012 has saved 7% of GDP, equivalent to EUR 2.500 US\$ per capita, or EUR 800 million for the economy. It has also been estimated that renewables for heating and

cooling could save EUR 11,5 billion per year within EU.

1.5 Constructive Geothermal Cooperation

Geothermal energy deployment requires the coordination of multi-disciplinary topics from earth sciences, engineering, social and behavioural sciences, to commercial sectors, in order to optimise the geothermal resource characterization, development, operation, management and public acceptance. One of the key technological challenges is to create systems and technologies that will streamline and optimise the sophisticated and complex workflows covering the lifecycle of a project. In addition, a growing geothermal sector faces the organisational and political challenge to create organisational structures and processes within the European geothermal community and to integrate national and European policy development and implementation.

National geothermal energy programs have 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 unsurprisingly duplicated in other European countries. The fragmented nature of the geothermal industry and hence technology development has become an obstacle to pan-European development considering the vastness of the geothermal resource and shared common challenges.

2. THE GEOTHERMAL ERA-NET

This ERA-NET (www.geothermaleranet.eu) was launched in 2012 supported by a EUR 2 million grant of the European Commission. Its principal aim is to deepen European cooperation on geothermal research at national and administrative levels and enable the integration of national research programs. The first four-year phase (2012-2016) is led by Orkustofnun, Iceland's National Energy Authority, and is a cooperation of research and innovation programme owners and managers (funding agents) from France, Germany, Hungary, Iceland, Italy, the Netherlands, Portugal, Slovakia, Slovenia, Switzerland and Turkey. The Geothermal ERA-NET is the one of the first steps towards a coordinated research in the EU through the SET-Plan (European Strategic Energy Technology Plan).

Through its actions, the Geothermal ERA NET aims to increase the uptake of geothermal energy; not only to contribute to an increased share of renewables in the energy mix, but also to improve security of supply and increase energy savings in Europe, and thus ultimately having a strong positive impact on Europe's economy and competitiveness. By doing so, the Geothermal ERA-NET's activities correspond to the delivery of a strategic contribution to the European Action Plan "Energy Policy for Europe".

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 help integrate intermittent renewable energies with its base load capacity. Countries participating in this ERA-NET build on shared and strong ambitions to include geothermal energy into their goals for 2020 and 2050 on the reduction of CO₂ emissions and uptake of clean energy technologies.

The fundamental "raison d'être" of the Geothermal ERA-NET is to support geothermal research in Europe and to encourage and enlarge the cooperation among geothermal research and innovation program owners and managers of energy agencies and ministries in Europe. The Geothermal ERA NET has assumed a prominent enabling role to assemble a previously 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 beyond.

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. 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 Technology Cooperation Programme (IEA Geothermal TCP) comprising 24 member countries and sponsors.

IEA Geothermal provides a world-wide platform to raise awareness and share knowledge on a wide range of activities related to the utilization of medium to high enthalpy geothermal resources, and thus is highly complementary to the more regionally focused Geothermal ERA NET. Another collaboration project, focussed on Enhanced and Super-heated Geothermal Systems, is the International Partnership on Geothermal Technology (IPGT), which involves the USA, Australia, Iceland, Switzerland and New Zealand. Like the IEA Geothermal, two 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.

A significant target is to establish a well-structured relationship at arm's length with the EERA Joint Programme on Geothermal Energy, whose aim is to contribute via the execution of research and development to the renewable energy targets for 2020 and beyond, in member and associated states.

3. OBJECTIVES AND STRUCTURE OF THE GEOTHERMAL ERA-NET

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. Efforts are made at national levels to ensure appropriate linkages to related R&D activities (renewable heating and cooling via ground storage heat pumps, power distribution and transmission).



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

3.1 Objectives

The overall objective is the mutual opening up of national research programmes and research infrastructures, and the development of joint activities.

The Geothermal ERA NET primary objectives are to:

- Deepen the cooperation on national and administrative level
- Be an enabler for the integration of national research
- Develop research agendas into a coherent European Geothermal R&D programme.

3.2 Structure

The ERA NET divides its activities 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 is based 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 (WP2). 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 feed into WP4 where joint activities are defined and implemented in WP7. Special attention is given to issues of human resources and mobility in WP6 where joint interests and actions are identified in a bottom-up approach and also fed into WP7 for implementation.

Work packages 3 and 5 supports the core activities during the entire project duration. WP3 comprises the establishment of a comprehensive, but fit-for-purpose geothermal information platform (essentially a network of national platforms) 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 lessen the fragmentation of transnational research activities and policies. These work packages continuously interact with WPs 2, 4 and 6.

4. JOINT ACTIVITIES

There are various possible ways for international collaboration of national research and innovation programme owners and managers to foster utilization of geothermal energy and innovation in Europe, which may in principle range from information exchange to multinational financing of demonstration projects.

The Geothermal ERA NET is one of a large number of ERA NETs that all aim to move forward their specific field. The ERALEARN initiative of the European Commission helps ERA NETs to benefit from their mutual experiences. The mapping and monitoring effort, supported by ERALEARN, has resulted in the following three groups of joint activities:

- Structuring common RD&D efforts
- RD&D quality assurance
- Human resources

A comment that must be made is that the majority of the ERA NETs focus on joint R&D, while the Geothermal ERA NET and other energy ERA NETs foster the cooperation between organisations that are both involved in R&D and in implementation activities. This results in a wider scope for possible joint activities.

To minimize the administrative burden, joint activities are fit-for-purpose and cost-effective. Within the Geothermal ERA NET, the approach was to consider various levels of potential joint activities. The following options were developed:

JA1 Information Exchange/ Knowledge Exchange groups) - low budget

Working groups would address issues through dedicated meetings, /workshops, and visits. This proves to be a very effective and easy to organise way to ensure that progress in a number of European countries is shared on a European scale.

JA2 Joint work/review – limited budget

These are joint assignment, e.g. to have an expert company produce a status report on a specific issue, a detailed study to solve a specific issue etc. All interested countries contribute funding for such an assignment, which results in a benefit to all.

JA3 Joint Call – significant budget

A joint call allows stakeholders in the participating countries to work jointly on developing new insights and new systems, in contrast to the first two types of joint activities that essentially aim to improve availability or analysis of existing information.

To create a scheme for the implementation of trans-European cooperation on geothermal energy, work package (WP) 4 “Development of joint activities” builds on a bottom-up approach for the realization of joint activities. This approach is based on the previous results of the Geothermal ERA-NET and delivers benefits of a European cooperation scheme. The approach combines the following requirements (see also Geothermal ERA NET deliverable, D 4.1):

- Minor effort of financial and human resources

- Based on the input from the geothermal community to ensure the necessity of the results
- Integration of stakeholders from the different fields of geothermal energy
- Capable to produce high-quality results and solutions for non-technical and technical issues
- Capable to identify several topics for joint calls

In a second phase this scheme was further developed and combined with the thematic needs on RD&D knowledge and information exchange and solutions to overcome non-technical and regulatory barriers.

In summary, seven Joint Activities (JA) on various topics were proposed:

- NWW – New ways of working: Financial Instruments and Funding of RD&D and Geothermal Projects
- OpERA – RD&D Knowledge Exchange on operational issues of geothermal installations in Europe
- PRGeo - RD&D Knowledge Exchange on public relations for geothermal energy
- New Concepts for geothermal energy production and usage
- ReSus - RD&D Knowledge Exchange on reservoir sustainability
- Tuning EGIP (European Geothermal Information Platform) for target users
- Geostat - Towards Consistency of geothermal data

The specific activities and working groups follow partly iterative and partly continuous approaches. In addition, the different working groups are coordinated by a steering committee of two countries for each activity, have developed an action plan until the end of the Geothermal ERA-NET.

4.1 Financial Instruments and Funding of RD&D and Geothermal Projects

The overall objective of this activity is to improve the synergies between different players in the field of geothermal utilization, to improve funding processes in R&D and the possibilities for project financing with the goal 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 recommend practical solutions, e.g. to prioritize in

future joint calls, increase investments and growth of geothermal projects in Europe.

The Joint Activity "New Ways of Working" goals are 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

It has 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). According to EGEC's report Financing Geothermal Energy the technique will surely become a key source in the European energy mix.

However, in order to realise its full potential to the benefit of European economies and citizens alike it needs increased and dedicated support now. With the accelerated deployment of geothermal energy requirement for investments it is clear that it cannot solely rely on public funds. Hence, the engagement of the private sector will also become increasingly more crucial.

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.

The final report from the task group will be finalised summer 2016.

4.2 OpERA – RD&D Knowledge Exchange on operational issues of geothermal installations in Europe

The major advantage of geothermal energy over other renewable energy sources is the time and site independent availability of the geothermal resource. To use this advantage, the operational availability of geothermal energy installations has to be stable on a high level. Scaling and material corrosion for instance, are issues in many geothermal areas in Europe (for example: boiling point scaling in production wells (calcium carbonate; metal sulfides), scaling in surface equipment (mostly amorphous silica; calcium carbonate and sulfides to a lesser degree), scaling in reinjection wells (amorphous silica). Both lead to breakdown times due to necessary repair or service works. Also other issues like high gas content of the

thermal brine or pressure related issues have to be discussed.

To create a platform for this discussion the OpERA working group was founded. The OpERA working group aimed on bringing together the national experts (Plant owners, project developers, researchers) to provide an overview of potential solutions, like adapted materials in the geothermal installation, the use of inhibitors or optimized pipe geometries or well design. Therefore, OpERA provided a platform for technical knowledge exchange to solve Operational issues on a European base.

As a first step towards this European knowledge exchange, OpERA organized a workshop on operational issues on the 1st & 2nd of October 2015 in Vaals (NL). 37 experts from 11 countries participated in the workshop. On the first day country overviews from Hungary, Italy, the Netherlands, Slovenia, Germany, Iceland, Switzerland, France, Denmark and Austria were presented to create an overview of the most urgent operational issues in Europe. These issues were summarized in the "OpERA-Magna Carta" (respecting the 800th anniversary of the real Magna Carta in 2015) which shows solved and unsolved issues on scaling, gas content, corrosion and reinjection by country.

The second day was structured with four topical sessions on scaling, scaling & gas content, corrosion and re-injection issues. In these sessions 13 presentations on specific issues, possible solutions and examples from different locations were held.

Both days were enveloped by discussion & summary sessions moderated by a specialist for operational issues from the oil & gas industry. The experts participated very actively in the fruitful discussions and solutions for several issues were addressed on a European base.

In the last session of the workshop, the "OpERA-Expert Group" was founded, to create a joint publication on operational issues in Europe. 22 experts accepted to provide input for this publication. Besides the country overviews and the "OpERA-Magna Carta" the publication will entail summaries of the general, solved and unsolved issues in the different topical fields and several excurses on specific topics as e.g. carbonate scaling, corrosion in low enthalpy fields or induced seismicity. The OpERA Joint Activity revealed the necessity of a trans-european knowledge exchange on specific topics and showed, that the community appreciates a neutral platform to discuss urgent issues on an open level without any country or company based restrictions. During the whole workshop the focus was on topics and solutions and not on competition. Therefore "OpERA" was a showcase, how a European geothermal community can work together in the future to support the further development of geothermal energy. Following the workshop and the publication further activities like a

transnational online information system on operational issues are planned.

4.3 PRGeo - RD&D Knowledge Exchange on public relations for geothermal energy

Sadly, known by the geothermal community, the lack of public acceptance for geothermal energy installations often hampers further developments in many countries. Furthermore, the advantages of using geothermal energy are little known, and media reports often spread information rather on its disadvantages (e.g. high upfront costs, drilling risks, environmental threats such as induced seismicity, ground swelling, pollution of ecosystems by the surface inlet of deep geothermal brines, etc.). The origin of the sceptical view on geothermal energy varies from the lack of information about the technology to wrong conflict management from project owners. As a result, political decision makers and potential investors have concerns about possible risks in implementing geothermal projects, and social resistance often results in significant slowdowns of the projects.

The joint activity PR-Geo aimed to exchange knowledge on the diverse approaches of Public Relations (PR) experienced in different European countries in order to make sure that geothermal energy can play its optimal role in Europe's future energy supply. A side event at the German Geothermal Conference at Haus der Technik in Essen was organized on November 4th 2015 with five invited speakers who presented the PR aspect of various types of projects from France, Germany, Italy and Switzerland.

The workshop concluded that although the PR work has been reinforced among project developers and operators in the recent years, it still can be optimized, especially by streamlining focused messages to the different target groups. Each geothermal energy project is unique. This applies both to the geological and technical characteristics and to the socio-demographic conditions. Therefore, the same and proper measures cannot be applied to all projects. Although different types of project examples were presented and discussed at the workshop, it was generally concluded that the acceptance of geothermal projects is a question of trust. PR work can therefore only be successful if it manages to create a basis of trust in which early, honest and strategically oriented communication has a crucial role.

4.4 New Concepts - RD&D Knowledge Exchange on new concepts for geothermal energy generation and use

The New Concepts (JA) mission is to stimulate creative concepts for European innovators in geothermal utilization and technology. It highlights opportunities in direct utilization of low enthalpy geothermal energy such as geothermal heat and cooling for smart cities, food production, and cosmetics. The activities create cooperation between the CleanTech sector and the European business

network and display successful innovative projects. Crucial in this JA is expanding and stimulating new opportunities. Trend in renewable energy is changing constantly and current EU statistics indicate a significant growth and importance of geothermal energy each year. New European Union Research and Innovation funding programmes, increased geothermal energy supports up to 15% or to almost 70M€ financial support and additional 30M€ in renewable heating and cooling.

New Concepts (JA) workshop was held in Geneva on October 30, 2015. It was organised by Geothermal ERA NET leaders, Iceland and the Netherlands, together with IEA Geothermal, and supported by Swiss Federal Office of Energy.

The workshop displayed the opportunities in the geothermal sector and stimulated growth of its industry in Europe. The focus was put on new and innovative applications of geothermal energy utilisation at a European level with interest from worldwide examples.

The workshop included an overview of GEO Innovative opportunities and pilot projects enhancing possibilities from small innovative ideas to large industry in Geothermal. The event had three sessions presented by specialists from Europe and one session based on worldwide example:

- Session I: EGS projects + direct use applications
- Session II: Direct use applications (new concepts – built environment)
- Session III: Direct use applications (new concepts – other sectors)
- Session IV: Innovative Applications of Geothermal Direct Use worldwide
- Visionary Panel Discussion, Conclusions and Next Steps

Each session had significant importance on different geothermal application issues. The closing session of the workshop included a visionary panel with ideas of future in geothermal energy development. The visionary panel had a challenging task for participants, which was to draw the future of geothermal with famous wax crayons from the 100-year-old Geneva-based company "Caran d'Arche". The outcome of delivered cartoons will be a part of the proceeding released in spring 2016.

The Geothermal ERA NET New Concepts may convey its aspirations to its stakeholders by communicating effectively and efficiently the benefits of such a framework and, eventually receive their long-lasting support in the development of this framework

4.5 ReSus - RD&D Knowledge Exchange on reservoir sustainability

To foster sustainable and safe use of geothermal reservoirs as well as increase the lifetime of the resource, boreholes and system components, it is crucial to understand the physical properties of the reservoir rocks and fluids and their interaction during the exploitation process.

The Joint Activity (JA) "ReSus" (Reservoir Sustainability) focus on setting up a platform to study geothermal reservoir sustainability, comparing the current practice used by the operators, highlighting the best solutions and studying the unsuccessful cases, in order to animate a fruitful debate to capture the current state-of-the-art and explore possible scenarios for future economic and sustainable exploitations.

Beyond the scientific community, the topic of such a JA clearly interests even regulatory authorities and operators who seek to implement sustainable development strategies.

The ReSus JA working group organized a web questionnaire to highlight the objectives of the stakeholders regarding reservoir sustainability and to collect their practices to achieve them. The questionnaire was structured in 2 parts. Part 1 investigated the respondent institution typologies, the institution principle interests, the reservoir horizontal and vertical scale field of interest. Part 2 surveyed the reservoir sustainability concept from three different point of view, i.e., Economic profitability, Public acceptance and Environmental impact.

The ReSus survey was conducted firstly in September 2015 and secondly in march 2016. The extension allowed to retrieve more input from European stakeholders. The preliminary results were presented during the Geothermal ERA-NET meeting in Reykjavik in April 2016. A report at completion of the ReSus JA is currently in preparation that will include the survey results as well as the main outcomes and recommendations gathered by this JA.

4.6 Tuning EGIP for target users

The work dedicated to the European Geothermal Information Platform (EGIP) is the first Joint Activity performed by some of Geo ERA-NET partners. Started in 2012, it produced a State of the art report and a Feasibility study (2013) that led to the development of a Pilot (2014). The results have been published by Trumpy et al. (2015).

Late 2014, the Geo ERA-NET project consortium and the Supervisory Board decided that a further step of EGIP evaluation was necessary. Consequently, this "Tuning EGIP for target users" JA aims to perform an analysis of the boundary conditions for such Geothermal Information Platform at European level. The JA is based on the experience learned from the EGIP Pilot in order to propose its complete implementation. A Web survey has been conducted to

give the EGIP Pilot accessible to European stakeholders and to collect their feedback on effective needs, impacts and benefits that EGIP must have. The results and conclusions of this survey are described in the Tuning EGIP JA report (2016).

Early 2016, the EGIP Expert Group was created to formulate INSPIRE oriented guidelines for the harmonization of geothermal data, and to envisage a call for tender for the implementation of EGIP. The Expert Group is supported by an Extended Expert Group gathering technical skills especially regarding the INSPIRE European Directive and geothermal databases. During the final course of Geo ERA-NET, the Expert Group will produce an overview of EGIP to prepare its implementation. Such a document will be dedicated to whom will take care of the development of the Information Platform. Considering the close end of the GEO ERA-NET project, the Expert Group also seeks for opportunities to find a framework where EGIP could come true.

4.7 Geostat - Towards Consistency

Data on geothermal energy is collected by various international organizations. These collections are based on questionnaires which are different although the objective is to collect the same data. Due to these differences the same data can be misunderstood, misinterpreted and give wrong signals. Therefore, a common ground is needed to enable use and comparison of energy statistics, increase reliability, security and decrease fragmentation in line with the aim of these organizations, motions and regulations.

Here are proposed objectives with measurable indicators and how GeoStat can achieve these:

1. Participating countries to aim at reducing the difference between industry and official statistics below a defined benchmark for year 2020. The following indicators are proposed on a national level annually:

- Total Net Maximum Electrical Capacity
- Total Electricity Generation
- Total Geothermal Direct Use and Heat in Final Use

GeoStat could facilitate by aiming at identifying the source of error in each case with dissemination and discussions on terminology and definitions and direct comparison of statistics for each nation.

2. Participating countries to aim at reducing duplication of efforts domestically. Measureable indicators suggested:

- Number of months until Joint Questionnaires to IEA and Eurostat on Renewables and Electricity and Heat are made available.

GeoStat could assist in making the files accessible electronically on a website with other sources accessible on a national basis.

3. Collaboration between entities on a domestic level having the following indicator:

- The respective experts responsible for each data submission for both official and industry statistics know about each other.

GeoStat can make the connections between experts on a domestic level.

4. Simplified process across organizations and reducing duplication of efforts with the following indicators:

- Associations and lobby groups should peer review official statistics.
- Terminology of industry should be adapted to official statistics when possible.
- Terminology of official statistics should be clear and understandable.

The intention of GeoStat is to make the connections and starting the review process in cooperation with the partners and to make the terminology clearer. GeoStat will write a short manual with terminology and definition already identified in this report, in particular for thermal capacity.

The seven presented joint actions are the base for the trans-European collaboration in the most relevant fields of geothermal energy. Topics identified in earlier steps of the implementation process can be addressed in a second phase of joint activities in the future. The selected actions are capable to enable and to foster a multinational cooperation for the development of geothermal energy. This can also be the starting point for more complex (JA2&3) activities in the future, if the benefit of multinational collaboration can be shown on the selected level with minor financial effort. The planned steps of each joint activity will be presented in chapter 3. Possible further steps and activities are presented in chapter 4.

5. THE NEXT PHASE OF EUROPEAN COLLABORATION -- GEOTHERMICA

The GEOTHERMAL ERA-NET has provided a strong platform for continued collaboration among Europe's geothermal research and innovation program owners and managers. Four years of intensive exchange and collaboration on research policies, programming, funding instruments and frequent interpersonal exchange have enabled the formation of strong relationships among participants. So much so, that the GEOTHERMAL ERA NET member countries intend to move to a subsequent stage in coordination of national research and innovation programme. Building on joint activities and prioritization of trans-European common research and

innovation topics and themes, and the continued support and facilitation of the European Commission to enhance and strengthen cooperation and coordination of national research and innovation programmes, a large number of GEOTHERMAL ERA NET countries and new European partners have teamed up to launch an ERA NET Cofund Action.

ERA NET Cofunds under Horizon 2020 support joint programming initiatives of European countries, in their preparation, establishment of networking structures, design, implementation and coordination of joint activities as well as Union topping-up of a trans-national call for proposals.

To this effect, 16 geothermal energy research and innovation programme owners and managers from 13 countries have come together and have formulated a plan to develop GEOTHERMICA as an ERA NET Cofund. GEOTHERMICA has been submitted in April 2016 to the European Commission for consideration as an official and sanctioned ERA-NET Cofund. Participating research and innovation program owners and managers hail from Belgium, Denmark, France, Germany, Iceland, Italy, the Netherlands, Portugal, Romania, Slovenia, Spain, Switzerland and Turkey.

Specifically, GEOTHERMICA aims to launch joint actions that demonstrate and validate novel concepts of geothermal energy utilization within the energy system and that identify paths to commerciality. Joint actions comprise joint calls and coordination activities, which will strengthen Europe's geothermal energy sector by building a tightly interconnected and well-coordinated network of European funding agents. For a first joint call, some EUR 30 million will be made available for a small number of major demonstration projects. Joint calls will have a strong industry participation with a targeted 50% contribution towards work programs and budgets of successful proposals. In addition to joint programming and joint calls, a number of additional activities will be undertaken to develop shared and deep knowledge, to promote operational excellence, to exchange good practices in the realm of support policies, and to define strategic recommendations related to long-lasting and durable joint pursuits of research and innovation.

Ultimately, a strong public sector will complement the research and innovation community as well as Europe's geothermal industry sector to build an overall strong European geothermal energy sector ready to contribute to the European Energy Union, the implementation of the SET Plan as specified by the SET Plan Roadmap.

6. CONCLUSIONS

The Geothermal ERA NET has been a crucial instrument provided, by the European Commission, to assemble national research and innovation programme owners and managers to embark on a path towards

integrating their work based on common principles, priorities and actions.

A publicly available inventory of existing support and funding schemes has been instrumental to identify strengths, weaknesses, threats and opportunities of national research and innovation programmes across European programs. In particular, and primarily the establishment of a common internet platform, the Geothermal ERANET website, allowed for the development of an inventory, which enables the sharing of good practices and emulation within national programs. Sharing RD&D efforts and a gap analysis has allowed the identification of common needs. This shared understanding in turn helps to communicate early phases of alignment and the need for continued cooperation with a focus on joint programming and joint calls. At the same time, this process helps national program owners and managers in the development of national strategies and implementation via national programming cycles in alignment with overarching goals, best achieved at European levels. Through progressive enlargement of the consortium to include other European countries, good practices will continue to be assembled and spread throughout Europe.

The development of stakeholder maps, communication strategies and their implementation plans has enabled efficient communication with national stakeholders; a task that is facilitated by the primary function of national Geothermal ERA NET participants as funding agents.

A particular and on-going focus will be on the interface with the European Commission and its administration. Coordination driven by technology specific national research and innovation programme owners and managers via the GEOTHERMAL ERA NET and a subsequent GEOTHERMICA action, needs to be coordinated with those activities of the European Commission. The latter are driven by complementary analysis, policy formulation and priority setting which along with consultations results in a top-down approach. The former is more akin to a bottom-up approach driven by national targets on the one hand, and driven by a fit-for-purpose, goal-oriented cooperation among Europe's countries. The bottom-up approach needs and will meet the top-down approach to deliver the shared goal of all national and EC research and innovation programme owners and managers: bringing geothermal energy resources to market. The ultimate, long-term goal beyond this ERA NET is that European countries along with the European Commission take up the role of the public sector champion of concerted geothermal energy development in Europe.

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