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GEORISK Project: Risk Mitigation and Insurance Schemes Adapted to Geothermal Market Maturity, the Right Scheme for my Market, Experience from Europe

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ABSTRACT

Geothermal project development has several risky components, the most important one being the resource risk. Beyond exploration, the bankability of a geothermal project is threatened by this geological risk.

De-risking tool such as risk insurance funds for geological risk already exist in some European countries such as France, Germany, Iceland, The Netherlands, Denmark and Switzerland. The geological risk is a common issue all over the world. Outside Europe, there is the Geothermal Development Facility (GDF) for Latin America and the Geothermal Risk Mitigation Facility (GRMF) for Africa, which offer some risk mitigation tools. With the notable exception of these regions, project developers have very little capability to financial de-risking of their projects.

The establishment of such risk insurance all over the world to cover the exploration phase and the first drilling test, is key for a large development of deep geothermal resources. It appears clear that a de-risking scheme must be designed, especially with the involvement of private financers, according to the market maturity of the sector in each country and region.

1. INTRODUCTION

As with other energy sources, geothermal energy faces a range of technical, economical, commercial, organizational and political risks. Some of the risks can and should be borne by the project owner, and financial consequences of the failure are routinely transferred to bodies that are better suited to carry specific risks. Yet other risks can be high enough to be – in the absence of a risk transfer mechanism – a show-stopper. Unless the subsurface is well explored and characterized for geothermal energy utilization (e.g. the Lardarello region, the Paris Basin, the major grabens along the Northern Anatolian Fault Zone of Turkey), the resource risk poses a formidable challenge, and is the major barrier to entry for geothermal project developers in Europe; also worldwide and seriously hampers its market uptake.

This resource risk, also called geological risk, associated to geothermal project development is unique. It includes:

- The short-term risk of not finding an economically sustainable geothermal resource after drilling
- The long-term risk of the geothermal resource naturally depleting rendering its exploitation economically unprofitable

Until the first borehole has been drilled into the geothermal reservoir, developers cannot be sure about the exact parameters (temperature and flow rate) of the planned electrical or heating and cooling (H&C) project. Once drilling has taken place, in situ pump tests, temperature and hydrological measurements are taken, which reduces the resource risk and makes it possible to attract external capital.

One of the most recent summaries of geothermal risk mitigation measures developed in some European countries, represents good study cases to be followed by countries with juvenile or emerging markets. It was elaborated in a framework of the EEA Project "GeoHeatPol" (2017; www.eeagrants.agh.edu.pl).

Some countries in Europe (France, Germany, Iceland, The Netherlands, Denmark and Switzerland) have already established public insurance schemes (e.g. geothermal guarantees, risk insurance funds, capital grants) that allow project developers to transfer some of the geological risk to public bodies. Risk mitigation schemes for geothermal have been recently launched by National and Multilateral funding agencies and banks in Latin America, Mexico, Chile, Eastern Africa. These latter schemes are mainly in the form of capital grants. In some countries however, privately issued insurance schemes are emerging. In most of Europe however, for a multitude of reasons, the private insurance sector stands back; e.g. the high exploration risk, the small size and exotic nature of the market and lack of experience.

In most cases, project developers 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. In effect net present values of project cash flows weighted for the probability of success/failure tend to be overly negative, thus effectively shutting out private capital from investing in geothermal energy.

The framework of the H2020 program, the GEORISK project, starting in October 2018 for 30 months, aims at establishing such risk insurance schemes all over Europe as well as in some key target third countries to cover the resource and the technical risks.

The objective of this paper is to present the main project results achieve thus far (mid-2019) and the methodology adopted to support the establishment of insurance schemes.

2. MAPPING THE RISK

2.1. The GEORISK Risk Mapping Database

In order to create adapted insurance schemes, the first mandatory step is to get a better understanding of the risks preventing a successful development of deep geothermal energy. In phase with international standards on risk management (i.e. ISO31000), the very first step is to list the various risks in the process of risk identification. For this process, a bottom-up approach was used, by gathering information from previous European projects (e.g. GEOELEC, DARLINGE, GEOWELL), from the existing literature on de-risking geothermal energy project, and from the wealth of experience of the various GEORISK partners.

At this stage, we used a broad definition of the type of risk: any event that can put a barrier to the viability (i.e. economic, environmental, social) of a geothermal energy project; the goal is to be as comprehensive as possible. Here, overlaps between different risks are not as important as potential gaps.

The outcome of this process is a register, published in March 2019, of about 50 risks. Each risk in the register is characterized by a description of one or several corresponding phases, types of consequences, and mitigation measures. Two kinds of mitigation measures are distinguished: technical measures, and financial measures (insurances).

The risks are organized into six categories:

- External hazards
- Risks related to the external context
- Risks due to internal deficiencies
- Risks due to subsurface uncertainties
- Risks due to technical issues
- Risks due to environmental issues

In addition to this categorization, each risk is placed in one or several phases, (1) identification/exploration or activities before drilling, (2) drilling/testing/development or activities before exploitation, (3) exploitation, and (4) post-closure phase includes all risks that may happen after the exploitation, drilling and development phases, and includes the decommissioning and abandonment of the wells. Each risk can have two types of consequences, either on economic objectives, often linked with the performance, or on health, safety, and environmental (HSE) objectives. In practice, all HSE risks have also, albeit indirectly, an economic impact.

This is the current version of the risk register and the method used for building it, but as the initial step of the project, will still evolve to be updated end 2020. The next step is the risk assessment where each risk will be rated and ranked. This will require more details on the context: geographical, geological, type of use, etc. The main deliverable of this activity will be an online tool for developers presenting the main risks for a given context along with the various mitigation solutions.

The focus of the GEORISK project is on the risks due to subsurface uncertainties, which encompass the aforementioned short-term and long-term geological risks. Nonetheless, it was important to get a comprehensive mapping of all potential risks in order to get a clearer picture of all barriers faced by geothermal energy development.

2.2. Mitigating the Geological Resource Risk Through Risk Assessment Tools: Improving Access to Information

Risk management does not limit itself to a list of "what could happen". After the risk identification process, all risks are linked with one or several mitigation solutions; it is important to stress that risks are not absolute hurdles, rather barriers that can be removed. In addition to technical solutions, the possibility of financial mitigation is assessed for each risk.

The ongoing GEORISK consultation survey aims to better understand how the risk and the uncertainties associated with deep geothermal projects are evolving during the development of a project. It is also to learn more about needs from market actors as well as to collect potential ideas for exploiting outputs and results of operating geothermal plants. Answering the survey helps the GEORISK project partners to better shape future risk mitigation schemes. The survey results will be used to create a free online tool of geothermal risk assessment. As contributors to this survey, respondents will have access to the prototype of this e-tool.

In the subsequent step, the objective is to use data collected to assess the risk, i.e. to rank them in a risk matrix, where each risk is given a score on probability and severity scales. This work can be challenging for broadly defined, generic risks, which is why it is important to introduce a greater level of details with risk factors. Risk factors can be defined as any factor influencing the risk. The main risk factors for geothermal energy projects are the geographical and geological context, the type of energy use, the target depth, etc. This risk assessment process will thus provide valuable information for geothermal project developers: given the characteristics of a project, a dedicated tool will provide a ranked list of the main risks, along with a knowledge base of potential technical and financial mitigation solutions.

3. DEVELOPPING GEOTHERMAL RISK MITIGATION SCHEMES

Geothermal energy represents a relevant component of the future energy systems in Europe. Results from past projects assessing its potential (GEODH and GEOELEC projects) show that geothermal energy has the potential to supply more than 10% of the energy consumption in the EU by 2050. Its main advantage is the possibility to offer, 24 hours a day or on demand, a wide range of supply option and services around electricity, and H&C in an uninterrupted manner. Deep geothermal has a great potential for development in many European states with some countries having made significant progress historically Italy, Iceland, and France, in recent years, Turkey, Germany, and Hungary.

As with other energy options, geothermal energy faces a range of technical, economical, commercial, organizational and political risks. Risk transfer allows the development of some geothermal projects, as it allows developer to transfer part of the excess risk – for instance the one linked to being the first developer in a given reservoir – and therefore to undertake the projects as the cost of capital – which directly reflects the risk of the project – is must lower. Unless the subsurface is particularly well explored and characterized for geothermal energy utilization (e.g. the Larderello region, the Paris Basin, the major grabens along the Northern Anatolian Fault Zone of Turkey), the resource risk poses a formidable challenge and is the major barrier to entry for geothermal project developers in Europe but also worldwide and seriously hampers its market uptake.

In order to facilitate project development, establishing risk mitigation schemes is a solution that has proven effective in several European countries. GEORISK project has inventoried 21 major schemes, 7 of them are terminated and sometimes proved not efficient, 12 are ongoing at world level and 3 have been proposed in Europe (EGRIF), for Africa (GeoFutures) and for EGS in mainland France. Many existing schemes that have been established on a national level in the past, in general being managed by the geological surveys in Iceland, Japan, Indonesia, Turkey, USA, Philippines, European Commission, are not listed neither studied because they were focusing to acquire first geological knowledge.

Four levels of success can be observed across the 21 funds assessed:

The first category is highly successful, with many developers applying, supported projects and geothermal plants completed. It includes mostly long-existing European schemes devoted to Heat Generation such as SAF Environment, Swiss 1987, The Netherlands Scheme, the German National Scheme.

- The second category encompasses attractive funds, in the way they attracted many applicants and awarded many supports, yet all money has not been cashed out and the completion of plants actually connected to the grid is still expected. Such funds are GRMF and GDF. The latter benefitted from the learnings of the former. Recently launched public funds, such as Turkish RSM and Swiss 2018, look promising. 8 projects are already engaged in the application process for the Turkish RSM. Swiss 2018 has officially accepted their first project a few months after its launch.

- The third category gathers unsuccessful public funds either because of unattractive service (Swiss 2008, Pluto, IRENA ADFD), insufficient funding (ARGEO RMF, GEOFUND) or adverse local market conditions for geothermal energy due to competition with low LCoE (levelized cost of electricity) of wind and solar power (MiRig, Mexico).

- The fourth category gathers the unsuccessful private schemes, mostly because either the risk borne is too high or because of unattractive high premiums (Munich Re Private, Marsh A, ART)

- The fifth category gathers the projects to come, such as EGRIF, GEOFUTURES, GEODEEP SAS. EGRIF should be much inspired from the French SAF Environment. GEOFUTURES has a sophisticated approach intending at solving barriers both on developers and stakeholders' sides, at the cost of a certain complexity. GEODEEP SAS is limited to EGS in mainland France.

It appears clear however that a risk mitigation scheme must be designed according to the market maturity of the sector (Fig. 1):

- Investment aid in forms of grants is seen more appropriate for juvenile markets. Starting with direct grants, this could evolve to repayable grants in case of success and thirdly to convertible grant aiming at financing the second well.
- A Public risk insurance scheme would fit for intermediate markets
- And Public-Private partnership for the risk insurance fund for pre-commercial technologies in a near mature market.

In complement of these schemes for geothermal risk mitigation, other types of financial instruments can contribute to reducing the financial risk for project developers. Some schemes can mitigate the technical risk, linked to drilling for example. For mature renewable energy technologies, private insurance schemes already exist, and could be replicated in the geothermal sector. In most markets, the required liquidity of the market is not yet attained, so publicly underwritten schemes are necessary.

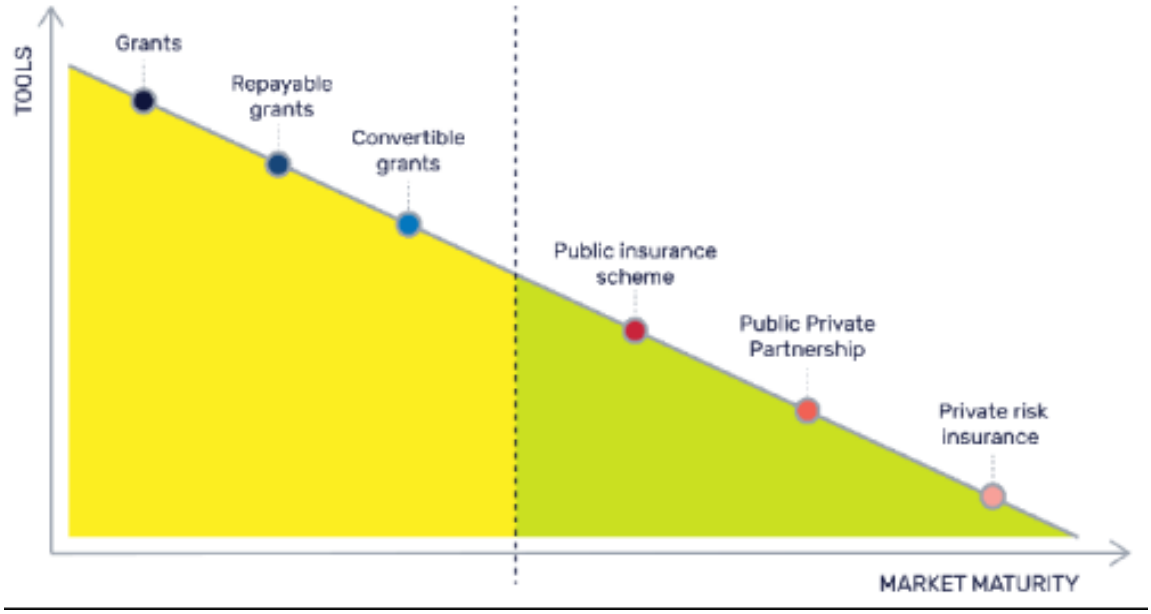

Figure 1: Presentation of the transition of financial tools to mitigate the resource risk per market maturity (EGEC)

4. TAILORING THE RISK MITIGATION SCHEME ACCORDING TO MARKET MATURITY

4.1. Geothermal Project Development Financial Profile

Financing the development of a project systematically includes a risk component, which is usually priced in the form of interest rates in the case of a loan, or high remuneration requirements in the case of equity.

When investing in a geothermal project, the issue which is exacerbated by the geological risk, is that a significant share of the total project cost must be spent before there can be a relevant decrease in the impact of the resource risk. Indeed, drilling represents between 50-70% of a deep geothermal project development cost in Europe. Geothermal project development usually require the drilling of the first well to decrease the uncertainty regarding the temperature and flowrate, which defines the capacity of the geothermal project, and therefore the revenue, which requires a large investment expenditure as noted in the figure below.

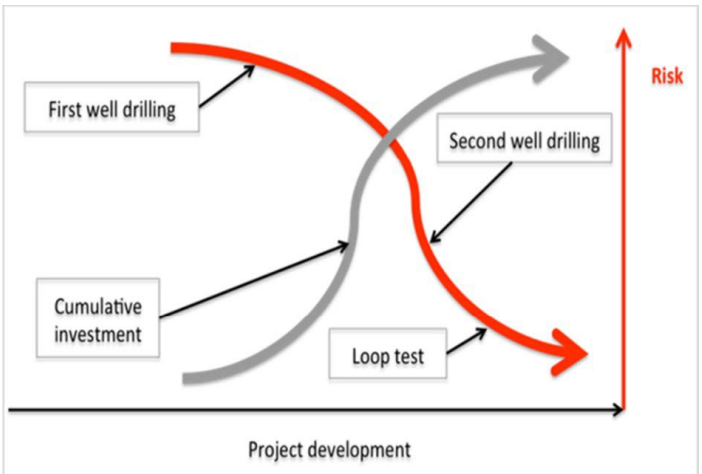

Figure 2: Geothermal project risk and cumulative investment cost (EGEC)

The cost of financing a geothermal project is also high due to the capital-intensive nature of geothermal energy projects where project development represents a large share of the total project costs, and there are no fuel costs and small O&M expenditures. This increases the importance of reducing the risk profile of geothermal projects to minimize capital costs.

With the exception of a few European market participants operating in well-developed geothermal regions, project developers have little capacity to manage the financial risk owing to the poor knowledge of the deep subsurface, lack of technological progress and high cost. In effect the probability of success/failure weighted net present values of project cash flows tend to be overly negative, thus effectively shutting out private capital from investing in geothermal energy.

However, with technology development, which increase the probability of success of finding and developing geothermal reserves, coupled with experience and thus reductions in cost. Project developers will eventually be able to accept and, where appropriate, transfer project risks (technical, economical, commercial, organizational and political) in such manner that private funding will become available. Until then, a public Geothermal Risk Insurance Fund is seen as an appealing support measure for geothermal.

4.2. Delivery of Support by the Risk Mitigation Scheme

Risk mitigation schemes for geothermal energy can deliver in different ways to mitigate the resource risk. In existing schemes – not considering full grants which are rather self-explanatory as a financing mechanism – two main types of mechanisms have been used to deliver on the risk mitigation schemes:

1) Ex post payment, in the same way as a conventional insurance contract. Once the risk materializes, the insurance scheme delivers support to project developers according to the terms of the contract (e.g. reimbursement of a given percentage of the drilling costs). Insurance schemes may be undertaken by the public or the private sector, provided there is a sufficient pool of projects and the failure rate remains low enough.

2) Guaranteed loan: If the project development is successful, then the loan must be paid back. However, if the geological risk occurs, then the loan is forgiven. Such loans may be provided either directly by the public sector or by private financing institutions. When it is forgiven, the government usually undertakes the financial responsibility.

4.3. Conditions for a Transition in the Insurance Schemes According to Market Maturity

Analyses of investment costs and risks underline that the financing of the exploration phase of a geothermal project is an important, if not the most important barrier to development. An unsuccessful drilling represents a large payment from a fund. Drilling costs can represent 50-70% of the total costs for a deep geothermal project for heating and cooling of 4-6 M EUR/MW_{th}.

While a geothermal resource risk mitigation scheme may be set up by the public (government) or private (insurance) sectors, the low number of geothermal projects, and the high level of risk, often require some part of public sector involvement. Indeed, in most markets, the portfolio of projects is not large enough to spread the risk – which is also often too high or hard to quantify due to a lack of sufficient past experiences. These characteristics make the establishment of fully private insurance schemes hard to justify in most markets. However, with the right framework schemes can progress from full grants for drilling towards insurance schemes, partly or fully private.

5. ESTABLISHING RISK MITIGATION IN NEW MARKETS FOR ALLOWING GEOTHERMAL ENERGY DEVELOPMENT

To establish a risk mitigation scheme for geothermal project development, several factors beyond the design of the scheme are crucial to enable success. Some practice on regulations is perceived as being pre-requisite or very favorable to the development of deep geothermal technology. This is the case, for instance, where:

- Availability and accessibility of information on geothermal resources for deep geothermal systems
- Clear definition of procedures and licensing authorities (e.g. setting up a unique geothermal licensing authority)
- Simplification of authorization and licensing procedures, transfer to regional (or local if appropriate) administration level
- Streamlined administrative procedures for geothermal licensing
- Guarantee of ownership rights for the resource
- Legislation on underground use should prioritize geothermal against other uses with higher environmental impact or risk (e.g. unconventional fossil fuels, CCS, and nuclear waste deposits)

5.1. Building on Best Practices

There are several examples of markets where the development of geothermal energy was successfully enabled through a suitable combination of incentive schemes and geothermal risk mitigation. Illustrated by the figure below, as the market progresses towards maturity, it is possible for the support framework to be increasingly left to market dynamics. At early stage of market maturity however, the role of public sector is crucially important in allowing the emergence of the geothermal sector.

An example in this respect is Poland – one of the three target countries of the GEORISK project. Geothermal heating market is at the beginning of development, because only 6 geoDHs have been operating there so far. All of them were mostly financed from public funds (grants, loans, subsidies), and from foreign aid funds in some cases. The geothermal heating market has been developing slowly so far also because the level of public support and investment funds were almost always limited. Moreover in 2012–-2015 that support was closed resulting in hampering the progress of existing geoDHs as well as the lack of new projects oriented for space heating; despite prospective geothermal potential, interest of local governments, other investors, general public, ecological reasons, etc.

However, soon after the launch of a state program to support the geothermal development for heating/electricity purposes in 2015/2016 many applications for funding geothermal research wells and other investment works were submitted to the Ministry of the Environment. The applications for drilling support came mainly from local governments, eligible to receive up to 100% of costs. In 2017–2019 about 10 such applications were approved for implementation. Several wells were already drilled, while several next were in the course of drilling or in pre-drilling stage (2018-2019). In 2019 further positive decisions on supporting the drillings and other investments oriented for geoDH were expected. In 2019 next public support program was launched.

The above facts present a specific proof that public support is an indispensable measure for the development of geothermal heating at juvenile markets. This is especially important in the countries where strong competition from conventional heating sources takes place – like from coal in the case of Poland. The lack or limited scope of public supportive incentives not only slows down, but even hinders the development of the use of geothermal heat.

As a result of the public support programs launched in 2016 and 2019 one can expect that in the coming years in Poland geothermal will be introduced to subsequent heating networks, while already existing geoDHs will provide more heat. Hence, the geothermal market will grow. It is therefore necessary to introduce next public measures supporting the geothermal development in the form of public geothermal risk mitigation fund. It will limit the short-term technical and resource risk during drilling and testing the wells, and a long-term risk during exploitation stage. It will also help to maintain the durability of projects initiated thanks to earlier public support, ease to start next investments, as well as facilitate a long-term sustainable exploitation of geothermal resources and heating systems. These are important conditions for maintaining the ecological effects, CO_2 and other GHGs reduction, at stable level over time. This is a measure which shall attract more investors and capital to enter the market since it will ensure the financial security of their projects for many years. The successful geothermal risk mitigation schemes existing in the states with mature geothermal markets are very instructive for Poland and other GEORISK target countries, both in Europe and in the third countries. Therefore, building on their best practices will create a basis for GEORISK framework proposals how to mitigate the risks in geothermal projects by implementing optimal and proven measures.

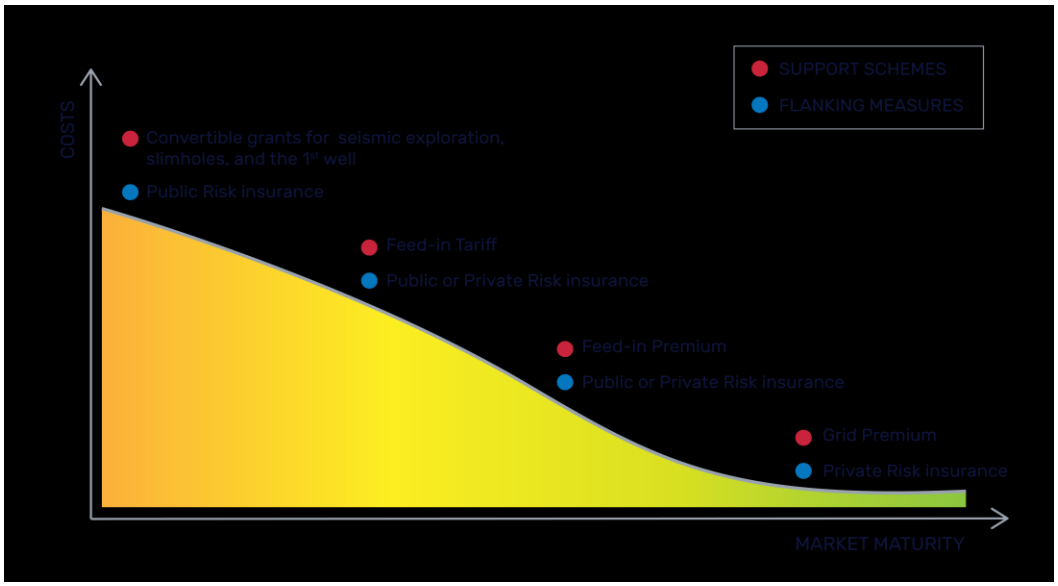

Figure 3: Support schemes for Geothermal adapted to technology maturity (EGEC)

5.2. The Objectives of the GEORISK Project

The GEORISK project started in October 2018. It will work to establish geothermal risk insurance fund all over Europe and in some key target third countries. To achieve this task, the project undertakes an extensive research work regarding the components of the geothermal resource risk, aiming at an exhaustive assessment and understanding of the different factors that may impact project development, and how they affect geothermal energy projects.

By providing an overview of the main risks, in terms of resource (geological), technical, and environmental, associated for the development of deep geothermal projects. The project aims to help comparing the risk of geothermal development with the risk of other renewable energy sources. This knowledge will help to better understand the risks for the project developers but also the financers and the decision-makers, and thus find the best financial solutions. The project also aims to develop tools to help the actors of the sector better identify and mitigate the risks.

By providing an overview, assessment and comparison of the different types of financial instruments, established or innovative, dealing with risk-mitigation, the GEORISK project also aims to develop a set of criteria on how to best apply a given risk mitigation scheme, and which specific type of instrument is best suited to a given market. In addition, it will set a blueprint for allowing geothermal resource risk mitigation schemes to evolve along with the increase in maturity of the geothermal sector, in order to be best suited for the optimal coverage of the resource risk, without hampering market development.

While the GEORISK project has an overarching objective to establish a risk mitigation scheme throughout Europe, the project has some intermediary objectives with a specific focus on key geothermal energy market. The project therefore aims at the development of insurance schemes in Hungary, Greece and Poland, and structuring a perspective on the transition of existing schemes in France, Germany, Turkey and Switzerland. This is notably pursued through:

- A definition of market maturity stages,
- Creation of a legal, financial and a technical model in target countries to adapt the scheme to the state of the market,
- Simulation of the financial sustainability of the scheme.

In addition, the project aims to build on the experience acquired during its duration to lay the foundation for the establishment of geothermal risk mitigation schemes within the three years of the end of the project, in some European target countries (Denmark, Netherlands, Belgium, Croatia, Slovenia) and outside Europe (Kenya, Chile, Mexico…), as well as explore the groundwork for a transnational risk mitigation scheme.

6. CONCLUSIONS

Key recommendations for designing new and improving the functioning of existing public support schemes for geothermal include:

- Support schemes are crucial tools of public policy for geothermal to compensate for market failures and to allow the technology to progress along its learning curve. They are temporary and shall be phased out as this technology reaches full competitiveness.
- Market failures and unfair competition prevent full competition in the electricity and heat markets, while the current capital crunch obstructs the necessary private financing mobilization to realize the enormous geothermal potential
- Geothermal technologies hold significant potential for cost reduction. Dedicated support schemes should allow cost reductions
- Innovative financing mechanisms should be adapted to the specificities of geothermal technologies and according to the level of maturity of markets and technologies
- Geothermal Risk Insurance Fund is seen as an appealing public support measure for overcoming the geological risk. As costs decrease and markets develop, the private sector will be able to manage project risks, for example with private insurance schemes, and attract private funding
- While designing a support scheme, policymakers should take a holistic approach, which goes beyond the LCoE and includes system costs and all externalities. As an alternative, there is the chance to offer a bonus to geothermal for the benefits it provides to the overall electricity system: flexibility and base-load
- Geothermal heat technologies are heading for competitiveness, but support is still needed in certain cases, notably in emerging and in transition markets and where a level-playing field does not exist
- Given the level of maturity of innovative geothermal technologies and the negligible support received so far, it seems premature to talk about the need for more market-based mechanisms or even phasing-out financial support for geothermal

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