

# Map of geothermal market actors

A mapping of the private stakeholders potentially active in RD&I on geothermal

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**Deep GEOTHERMAL IWG**  
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## CONTENTS

Executive summary.....	3
1. Introduction.....	4
2. Methodology of the deliverable.....	4
3. Involvement of private actors in the IP: Ongoing and planned R&I Activities .....	4
Title: Geothermal heat in urban areas.....	6
Title: Materials, methods and equipment to improve operational availability (high temperatures, corrosion, scaling).....	7
Title: Improvement of performance (conversion to electricity and direct use of heat) .....	8
Title: Exploration techniques (including resource prediction and exploratory drilling).....	9
Title: Advanced drilling/well completion techniques.....	10
Title: Integration of geothermal heat and power in the energy system and grid flexibility .....	11
Title: Zero emissions power plants.....	12
Title: Increasing awareness of local communities and involvement of stakeholders in sustainable geothermal solutions .....	13
Title: Risk mitigation (financial/project) .....	14
4. Co-funding from private companies in European projects .....	15
4.1 Horizon 2020 programme.....	15
4.2 GEOTHERMICA-funded projects.....	21
4.3 Analysis of the contribution from Industry in European R&I projects.....	24
5. Potential new private actors to execute the IP.....	25
5.1 Exhibitors at Trade Fairs and Members of associations and platforms.....	25
5.2 Deep geothermal companies operating in Europe .....	35
6. Conclusion .....	41

## Executive summary

In the SET plan, Europe has set its ambitions also for geothermal. A specific geothermal Implementation plan (IP) has been released and is now executed. To ensure the adequate execution of the IP, a task is dedicated to coordinate private funds and focusing them on the Implementation Plan's R&I and non-technical priorities. The deliverable aims at producing a mapping of the private stakeholders potentially active in RD&I on geothermal.

The SET Plan Temporary Working Group Deep Geothermal Implementation Plan identifies 10 areas of priorities for RD&I actions in the deep geothermal sector which cover a broad range of topics for the deep geothermal sectors and involve all segments of the deep geothermal value chain.

Many actors of the geothermal sectors are involved in publicly funded research projects, such as Horizon 2020 which funds projects that strive to the implementation of the SET Plan priorities. Beyond the actors already involved in projects contributing to the achievement of the SET Plan Deep Geothermal IWP (H2020, Geothermica), the report identifies key actors of the private sector that may potentially contribute to these objectives. It considers the attendance at large geothermal events such as the European Geothermal Congress, looking at companies involved in such platforms as the RHC ETIP Geothermal Panel and the ETIP Deep Geothermal, or by looking at the membership of organisations. EGEC's membership represents the actors of the whole geothermal value chain. Projects such as Geo-Energy Europe are also valuable tool for disseminating the RD&I priorities for deep geothermal and engaging with potential actors for implementation.

## 1. Introduction

The specific geothermal Implementation plan (IP) from the Implementation Working Group of the SET plan is now executed for achieving the ambition set for geothermal.

To ensure the adequate execution of the IP, a task is dedicated to coordinate private funds and focusing them on the Implementation Plan's R&I and non-technical priorities.

The deliverable aims at producing a mapping of the private stakeholders potentially active in RD&I on geothermal.

This report is done in the frame of a general task to analyse private financing of geothermal research and innovation. This task starts with this mapping of the private stakeholders potentially active in RD&I on geothermal. The map is based on existing recent data available from ongoing projects such as DG-ETIP and Geo-energy Europe which are working on describing the European geothermal supply chain. This mapping is done to ensure that the engagement effort is focused to stakeholders having a highest potential towards the achievement of IP objectives.

## 2. Methodology of the deliverable

Building from the SET Plan Deep geothermal priorities for ongoing RD&I activities, the deliverable identifies and proposes a mapping for each subsector. It provides also a general presentation of private actors already active in R&I, especially private companies co-funding in H2020 and GEOTHERMICA-ERANET projects. Finally the report presents the potential companies which could also execute the IP, based on previous mapping done in DG-ETIP and Geo-energy Europe projects but also EGEC Market Reports and networks of private stakeholders active in deep geothermal.

## 3. Involvement of private actors in the IP: Ongoing and planned R&I Activities

The SET Plan Temporary Working Group Deep Geothermal Implementation Plan identified 10 areas of priorities for RD&I actions in the deep geothermal sector. These priorities include:

- Geothermal heat in urban areas;
- Materials, methods and equipment to improve operational availability
- Enhancement of reservoir (conventional and unconventional);
- Improvement of performance;
- Exploration techniques;
- Drilling techniques;
- Flexibility from geothermal CHP plants;
- Zero emissions power plants;
- Community and stakeholder acceptance of geothermal projects;
- Risk mitigation.

These various priorities cover a broad range of topics for the deep geothermal sectors and involve all segments of the deep geothermal value chain. Across the different parts of the geothermal value chain, different types of actors will contribute their own expertise and resources to advancing the priorities for research, development and innovation in the deep geothermal sectors along the lines identified in the SET Plan TWG Deep geothermal Implementation Plan.

For each priority, the scope is briefly described and the typology of actors to implement the SET Plan Deep geothermal RD&I priorities is described.

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY	DG TWG		
<b>Title: Geothermal heat in urban areas</b>	R&I Activity.1		
<p><b>Scope:</b> To enhance the European heat transition to renewable energy by providing geothermal based solutions for urban areas. To contribute to decarbonising energy use for heating and cooling in cities and to improve air quality.</p>			
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b>  Advancing R&amp;I for geothermal heat in urban areas involves to “Demonstrate new heating concepts for urban areas based on geothermal energy and/converting conventional district heating networks of urban areas into renewable heating systems based on geothermal energy; enable the smart use of thermal grids with emphasis on flexible supply of resources, adapted to different source temperatures and varying demand; and position geothermal utilization (including underground storage) as a crucial pillar for the (heat) transition of the energy system.  Activities include geothermal heat for industry and agriculture, underground thermal energy storage (UTES), innovative and multiple uses for geothermal energy and side-products, balneological systems, and design and operation of geothermal doublets.”  These priorities have a strong focus on the deployment of new business models, and the development of new projects in previously untapped geothermal areas. The main aspect of innovation for this priority rests in the development of key demonstration projects to serve as a basis for market uptake. In this case, the involvement of project developers is crucial to the progress of this R&amp;I priority. However, the focus on the development of smart thermal grids, and notably the focus on the use of geothermal heat for new activities (typically by businesses from industry to agriculture), or for underground thermal storage, put heat users and heat exchanger manufacturers at the forefront of the R&amp;I effort. Generally as well, heat system developers play an important role in enabling the use of this technology by new actors. Finally, service companies active in financing, legal aspects but also heat supply such as ESCOs will be key actors.  Per the SET Plan TWG Deep Geothermal Implementation Plan, 30M EUR are expected to be contributed from industry to achieving this priority, on top of the public support allocated to its pursuit.</p>			
<b>TRL at start:</b> 7	<b>TRL at end:</b> 9		
<b>Total budget required:</b> €73.3m	<b>Flagship:</b>	Yes	

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY	DG TWG
<p><b>Title: Materials, methods and equipment to improve operational availability (high temperatures, corrosion, scaling)</b></p>	<p>R&amp;I Activity.2</p>
<p><b>Scope:</b> Developing new materials, methods and equipment suitable to solve problems commonly encountered in geothermal applications (resistance to corrosion and scaling) for low and high temperatures; decreasing the overall cost of a geothermal project.</p>	
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>Geothermal project may be faced with high operating costs and lower availability as a result of different effect related to the extraction of geothermal energy. In particular, the reaction between the components of the geothermal installation and the geothermal brine may lead to corrosion and/or scaling. Mitigating these impacts through innovation on materials, methods and equipment, and enabling geothermal systems to operate at higher temperatures is another key priority identified by the IWG Deep Geothermal Implementation Plan. “The materials and equipment required need to cope with hostile and aggressive reservoir environments and thermo-chemical fluid properties; the goal is to improve equipment reliability and to increase the plant utilization factor. Developing materials and/or methods and/or equipment such as pumps and heat exchangers for the application in all parts of a geothermal plant to minimize operational issues related to high temperatures, scaling, corrosion, and gas content.”</p> <p>To foster R&amp;I in this priority area, different types of actors are able to implement:</p> <ul style="list-style-type: none"> <li>- Manufacturers of equipment through research and innovation on materials or design to reduce the adverse impact of geothermal operation;</li> <li>- Operators of geothermal installations in the management of their equipment to maximise availability while mitigating corrosion and scaling at best;</li> <li>- Manufacturers of inhibitors and other chemical products that are commonly used to improve operational availability to maximise their efficiency.</li> </ul>	
<p><b>TRL at start:</b> 5 (Equipment); 4 (Materials)</p>	<p><b>TRL at end:</b> 9 (Equipment); 6 (Materials)</p>
<p><b>Total budget required:</b> €25.6m</p>	<p><b>Flagship:</b> No</p>

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY		DG TWG
<p><b>Title: Improvement of performance (conversion to electricity and direct use of heat)</b></p>		R&I Activity.4
<p><b>Scope:</b> To improve the overall conversion efficiency and reduce the cost of geothermal energy utilization. To develop an EU technology solution with a perspective to become a worldwide standard. To improve the efficiency of binary cycle power plants, including application to high temperatures, use as bottoming cycle and the capability of dealing efficiently with variable heat and electricity supply.</p>		
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>The energy available from the geothermal brine is often much greater than the energy harnessed by the geothermal plant, either for electricity, cogeneration or heat. A key aspect of the operation of geothermal installations is the management of brine temperature, notably to ensure the temperature balance of the system. In many cases however, an improvement of the conversion of the geothermal energy in electricity or for use in heating can yield more energy production. The Implementation Plan identifies “considerable potential for an increase of system efficiency e.g. design of improved heat exchangers and pumps, selection of materials, new working fluids with very small GWP (Global Warming Potential), increase in expander efficiency, improved efficiency of the cooling system by enhancement of the air-cooler/condenser and matching to the cycle, or avoiding the dumping of useful heat into the environment by promoting the low-enthalpy industrial use of the circulating fluid. Utilizing high temperature/enthalpy geothermal fluids through a binary power plant can solve some of the material challenges. Bottoming/hybridization of existing or new power plants and development of new cycle concepts is also matter of interest.</p> <p>In order to cope with fluctuations of the heat demand, flexible supply units are necessary that are not designed for one specific optimal condition, but in a way that maximizes the use of the heat source. Such systems should also consider hybridization with various sources of renewable heat, such as biomass or solar thermal. Technical solutions should be tested and their applicability demonstrated, promoting the flexible use of the geothermal heat source depending on demand (electricity and heat). This implies an optimization of partial load behaviour and flexible control strategies for the operation of the whole system. Activities are also directed to facilitating the direct use of heat for industry and/or municipality by finding new innovative and multiple uses for the geothermal resource.”</p> <p>The manufacturers of turbines and other surface components, eg heat exchangers, are clearly the main category of actors to implement the RD&amp;I effort in this priority area.</p>		
<b>TRL at start:</b> 5-6		<b>TRL at end:</b> 7-8
<b>Total budget required:</b> €21m		<b>Flagship:</b> No



DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY	DG TWG
<p><b>Title: Exploration techniques (including resource prediction and exploratory drilling)</b></p>	<p>R&amp;I Activity.5</p>
<p><b>Scope:</b> Improving the precision of pre-drilling exploration and performance prediction by regularly updating methodological approaches. Moving beyond the state of the art by testing new tools, developing new approaches and taking advantage of improved software and computing power, thereby reducing uncertainty and bringing down exploration costs.</p>	
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>The further deployment of geothermal beyond traditional development areas require a great deal of improvement in exploration techniques, notably with a focus on increasing reliability, precision and reducing costs. To ensure a reliable pre-drilling assessment of geothermal resources, high resolution exploration methods and approaches are essential to minimize exploration risks. This will be achieved by:</p> <p>a) The development of new tools and techniques coupled with innovative modeling techniques, increasing measurement precision and applying faster analysis of acquired data to achieve a precise predictive model of the reservoir.</p> <p>b) The update and improvement of state-of-the-art exploration techniques and methods to reduce the average cost for exploration while increasing the quality of the used method. Such progress must address in increasing detail the geological complexity of resources, and increasing target depths.</p> <p>The Geoscience sector and actors involved in the development and the manufacturing of exploration equipment are the key type of actors to develop this priority.</p>	
<p><b>TRL at start:</b> 5-6</p>	<p><b>TRL at end:</b> 7-8</p>
<p><b>Total budget required:</b> €49m</p>	<p><b>Flagship:</b> No</p>

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY	DG TWG
<p><b>Title: Advanced drilling/well completion techniques</b></p>	<p>R&amp;I Activity.6</p>
<p><b>Scope:</b> Reduction in drilling/well completion costs. Demonstrate concepts that can significantly reduce drilling/well completion costs (reduce drilling time and non-productive time, reduce costs, mitigate risks) or enhance reservoir performance (including directional and horizontal multilateral drilling). The target is to reduce cost for drilling and underground installations by at least 25% compared to the situation today.</p>	
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>Drilling typically accounts for between a third and half of geothermal energy total project costs. The TWG DG implementation plan notes that “reductions in specific well cost (€/MWh) will substantially influence the overall economics of a deep geothermal plant. To increase the economic viability of a geothermal development, advanced drilling technologies, currently not used in geothermal well construction, have to be adapted and optimized for the specific project requirements. Implementation of advanced technologies includes, but is not limited to, process automatization, drilling fluids to compensate unwanted loss of circulation zones as well as improved cementing procedures and well cladding, and stimulation methods improvement for deep wells. Risk assessment and lifetime analysis of the new technologies and approaches must be part of the work. Innovative system to avoid/reduce the discharge of geothermal fluid into the environment while drilling and flow tests will be considered. Horizontal - multilateral wells clusters in various geological formations will be also considered. Targeted (e.g. compact and lightweight) equipment and techniques for drilling and well completion in urban areas is another challenge in this area. Increased technology transfer from the oil and gas industry on horizontal well drilling and completion is needed. The proposed procedures should result in a significant reduction of overall costs over the lifetime of the installations.</p> <p>New methods for drilling and well completion in the various geological formations relevant for geothermal energy with the potential to accelerate the process, reducing costs and risks shall be tested in realistic settings. Such methods include percussive drilling for deep/hot wells (fluid hammers etc.) and non-mechanical drilling method development (such as laser, plasma, hydrothermal flame drilling). Benchmark testing in boreholes should be attempted. The efforts will be directed to demanding environments (e.g. &gt;5000 m depth and T&gt;250°C) and all relevant geological formations.”</p> <p>A wide array of actors are among those that contribute to implementing this R&amp;I priority:</p> <ul style="list-style-type: none"> <li>- manufacturer of drilling rigs, for instance the manufacturing of more automated drilling rigs, or machines that can drill faster or more accurately, rigs that enable new drilling techniques;</li> <li>- Manufacturers of drill bits (development of innovative designs, innovative drilling solutions);</li> <li>- Drilling rigs operators</li> <li>- Manufacturers of logging equipment and other drilling components.</li> <li>- Sub-services companies, drilling supervisors</li> </ul>	
<p><b>TRL at start:</b> 5 (improvement), 3 (novel)</p>	<p><b>TRL at end:</b> 7 (improvement), 5 (novel)</p>
<p><b>Total budget required:</b> €52.1m</p>	<p><b>Flagship:</b> No</p>

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY		DG TWG	
<p><b>Title: Integration of geothermal heat and power in the energy system and grid flexibility</b></p>		R&I Activity.7	
<p><b>Scope:</b> Integration of flexible generation from geothermal power in the energy sector</p>			
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>Geothermal energy is a major solution for providing flexibility in the energy systems, notably at the interconnection point of the electricity and heating and cooling sectors, for instance with the provision of flexibility or underground thermal energy storage for seasonal storage. In the framework of this priority, the Implementation plan identifies that: Demonstrate the technical and economic feasibility of responding to commands from a grid operator, at any time, to increase or decrease output ramp up and down. Demonstrating the automatic generation control (load following / ride-through capabilities to grid specifications) and ancillary services of geothermal power plants. Addressing flexible heat/cold and electricity supply from binary cycles and EGS power plants, including coupling with renewable energy sources; addressing specific problems of geothermal power production in isolated energy networks (islands). Thermoelectric energy storage integrated with district heating networks and dedicated equipment (heat pumps, ORC turbo-expanders, and heat exchanger networks, with hot and cold reservoirs able to cover variable demand of heat, cold and electricity.</p> <p>Activities will include impact on the development of transmission and distribution infrastructure and the interplay with other flexibility options (e.g. demand-side management and storage), and test on dispatchability. Furthermore, the flexible generation should be able to provide additional services to the grid such as peak power, role in electricity balancing/reserve market.”</p> <p>The key actors for the implementation of this priority include:</p> <ul style="list-style-type: none"> <li>- Manufacturers of turbines and generators</li> <li>- Developers of UTES systems</li> <li>- Manufacturers of heat exchangers, surface components</li> <li>- Operators of power plants</li> <li>- Services companies: energy traders, legal consultancy...</li> </ul>			
<p><b>TRL at start:</b> 4-5</p>		<p><b>TRL at end:</b> 7-9</p>	
<p><b>Total budget required:</b> €11.5</p>		<p><b>Flagship:</b></p>	<p>Yes</p>

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY		DG TWG	
<b>Title: Zero emissions power plants</b>		R&I Activity.8	
<p><b>Scope:</b> Increasing the feasibility of closed-loop reinjection and demonstrating the capture of non-condensable gases (Zero emission power plants).</p>			
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>For geothermal to scale up, it is crucial to ensure plants are deployed in a way to mitigate as much as possible the environmental impact linked to the development and the operation of geothermal power plants. To foster acceptability, and to maximise the legitimacy of geothermal power in the context of climate change mitigation, developing zero emissions power plants have been identified as a priority by the SET Plan TWG Deep geothermal: “Zero emission power plants and development of CO2 capture, storage and reinjection schemes for reservoirs with high CO2-content.</p> <p>Increasing the feasibility and reliability of closed-loop reinjection and demonstrating the capture of non-condensable gases (NCGs). Development of systems for capture and re-injection of chemical compounds associated with produced geothermal fluids.</p> <p>NCGs are often present in geothermal brines, and may contain contaminants requiring chemical processing. Depending on reservoir conditions (thermodynamics and composition, including saline equilibria) the challenge can in some cases be addressed avoiding flashing of the resource, or maintaining a high flash pressure, possibly using hybrid solutions. Solutions for complete reinjection into the reservoir are targeted, with NCGs in gaseous or liquid state. These solutions imply correct matching to the power cycle and development of new equipment (compressors, pumps, intercoolers, mixing nozzles, and possibly refrigeration equipment). Research will deal both with whole process optimization, and new equipment. The first power plants of this type are expected within 2025 and may represent a worldwide flagship, with relevant market fallouts for many countries (IT, TR, IS, Kenya...)”</p> <p>In this area, the main actors for promoting innovation include:</p> <ul style="list-style-type: none"> <li>- Geothermal power plants developers;</li> <li>- Manufacturers of Geothermal power plants equipment (brine supply, cooling...);</li> <li>- Manufacturers of turbines;</li> </ul>			
<b>TRL at start:</b> 5-6		<b>TRL at end:</b> 6-7	
<b>Total budget required:</b> €123.4m		<b>Flagship:</b>	Yes

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY		DG TWG
<p><b>Title: Increasing awareness of local communities and involvement of stakeholders in sustainable geothermal solutions</b></p>		NTBE-A
<p><b>Scope:</b></p> <p><b>A:</b> Public acceptance: improve community perceptions about non-condensable gas emissions, micro-seismicity, stimulation, and other environmental effects. Coordination of national and regional regulatory oversight practices for health, safety and environmental aspects of geothermal projects.</p> <p><b>B:</b> Best practices for managing health, safety and environmental aspects of geothermal projects. Seismic monitoring and mapping of seismic events, guidelines for stimulation indicators in order to prevent surface impacts.</p>		
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b></p> <p>The SET Plan TWG Deep Geothermal identifies the improvement of community acceptance for deep geothermal as a key RD&amp;I priority. It notes that :”To address environmental and social concerns that pose barriers limiting the contribution of geothermal energy to the energy mix, the challenge is to assess the nature of public concerns and the elements that influence individual and group perceptions of geothermal installations, to increase the understanding of the socio-economic dimension of geothermal energy, and, where needed, to promote change in community responses to new and existing geothermal installations. Different technologies and possible technological solutions, for reducing environmental effects and enhance societal benefits, including reinjection of incondensable gases in deep geothermal plants, and seismicity control, are key elements of the socio-environmental assessment. Risk management strategies and adequate technology selection, for example induced seismicity or emission reduction should be addressed.”</p> <p>In this area, the actors to implement this RD&amp;I priority include:</p> <ul style="list-style-type: none"> <li>- Developers of geothermal plants;</li> <li>- [see Zero emissions power plants]</li> <li>- Manufacturers of gas removal systems;</li> <li>- Operators of geothermal plants.</li> <li>- services companies: communication agencies...</li> </ul>		
<b>TRL at start:</b> not applicable		<b>TRL at end:</b> not applicable
<b>Total budget required:</b> €21m	<b>Flagship:</b>	No

DESCRIPTION OF RESEARCH AND INNOVATION ACTIVITY		DG TWG
<b>Title: Risk mitigation (financial/project)</b>		NTBE.B
<p><b>Scope:</b> Coordination of national geological risk mitigation methods and financial schemes (e.g. exploration grants, geothermal guarantee schemes).</p>		
<p><b>Typology of actors to implement the SET Plan Deep geothermal RD&amp;I priorities</b>            Geothermal risk is a major factor preventing the development of new project. The TWG Deep geothermal identifies the mitigation of financial or project risks for deep geothermal projects as a key RD&amp;I priority to enable greater deployment. “Risk mitigation is crucial for widespread deployment of geothermal energy. The Netherlands, France, or Switzerland are examples of European countries that offer geothermal guarantee schemes. The schemes differ widely in the rationale, set-up, financing, coverage, procedural aspects, mode of pay-out, fee structure and so on. The activity will collate good practices (worth replicating) and lessons learnt. Advanced approaches and guidelines on how to address and quantify exploration risk, and financial tools that help mitigate such risks will be developed and paths towards a Europe-wide system will be explored (additional stakeholder consultation, creation of a «task force / working group», development of European concepts).”            In this area, the public sector is a major driver of innovation. However, in the private sector, insurance or reinsurance companies are ideally suited to foster R&amp;I in that sector.</p>		
<b>TRL at start:</b> NA		<b>TRL at end:</b> NA
<b>Total budget required:</b> €177m		<b>Flagship:</b> No

## 4. Co-funding from private companies in European projects

Presentation of the actors already active as partners in R&I co-funded European projects. These include private industrial actors and public authorities or research institutions (e.g. universities):

### 4.1 Horizon 2020 programme

*Table 1. List of partners involved in geothermal related Horizon 2020 projects (Private actors are in bold, list may not be exhaustive as to the geothermal projects considered. Coordination and Support Actions such as DG-ETIP, GEOTHERMICA, RHC Platform, SMARTSPEND and the SU-DG-IWG are not listed)*

PROJECT	COMPANY
CHPM2030	<b>MINPOL GMBH</b>
CHPM2030	VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.
CHPM2030	KATHOLIEKE UNIVERSITEIT LEUVEN
CHPM2030	FEDERATION EUROPEENNE DES GEOLOGUES
CHPM2030	SZEGEDI TUDOMANYEGYETEM
CHPM2030	MISKOLCI EGYETEM
CHPM2030	ISLENSKAR ORKURANNSOKNIR
CHPM2030	Laboratorio Nacional de Energia e Geologia I.P.
CHPM2030	INSTITUTUL GEOLOGIC AL ROMANIEI
CHPM2030	LA PALMA RESEARCH CENTRE FOR FUTURE STUDIES SL
CHPM2030	SVERIGES GEOLOGISKA UNDERSOKNING
CHPM2030	UNITED KINGDOM RESEARCH AND INNOVATION
CoolHeating	<b>GUSSING ENERGY TECHNOLOGIES GMBH</b>
CoolHeating	JAVNO PREDUZECE ELEKTROPRIVREDA BOSNE I HERCEGOVINE DD*
CoolHeating	OPCINE VISOKO
CoolHeating	SVEUCILISTE U ZAGREBU, FAKULTET STROJARSTVA I BRODOGRADNJE
CoolHeating	<b>MEDUNARODNI CENTAR ZA ODRZIVI RAZVOJ ENERGETIKE VODA I OKOLISA</b>
CoolHeating	<b>PLANENERGI FOND</b>
CoolHeating	<b>WIRTSCHAFT UND INFRASTRUKTUR GMBH &amp; CO PLANUNGS KG</b>
CoolHeating	ELEKTROTEHNICKI FAKULTET UNIVERZITET U BEOGRADU
CoolHeating	GRAD SABAC
CoolHeating	SKUPINA FABRIKA RAZISKAVE IN RAZVOJ DOO

CoolHeating	OBCINA LJUTOMER
DEEPEGS	<b>FONROCHE GEOTHERMIE SAS</b>
DEEPEGS	BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES
DEEPEGS	<b>Herrenknecht Vertical GmbH</b>
DEEPEGS	KARLSRUHER INSTITUT FUER TECHNOLOGIE
DEEPEGS	<b>LANDSVIRKJUN SAMEIGNARFELAG</b>
DEEPEGS	ISLENSKAR ORKURANNSOKNIR
DEEPEGS	GEORG-RANNSOKNARKLASI I JARDHITA
DEEPEGS	<b>HS ORKA HF</b>
DEEPEGS	<b>ENEL GREEN POWER SPA</b>
DEEPEGS	<b>STATOIL PETROLEUM AS</b>
Descramble	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN
Descramble	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL
Descramble	TECHNISCHE UNIVERSITAET BERGAKADEMIE FREIBERG
Descramble	<b>ENEL Green Power</b>
Descramble	CNR
Descramble	SINTEF AS
Descramble	STIFTELSEN SINTEF
DESTRESS	<b>ES-GEOTHERMIE</b>
DESTRESS	UNIVERSITE DE STRASBOURG
DESTRESS	<b>ENBW ENERGIE BADEN-WURTTENBERG AG</b>
DESTRESS	<b>GEOTHERMIE NEUBRANDENBURG GMBH</b>
DESTRESS	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHESGEOFORSCHUNGSZENTRUM GFZ
DESTRESS	<b>GEOTERMA UAB</b>
DESTRESS	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
DESTRESS	TECHNISCHE UNIVERSITEIT DELFT
DESTRESS	ECW GEOMANAGEMENT BV
DESTRESS	TRIAS WESTLAND BV
DESTRESS	UNIVERSITY OF GLASGOW
GECO	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS
GECO	IFP Energies nouvelles
GECO	<b>STORENGY SA</b>
GECO	HOCHSCHULE BOCHUM
GECO	ISLENSKAR ORKURANNSOKNIR
GECO	GEORG-RANNSOKNARKLASI I JARDHITA
GECO	<b>ORKUVEITA REYKJAVIKUR SF</b>
GECO	UNIVERSITA DEGLI STUDI DI FIRENZE
GECO	<b>GRAZIELLA GREEN POWER S.P.A.</b>
GECO	CONSIGLIO NAZIONALE DELLE RICERCHE
GECO	<b>PLAN B CO2 BV</b>



GECO	INSTITUTT FOR ENERGITEKNIKK
GECO	FUNDACION CIRCE CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERGETICOS
GECO	ASOCIACION DE INVESTIGACION METALURGICA DEL NOROESTE
GECO	<b>ZORLU ENERJI ELEKTRIK URETIM AS</b>
GECO	MIDDLE EAST TECHNICAL UNIVERSITY
GECO	HASKOLI ISLANDS
GECO	UNITED KINGDOM RESEARCH AND INNOVATION
GeMex	EUROPEAN GEOTHERMAL ENERGY COUNCIL
GeMex	BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES
GeMex	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN
GeMex	TECHNISCHE UNIVERSITAT DARMSTADT
GeMex	KARLSRUHER INSTITUT FUER TECHNOLOGIE
GeMex	HOCHSCHULE BOCHUM
GeMex	HELMHOLTZ-ZENTRUM FUR UMWELTFORSCHUNG GMBH - UFZ
GeMex	IGA SERVICE GMBH
GeMex	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHESGEOFORSCHUNGSZENTRUM GFZ
GeMex	CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING FONDATION
GeMex	ISLENSKAR ORKURANNSOKNIR
GeMex	UNIVERSITA DEGLI STUDI DI BARI ALDO MORO
GeMex	CONSIGLIO NAZIONALE DELLE RICERCHE
GeMex	ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE
GeMex	UNIVERSITA DEGLI STUDI ROMA TRE
GeMex	AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE
GeMex	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA
GeMex	UNIVERSITA DEGLI STUDI DI TORINO
GeMex	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
GeMex	UNIVERSITEIT UTRECHT
GeMex	INSTITUTT FOR ENERGITEKNIKK
GeMex	UNI RESEARCH AS
GeMex	PANSTWOWY INSTYTUT GEOLOGICZNY - PANSTWOWY INSTYTUT BADAWCZY
GeMex	UNITED KINGDOM RESEARCH AND INNOVATION
Geo-Coat	ORKUVEITA REYKJAVIKUR SF
Geo-Coat	HASKOLI ISLANDS

Geo-Coat	<b>GEROSION EHF</b>
Geo-Coat	NYSKOPUNARMIDSTOD ISLANDS
Geo-Coat	<b>FLOWPHYS AS</b>
Geo-Coat	UNIVERSITATEA POLITEHNICA DIN BUCURESTI
Geo-Coat	<b>TEHNOID COM SRL</b>
Geo-Coat	METAV - CERETARE DEZVOLTARE SRL
Geo-Coat	<b>WEIR GROUP PLC (THE)</b>
Geo-Coat	<b>TECHNOVATIVE SOLUTIONS LTD</b>
Geo-Coat	<b>TWI LIMITED</b>
GEOENVI	VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.
GEOENVI	EUROPEAN GEOTHERMAL ENERGY COUNCIL
GEOENVI	BRGM
GEOENVI	ARMINES
GEOENVI	<b>ES-GEOTHERMIE</b>
GEOENVI	MINING AND GEOLOGICAL SURVEY OF HUNGARY
GEOENVI	ISLENSKAR ORKURANNSOKNIR
GEOENVI	GEORG-RANNSOKNARKLASI I JARDHITA
GEOENVI	ORKUSTOFNUN
GEOENVI	<b>RETE GEOTERMICA</b>
GEOENVI	<b>ENEL GREEN POWER SPA</b>
GEOENVI	CONSORZIO PER LO SVILUPPO DELLE AREE GEOTERMICHE
GEOENVI	CONSORZIO INTERUNIVERSITARIO PER LO SVILUPPO DEI SISTEMI A GRANDE INTERFASE
GEOENVI	CONSIGLIO NAZIONALE DELLE RICERCHE
GEOENVI	JEOTERMAL ELEKTRIK SANTRAL YATIRIMCILARI DERNEGI
GEOENVI	DOKUZ EYLUL UNIVERSITESI
GEORISK	EUROPEAN GEOTHERMAL ENERGY COUNCIL
GEORISK	AFPG
GEORISK	BRGM
<b>GEORISK</b>	<b>GEC-CO GLOBAL ENGINEERING &amp; CONSULTING - COMPANY GMBH</b>
GEORISK	BUNDESVERBAND GEOTHERMIE EV
GEORISK	CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING FONDATION
<b>GEORISK</b>	<b>ANONIMI ETAIRIA DIAXEIRISIS ANANEOSIMON PIGON ENERGEIAS</b>
<b>GEORISK</b>	<b>GEOTERMIA EXPRESSZ MERNOKI TANACSADO IRODA KORLATOLT FELELOSSEGU TARSASAG</b>
GEORISK	MINING AND GEOLOGICAL SURVEY OF HUNGARY
GEORISK	POLSKA ACADEMIA NAUK INSTYTUT GOSPODARKI SUROWCAMI MINERALNYMI I ENERGIA

GEORISK	FEDERAL DEPARTMENT FOR ENVIRONMENT, TRANSPORT, ENERGY AND COMMUNICATIONS, SWITZERLAND
GEORISK	GEOTHERMIE-SCHWEIZ
GEORISK	TURKIYE BILIMSEL VE TEKNOLOJIK ARASTIRMA KURUMU
GEORISK	JEOTERMAL ELEKTRIK SANTRAL YATIRIMCILARI DERNEGI
GEORISK	<b>TURKIYE KALKINMA BANKASI ANONIM SIRKETI</b>
GEOSMART	VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.
GEOSMART	<b>ATLAS COPCO AIRPOWER NV</b>
GEOSMART	EUROPEAN GEOTHERMAL ENERGY COUNCIL
GEOSMART	CEA
GEOSMART	<b>BERTIN TECHNOLOGIES</b>
GEOSMART	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
GEOSMART	<b>ORKUVEITA REYKJAVIKUR SF</b>
GEOSMART	HASKOLI ISLANDS
GEOSMART	<b>GEROSION EHF</b>
<b>GEOSMART</b>	<b>pvald ehf</b>
GEOSMART	NYSKOPUNARMIDSTOD ISLANDS
GEOSMART	<b>SPIKE RENEWABLES SRL</b>
GEOSMART	CONSORZIO PER LO SVILUPPO DELLE AREE GEOTERMICHE
GEOSMART	<b>FLOWPHYS AS</b>
GEOSMART	<b>Zorlu Energy</b>
GEOSMART	MIDDLE EAST TECHNICAL UNIVERSITY
GEOSMART	KADIR HAS UNIVERSITESI
GEOSMART	<b>TWI LIMITED</b>
GEOSMART	<b>TECHNOVATIVE SOLUTIONS LTD</b>
GeoWell	BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES
GeoWell	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHESGEOFORSCHUNGSZENTRUM GFZ
GeoWell	<b>HS ORKA HF</b>
GeoWell	ISLENSKAR ORKURANNSOKNIR
GeoWell	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
GeoWell	<b>AKIET BV</b>
GeoWell	INTERNATIONAL RESEARCH INSTITUTE OFSTAVANGER AS
GeoWell	<b>STATOIL PETROLEUM AS</b>
MEET	INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE
MEET	SVEUCILISTE U ZAGREBU FAKULTET ELEKTROTEHNIKE I RACUNARSTVA
MEET	<b>ES-GEOTHERMIE</b>
MEET	INSTITUT POLYTECHNIQUE UNILASALLE
MEET	<b>GEOPHYSICAL INVERSION &amp; MODELING LABS</b>

MEET	UNIVERSITE DE CERGY-PONTOISE
MEET	<b>VERMILION REP SAS</b>
MEET	<b>ENOGIA</b>
MEET	<b>FEBUS OPTICS</b>
MEET	<b>AYMING</b>
MEET	TECHNISCHE UNIVERSITAT DARMSTADT
MEET	UNIVERSITATSENERGIE GOTTINGEN GMBH
MEET	GEORG-AUGUST-UNIVERSITAT GOTTINGENSTIFTUNG OFFENTLICHEN RECHTS
MEET	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHESGEOFORSCHUNGSZENTRUM GFZ
MEET	<b>GEOTHERMAL ENGINEERING GMBH</b>
MEET	NYSKOPUNARMIDSTOD ISLANDS
progRESsHEAT	O.Oe. Energiesparverband
progRESsHEAT	TECHNISCHE UNIVERSITAET WIEN
progRESsHEAT	MESTO LITOMERICE
progRESsHEAT	DANMARKS TEKNISKE UNIVERSITET
progRESsHEAT	GATE 21
progRESsHEAT	ENERGY CITIES/ENERGIE-CITES ASSOCIATION
progRESsHEAT	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
progRESsHEAT	IREES GMBH - INSTITUT FUR RESSOURCENEFFIZIENZ UND ENERGIESTRATEGIEN
progRESsHEAT	<b>EE ENERGY ENGINEERS GMBH</b>
progRESsHEAT	INEGI - INSTITUTO DE CIENCIA E INOVACAO EM ENGENHARIA MECANICA E ENGENHARIA INDUSTRIAL
progRESsHEAT	AGENTIA PENTRU MANAGEMENTUL ENERGIEI SI PROTECTIA MEDIULUI BRASOV
SURE	DANMARKS TEKNISKE UNIVERSITET
SURE	HOCHSCHULE BOCHUM
SURE	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHESGEOFORSCHUNGSZENTRUM GFZ
SURE	ISLENSKAR ORKURANNSOKNIR
SURE	<b>GEOTERMA UAB</b>
SURE	Gamtos tyrimų centras
SURE	TECHNISCHE UNIVERSITEIT DELFT
SURE	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
SURE	<b>WELLSERVICES BV</b>
SURE	IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE
Thermodrill	MONTANUNIVERSITAET LEOBEN
Thermodrill	<b>RAG ENERGY DRILLING GMBH</b>
Thermodrill	<b>SIRIUS-ES HANDELS GMBH</b>

Thermodrill	<b>ES-GEOTHERMIE</b>
Thermodrill	<b>BESTEC GMBH</b>
Thermodrill	TECHNISCHE UNIVERSITAET MUENCHEN
Thermodrill	<b>SMITH INTERNATIONAL ITALIA SPA</b>
Thermodrill	<b>INERCO INGENIERIA, TECNOLOGIA Y CONSULTORIA, SA</b>

## 4.2 GEOTHERMICA-funded projects

GEOTHERMICA is a consortium of geothermal energy research & development institutions from 15 European countries and regions and the newly associated in 2019, the U.S. Department of Energy (DOE). GEOTHERMICA's objective is to accelerate the development of geothermal energy globally, by combining financial resources and know-how of its respective partners, as well as expanding the use of clean and renewable low carbon geothermal energy beyond its traditional markets and regions. GEOTHERMICA seeks to explore optimization of geothermal heat and power generation, including innovative integrated and combined systems. To date, GEOTHERMICA has financed in its first call, with the support of the European Commission, eight large Inter-European projects allocating close to EUR 30 million. The USA joined the consortium in 2019 giving GEOTHERMICA the weight to influence and accelerate geothermal energy globally. A second joint call is launched in 2019.

*Table 2. List of actors involved in GEOTHERMICA funded projects for the first call (Private actors are in bold)*

<b>Gipmans</b>	Netherlands
<b>Huisman Well Technology BV</b>	Netherlands
Geothermie Zentrum Bochum	Germany
VITO (Vlaamse Instelling voor Technologisch Onderzoek)	Belgium
<b>Radial Drilling Europe BV</b>	Netherlands
Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek	Netherlands
Geop Denmark	Denmark
<b>Thomas More Kempen</b>	Belgium
Swiss Seismological Service, ETH Zurich	Switzerland
Iceland GeoSurvey (ÍSOR)	Iceland
<b>GeoEnergie Suisse AG</b>	Switzerland
<b>Reykjavik Energie</b>	Iceland
Dublin Institute for Advanced Studies	Iceland

GFZ - German Research Centre for Geosciences	Germany
TNO	Netherlands
<b>Landsvirkjun</b>	Iceland
<b>HS Orka</b>	Iceland
<b>Samrækt efh</b>	Iceland
Wageningen UR	Netherlands
University of Iceland	Iceland
<b>LandInqAquaculture</b>	Netherlands
Ammerlan The Green Innovator	Netherlands
University of Maribor	Slovenia
Municipality of Brezice	Slovenia
<b>Gavin and Doherty Geosolutions Ltd.</b>	Ireland
Universitat de Barcelona	Spain
Dublin City Council	Ireland
University College Dublin - Irish Centre for Research in Applied Geosciences	Ireland
<b>Geotermisk Operatørselskab</b>	Denmark
Dublin Institute for Advances Studies	Ireland
Barcelona Supercomputing Center	Spain
Geothermal Association of Ireland	Ireland
Spanish Geothermal Technology Platform	Spain
Institut Cartogràfic i Geologic de Catalunya	Spain
<b>Energie Wasser Bern</b>	Switzerland
<b>SIG</b>	Switzerland
<b>IF Technology</b>	Netherlands
KWR Watercycle Research Institute	Netherlands
<b>ECW Geomanagement BV</b>	Netherlands
University of Geneva	Switzerland
Eidgenössische Technische Hochschule Zurich	Switzerland

University of Neuchatel	Switzerland
University of Bern	Switzerland
BRGM	France
<b>Storengy</b>	France
Bochum University of Applied Sciences / International Geothermal Centre	Germany
GEUS	Denmark
<b>PlanEnergi</b>	Denmark
University of the Azores	Portugal
<b>Reykjavik Energy</b>	Iceland
<b>delta-h Engineering GmbH</b>	Germany
<b>Noda GmbH</b>	Germany
SPIE Belgium	Belgium
Kempens Warmtebedrijf	Belgium
Universitat Politècnica de Catalunya	Spain
Netherlands Institute of Ecology	Netherlands
Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek	Netherlands
Danmarks og Grønlands Geologiske Undersøgelse	Denmark
FORCE Technology	Denmark
Helmholtz Zentrum Potsdam Deutsches Geoforschungszentrum	Germany
<b>Ammerlaan Geothermie B.V.</b>	Netherlands
<b>Greenwell Westland Bv.</b>	Netherlands
<b>Geo-Energie Suisse AG</b>	Switzerland
RWTH Aachen	Germany
<b>H. ANGER'S SÖHNE Bohr- und Brunnenbauges. mbH</b>	Germany
SIRIUS-ES	Germany
<b>ES-Géothermie</b>	France
CETIM-CERMAT	France
CSIC Consejo Superior de Investigaciones Científicas	Spain

<b>Welltec</b>	Denmark
ETH Zurich	Switzerland

### 4.3 Analysis of the contribution from Industry in European R&I projects

Significant levels of funding for R&I are coming from industry. A large part of the RD&I from industry is dedicated to innovation and high TRL. The total number of private projects is hard to estimate, but it can be assumed that it represents a third of all RD&I investment for geothermal in Europe.

The variation in R&D efforts among EU Member States also holds true for the R&D expenditure of industries in the geothermal sector. The scale of technologies involved is so vast and the related value chain so complex that it is impossible to identify all private investments at the different stages of geothermal innovation processes.

As a matter of fact, EU R&I funding allocated to geothermal energy during the Horizon 2020 European program amounted to around € 250 million by the end of 2018. This sum was divided between an EU contribution of € 160 million and a private sector contribution of € 85 million. In total, 36 projects have been co-funded by public money from H2020 calls on RES&EE and Industrial leadership, as well as from SME-instruments, INTERREG and ERASMUS+.

The cofounding from GEOTHERMICA – ERA NET is currently supporting eight transnational projects on geothermal energy. The total investment in the projects amounts to nearly € 50 million, about half of which is funded by GEOTHERMICA, the other half coming from the project partners, notably those from the industry bringing private financing to the project as their co-financing.



## 5. Potential new private actors to execute the IP

Beyond the actors already involved in projects contributing to the achievement of the SET Plan Deep Geothermal IWP (H2020, Geothermica), it is possible to identify key actors of the private sector that may potentially contribute to these objectives. This can be done from one side by considering the attendance of events such as the European Geothermal Congress, looking at companies involved in such platforms as the RHC ETIP Geothermal Panel and the ETIP Deep Geothermal, or by looking at the membership of organisations such as EGEC whose membership represents actors of the whole geothermal value chain. Projects such as Geo-Energy Europe are also valuable tool for disseminating the RD&I priorities for deep geothermal and engaging with potential actors for implementation.

From the other side, companies operating in the deep geothermal sector in Europe can be identified along the value chain.

### 5.1 Exhibitors at Trade Fairs and Members of associations and platforms

#### 5.1.1 European Geothermal Congress: List of Exhibitors

The European Geothermal Congress (EGC) is one of the major events for the geothermal industry in Europe. It gathers representatives from the geothermal industry representing the whole value chain, from the public and the private sector. Many of the participants and supporters of the EGC are already involved in fostering the RD&I priorities for the deep geothermal sector, either through involvement in European funded or nationally funded RD&I projects, or through the innovation they pursue as part of their activities in order to increase their competitiveness within the geothermal value chain.

The list of exhibitors to the EGC2019 provides a first perspective on which potential actors could be supporting the pursuit of the RD&I priorities set in the DG TWG Implementation Plan. The exhibitors at the EGC2019 represent all segment of the geothermal value chain, though with a strong focus on deep geothermal. Many highly innovative companies were present, corresponding to the different priorities put forward in the SET Plan Deep Geothermal Implementation Plan.

*Table 3. List of exhibitors at the 2019 European Geothermal Congress (EGC2019)*

EBN	EBN (the Netherlands government energy trust, by order of the Minister of Economic Affairs and Climate Policy) is a company in the energy sector of which the shares are 100 percent owned by the Dutch state.
Turboden	Turboden, a Mitsubishi Heavy Industries group company, is an Italian firm and a global leader in the design, manufacture and maintenance of Organic Rankine Cycle (ORC) systems, highly suitable for distributed generation.

Huisman Geo	Huisman, founded in 1929, is a worldwide operating company delivering step changing technical solutions to world's leading companies in the oil & gas, renewables, leisure and civil industries.
BHGE	Baker Hughes, a GE company (NYSE:BHGE) is the world's first and only fullstream provider of integrated oilfield products, services and digital solutions.
Nalco Water	Nalco Water is the world leading company in chemical treatments and process solutions with years of expertise in optimizing system chemistry for Geothermal Plants both of low and high enthalpy operations.
Stichting Platform Geothermie	The Geothermal Platform is co-organising EGC 2019, and is a non-profit organization (NGO) focused on promoting the responsible application of (deep) geothermal energy or geothermal heat in the Netherlands. The Platform does this by, among other things, transferring knowledge and providing information about (deep) geothermal energy through presentations, publications, newsletters and the organization of symposia and working visits.
Bodemenergie NL	BodemenergieNL is the branche of industry association for all companies and organizations working on ATES and BTES Netherlands.
H.P. Well Screen B.V.	One of Europe's largest manufactures and specialist of wedge wire screen filtration products. It offers customized screen solutions of applications in the Oil&Gas, Water, Geothermal, Petrochemical, General Filtration Industries and Architecture.
Newpark Drilling Fluids Germany GmbH	Newpark Drilling Fluids provides value-added drilling fluids products and services to thousands of wells around the world.
altcom Limited	altcom provides software, services and consultancy for microseismic and induced seismicity analysis to the geothermal and hydrocarbon industries. microseisgram is a platform independent software package that provides enhanced microseismic data processing and Quality Control (QC) capabilities.

TNO	TNO conducts independent and internationally leading research in the Netherlands. It aims to set the agenda, and have an initiating and supporting role for government, industry and NGOs.
VITO NV	VITO is an independent Flemish research organization in the area of cleantech and sustainable development. Geothermal energy forms an indispensable link in the renewable energy mix of the future. VITO is building the first deep geothermal energy plant in Flanders
RAG Energy Drilling	Drilling Contractor (Drilling Rigs, Workover Rigs, Slick- & Wireline Services) with own personnel and Well Engineering & Surface Engineering Departments.
Silenos Energy	<a href="https://www.silenos-energy.com/databases/internet/_public/content30.nsf/web30?Openagent&amp;id=DE_SILENOSENERGY_DE_Portrait&amp;men1=2&amp;sid=210">https://www.silenos-energy.com/databases/internet/_public/content30.nsf/web30?Openagent&amp;id=DE_SILENOSENERGY_DE_Portrait&amp;men1=2&amp;sid=210</a>
sirius e.s.	Sirius-ES is a special company for demanding and sophisticated drilling projects in the fields of geothermal, oil and gas energy.
TLS Geothermics	TLS Geothermics is a geosciences engineering company, explorer and developer of geothermal energy for heat and power production.
Storengy	Storengy, an ENGIE subsidiary, is one of the world leaders in underground natural gas storage. It is positioned today as a key player in the development of geothermal energy (heat/cold production and power generation), as well as innovative production and storage solutions for carbon-free energy (biomethane, hydrogen, Power-to-Gas, synthetic methane, ...).
ENGIE	The Engie group is a global reference in low-carbon energy and services. Its ambition is to become the world leader in the zero-carbon transition “as a service” for its customers, in particular global companies and local authorities. It relies on its key activities (renewable energy, gas, services) to offer competitive turnkey solutions.

HakaGerodur AC	GERO <sup>therm</sup> ®- geothermal systems are designed for the use of geothermal energy or to deduct (store) surplus heat into the ground.
Made in Germany	With “Geothermal Energy – Made in Germany” the German Geothermal Association presents with its co-exhibitors the potential of German know-how in the whole value chain. The energy agency “EnergieAgentur. NRW” with its Network Geothermal Energy and 1500 members provides a platform for experts and informs the public about Geothermal Energy in the region of North Rhine-Westphalia.
DMT GmbH & Co. KG	DMT has been involved in an advisory capacity for numerous geothermal projects that use varying techniques and by supplying professional geophysical instrumentation.
Odfjell Well Services	Odfjell Well Services is a significant global player within the upstream Oil, Gas and Geothermal service sector, providing tubular running services, drilling tool rental and well intervention services.
AFPG/GEODEEP	Since 2014, the French geothermal association of professionals (AFPG) based in Paris hosts GEODEEP, the French geothermal Cluster for heat and power. GEODEEP aims at federating French companies involved in deep geothermal energy with export activities.
PanTerra Geoconsultants B.V.	PanTerra Geoconsultants B.V. provides a comprehensive suite of geothermal services ranging from feasibility studies, sub-surface analysis, geology, geothermal business case evaluations, well- and facility engineering, operational support, second opinion analysis, etc.
GEOS Drilling Fluids Company	GEOS is a full-service drilling fluids company headquartered in Ankara, Turkey. We are the leader in Turkey for Engineered Drilling Fluids Systems and Waste Management Services for oil, gas and geothermal drilling industry.
National Oilwell Varco (NOV)	Provides technical expertise, equipment and operational support necessary for O&G and geothermal drilling projects. Integrate leading/innovative products to deliver greater certainty, safety, reliability. It provides integrated suite of

	<p>oilfield tubular solutions to maximize asset life cycle, improves safety and performance in drilling, production...</p> <p>Fiber Glass Systems delivers composite pipe and composite structures engineered for efficiency and performance. Fluid Control provides high-performance drilling fluids, completion services, solids control and waste management solutions.</p>
SGS Nederland B.V. (Subsurface Consultancy)	<p>The SGS Subsurface Consultancy team provides integrated solutions for energy projects, covering all subsurface, well and facilities aspects - from exploration through development and production to abandonment.</p>
ERDWERK GmbH	<p>Since being founded in 2002 with a focus on planning deep geothermal projects in the Munich area, Erdwerk has developed to an internationally renowned independent planning and consultancy office covering many aspects of the complexity of geothermal projects worldwide.</p>
IOT Holland	<p>IOT Holland (member of IOT Group) is an international recognized rental and supply company in the oil, gas, salt, water, geothermal and HDD-drilling industry with bases in Europe, Africa, Middle East and Asia-Pacific.</p>
Seequent Limited	<p>Seequent is a global leader in the development of visual data science software.</p>
TÜV SÜD Industrie Service GmbH	<p>TÜV SÜD Industrie Service GmbH is one of the largest legal entities of the TÜV SÜD Group. It brings together expertise and experience that benefit industry, real estate and infrastructure.</p>
IGC Events	<p>IGC.events is a joint venture by Enerchange and ThinkGeoEnergy focused on holding geothermal energy events bringing together decision makers from all segments of the global geothermal energy sector.</p>
Borets International Ltd	<p>Borets is the leading global provider of electric submersible pumps (ESPs) – 25% of all ESP systems installed worldwide are manufactured by Borets.</p>
Geo-Energy Europe	<p>The GEO-ENERGY EUROPE metacluster brings together and works on the internationalisation of the European know-how, technologies and experience in deep geothermal. GEO-</p>

	ENERGY EUROPE currently represents over 600 members, including 300+ SMEs, from 23 EU countries, and covers the entire deep geothermal value chain.
SUEZ	SUEZ Water Technologies & Solutions (WTS) offers the most comprehensive set of chemical and equipment solutions and services available, helping customers manage and optimize their water resources and process challenges across all industries. In geothermal industry, SUEZ WTS has domain expertise in scale & corrosion control programs in both production wells and surface systems. In addition to these services, SUEZ also supplies engineering support on H2S scavenging/managing applications, heavy metal removal (mercury, etc) and 24/7 condenser performance support with remote monitoring options.
Well Engineering Partners	WEP delivered its first geothermal well in 2006 in The Netherlands. In the years after, WEP has grown to the leading geothermal well engineering & drilling management company in The Netherlands. Almost 95% of all geothermal wells in The Netherlands are delivered by WEP.
GPC IP	GPC INSTRUMENTATION PROCESS (GPC IP) is a consulting engineers bureau and a service company with a view to promote new drilling/ completion/production technologies. Its activities address the following areas of engineering and services: well drilling and completion, reservoir engineering and resource/reserve assessments, well logging/testing, reservoir simulation and resource management, exploitation monitoring, surveillance and maintenance of production facilities, workover of damaged wells and completions, coiled tubing service, waste processing, abatement and disposal, chemical inhibition of corrosion/scaling/microbiological damage, feasibility studies and financial planning, environmental impact surveys, legal/institutional aspects of resource management. GEOFLUID is a sister company of GPC IP.
CFG (Compagnie Française de Géothermie)	CFG is an historical actor of geothermal energy development in France and abroad and was able to secure know-how and knowledge, building on today's individual engineering skills to provide its clients with the best expertise to develop their geothermal project. On the French geothermal market, CFG is the leader for prefeasibility and feasibility studies, for the

	supervision of drilling of new geothermal wells (70%market share since 2007) and geothermal plants monitoring maintenance (20 geothermal plants in contract).
Inco-Drilling BV	Inco-Drilling provides Directional Drilling Services for the Geothermal Market focused on cost effective solutions.
Dutch Filtration	Dutch Filtration has built their knowledge of filtration solutions over many years of experience. It has a state of the art machine facility to manufacture our filtration products and equipment.

### 5.1.2 EGEC Membership

EGEC is a non-profit international organisation founded in 1998 whose aim is to promote the European geothermal industry and enable its development both in Europe and worldwide, by shaping policy, improving business condition, and driving more research and development.

The EGEC Membership<sup>1</sup> with more than 120 members from 28 countries, is quite representative of the entire geothermal sector. EGEC members include private companies across the value chain, national associations, consultants, research centres, geological surveys, and public authorities. As highlighted by the figure below, the EGEC Members correspond to the different categories of actors susceptible to pursue the various RD&I priorities listed by the TWG Deep geothermal implementation plan. When considering the full list of EGEC members, many of these actors are already involved in the H2020 or Geothermica projects listed above, and therefore already contributing to the implementation of the Deep Geothermal RD&I priorities.

By being members of EGEC, or other such geothermal association at the national level, companies are already in a leadership position for engaging in shaping the RD&I framework for geothermal energy, and as such a major potential relay.

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<sup>1</sup> <https://www.egec.org/egec-members-directory/>

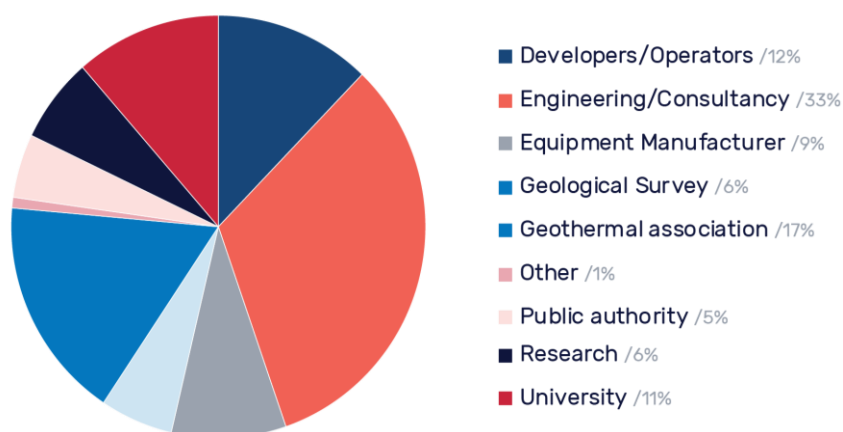


Figure 1. EGEN Members by sector of activity (March 2017)

### 5.1.3 Members of National geothermal associations

National geothermal associations from the countries involved in the IP are a target group. They are private bodies which do not implement R&I projects but they support the dissemination of research project results and some of them hosts a National Research Platforms (e.g. GEOPLAT in Spain).

Table 4. List of national geothermal associations

ACLUXEGA	Spain
AFPG	France
AnigHP - Associazione Nazionale Impianti Geotermia Heat Pump	Italy
APPA	Spain
Bundesverband Geothermie e.V	Germany
COSVIG - Consorzio per lo Sviluppo delle Aree Geotermiche	Italy
Estonian Geothermal Association	Estonia
Geothermal Association of Ireland - GAI	Ireland
GSHP Association UK	United Kingdom
Hungarian Geothermal Association?(HGA)	Hungary
JESDER	Turkey
Macedonian Geothermal Association	Macedonia
NVOE/Bodemenergie NL	The Netherlands
Polish Geothermal Society (Polskie Stowarzyszenie Geotermiczne, PSG)	Poland
Rete Geotermica	Italy



Romanian Geoexchange Society - RGS	Romania
Syndicat des énergies renouvelables - SER	France
STICHTING PLATFORM GEOTHERMIE	The Netherlands
Swiss Geothermal Association SGA - Geothermie.ch / SVG - Schweizerische Vereinigung f?r Geothermie	Switzerland
UGI (UNIONE GEOTERMICA ITALIANA)	Italy

### 5.1.4 ETIP DG Members

The European Technology and Innovation Platform on Deep Geothermal, ETIP DG, is a platform supported by the European Union that aims to precisely identify the RD&I needs of the European deep geothermal industry and propose pathways to act on them. As other ETIPs, the ETIP DG is a platform to which any actors of the geothermal sector can personally join, representing their companies or organizations.

By definition, members of the ETIP DG are actors that have a strong interest in fostering the implementation of the RD&I priorities identified by the TWG Deep geothermal.

As described in the figure below, the ETIP DG Membership has a high potential for fostering the RD&I priorities of the deep geothermal sector, notably by considering the large share of members from the geothermal industry (53%) and from the research sector (35%).

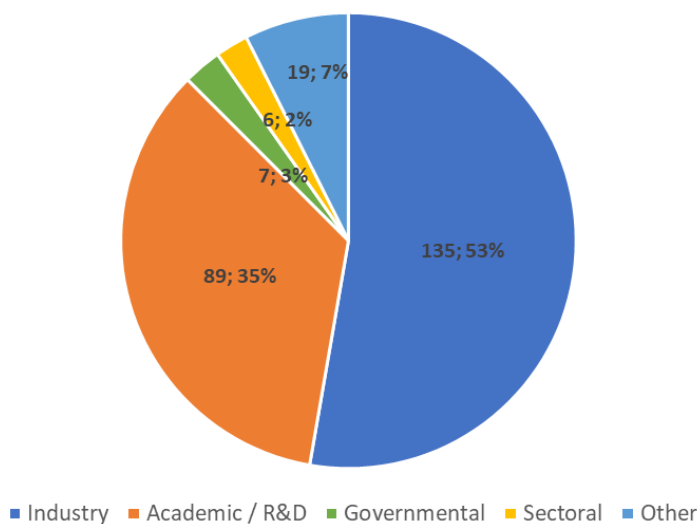


Figure 2. ETIP-DG Members per category

### 5.1.5 Geo-Energy Europe: European geothermal SMEs as potential innovation actors

The Geo-Energy Europe (<https://www.geoenergyeurope.com/>) project is funded by the European Union under the COSME programme. It aims at establishing a metacluster that brings together the European SMEs involved in the geothermal sector to help them access international markets beyond the EU.

As such, the focus of the GEE project is not the promotion of the Europe’s RD&I priorities, but European SMEs involved in the geothermal sector are often among the actors that contribute to the implementation of these priorities, finding their competitive edge through the provision of innovative solutions as cost-efficiently as possible. Therefore, the GEE Membership base can be a valuable reserve of potential actors for the implementation of the TWG Deep Geothermal RD&I priorities.

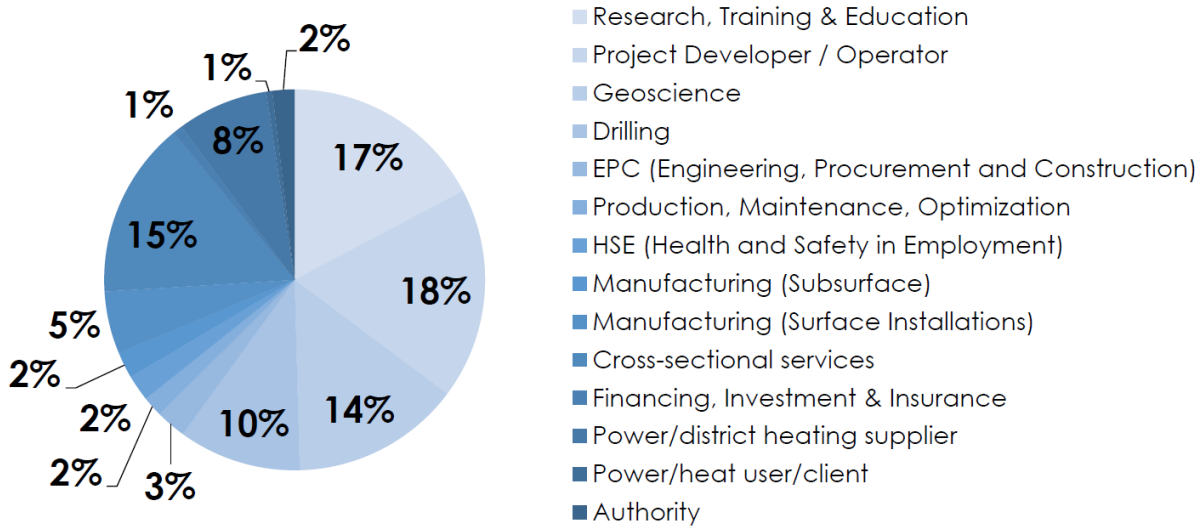


Figure 3. Position in value chain of Geo-Energy Europe (GEE)

The Members of the different clusters involved in the Geo-Energy Europe project represent the entire geothermal value chain, across a wide array of European countries. The various focuses of the different clusters in Geo-Energy Europe guarantee a diversity of actors represented in the metacluster membership base. Besides, in line with the GEE project priority on the internationalisation of the activities of SMEs involved in the geoenery sector, SMEs represent a large share – 54% - of the membership base.

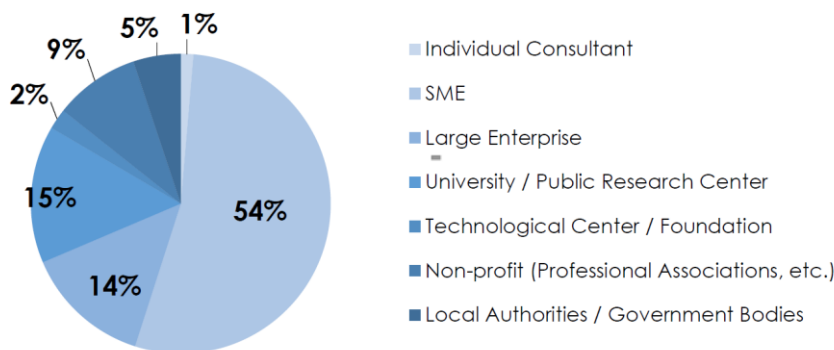


Figure 4. Geo-Energy Europe (GEE) Members Structure Type

## 5.2 Deep geothermal companies operating in Europe

### 5.2.1 Developers and operators of geothermal energy projects in Europe

Considering the developers and operators of geothermal energy projects in Europe allows to identify which actors are potentially best placed to carry on projects that contribute to the implementation of the RD&I priorities for the deep geothermal sector. Indeed, the developers and operators of existing plants or ongoing geothermal projects are quite reflective of the category of actors that are likely to engage in the development of geothermal energy projects, notably in new markets.

The 2018 EGEC Geothermal Market Report identified the trends towards the entry of new actors for operators and developers of geothermal electricity projects and heating and cooling in Europe, a trend carried by the general growth of geothermal capacity, in particular through the emergence of new key markets for geothermal energy. The figures below for instance underline the importance of Turkish operators in today's geothermal electricity market, as well as the emergence of new developers for France, Italy, Greece.

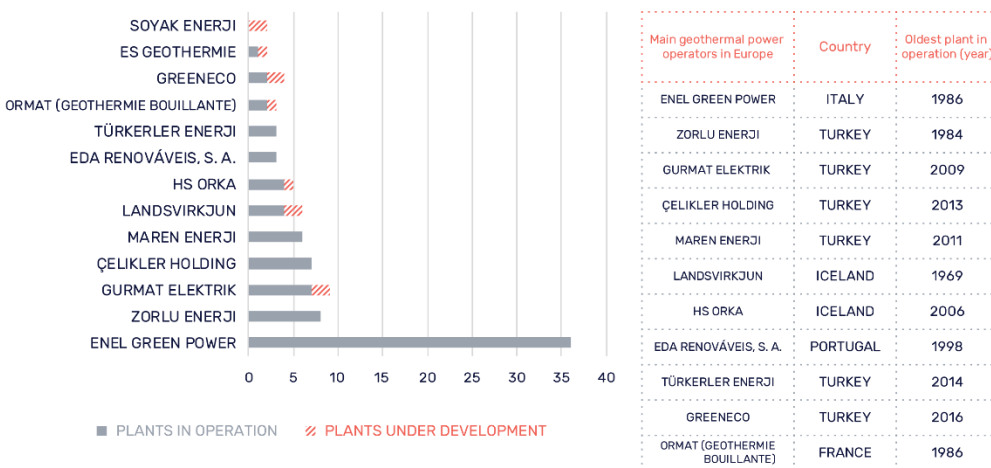


Figure 5. EGEC Market Report 2018, Key Europeans operators for geothermal electricity

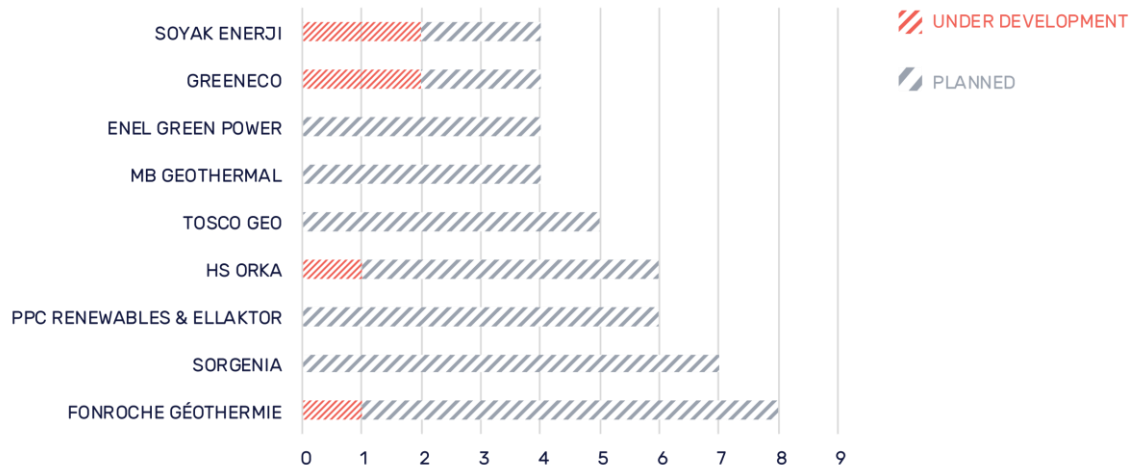


Figure 6. EGEC Market Report 2018, Europeans developers for geothermal electricity

Looking at operators for the deep geothermal heating and cooling sector highlights a key feature of this type of projects that need to be acknowledge when considering potential actors for fostering the RD&I priorities of the deep geothermal sector. Indeed, in many cases deep geothermal heating and cooling projects are undertaken by local authorities or by local energy companies – which tend to be at least partially owned by local authorities. Moreover, although private developers do account for a significant part of the market – though less than half of it – it is worth considering that in many cases the development of the projects is undertaken in direct partnership with the local authorities which guarantee a demand of the geothermal heat that is generated. In that regard the French model of “Délégation de Service Public” where a local authority commissions a private developer (often large developers) to develop a project on its behalf is a good example of this type of relationship between the public and private sector for deep geothermal heating and cooling projects. Large private operators in this case typically involve companies such as Engie Cofely, Coriance, DALKIA, Nordurorka, Veitur, GeoEnergy Service, Enel Green Power, Transgex SA, Slovgeoterm, PannErgy...

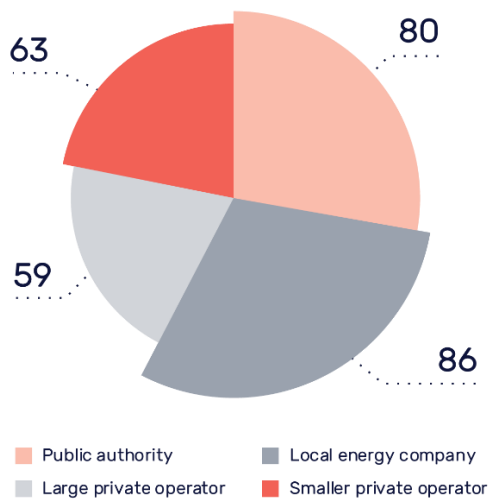


Figure 7. EGEC Market Report 2018, Typology of operators in deep geothermal H&C

### 5.2.2 Deep Geothermal drilling companies

Drilling market conditions are different all over Europe as a result of different national regulatory frameworks which creates a barrier to the creation of a European geothermal drilling market. In some countries, the number of drilling companies is not high enough to allow full competition and therefore competitive prices.

Table 5. Snapshot of the subsurface equipment manufacturers and service providers in Europe (Source: GEOELEC).

TYPE	NAME	GEOGRAPHICAL COVERAGE
Equipment Manufacturer/provider; Drilling Service Company	Aker Solutions	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Amec	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Bentec	Europe
Equipment Manufacturer/provider; Drilling Service Company	BHGE	Europe
Equipment Manufacturer/provider; Drilling Service Company	Cape Industrial Services	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Drillmec	Europe
Equipment Manufacturer/provider; Drilling Service Company	Drillstar	Europe
Equipment Manufacturer/provider; Drilling Service Company	Fangmann	Europe

Equipment Manufacturer/provider; Drilling Service Company	Fugro	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Halliburton	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Huisman	Europe
Equipment Manufacturer/provider; Drilling Service Company	Herrenknecht	Europe
Equipment Manufacturer/provider; Drilling Service Company	Marathon	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Noble Drilling	Europe
Equipment Manufacturer/provider; Drilling Service Company	Odjfell Drilling	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Schlumberger	Worldwide
Equipment Manufacturer/provider; Drilling Service Company	Weatherford	Europe
Equipment Manufacturer/provider; Drilling Service Company	Welltec	Europe
Equipment Manufacturer/provider; Drilling Service Company	Scientific Drilling	Worldwide
Driller/Rig Owner	Anger	Europe
Driller/Rig Owner	Apache	Worldwide
Driller/Rig Owner	Boldon Drilling	Europe
Driller/Rig Owner	BAUER	Europe
Driller/Rig Owner	Celler Brunnenbau	Worldwide
Driller/Rig Owner	COFOR	Europe
Driller/Rig Owner	CROSCO	Europe
Driller/Rig Owner	DAFORA	Europe
Driller/Rig Owner	Dalrup	Europe
Driller/Rig Owner	Enel GP	Europe
Driller/Rig Owner	Herrenknecht	Europe
Driller/Rig Owner	Iceland Drilling	Europe
Driller/Rig Owner	ITAG	Europe
Driller/Rig Owner	KCA Deutag	Europe
Driller/Rig Owner	Maersk	Worldwide
Driller/Rig Owner	Marriott Group	Worldwide
Driller/Rig Owner	NOV	Worldwide
Driller/Rig Owner	SAIPEM	Europe
Driller/Rig Owner	SMP	Worldwide
Driller/Rig Owner	Transmark EDS	Europe

### 5.2.3 Equipment Manufacturers

Different geothermal energy technologies have different requirements in terms of equipment required to develop the geothermal resource, or to produce energy from the plant. The figure below for instance highlights the different equipment requirements for a geothermal power plants according to the typology of the plant, detailing notably the different components for geothermal power plants surface equipment.

EQUIPMENT	TYPE OF POWER PLANTS		
	Dry steam	Single/Double flash	Binary
<b>Steam and/or brine supply</b>			
Downhole pumps			
Wellhead valves and controls			
Steam piping			
Brine piping			
<b>Heat exchangers</b>			
Evaporators			
Condensers			
<b>Turbine-generator and controls</b>			
Steam turbine			
Dual admission turbine		Double flash	
Binary turbine			
Control system			
<b>Plant pumps</b>			
Cooling water circulation			
Reinjection of brine, separated water and condensate			
<b>Non condensable gas removal system</b>			
Steam-jet ejectors			
Compressors			
Vacuum pumps			
<b>Cooling</b>			
Cooling tower			
Air cooling			

Figure 8. Major Equipment Use per power plant category  
(Source: EGEC Market Report 2016)

#### STEAM/BRINE SUPPLY AND DOWNHOLE PUMP (ESP):

**Typology:** Sector with an important presence of service and equipment manufacturing companies in close link with the oil & gas sector.

**Example of Key Players:** Schlumberger, Baker Hughes, GE Oil & Gas, ITT/ Goulds, Canadian ESP, Flowserve, Halliburton, Weatherford International, Borets Company and LLC

## PLANT CONSTRUCTION:

**Typology:** Utilities, turbine manufacturers with plant construction departments, general development companies with a power plant department.

**Example of key players:** ENEL GP, EnBW, ES, Turboden MHI, Ormat, Atlas Copco, GE/Alstom, EPC Technip, Clemessy Eiffage...

## INHIBITER PRODUCERS AND OTHER O&M SERVICES:

**Typology:** Chemical manufacturers from the water sector or from the Oil & Gas O&M sector.

**Example of key actors:** Nalco Water, Suez Environment, CHIMEC, Roemex

## HEAT EXCHANGERS:

**Typology:** Manufacturing companies, notably involved in the general manufacturing of heating and cooling equipment. May be generalist large companies or very specialised SMEs

Example of key actors: Alfa Laval AB (Sweden), Danfoss & Sondex Holdings A/S (Denmark), Kelvion Holdings GmbH (Germany), SPX Corporation (US), Xylem Inc. (US), Gunter AG & Co. KG (Germany), Hamon & Cie International SA (Belgium), Modine Manufacturing Company (US) and SWEP International AB (Denmark)

## 2D AND 3D GEOLOGICAL MODELS, GEOPHYSICAL EQUIPMENT:

**Typology:** highly specialized Medium size companies. Close links to the minerals sectors

**Example of key actors:** Sercel in France, ION and IVI in the USA

## SEISMIC ACQUISITION INSTRUMENTS

**Typology:** large subsurface service companies operating worldwide, specialised SMEs

**Example of key actors:** Schlumberger, Baker Hughes (a GE company), Halliburton, Fugro, DMT. Other Phoenix, Metronix, Zonge

### 5.2.4 Services companies

## EXPLORATION SERVICES:

**Typology:** Companies involved in the O&G sector for well development, or companies specialized on geothermal energy bringing extensive expertise about the specifics of geothermal project development

**Example of key actors:** Schlumberger, Baker Hughes (a GE company), Halliburton, Fugro, DMT, CGG, and PBG Geophysical Exploration Ltd.



## 6. Conclusion

The geothermal sector is a diverse, highly innovative sector, which leads many different types of actors to be engaged in fostering the R&I priorities identified by the SET Plan Implementation Working Group Deep Geothermal. Many of these actors are engaged, usually in partnership with non-industrial actors such as the research communities in public funded projects, for instance programmes such as Horizon 2020 or Geothermica. Meanwhile, as the geothermal sector remains very competitive, industrial actors also often carry out innovation in the various projects they are developing commercially as they seek to decrease the cost of producing geothermal energy. All industrial actors are therefore susceptible to engage in the implementation of the R&I priorities for deep geothermal.

Meanwhile, the geothermal sector, while not necessarily a very concentrated community, remains structured by key organisations and events, which constitute relays of the geothermal industry, where experience sharing happens, and cooperation emerge, fostering innovation. These institutions of the geothermal community are crucial in identifying the key industrial actors of the geothermal sector.