Deliverable 1.4.6
THE GEOTHERMAL SECTOR REPORT

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April 2016

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EXECUTIVE SUMMARY

The climate change accord reached by over 195 countries last December in Paris provides a strong mandate for governments to push forward the transition toward 100% renewable energy future. Renewable energy is a key sector for achieving targets under the EU 2020 framework. In this regard, geothermal has a significant role to play in contributing to the reduction of CO2 emission, EU energy independence but also in fostering the creation of new green employment opportunities at the local and international levels.

But without the availability of adequately trained human resources to respond to the needs of the industry, this transition will be possible. The current persisting skills gaps and shortages in the sector which have been reported for several years now, need to be urgently addressed to support the further deployment of the geothermal sector.

The KnowRES project survey research aims at providing an instant picture of the geothermal jobs market while identifying the (recruitment) challenges companies in the sector are facing. In addition to identifying the current three most wanted profiles, the research also highlights the critical skills and competencies the sector need for a successful deployment including recruitment forecasts for the next 2 years. The survey research primarily covers geothermal technology for electricity generation but companies operating in the heat sector have also been included.

SURVEY KEY FINDINGS

Forty-four companies/organisations have participated in the survey research. They are located in 16 countries (Europe + USA and Turkey).
<table>
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<th>Recruitment challenges</th>
<th>Difficulty in finding the right combination of technical and soft skills. Skills gaps and shortage concentrated at the Feasibility phase of the value chain</th>
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INTRODUCTION

The resolution adopted at COP21 last December in Paris gives the momentum for a vision of a hundred percent renewable energy future. This historic agreement represents a corner stone to a carbon-free world by clearly identifying the deployment of renewable energies as the mainstream solution to reach the main renewable energy objectives of the EU.

The main political objectives of the EU’s renewable strategy are: decreased use of fossil energy sources, reduced CO2 emissions and increased energy self-sufficiency. In his key priorities for the European Union, Jean-Claude Juncker clearly asserted this EU political commitment when he declared:

“I want to keep our European energy market open to our neighbours. However, if the price for energy from the East becomes too expensive, either in commercial or in political terms, Europe should be able to switch very swiftly to other supply channels. We need to be able to reverse energy flows when necessary. And we need to strengthen the share of renewable energies on our continent. This is not only a matter of a responsible climate change policy. It is, at the same time, an industrial policy imperative if we still want to have affordable energy at our disposal in the medium term. I therefore want Europe’s Energy Union to become the world number one in renewable energies.” (1)

The recent historic agreement concluded at the COP21 in Paris represents a great confidence boost for the renewable energy sector. The geothermal sector has an important role to play toward the EU reaching its renewable energy target. However the existing skill gap in the sector may hinder the further deployment of the industry. Indeed, the further development of the sector is only possible if the required skills and competences are available. Finding and retaining qualified staff remain a major challenge for companies in the sector.

By helping closing the skill gaps, the KnowRES project intends to respond to the above mentioned recruitment challenge.
The KnowRES project primarily covers geothermal technology for electricity generation. However, the value chain and therefore the skills required in the upstream sector (exploration and production) is in common with deep geothermal technology for heat (e.g. for district heating). For the purpose of this analysis, therefore, companies operating in the heat sector only have also been interviewed and involved.

1- THE KNOWRES PROJECT

KnowRES, The Knowledge Centre for Renewable Energy Jobs, provides job intelligence to industry, candidates and academic and training institutions, while performing an analysis of the skills needed by the industry to ensure that the provided education and training courses are tailor-made to the sectors’ needs. The overall aim of the project is to help closing the skill gaps in the renewable energy sector.

The project, co-funded by the European Union, is coordinated by EUREC, the association of European renewable energy research centres. The project partners include five industry associations namely AEBIOM for the biomass sector, Ocean Energy Europe for the ocean sector, ESTELA for the solar thermal electricity sector, AssoRinnovabili for the small hydropower sector and EGEC for the geothermal sector; one research centre in Spain CIRCE; one university in the Netherlands Hanze University of Applied Sciences; one company from the private sector, Greenfish, specialised in green jobs recruitment. The project covers, in its analysis, the following sectors: Biomass, Photovoltaics, Ocean Energy, Solar Thermal, Small Hydropower and Geothermal.

1.1- ABOUT THE SECTORAL REPORT

The sectoral report summarises the survey findings and provides information on recruitment trends, forecasts and “most wanted profiles” including key competences. The report represents a “snapshot” of the sector job market by identifying the profiles that companies are
looking for and providing critical information on required core and soft skills that make a successful matching between a candidate’s profile and a job’s requirements. Finally, the report also highlights the expertise and competences that are lacking and/or need to be further developed. A separate report will be issued for each sector while an overall Renewable Energy Jobs Barometer will be drafted to cover for all concerned sectors under the KnowRES project.

**PURPOSE**

The report intends to address the following questions:

- What is the recruitment trend for companies and what (recruitment) challenges are they currently faced with?
- What are the most wanted profiles among the existing job functions along the solar thermal electricity value chain and what are they about?
- Are there any new functions/roles in the sector and what are they?
- What skills and competencies are particularly in demand?
- What issues need to be addressed in order to close the skill gaps in the sector?

While many studies now assess the global employment trend per sector, this report focuses on assessing concrete recruitment needs of companies. The unique collaboration between leading companies, international organisations and academic institutions, under the framework of the KnowRES project, enabled the gathering of pertinent information.

**TARGET AUDIENCE**

This report’s up to date job intelligence and key findings are directed towards the industry, job candidates, education and training actors. This report is also of relevance to a broader audience such as policy makers seeking specific employment data or recruitment firms interested in job content information and trends.
METHODOLOGY

Given the scope of the subject to be researched, the timeframe and the resources available, a qualitative survey research was proposed for mapping the job market in the solar thermal electricity sector. The rationale behind the survey research is to assess current recruitment challenges and employment opportunities in the geothermal industry by providing an instant picture of the sector’s job market with concrete information that could be exploitable immediately by concerned stakeholders, thus taking into account the time (short-term) imperative under which companies are operating.

In addition to the survey results, desk research and face to face interviews with relevant experts were carried out in order to allow for deeper analysis and to provide more complete information on job contents and trends.

LABOUR MARKET TOOLS – JOBS BAROMETER

The testing of the developed labour market tools (i.e. survey research complemented by individual interviews,
experts’ meetings) enabled the adaptation of the job barometer to the specificity of each renewable energy sector.

The developed and tested tools are intended to be replicated to allow for the mapping of job markets in other sectors. This can be done on an ad hoc basis whenever there is a need for an instant picture of a specific sector or sub-sector but the tools are especially interesting when used in a systematic and consistent manner and in a longer term period as the comparison of year to year survey research findings will constitute a concrete and accurate up to date jobs barometer

**EXPERT ROUNDTABLES – PANEL DISCUSSIONS**

Other tools such as expert roundtables or panel discussions are very valuable to complement the above-mentioned tools in filling the gaps. Experts are invited to provide guidance and feedbacks on the project deliverables by exchanging views on possible innovative approaches and how the effectiveness of established approaches/tools might be enhanced. In addition, the experts will share information on existing initiatives on employment and training in the renewable energy sector in order to define further cooperation opportunities and support the long-term sustainability of KnowRES. To this extent, the KnowRES Advisory Board has been created. It is composed of representatives from different disciplines: PV industry association, RE industry association in Belgium, International organization, Employment agency for Brussels and Wallonia, Wind industry association, Sustainable energy association, greentech job cooperation between EU and Maghreb.
2-THE GEOTHERMAL SECTOR

2.1-WHAT IS GEOTHERMAL AND HOW DOES IT WORK?

Geothermal energy is the energy stored in form of heat below the earth’s surface. Deep geothermal resources can be used for the generation of electricity, combined heat and power, and heat only (e.g. for local district heating systems or process heat).

As a renewable source of energy, geothermal is widely regarded as having major advantages over other energy sources in relation to climate impact and reliability. The IEA underlined this point in its Geothermal Technology Roadmap: ‘Geothermal typically provides base-load generation, since it is generally immune from weather effects and does not show seasonal variation. Capacity factors of new geothermal power plants can reach 95%. The base-load characteristic of geothermal power distinguishes it from several other renewable technologies that produce variable power.’

If it is true that geothermal power plants have traditionally been built to operate continuously at maximum output, with technological development they can also be designed to be flexible, meaning capable of responding to system operators’ needs. Indeed, a geothermal power plant can be used in partial load operation and, especially with new binary technology, can quickly ramp their output up and down on demand, thereby providing the much needed flexibility for modern electricity systems.

The technological systems for geothermal electricity production can be subdivided in three broad categories, which are linked to the temperature ranges:

**Medium Enthalpy resources (80°C - 150°C):** this range of temperature is appropriate for use with binary plants (Organic Rankine or Kalina cycle), with typical power in the range 0.1-10 MWe. These systems are also suitable for heat and combined heat and power (cogeneration).

**High Enthalpy resources: (150°C - 390°C):** temperatures in this range can be exploited with dry steam, flash and hybrid plants, with typical power in the range 10-100 MWe. These
systems also allow heat cogeneration for large towns’ district heating. Above 200°C, these resources are generally limited to volcanic areas.

**Supercritical unconventional resources (above 390°C):** temperatures in this range, limited to volcanic areas, generally involve superheated dry steam plants, with power per unit volume of fluid up to one order of magnitude larger than conventional resources. Low enthalpy (between 50 and 80 °C) as well as medium and high enthalpy resources are directly used for the generation of heat and cold (e.g. for local district heating).

Besides the temperature range, the methods of exploitation can be further subdivided in two categories: conventional and binary (low temperature).

**Conventional technology**

Operating with large hydrothermal reservoirs at high temperature, i.e. above 150°C, such as those found in Tuscany (Italy) and Iceland, conventional geothermal technology (dry steam and flash steam turbines) has more than a century of history and is fully competitive today. However, it is very unlikely that new large geothermal reservoirs will be discovered in Europe. Therefore new projects need to be adapted to smaller and cooler resources.

**Binary technology**

Binary, known also as Organic Rankine Cycle (ORC) or Kalina Cycle, plants operate usually with waters in the 100°C to 180°C temperature range. In a binary system, the heat of water is transferred to a separate liquid with a lower boiling temperature. The separate liquid is called a ‘working fluid’. When the hot geothermal water is brought to surface from deep underground, it is run through a ‘heat exchanger’ which transfers the heat from the geothermal water to the liquid working fluid. What makes a binary system unique is that it operates a two closed-loops (hence, binary); neither the geothermal water nor the working fluid are exposed to the surface environment. All the water that is brought to surface has to be re-injected, and after vaporising, the working fluid is cooled to its liquid state, so it may repeat the process. There are no-emissions in the binary geothermal cycle.

Additionally, new technology allows producing electricity from hot rock resources using EGS techniques that would enable thermal energy recovery from outside of traditionally favourable regions.
Enhanced Geothermal Systems (EGS)

An EGS is an underground reservoir that has been created or improved artificially. The EGS concept is going to greatly increase geothermal potential as it allows for the production of geothermal electricity nearly anywhere in Europe with medium and low temperature.

An Enhanced Geothermal System concept involves:

- Using the natural fracture systems in basement rocks
- Enlarging permeability through stimulation
- Installing a multi-well system

Through pumping and lifting, forcing the water to migrate through the fracture system of enhanced permeability ("reservoir") and use the energy for power and/or heat production.
2.2-FIGURES AND TRENDS OF THE GEOTHERMAL SECTOR

Geothermal electricity in Europe is growing slowly but continuously, not only in traditional areas but also in areas with low-medium temperature resources through the utilisation of binary plant technologies. Indeed, the geothermal electricity market has seen a renewed momentum in the last 5 years (see figure below).

![Figure 3: Cumulative installed capacity in the geothermal power sector (2011-15). Source: EGEC Market Report 2015](image)

In Europe there are 88 operational power plants with a total installed capacity of 2.1 GW. The installed capacity in the European Union is about 1 GW, with 52 plants in operation.

The figure overleaf illustrates the current and projected installed capacity by country. In the European Union, most of the installed capacity is in Tuscany, Italy.
The production of geothermal electricity in the EU in 2014 was 6.2 TWh. The projections in the national renewable energy action plans estimate a geothermal electricity production in the EU-28 of 11 TWh in 2020.

According to the recent GEOELEC resource assessment, in 2030 the economic potential of geothermal power in the EU amounts to 34 TWh. Thanks to economies of scale, innovative drilling concepts and cost reduction, the economic potential in the EU grows to approximately 2570 TWh in 2050 (potentially covering as much as 50% of the projected electricity produced in the EU) and more than 4000 TWh including Iceland, Turkey and Switzerland. This at ≤100 EUR/MWh all costs included.
As already mentioned, in the upstream sector (exploration and production) there is no difference between power and heat generation when it comes to value chain and skills required. It is therefore worth reporting some trends for the deep geothermal heat sector as well.

This is the most dynamic geothermal market segment. In Europe there are 257 district heating plants in operation with a total installed capacity of 4.7 GW. 23 new district heating plants were commissioned in 2014 and 2015, with a total new capacity of 281.84 MWth. The figure below provides the number of systems installed and under development by country.
2.3- JOBS IN THE GEOTHERMAL SECTOR?

Under the GEOELEC project framework, an employment study was carried out from 2011 to 2013. The study estimated that there were (2013) around 3000 jobs directly related to geothermal electricity in the EU-28. Geothermal energy direct jobs can be broken down into different types, from geologists and engineers, drillers and workers in equipment factories to project managers. Geothermal power also generates indirect jobs, for example with suppliers of raw...
materials and induced jobs. The estimated total number of geothermal power jobs in 2013 was 10,000 jobs. Based on the projects under development and under investigation as well as new installed capacity, job creation is expected by 2020 in Italy, Hungary, Greece, Portugal, France, Germany, Spain, UK, Iceland, Turkey, Belgium, Slovakia and Switzerland. By 2030, more than 100,000 people should be employed in the sector.

<table>
<thead>
<tr>
<th>Start-up</th>
<th>Exploration</th>
<th>Drilling</th>
<th>Production and Construction</th>
<th>Operation and Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Geologists</td>
<td>• Geologists</td>
<td>• Drilling engineers</td>
<td>• Engineers</td>
<td>• Plant managers</td>
</tr>
<tr>
<td>• Biologists</td>
<td>• Geophysicists</td>
<td>• Rig hands</td>
<td>• Power plant designers</td>
<td>• Engineers</td>
</tr>
<tr>
<td>• Hydrologists</td>
<td>• Geochemists</td>
<td>• Mud loggers</td>
<td>• Document controllers</td>
<td>• Plant technicians</td>
</tr>
<tr>
<td>• Archeologists</td>
<td>• Engineers</td>
<td>• Drilling fluids personnel</td>
<td>• Project managers</td>
<td>• Site operators</td>
</tr>
<tr>
<td>• Lawyers</td>
<td>• GIS specialists</td>
<td>• Cementing personnel</td>
<td>• Construction managers</td>
<td>• Service repairmen</td>
</tr>
<tr>
<td>• Paralegals</td>
<td>• Exploration drillers</td>
<td>• Casing crews</td>
<td>• Project engineers</td>
<td></td>
</tr>
<tr>
<td>• Environmental engineers</td>
<td>• Sample analysts</td>
<td>• Directional drillers</td>
<td>• Reservoir and Field engineers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Consultants</td>
<td>• Rig transportation</td>
<td>• Safety managers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fuel transportation</td>
<td>• Welders</td>
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<td></td>
<td>• Welders</td>
<td>• Safety managers</td>
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<tr>
<td></td>
<td></td>
<td>• Safety managers</td>
<td>• Steel erectors</td>
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<tr>
<td></td>
<td></td>
<td>• Geologists</td>
<td>• Concrete placers</td>
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<td></td>
<td></td>
<td>• Construction personnel</td>
<td>• Assembly mechanics</td>
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<td></td>
<td></td>
<td></td>
<td>• Inspection personnel</td>
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</table>

**Enabling activities:** IT professionals, Human resource professionals, Health and safety consultants, Administration, Insurer representatives, Management, Government office workers, Educators and trainers, Accountants, Auditors, Financers, Publishers and Science writers

Table 1: Job types trough the project development and operation – Geoelec

Over the last few years little new installed capacity has caused a concentration of jobs mainly in O&M of the already installed power plants (1 GWe capacity), traditionally requiring only a few workers. The development of a significant number of new projects will trigger a real
boom in labour intensive activities such as exploration, drilling, construction and manufacturing (www.geoelec.eu)

Figure 7: Jobs in Renewable Energy, Source: REN21 Renewables 2015 Global Status Report
Worldwide, about 150,000 persons were employed in the sector in 2014 (for an installed capacity of 13 GWe), according to the estimates of the REN21 Renewables 2015 Global Status Report. And this number is expected to increase given the slow but steady growth the sector is experiencing in both developed and developing countries.

3- THE MOST WANTED PROFILES SURVEY RESEARCH

3.1-THE SURVEY RESEARCH

In order to assess companies and organisations’ challenges, their recruitment needs and projections, a tailor made survey was designed by the Green jobs specialist and reviewed together with the concerned industry association designated staff to ensure that the
information to be collected would be useful and exploitable to all concerned parties (i.e. industry association, companies, training institutions/universities and job candidates). In this regard and for consistency purposes, it was important that all partners involved agreed on working with the same value chain and generic job occupations which were incorporated in the questionnaire.

Under the project partners’ agreement, the industry associations are responsible for broadcasting the survey questionnaire to their respective member companies/organisations as well as companies in their network. A success indicator of 50% responses to the total number of companies/organisations targeted was required.

The online survey responses were supplemented by individual – face to face- interviews with people who are performing the job, rather than the Human Resource staff, in order to obtain as specific answers as possible.

### 3.1.1-ANALYTICAL FRAMEWORK: THE VALUE CHAIN(S)

This report considers employment throughout the whole deep geothermal value chain. The above renewable energy value chain was therefore reviewed and updated together with EGEC, the European geothermal association to include more detailed job occupations. This was for consistency purpose to ensure that all partners involved are working with the same value chain and generic job occupations, which were incorporated in the survey research. The updated Geothermal value chain is based on the one used in the GEOELEC project which includes the following phases:

- Start-up
- Exploration
Activities of each phase of geothermal power development include geothermal exploration, drilling engineering, management and supervision, field development and steam gathering system design, geothermal plant design, start-up and commissioning, operations and maintenance, software development, teaching and training.

A detailed value chain with corresponding job occupations can be found in annex A.

3.1.2-SURVEY FINDINGS

A total of forty four (44) companies/organisations participated in the survey research. These companies are located in the following sixteen countries (from highest to lowest participation rate):

- Germany (22.7%)
- Italy (9%)
- France (9%)
- The Netherlands (6.8%)
- Belgium (6.8%)
- Slovenia (4.5%)
- USA (4.5%)
- Austria (4.5%)
- Denmark (4.5%)
- Hungary (4.5%)
- Iceland (4.5%)
- Kenya (4.5%)
Norway (4.5%)
Poland (4.5%)
Spain (4.5%)
Turkey (4.5%)

These figures are not completely representative of companies' geographical location in the sector, since the bulk is in Iceland, Italy, France, Germany, Turkey and Hungary.

**Location on the value chain**

In the geothermal sector many companies are active in various phases of the value chain with some companies covering the entire value chain from start-up to the production of geothermal energy, and from the underground to the surface systems. Indeed, over 67 per cent of companies have activities covering different phases and only 2.33 per cent of companies are located at a single phase such as the start-up phase as well as the Operation & Maintenance phase. Below are a few examples of overlapping activities cited by companies:

- Drilling and construction, O&M, design and manufacture + cross cutting
- Construction and R&D – Engineering planning
- Start-up, O&M, construction
- Exploration, consulting, development, R&D
- Start-up, geothermal sites, permitting, EPC
- Consulting, exploration, project development

The value chain can be summed up with the following categories:

- Services and engineering
- Developers and operators
- Equipments manufacturers, Plant constructors
- Drillers

*We cover all aspects of geothermal energy, from screening the first ideas to the operation of the plant, on a general level*
Based on the information collected, we can deduce that there is currently a high level of activities at the exploration phase, with many projects under development or investigation, given that the majority of the surveyed companies are involved in this critical phase in addition to the 18.60 per cent of companies fully devoted to exploration activities. R&D and O&M activities are also well represented.

**Number of staff**

The size of the companies depends on a number of factors such as supportive legislation, location, the maturity of the market they are covering, the age of the company (i.e. whether it is a new entrant or a long established one), its structure and financial background (i.e. whether it is a unit part of a big group or an independent company).

![Number of staff](image.png)

**Figure 8: Number of staff**

Small and medium enterprises are well represented in the survey research as companies with less than 50 staff accounts for 52 per cent, mainly for services and engineering but also some project developers. Companies with over 500 person-strong staff account for 21 percent.
Eleven per cent of surveyed companies have between 100 and 250 staff, nine per cent between 50 and 100 staff and seven per cent between 250 and 500 staff.

**Periods when companies entered the geothermal sector**

The companies surveyed entered the geothermal sector at different periods; the pioneers joined the sector at the very beginning in the 1930s and since the 1980s there has been a regular trend of companies extending or developing their activities in the geothermal sector. The sector has experienced a slow-down in the late nineties until 2005/2010, when involvement from companies peaked until 2010-2011. We have witnessed within the last 5 years a resurgence of interest in geothermal power, after nearly a decade of only small development in capacity in the deep geothermal sector, both for electricity and for direct uses (mainly district heating). A substantial number of projects have been developed throughout Europe, and geothermal energy is on its way to become a key player in the European energy market. The slow but steady development of the sector and the slow but regular number of companies entering the sector reflects the direct link between geothermal technology deployment and economic activities.

**High confidence in the geothermal sector**

The interviewed staff overwhelmingly expressed high confidence in their respective company/organization. When asked about the strengths of their company/organization, the following results were obtained:

- Quantity and quality of industrial and scientific expertise (88.64%)
- Employees’ loyalty and commitment (50%)
- Strong Careers development possibilities (43.18%)
- Access to internal and/or external training opportunities (50%)
- Possibilities of staff exchange with academic sector (universities, research center, etc) (40.91%)

The staff positive appreciation of their respective company should translate into a low turn-over in the sector.
**Biggest developments that will influence the sector in the next 2 to 5 years**

Many developments impacting the geothermal sector were suggested. However, the following ones have been highlighted:

- Development of drilling expertise (reduction of required drilling time, reduction of drilling costs as well as improvement of safer drilling).
- More predictable legal and financial framework (reduction of governmental grants and subsidies)
- Risk mitigation mechanisms (more financial support in the early phase to mitigate resource risk)
- Identification of solutions for scaling control (development of scaling proof pump systems)
- Flexibility of the sector in keeping up with changes (development of oil & gas industry)
- More efficient communication and dissemination of technological progress
- Better training for O&M

There is a need to improve the image and communicate on the value of the sector to attract more investment from the private sector which is crucial given the reduction of financial support from the public sector.

**Key competencies critical to the success of the sector in the next 2 to 5 years**

Flexibility is the number one competence companies find is critical for a candidate to possess in order to successfully adapt to changing environment, and especially to the customers evolving needs. Flexibility is also important for the staff to cope with the frequent travels and long period missions. More specifically expertise in the following fields has been cited:

- Reservoir engineering
- Project management
• Drilling expertise
• Process, chemical and material engineering
• Geophysicist
• Commercial and financial skills

Based on the responses, we can foresee that multi-discipline trained engineers (reservoir, drilling and O&M) will be in high demand in the next 2 to 5 years.

Recruitment challenges: skills shortages at the Feasibility drilling phase of value chain
While there is currently a severe lack of drilling engineers in the geothermal sector, over half of the companies interviewed (51.22%) said they never had any difficulties in finding suitable candidates. If we remove companies that are not hiring, the percentage of companies that have no hiring problem is edging closer to 44%.

For companies that have been confronted to skill shortage and skills gaps, 12 per cent said the candidates lacked appropriate education, 19.5 per cent mentioned the insufficient professional experience and close to 5 per cent said not enough applications were received for their job vacancies.

The skill shortage in the sector is mainly concentrated at the very specific Feasibility drilling phase of the value chain. The lack of technical skills need to be filled but finding the right combination of technical and soft skill is difficult given many of the potential suitable candidates may come from the oil & gas sector which has a different culture and pay level from the geothermal sector.

Recruitment channels
All recruitment channels are widely used, the predominant channel being the company/partners’ websites (55%) where many spontaneous applications are received. Services from recruitment agencies (36.11%) are welcomed for highly demanded and scarce
profiles. Other recruitment channels (22%) include newspapers, universities for attracting young graduates and professional network –including “word to mouth” as well as relevant conferences.

Training schemes for new staff: mainly internal on the job trainings

Two-third (65.9%) of surveyed companies responded when asked whether their organization or firm organise training schemes for newly hired staff. Among the replies, 34.5 per cent offer internal trainings, 10.3 per cent organize internal and external trainings and 27.5 per cent do not offer any training at all.

Internal trainings cover different contents and the durations may vary from several days of induction courses, 1.5 day workshop per month, 4 weeks to 6 - 12

“All employees are actively encouraged to seek personal development opportunities both internally and externally. Internally, employees receive training and develop through on-going exchange and informally arranged sessions with colleagues. Externally, employees are encouraged to seek relevant courses which are either project specific or cover a subject area which an individual wishes to develop.”
months or continuous on the job training with the coaching of an experienced colleague.

One company (SME) based in Munich, offers a comprehensive internal and external training and career development scheme to its staff.

Many of the companies that are currently not organizing any training, are considering offering trainings in area such as operation & maintenance but the materialization of the planning will depend on upcoming projects and budget availability.

**Recruitment forecasts**

The hugely volatile nature of the geothermal industry, with close links with other geosciences sectors, means that job openings are difficult to predict. Among the 70 per cent of companies that responded to the question of short term recruitment, 51.60 per cent will not be hiring. This number includes some companies that are still considering or weighing the possibility of hiring.

Among the 48.40 per cent of companies that will be hiring in the near future, below are the required profiles and expertise they will be looking for:

- Reservoir engineers
- Drilling engineers
- Product development managers with drilling services background
- Sales engineers or technical sales
- Sales people (not necessarily technical knowledge required, get trained on the job)
- R&D (challenging to find German speaking candidates)
- Installers and service technicians
- Staff with start-up experience and O&M
- Project and plant managers
- Lab analyst for geochemical analysis
- Geo-scientists (with basic or advanced skills in numerical modeling)
- Other cross-cutting such as finance or team managers.

Looking for managers with engineering degree (flexible, resistant, long term)
The above list concerns mainly new jobs vacancies but some recruitment forecasts are mainly to replace the retiring staff.

**Transferability of skills from other sectors to the geothermal sector**

There is a high level of skill transferability from oil & gas, mining and in general hydrocarbon industry. There is a high potential for oil and gas or mining experience transfer to geothermal sector. New entrants to the geothermal sector from oil and gas or mining would provide essential additional supply chain capacity. The skill transfer is especially high in the following phases of the value chain: Exploration, Feasibility drilling and drilling and construction

**Planning and development phase.** Larger surveying companies often from the oil and gas sector are capable of offering a full service covering environmental, geophysical, geotechnical surveying

High level skill transferability from oil & gas, mining and in general hydrocarbon industry

Typically many professionals have made the transition from the oil & gas sector. We have had good experience with such recruits as the skill set closely mirrors the geothermal sector.

### 3.1.3 CONCLUSIONS OF THE SURVEY FINDINGS

Geothermal is a highly volatile industry which makes job forecasts very difficult. When hiring, companies would rather hire multi-disciplines engineers and provide them with thematic and on the job training depending on the type of projects they will be working on. This explains why Flexibility is a key competence needed in the sector.

In the last eighteen months, the shortage of technical skills has improved thanks to the surplus of workforce from oil & gas that can be (partially) absorbed by the geothermal sector. However, finding the right set of technical and soft and language skills remains a major recruitment challenge for companies in the geothermal sector.
3.2-MOST WANTED PROFILES

The most wanted profiles companies/organisations are currently looking for are:

- **Drilling engineer** (supervisor). This function is located at the geothermal power development phase of the value chain. This is a key position given that feasibility drilling aims at examining the financial and technical feasibility of a project.

- **Project manager** (drilling & construction) This is a highly qualified position requiring a minimum of 10 years work experience with high level of responsibilities including the planning, execution and monitoring of all aspects of a project (technical, financial, risk assessment, reporting...)

- **Plant manager** (O&M). The maintenance manager provides direct supervision to the maintenance personnel, ensures the efficient, reliable operation of the facility, and ensures compliance with safety and environmental standards.

In addition, some testimonials from people occupying these job functions under the “profile of the month” framework (every month, an interview of a professional working in the Renewable Energy sector is published on the KnowRES website), will provide further insight on the various trajectories that lead them to their current role/occupation.
3.2.1- Drilling engineer (supervisor)

The Drilling engineer (supervisor) must ensure that the daily drilling and completion operations are planned and executed in a safe, efficient and cost effective manner such that the well objectives are delivered on time and within budget.

Example of a job description of a drilling engineer (supervisor)

Responsibilities and duties

- Ensure continuous operational excellence and drive a culture of performance
- Actively participate in promoting a safety conscious working environment
- Strong team player with constant focus on creating a good working atmosphere and relationships with key stakeholders
- Accurate and diligent reporting of all activities and safety related incidents
- Ensure all equipment, material and services are available as and when needed
- Ensure that all activities are conducted in accordance with applicable governmental rules and regulations
- Ensure that in all matters, prior to decision, correct technical and commercial assessments are made, due diligence observed and initiative taken to secure the safest and most cost-effective solution
- Identify and suggest new working procedures and/or cost reducing measures within area of responsibility
- Report to the Drilling Superintendent

Experience and skills required

The successful candidate has an engineering degree or similar educational background and has minimum 10 years operational experience as Drilling engineer (supervisor).

- A decisive and visible leader that naturally accept responsibility and accountability for the operations and the team
- A highly skilled technical professional with a broad drilling and completion experience
- A motivated self-starter that can drive performance
- An excellent communicator and team player on all levels
- Comfortable with working in a dynamic multidisciplinary environment
3.2.2- Project Manager

A company, leader in the geothermal energy industry is seeking a Geothermal Project Manager, who would be based in Lima, Peru for an expected duration of 2 to 3 years.

The ideal candidate would have at least 10 years post graduate experience (ideally in renewable energy), including project engineering/management skills and knowledge in civil works at the early stages of a Geothermal project.

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**Example of job description of a Project Manager**

**Responsibilities and duties**

- Lead the planning, execution and monitoring of his assigned Project/s – scope shall include activities related to construction / civil works, transmission line development, power plant development, etc.
- Direct, control and manage all technical / execution aspects of the project including procurement and all external work undertaken by contractors and consultants

**Experience and skills required**

- At least 10 years post graduate experience, ideally in renewable energy
- Project engineering/management skills
- Knowledge in civil works at the early stages of a Geothermal project
- Spanish language skills

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3.2.3- Plant Manager, O&M

The plant manager, O&M position provides direct supervision to the maintenance personnel, ensures the efficient, reliable operation of the facility, and ensures compliance with safety and environmental standards.
Example of job description of a plant manager

**Responsibilities and duties**

- Coordinate and supervise all maintenance functions necessary to ensure the efficient and reliable operation of the plant to meet scheduled production level. Must be able to take immediate and decisive action to minimize disruption of operations.
- Responsible for plant operating performance as related to equipment reliability and performance. Schedules all maintenance activities with plant personnel and outside service providers.
- Maintain and enforce safety procedures, including all lockout/tagout and safe work procedures. Maintain direct working relationship with environmental, health and safety representatives.
- Develop and direct the implementation of maintenance procedures and plans to assure optimum efficiency and effectiveness in outage planning, giving consideration to equipment capabilities, customer demands, operating personnel and equipment maintenance requirements.
- Develop and maintain computerized maintenance management program, including routine, outage, preventive and predictive maintenance programs.
- Coordinate, schedule and conduct mechanical, electrical, and instrumentation maintenance repair and preventative maintenance.
- Schedule materials, equipment and personnel for plant activities.
- Maintain needed site spare parts in coordination with maintenance and warehouse personnel.
- Actively supports compliance with all applicable provisions of labor laws, environmental regulations, as well as company policies and procedures.
- Perform administrative activities necessary for the effective management of the department, including employee safety, selection and development of employees, salary administration, budget administration, employee counseling and motivation, organizational goals and objectives, planning, organizing, integrating, measuring, and reporting the work performed within the department.

- Develop contracts, in coordination with others, and oversee performance of maintenance service agreements and support contractors required for on-site maintenance, services, equipment rentals and maintenance training.
- Be able to perform the duties of the plant manager in his/her absence.

**Experience and skills required**

Bachelor’s Degree in applicable field; or the equivalent combination of education and experience.

A minimum of five years of related power plant operations or maintenance experience.

- Demonstrated communication and interpersonal skills to communicate expectations, coach employees, provide feedback, and work collaboratively with other departments.
- Effective verbal and written communication skills, including presentation skills.
- Effective analytical, and problem solving, and decision making skills.
- Ability to prioritize and handle multiple tasks and projects concurrently.
- Ability to read and interpret written documents such as drawings, manuals, procedures, contracts, financial reports, safety rules, policies, and professional periodicals/journals.
- Ability to write routine reports, business correspondence and manuals. Ability to effectively present information and respond to questions from groups of managers, clients, customers, and employees at all levels.
- Ability to define problems, collect data, establish facts, and draw valid conclusions. Able to conceptualize and develop creative alternatives to problem resolution. Capability of interpreting an extensive variety of technical instructions in written, oral, diagram, or schedule form.
- Project management skills; ability to prioritize and handle multiple issues and projects concurrently.
- Knowledge of laws and regulations affecting an electric generating facility.
- Understanding of electric generating plant systems.
CONCLUSIONS AND KEY RECOMMENDATIONS

More efficient communication to attract private investments

The legal and financial framework conditions will have the biggest impact on the geothermal sector in the next 2 to 5 years. Given the decrease of governmental financial support, the challenge is to attract more private investment. To that effect, more efficient communication on the value and potential of the sector should be enhanced.

Importance of job intelligence to help close skills gaps and shortage

The highly volatile nature of the industry makes it difficult for the companies to plan and predict the competencies they will require. At the same time, to find a job in the sector can prove to be a daunting experience for the newly graduated candidate or a more experienced professional coming from another sector. Therefore, providing accurate and concrete job intelligence is crucial to bridge the information gap between what is needed from the industry and competencies new entrants are bringing to the market.

Focus on soft and language skills

Beyond the technical skills, the focus should be put on soft and languages skills that are specifically relevant to the geothermal sector. Each geothermal plant, each location has different characteristics, flexibility is a key competence to successfully adapt to the evolving needs of the customers and to the changing environment. Moreover, being able to speak the local language is also crucial to reduce the existing cultural divide when working in new country markets.

Synergies on training topics

SMEs have less capacity to train their staff than bigger companies. However, some training topics such as health and safety or O&M could benefit the sector as a whole. Therefore, the
creation of a task force or platform could be envisaged to pull synergies and funding for common training.

Finally, a sectoral report represents a “snapshot” of the job market at a particular moment but for it to remain relevant and useful it requires the commitment and regular feedback of all stakeholders (industry, training institutions and public sector).
REFERENCES

1- http://juncker.epp.eu/my-priorities
2- www.geoelec.eu and www.geodh.eu

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ANNEX A: DETAILED GEOTHERMAL ENERGY VALUE CHAIN

START-UP

• Geologists
• Biologists
• Hydrologists
• Archeologists
• Lawyers
• Paralegals
• Environmental engineers

EXPLORATION

• Geologists
• Geophysicists
• Geochemists
• Engineers
• GIS specialists
• Exploration drillers
• Sample analysts
• Consultants

FEASIBILITY DRILLING

• Drilling engineers
• Rig hands
• Mud loggers
• Drilling fluids personnel
• Cementing personnel
• Casing crews
• Directional drillers
• Rig transportation
• Fuel transportation
• Welders
• Safety managers
• Geologists
• Construction personnel
DRILLING AND CONSTRUCTION

- Engineers
- Power plant designers
- Document controllers
- Project managers
- Construction managers
- Project engineers
- Field engineers
- Safety managers
- Welders
- Steel erectors
- Concrete placers
- Assembly mechanics
- Inspection personnel

OPERATION and MAINTENANCE

- Plant managers
- Engineers
- Plant technicians
- Site operators
- Service repairmen

OTHER, CROSS-CUTTING/ENABLING ACTIVITIES

- IT professionals,
- Human resource professionals
- Health and safety consultants
- Administration, Insurer representatives
- Management
- Government office workers
- Educators and trainers
- Accountants
- Auditors
- Financers
- Communication & Marketing
- Science writers
ANNEX B: MOST WANTED PROFILES SURVEY QUESTIONNAIRE

1. Name, address, contacts details of the company/organisation

2. Where do you locate your firm/organization in the geothermal value chain (more than one option is possible)?
   - Start up
   - Exploration
   - Feasibility drilling
   - Drilling and construction
   - Operation and maintenance
   - Other cross-cutting/enabling activities

3. How many staff does your company have?
   - Less than 50
   - Between 50 and 100
   - Between 100 and 250
   - Between 250 and 500
   - Over 500

4. Since when is your company active in the geothermal industry?

5. What are the strengths of your company/organization?
   - Quantity and quality of industrial and scientific expertise
   - Employees’ loyalty and commitment
   - Strong Careers development possibilities
   - Possibilities of changing position internally
   - Possibilities of staff exchange with academic sector (universities, research center, etc)
   - Access to internal and/or external training opportunities
   - Other (please specify)
6. Does your company have a training scheme for new staff?
   - Yes, internal training (please indicate the title and duration of the training)
   - Yes, outsourced training (please indicate the title, duration and training institutions)
   - No

7. What do you think will be the biggest developments that will influence the geothermal industry in the next 2 to 5 years?

8. Taking into account these expected changes, what would you consider as the key competencies critical to the success of your company/organization and to the geothermal industry today and for the coming 2 to 5 years?

9. Companies’ recruitment challenges: What are your top 3 priorities and/or concerns related to the staffing of your company/organization?

10. Do you anticipate new job opening in the future? If yes, which profiles, skills/competencies are you particularly looking for?

11. In the past years, did your companies come across any difficulties in finding suitable candidates?
   - Yes, the candidates did not have the appropriate education
   - Yes, the candidates had insufficient professional experience
   - Yes, too many applications were received and not enough time to review them adequately
   - Yes, not enough applications were received
   - No
   - Other (please specify)

12. Through which channel do you advertise new job positions?
   - Job boards
   - Social media
   - Company/partner websites
   - Internal recruitment channel
   - Recruitment agency
13. What occupations/jobs are the most difficult to fill with qualified workers?

**Start up**
- Geologists
- Biologists
- Hydrologists
- Archeologists
- Lawyers
- Paralegals
- Environmental engineers

**Further comments:**

**Exploration**
- Geologists
- Geophysicists
- Geochemists
- Engineers
- GIS specialists
- Exploration drillers
- Sample analysts
- Consultants

**Further comments**

**Feasibility drilling**
- Drilling engineers
- Rig hands
- Mud loggers
- Drilling fluids personnel
- Cementing personnel
- Casing crews
• Directional drillers
• Rig transportation
• Fuel transportation
• Welders
• Safety managers
• Geologists
• Construction personnel

Further comments:

Drilling and construction
• Engineers
• Power plant designers
• Document controllers
• Project managers
• Construction managers
• Project engineers
• Field engineers
• Safety managers
• Welders
• Steel erectors
• Concrete placers
• Assembly mechanics
• Inspection personnel

Further comments:

Operation and maintenance
• Plant managers
• Engineers
• Plant technicians
• Site operators
• Service repairmen
Further comments:

Other cross cutting/enabling activities

- IT professionals,
- Human resource professionals
- Health and safety consultants
- Administration, Insurer representatives
- Management
- Government office workers
- Educators and trainers
- Accountants
- Auditors
- Financers
- Communication & Marketing
- Science writers

Further comments:

14. What specific information (regarding jobs) would interest your company/organization?

15. In the context of the current skills shortage, from which sectors would you consider searching for competencies and skills that could be transferable to the geothermal electricity sector?

16. Would you be interested in collaborating with the academic world on shaping education/training programmes?

Yes, please send me more information by email at

No

For your information, an Experts meeting will take place during the Geo THERM conference in Offenburg (25-26th February 2015) where the survey research results will be presented. Recruitment consultants will be available for bilateral interviews/meetings and to provide careers advice. THANK YOU!