Human Resources: Identification of Training Needs and Knowledge Gaps

Survey Results

February, 2015

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Eva Dögg Diego Þorkelsdóttir, Lilja Steinunn Jónsdóttir, Sigurður Björnsson

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Coordination Office, Geothermal ERA NET

Orkustofnun, Grensásvegi 9, 108 Reykjavík

Tel: +-354-569 6000,

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Abstract

This report shows research, development and demonstration needs for geothermal development in countries, participating in ERANET Geothermal energy. These RD&D needs have been identified by the participants of ERANET Geothermal energy. They will be an important input in setting up joint activities between the partner countries

Executive summary

The purpose of work package 6.2, and thus this report, is to identify training needs and knowledge gaps within the geothermal sector. The need for enlarged workforce within the energy sector is expected to increase in coming years, at the same time as the current workforce is approaching retirement, and skill shortages have already been reported.[1][2][3] Thus it is necessary to look not only at the present situation and foreseeable human resources need of the geothermal sector, but also at the up and coming human resources that soon enter the geothermal workforce and the educational opportunities provided for this group. As a means of collecting information and evidence on a European level, two online surveys were designed and conducted with the goal of addressing the aforementioned questions. This report includes the results from both surveys. The former survey was directed towards universities. The target group was identified and listed in the inventory of available mobility and training programmes (D6.1). The status and development of student numbers was analysed as well as course offering in geothermal related education. The latter survey had the aim of examining the current situation of human resources within the geothermal sector, as well as future prospects. The target group was identified by each partner within the ERA-Geothermal consortium.

The first survey sought out to examine the human resources that soon enter the geothermal workforce and the educational opportunities provided for this group. It can, therefore, be seen as a further extension or elaboration on task 6.1 (inventory report D6.1). The higher education institutions (HEIs), identified in the inventory report, were targeted. The main conclusions are:

- student numbers on all levels (Bachelor, Master and Doctor) have been increasing for the last five academic years (2009 – 2014)
- institutions are expecting a further increase in student numbers in the foreseeable future (next five years)
- there is a lack of holistic programmes dedicated to geothermal energy
- there is a perceived need for more opportunities on mobility for students and staff in the field of geothermal studies.

The second survey had the aim of examining the current situation of human resources within the geothermal sector, as well as future prospects. The ERA-Geothermal partners were asked to identify those they deemed as "major players" in the geothermal sector within their country. "Major players" were in this instance classified as influential or leading institutions, organisations and/or business enterprises. The main conclusions are:

[1] The Energy Institute, Deloitte and Norman Broadbent. (2008). *Skills Needs in the Energy Industry*. London: the Energy Institute.

[2] GeoElec. (2013). *Action Plan for Promoting Workers' Mobility and Establishing an Education System.* Washington: Simeonova, D. (EGEC).

[3] The Energy Research Partnership. (2007). *Investigation into High-Level Skills Shortages in the Energy Sector*. London: the Energy Research Partnership.

- majority of the respondents are conducting research and development within the field of geothermal
- majority of respondents have less than 100 employees. The respondents with 100 or less employees have on average 85% of their personnel dedicated to geothermal activities, while respondents with a workforce above 100 employees have less than 5% of their personnel dedicated to geothermal activities.
- less than half (38%) of the respondents were currently lacking personnel with specialized skills and knowledge in geothermal activities, still it is the perception of the majority that there is a lack of personnel in the geothermal sector in general (55%).
- there are a number of factors that contribute to this perception on lack of personnel, such as:
- Geothermal policy: unclear vision on geothermal issues at the European level and lack of commitment to the geothermal sector by national government
- Industry factors: lack of collaboration and coordination between stakeholder
- Educational factors: lack of continuous education within the sector, too few geothermal opportunities, and lack of appropriate trainers.
- it is also clear that respondents believe that there will be an increased demand for personnel with specialised skills and knowledge in geothermal activities in the foreseeable future.

This report should thus shed some light on possible training needs and knowledge gaps that need to be addressed in order to achieve adequate human resources for meeting renewable energy goals, such as those stipulated in the EU's renewable energy directive.[4].

[4] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

Work Package 6 description

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

Based on the results from the mapping exercise (task 6.1.) the inventory of available mobility and training programmes will be compared with the long term ambitions for the use of geothermal resources in Europe. A working group will identify possible training needs and knowledge gaps that need to be addressed in order to achieve adequate human resources for meeting those goals. The task-force will for example look into the need for transnational programme collaboration, mutual opening of national programmes, establishment of common programmes and need for dedicated programmes at Community level. The result will be a study analysing the various options and recommendations for collaboration in the area of human resources, mobility and training. Recommendations for joint actions in the area of human resources issues will be presented to the project supervisory board.

1 Introduction

The issue of human resources within the energy sector has been widely discussed in recent years. Employment within the sector is expected to increase in coming years, the current workforce is approaching retirement, and skill shortages have already been reported. Adequate training and educational opportunities also seem to be limited within certain areas of the sector. It is within this realm of discussion that task 6.2 of the Geothermal ERA-NET is centred. The task has a clear focus on human resources within the geothermal sector, as well as potential knowledge gaps and training needs. The official task description is as follows:

Based on the results from the mapping exercise (task 6.1.) the inventory of available mobility and training programmes will be compared with the long term ambitions for the use of geothermal resources in Europe. A working group will identify possible training needs and knowledge gaps that need to be addressed in order to achieve adequate human resources for meeting those goals. The task-force will for example look into the need for transnational programme collaboration, mutual opening of national programmes, establishment of common programmes and need for dedicated programmes at Community level. The result will be a study analysing the various options and recommendations for collaboration in the area of human resources, mobility and training. Recommendations for joint actions in the area of human resources issues will be presented to the project supervisory board.

The objectives of task 6.2 are, therefore, to construct a clearer view of both the future of educational and training opportunities within the sector, as well as current and future needs of human resources to fulfil renewable energy goals, such as those stipulated in the EU's renewable energy directive . The working group that undertook the task saw it as being essentially twofold: a) to map future human resources, i.e. students undertaking geothermal education, and potential knowledge gaps in education and training offerings to this group and b) to assess the current supply of human resources within the sector and future prospects in this area. Having a clearer view of the current and perceived future situation would hopefully provide all relevant parties with useful information regarding which direction to take in terms of efficient actions, such as collaboration and joint actions.

As means of collecting information and evidence on a European level, two online surveys were designed and conducted. The goal with the surveys was to address the aforementioned questions of human resources, knowledge gaps and training opportunities within the geothermal sector. This report will include the results of both surveys and relevant discussion, as well as recommended further steps, such as joint actions in the area of human resources issues.

2 The Status and Development of Student Numbers and Course Offering in Geothermal Education

The first survey sought out to examine the up and coming human resources that would soon enter the geothermal workforce and the educational opportunities provided for this group. This survey can, therefore, be seen as a further extension or elaboration on task 6.1 (inventory report).

Considerable work had already been done in identifying geothermal education providers in Europe (task 6.1). It was, therefore, decided to target the higher education institutions (HEIs) identified in the inventory report from the previous task. The list is, however, by no means exhaustive, and, therefore, the results anticipated from this survey only intended as an indicator of the current status or future prospects, as well as a valuable input into further discussions. It must also be noted that midway through the task additional partners from Portugal and Slovenia joined the Geothermal ERA-NET. For the purpose of the survey, these two partners identified HEIs within their countries which offer geothermal education. Furthermore, this mode of convenience sampling was also deemed feasible by the working group due to the tight timeframe of the task.

The survey was conducted online from June 24th to November 2nd. All in all, 81 HEIs were identified as possible participants in the survey. ManninowskEach Geothermal ERA-NET partner became actively involved as they were responsible for distributing the survey link within their country. Those HEIs that were not located within ERA-NET partner countries, received a link from the Icelandic partner (Rannis). The partners were encouraged to seek out respondents within the institutions that could both answer questions regarding student numbers and course/programme development within the field, as well as mobility opportunities (e.g. deans).

It should also be added that this phase of the survey carried an extra advantage of both introducing the work of the Geothermal ERA-NET group to the HEIs in question, as well as opening up a dialogue between the partner in each country and its national geothermal education providers.

2.1 Survey Design

The survey questions were formed by the Icelandic working group in close collaboration with the National Research Council of Italy, as well as outside stakeholders from the geothermal community in Iceland. The construction of the education survey was as follows:

2.1.1 Background Information

- Location of institution.

- Name of institution.

2.1.2 Geothermal Courses and Final Projects

- The current number of geothermal courses offered to students on ISCED levels 6-8[5] and further information regarding language and course description. This was seen as further elaboration on the inventory work conducted in task 6.1.
- The number of students by ISCED levels 6-8 registered in geothermal courses during the last five academic years (2010-2014).
- The number of theses, dissertations and/or final projects with a special geothermal focus that were completed during the last five academic years (2010-2014).

As no distinct geothermal programmes were identified in the inventory report from task 6.1, and the fact that geothermal studies are often offered as a part of other programmes (such as geology and engineering), the only approach to determine student numbers of those focusing their studies on geothermal energy was to ask about student numbers in geothermal courses and the number of completed theses, dissertations and/or final projects with a geothermal focus.

2.1.3 Future Student Prospects

- Short-term estimation of the development of student numbers in geothermal courses up until 2020 and the reasons for increase/decrease of those numbers when applicable.
- Long-term estimation of the development of students numbers in geothermal courses up until 2050 and the factors most likely to affect the development (e.g. pertaining to industry, academia, policy making etc.).

2.1.4 Development of Geothermal Education and Training

- Estimation of the development of geothermal course offering up until 2022, as well as further information regarding new courses or reasons if decrease is perceived.

2.1.5 Geothermal Programmes

- Whether the institution offers geothermal programmes and if so the number of students on ISCED levels 6-8.

[5] UNESCO Institute for Statistics. (2012). *International Standard Classification of Education ISCED 2011*. Montreal, Canada: UNESCO Institute for Statistics.

- Plans of those who offer programmes of increasing their programme offering in the next 6 years and the reasons why or why not.
- Plans of those who do not offer programmes to do so in next 6 years and the reasons why or why not.

2.1.6 Mobility Opportunities

- The availability of specific mobility opportunities that focus on geothermal energy.
- Students and staff use of currently available European mobility programmes.
- Need for further mobility opportunities.

At the end respondents were asked to leave an e-mail address should they agree to be contacted by the working group for additional information. Also, should they want to amend or add to the summary of their institution in the inventory report from task 6.1, they were offered a chance to do so.

2.2 Survey Results

The following section outlines the main results from the survey on students and education in geothermal energy. As discussed above, the survey should have reached 71 participants listed in the inventory report from task 6.1, as well as HEIs identified by the new Geothermal ERA-NET partners in Portugal and Slovenia. After the cleaning up of incomplete answers the response rate was 20 institutions out of 83, or 24%.

2.2.1 Background Information of Participants

HEIs providing geothermal education in sixteen European countries were sent an invitation to participate in the survey. Twenty HEIs from seven countries responded to the survey: Portugal (7), Hungary (4), Germany (3), Iceland (2), Italy (2), France (1) and the Netherlands (1). Please refer to table 1 for a list of countries that received an invitation to participate.

Croatia	**France**	**Germany**	**Greece**
Hungary	**Iceland**	**Italy**	**Macedonia**
Netherlands	**Poland**	**Portugal**	**Romania**

Slovakia	**Slovenia**	**Switzerland**	**Turkey**

Table 1 – Countries that received an invitation to participate in the survey.

2.2.2 Geothermal Courses and Final Projects

As none of the HEIs in the aforementioned inventory report seemed to offer specific geothermal programmes, it was decided to ask respondents rather for the number of geothermal courses than programmes, as well as the number of students enrolled in those courses, in order to gain a view of the scope of geothermal education and at the same time distinguish trends in student numbers. Again it is worth noting that due to the fact that the inventory list was not exhaustive and that only 20 HEIs completed the questions, the view is undoubtedly limited.

	Total Number of Geothermal Courses	Total Number of ECTS in Geothermal Courses
Bachelor or equivalent (ISCED6)	**32**	**146**
Master or equivalent (ISCED7)	**35**	**106**
Doctor or equivalent (ISCED8)	**27**	**321**

Table 2 - How many geothermal courses does your institution offer and how many ECTS (European Credit Transfer & Accumulation System) credits do these courses constitute? The table shows total numbers from all respondents. n=20.

All responding HEIs reported in total a bachelor's level course offering of 32 geothermal courses, equal to 146 ECTS. Number of courses range from 0 to 11, with a median value of 1. The number of ECTS range from 0 to 71 with a median value of 5. Similarly, the total number of master's level courses is 35, equal to 106 ECTS. Number of courses range from 0 to 20, with a median value of 1, and the ECTS credits from 0 to 60 with a median value of 3. Lastly, viewing the doctoral level, the HEIs in question offer 27 courses in total at this level, which equal 321 ECTS. Number of courses range from 0 to 20, with a median value of 1. The number of ECTS range from 0 to 300 with a median value of 2. Table 2 above shows the total number of geothermal courses and their ECTS value by educational level.

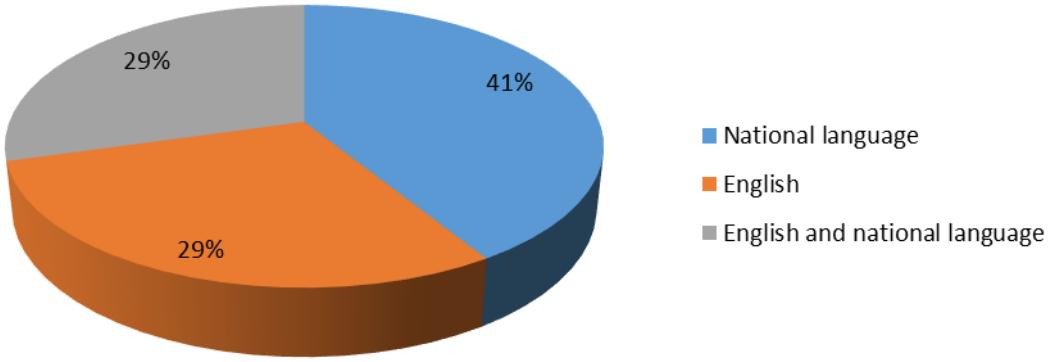

Figure 1 - The language in which geothermal courses are conducted. n=17.

Respondent were also asked to identify in which language the courses in question were conducted. Seventeen responses show that ten HEIs only offered courses in the national language of the respective country (41%), whereas five only offer courses in English (29%). Additional five institutions offer courses in both English and the national language (29%) (see fig. 1).

Academic Years	Bachelor or eqv. (ISCED6)	Master or eqv. (ISCED7)	Doctor or eqv. (ISCED 8)
2013-2014	177	358	24
2012-2013	173	313	65
2011-2012	170	185	34
2010-2011	148	139	61
2009-2010	151	132	13

Table 3 – The total number of students (headcount) registered in geothermal courses by educational levels during 2009-2014 academic years. n=16.

When viewing the total number of students registered in geothermal courses in table 3, it becomes apparent that student numbers are on the rise. The survey results show that students

at the bachelor's level slowly, but steadily, increased from 151 in 2009-2010 to 177 in 2013-2014, with a minor downward curve in 2010-2011 to 148, but a subsequent rise to 170. During these five academic years the number of students has risen by 17%. The increase at the master's level is more dramatic, going from 132 students in 2009-2010 to 358 in 2013-2014, or an increase of 171%. The greatest growth in student numbers at the master's level is evident from 2011-2012 to 2012-2013 (69%). Numbers at the doctoral level are more fluctuating, although here it is important to have in mind the small size of the dataset, as well as different profiles and degree offerings of institutions. One institution, for example, reported 40 doctoral students in 2010-2011 and 2012-2013. On the whole, the increase from 2009-2010 to 2013-2014 amounts to 85%.

Academic Years	**Bachelor or eqv. (ISCED6)**	**Master or eqv. (ISCED7)**	**Doctor or eqv. (ISCED8)**
2013-2014	61	17	2
2012-2013	53	19	5
2011-2012	45	13	11
2010-2011	43	8	12
2009-2010	36	6	8

Table 4 - The total number of theses, dissertations and/or final projects with a special geothermal focus by educational level completed during the 2009-2014 academic years. n=12.

Respondents were also asked to identify the number of theses, dissertations and/or final projects at their institution that had a special geothermal focus (see table 4). This was, again, done to try to capture all potential students focusing on geothermal energy, even though their degree programmes were not specifically geothermal in nature. The trends here seem to be similar to the student number trends. Final projects, thesis or dissertations at the Bachelor level are on the rise, going from 36 to 61 during the six year period, which is an increase of 69%. The master's level has lower numbers, but an increase all the same from 6 in 2009-2010 to 17 in 2013-2014. This is a dramatic increase percentage wise of 183%. When viewing the numbers for doctoral thesis and/or dissertations the numbers are again fluctuating, increasing from 8 in 2009-2010 to 12 in the next academic year. Then steadily decreasing from 2011

onwards. When looking at the period as a whole, doctoral theses and/or dissertations have decreased by 75%. Again, one must keep in mind the small size of the dataset when interpreting these numbers, as well as different profiles of the institutions in question

2.2.3 Future Student Prospects

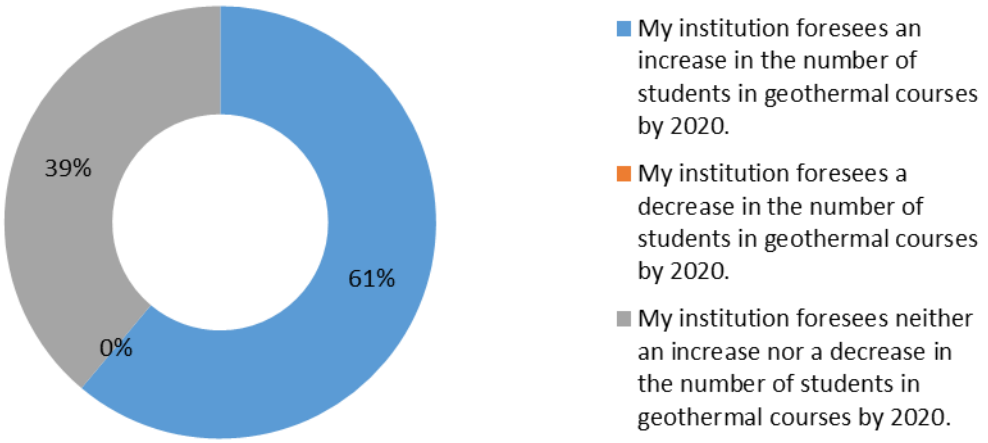

Figure 2 - The development of students registered in geothermal courses. n=18.

Eleven institutions foresaw an increase in the number of students in geothermal courses by 2020 (61%). Seven respondents estimated that the situation with student registration in geothermal courses would be roughly the same in 2020 (39%), and none foresaw a decrease in the number of students in geothermal courses (see fig. 2).

When asked about why they were expecting an increase in student numbers the answers varied. Three HEIs were already experiencing a rise in student numbers and were responding by offering a new master's level programme, increasing student numbers within geothermal related programmes, and hiring of a part-time professor in geothermal engineering. Others seemed to be anticipating future demands, one mentioning that should there be a rise in demand for specialists within a particular subfield of geothermy, the institution would be able to respond by developing further courses. Similarly, another said that numbers had been on the rise for the last few years and should that trend continue they could take in even more students if budget allowed. Also, participation in European geothermal projects was

mentioned as a reason for a perceived increase. Lastly, one respondent saw the increase as being inevitable as renewable energy was one of the main issues in Europe.

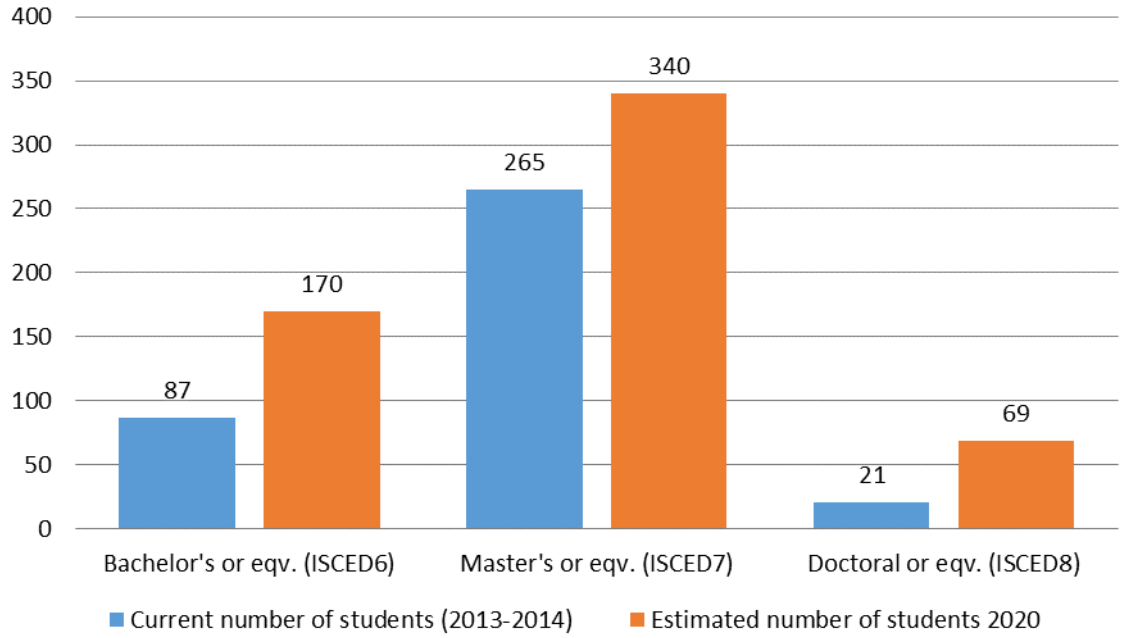

Figure 3 – Total estimated number of students in geothermal courses in 2020 and total number of students in geothermal courses in 2013-2014 by levels of education. n=8.

The same group of respondents was also asked to estimate how many students they foresaw being registered in geothermal courses at their institution in 2020. When comparing those values to the actual numbers provided for the academic year 2013-2014 from the same respondents, it is evident that increase is perceived to take place on all educational levels (see fig. 3). The number of Bachelor students is believed to increase by 95% in the six year period, master's students by 28% and the largest increase is on the doctoral level, or an increase amounting to 229%.

Participants were also asked to comment on the long-term development of students in geothermal courses up until 2050. The majority of respondents believed that the numbers would increase during this period (8), although some said that it would be inevitably depend upon demand, as well as economic and/or policy factors. Four respondents foresaw fluctuations in student numbers, whereas two believed student numbers would be similar to the current situation. Only one respondent thought student numbers might decrease in the period up until 2050, but only due to demographic reasons.

Student Numbers Will Increase	Student Numbers Will Fluctuate	Student Numbers Will Stay the Same	Student Numbers Will Decrease
National favourable geothermal conditions, EU has made geothermal development a priority and geothermal has becoming the most promising form of alternative energy worldwide.	**Policy making within the sector and geothermal industry** that needs to reinforce the **investments** in this research area.	Government limitations on installation of non-geothermal heat pumps.	The state of the geothermal industry, if it develops the students will see the possibilities.
Availability of public and private investment.	Geothermal industry factors.	**Economic position** of geothermal energy.	
Higher demand within industry, better visibility and political support.	Factors pertaining to the geothermal industry, academia and **policy making within the sector**.		
Investment decision with regards to research in the field.	Lack of economic **investment** in the field (particularly EGS).		
Innovation and investment in the geothermal industry.			
Limited governmental funding and lack of facilities.			
Policy making in the sector.			
Intensify the knowledge exchange with industry.			

Table 5 - Factors believed to most likely affect the development of student numbers in geothermal courses up until 2050 by groups of general attitude towards changes in student numbers.

When asked what factors they believed would most likely affect the development, the most notable answers were those of economic nature, such as lack of investment in the research

within the geothermal field, lack of governmental funding and the economic position in general; as well as factors pertaining to policy making within the sector. Factors to do with the sector itself were also mentioned, such as its visibility and general state. Interestingly, no specific academic factors were listed in this respect, apart from the need to intensify the knowledge exchange with industry. For a list of responses, please refer to table 5 above.

2.2.4 Development of Geothermal Education and Training

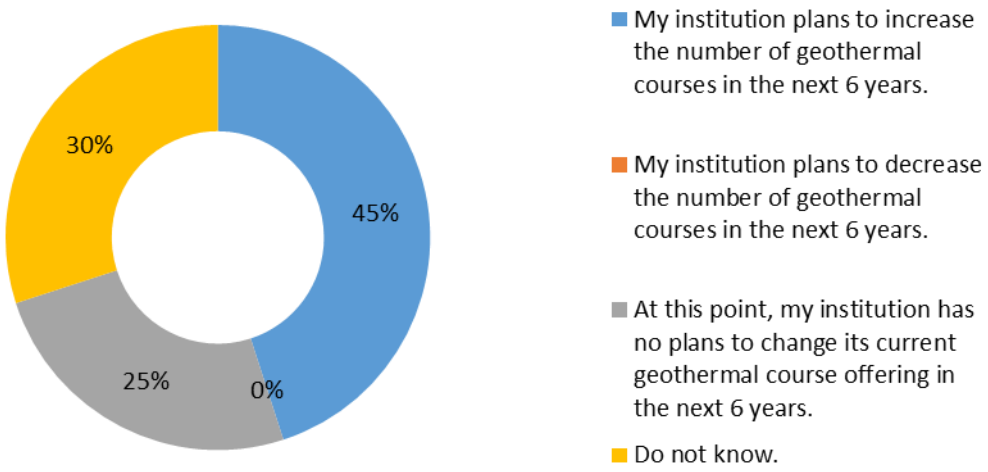

Figure 4 - The development of geothermal courses when looking ahead to 2020. n=20.

Nine respondents reported plans to increase the number of geothermal courses in the next six years (45%). Six respondents did not know whether such plans were underway (30%) and another five said that at this point no plans were to change geothermal course offering at their institution during the next six years (25%). None reported an intended decrease of geothermal courses (see fig. 4).

New line: Geothermal Technician – fourth level.	Master Geothermal Engineering without any sub-fields.
At Doctorate levels courses are introduced yearly depending on the availability of the staff. I suppose aspects in Geochemistry and Geophysics applied to geothermics can be developed.	Under discussion to combine courses on Geological Exploration and Borehole Geology, as well as Borehole Geophysics and Reservoir Engineering, and introducing a course on Project Management and Funding.
Depending on the needs, we will be able to open, if necessary, a course on surface, low-energy, geothermal energy.	Introduction at the BSc level, MSc class on exploration and reservoir assessment.
The topics for which credits are given are Renewable Energy (5 credits), Advanced Geology (6), Advanced Geophysics (6), Fluid Dynamics (6), Hydrogeology (5), Drilling Well Design (6), Geothermal Reservoir (5), Geothermal Water Production (5), Geoinformatics (5), Geothermal Chemistry (5), Geothermal Heat-Transfer Systems (5), Geothermal Heat-Transfer Systems (5), Geothermal Power Production (5), Geothermal Direct Uses (5), Geothermal Heat Pump (5), and Geothermal Environmental Impacts (5).	Thermal water resources management. Applied geophysical courses dealing with geothermica are previewed.

Table 6 - Geothermal courses in preparation.

The group of nine HEIs which intended to introduce new geothermal courses were prompted for more information. The plans included both individual geothermal courses, combination of older courses, and even new programmes. For further information, please refer to table 6 above.

2.2.5 Geothermal Programmes

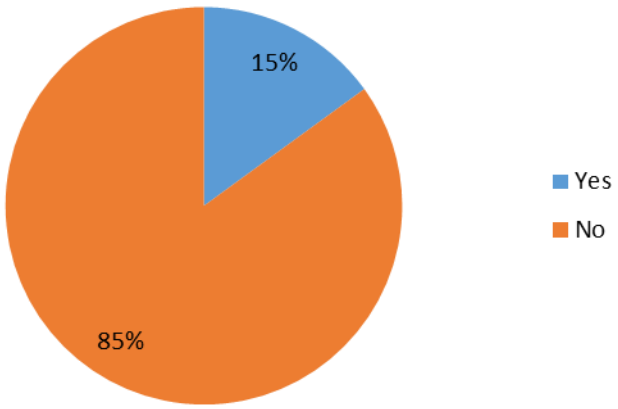

Figure 5 - Does your institution offer whole programmes that are entirely dedicated to geothermal energy? n=20.

Only three respondents reported that their HEI offered programmes entirely dedicated to geothermal energy (15%). When asked if they foresaw an increase in such courses during the next six years, one provided a positive answer and cited the reason to be a foreseeable increase in the number of geothermal courses being taught in the future. Two did not see an increase, one of which cited capacity as a hindrance, and the other reported that work was underway to revise the institution's current educational programme offering and perhaps new programmes on Project Managing and Financial Modelling might be offered.

Out of the 17 HEIs not offering specific geothermal programmes (85%), four foresaw offering such programmes in the next six years, six did not, and an additional seven did not know. Asked about reasons therefor, the reasons varied between groups. One of those with plans of establishing a geothermal programme had already arranged to do so via a geothermal alliance, whereas another cited his/her reason to simply be for the greater good of using water in a sustainable manner. The institutions not planning to establish a specific geothermal programme felt that the geothermal education embedded within their other programmes was sufficient; that geothermal energy was not their area of expertise or that their focus should be on other renewable sources of energy due to their geographical context. Finally, the group that consisted of unsure respondents mostly mentioned economic factors as reasons for their uncertainty.

2.2.6 Mobility Opportunities

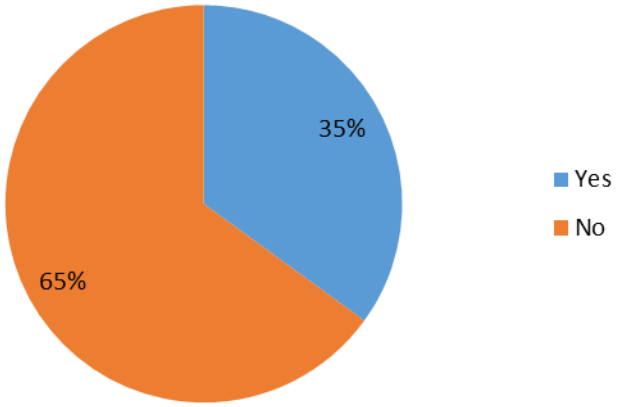

Figure 6 - Are there specific mobility opportunities available at your institution for students and/or staff members who are focusing or want to focus on geothermal energy? n=20.

When asked about specific mobility opportunities in relation to geothermal energy at their institutions, the majority of respondents gave a negative response (65%). The remaining 35% believed such opportunities to be available at their institution (see fig. 6) and a few of them gave examples. One respondent said that he/she was going abroad as a visiting professor, whilst others listed the Erasmus programme, as well as the European Energy Research Alliance and the International Geothermal Association.

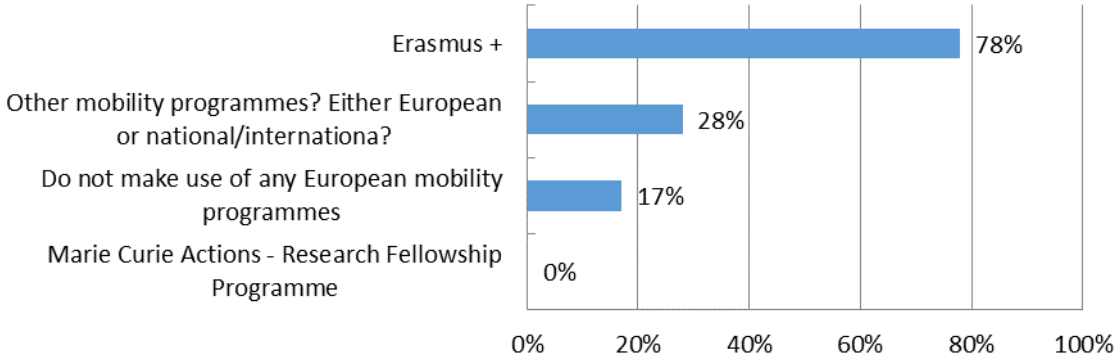

Figure 7 - Do students at your institution that are focusing on geothermal energy in their studies, make use of any of the following European mobility programmes? n=18.

Asked about which mobility programmes students focusing their studies on geothermal energy were making use of, about three fourths mentioned Erasmus+ (78%) and 28% other mobility opportunities such as EEA grants, bilateral cooperation, dual study and the Idea

League network of European universities. Here respondents could choose more than one activity. Around 17% of respondents reported that the students at their institution did not make use of any European mobility programme (see fig. 7).

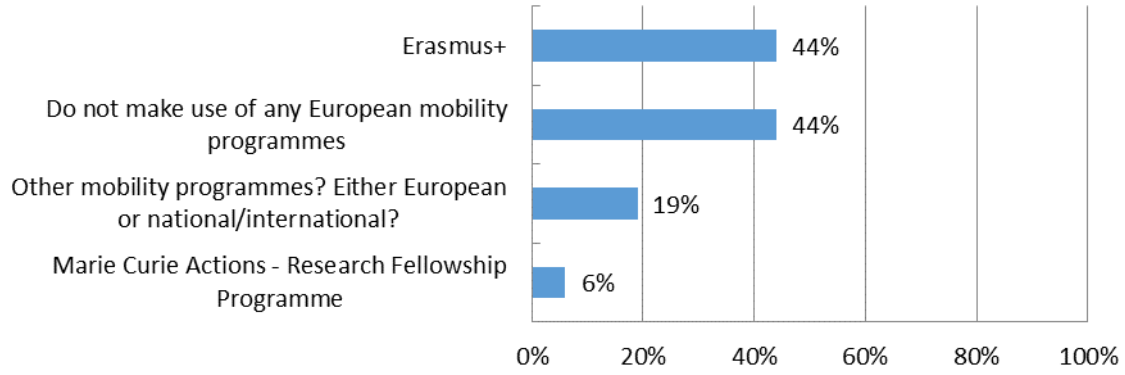

Figure 8 - Do staff members at your institution that are focusing on geothermal energy, make use of any of the following European mobility programmes? n=16.

Respondents were also asked about staff involvement in mobility opportunities, where respondents could also choose more than one activity. In 44% of cases staff members had made use of Erasmus+ and 6% had partaken in Marie Curie Actions. Around 19% also reported other mobility opportunities, such as; EEA, Inter-institutional agreements and the Stanford Geothermal Program (Geothermal Resource Council, USA). Another 44% of respondents believed staff members of their institution did not make use of any European mobility opportunities (see fig. 8).

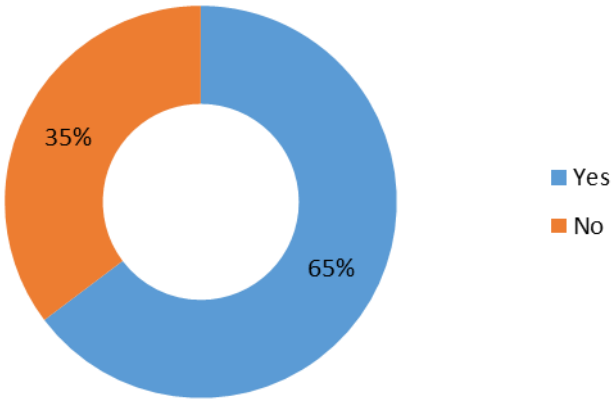

Figure 9 - Do you feel that there is a need for more mobility opportunities for your students and/or staff members in the geothermal field? n=17.

As evident from figure 9, the majority of respondents agreed when asked about the need for further mobility opportunities for students and/or staff members (65%), whereas 35% disagreed. Those who agreed provided several ideas, such as summer schools, specific programmes and industry relations. For a comprehensive list of responses, please refer to table 7 below.

Recurrent summer schools on geothermal energy would be welcome.
Specific Programmes, increased number of fellowships.
Student mobility for courses and researchers' mobility to better define cooperation and common projects.
Allow them to work in geothermal industry or to attend geothermal courses abroad.
More collaboration at the academic level and in European RD&I projects.
Exchanging information and experiences between staff members.
Anything that develops geothermal in Hungary.

Table 7 - Ideas of mobility opportunities within the geothermal field for staff and students.

3 The Status and Development of Human Resources within the Geothermal Sector

The second survey had the aim of examining the current situation of human resources within the geothermal sector, as well as future prospects. Again the working group called upon the Geothermal ERA-NET partners, now for choosing participants, as well as sending out survey links. The partners were asked to identify those they deemed as "major players" in the geothermal sector within their country. "Major players" were in this instance classified as influential or leading institutions, organisations and/or business enterprises. Apart from this description, no restrictions were imposed on the selection of participants. The partners were also asked to document to which parties the survey link was sent. Only four of the partners provided the working group with such lists, so the actual number of how many received an invitation to participate in the survey is at this point unknown. The survey was kept open online from June 25th to November 2nd.

By using these means of purposive sampling, the idea was draw on the local knowledge and expertise of the ERA-NET partners to quickly target participants whose answers would give a good indication of the status of human resources within the sector. In fact, it was perceived as a construct of a European level consultancy group, which could provide expertise knowledge on the geothermal sector. When viewing the results, it must, however, be noted that this method also introduces possible biases as participants are handpicked using a subjective estimation of various individuals. As in the former survey, nonprobability sampling of this sort also comes with difficulties with generalisation. However, the sampling methods should not interfere with the purpose of both surveys, which were, as stated above, to look for indications, which could then serve as a base for further discussion and possible recommendations.

3.1 Survey Design

The survey questions were formed by the Icelandic working group in close collaboration with the National Research Council of Italy, as well as outside stakeholders from the geothermal

community in Iceland. It partly drew on a similar survey conducted by the GeoElec project[6] as this was perceived as providing an interesting comparison of results. The construction of the survey was as follows:

3.1.1 Background Information

- Location of institution/organisation/business enterprise.
- Sector of the institution/organisation/business enterprise (Frascati classification[7]).
- Types of geothermal activity.
- Division of activities on the geothermal value chain in percentages.

3.1.2 Human Resources within Your Institution/Organisation/Business Enterprise

- The number of employees, both headcount and full-time equivalent, at the end of 2013.
- The classification of occupations (ISCO-08[8]).
- Whether the institution/organisation/business enterprise in question is lacking personnel with specialised skills and knowledge in geothermal activities, and if so, which professions and/or skills.

3.1.3 Human Resources within the Geothermal Sector

- Whether the geothermal sector in general is lacking personnel with specialised skills and knowledge in geothermal activities, and if so, which professions and/or skills.

3.1.4 Factors Contributing to Lack of Human Resources

- The possible educational, industry, policy and/or sectorial factors that could contribute to the lack of human resources within the geothermal sector by degree of importance. Only if respondents reported a lack of personnel.

3.1.5 Possible Actions for Meeting the Need for Human Resources

- Possible actions for closing knowledge and training gaps within the geothermal sector.

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[6] GeoElec. (2013). *Employment Study: Solutions on Lack of Skilled Workers in the Geothermal Sector & Results of the Questionnaires*. Spyros Karytsas (Centre for Renewable Energy Sources and Saving).

1 [7] OECD. (2002). *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development* (6th ed.). Paris, France: OECD.

[8] International Labour Organization. (n.d.) *ISCO-08 Structure and Preliminary Correspondence with ISCO-88*. Retrieved from: http://www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm.

3.1.6 Future Outlook

- Whether the current supply of human resources within the geothermal sector will be able to meet the long term ambitions for the use of geothermal energy.
- Estimation of demand of personnel in the geothermal sector during the next 5-10 years, and if demand is perceived, then which professions/skills will be mostly needed.

Lastly, participants were asked to provide an e-mail address, if they agreed, should further questions arise during the processing of survey results.

3.2 Survey Results

As discussed before, neither cohort nor sample was determined in this survey. After the dataset had been cleaned, i.e. when incomplete answers that did not contain any information beside background information had been removed, the end result was 46 answers. As the working group only received four sample lists of participants from its partners, it is impossible to determine the actual response rate of the survey. The response rate for those partners who did send a sample list varied greatly: Germany 69% (9/13), Iceland 20% (3/15), France 19% (19/101) and Italy 10% (7/69).

3.2.1 Background Information of Participants

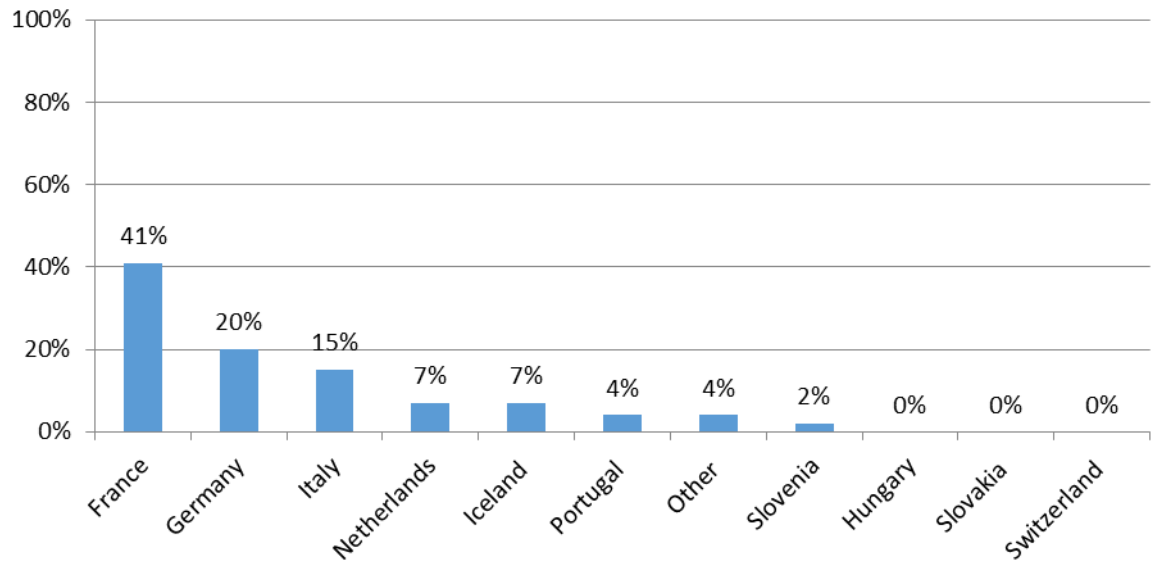

Figure 10 – Locations of institutions/organisations/business enterprises (headquarters). n=46.

When asked about location of the headquarters of the institution/organisation/business enterprise, the answers were distributed amongst nine countries (see fig. 10). Almost half of all answers came from France (41%), a fifth from Germany (20%) and 15% from Italy. Around 20% were distributed amongst the Netherlands, Iceland, Portugal and Slovenia (2-7%), and the remaining 4% of the other category had headquarters in USA and Dubai. None of the institutions/organisations/business enterprises had headquarters in Hungary, Slovakia or Switzerland.

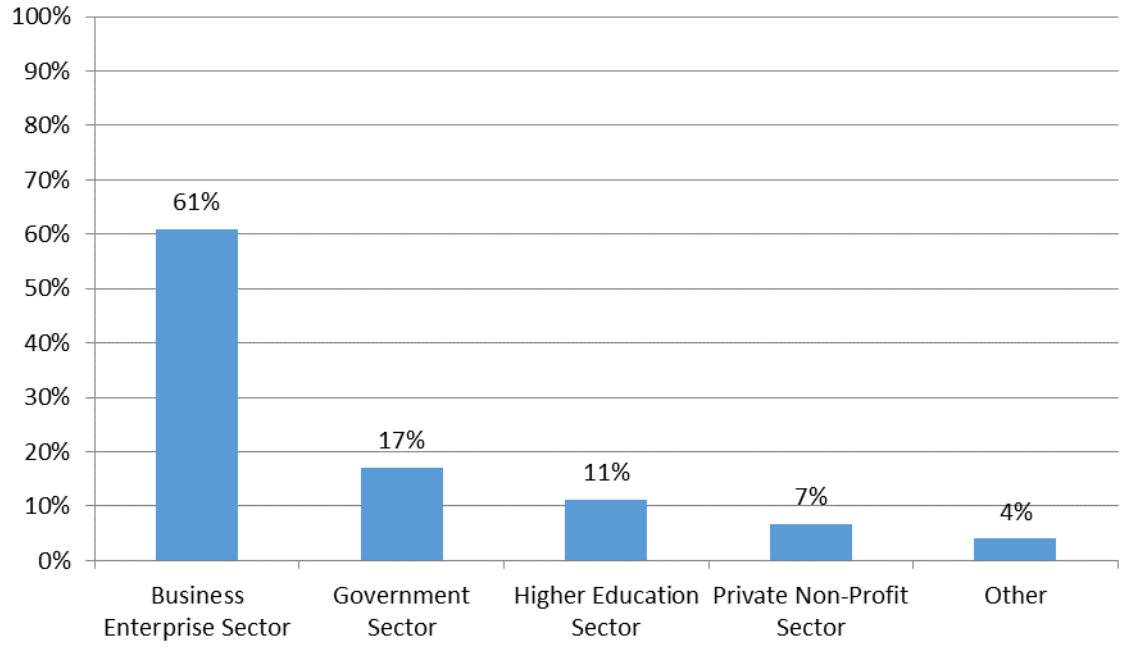

Figure 11 - Sector of institution/organisation/business enterprise. n=46.

The majority of respondents identified themselves as belonging to the business enterprise sector (61%), around 17% came from the government sector, 11% from the higher education sector and an additional 7% from the private non-profit sector (see fig. 11). Two respondents could not place themselves within those categories and opted to for the other option (7%). One of those was an NGO representing the interests of geothermal operators and the other was involved in social housing.

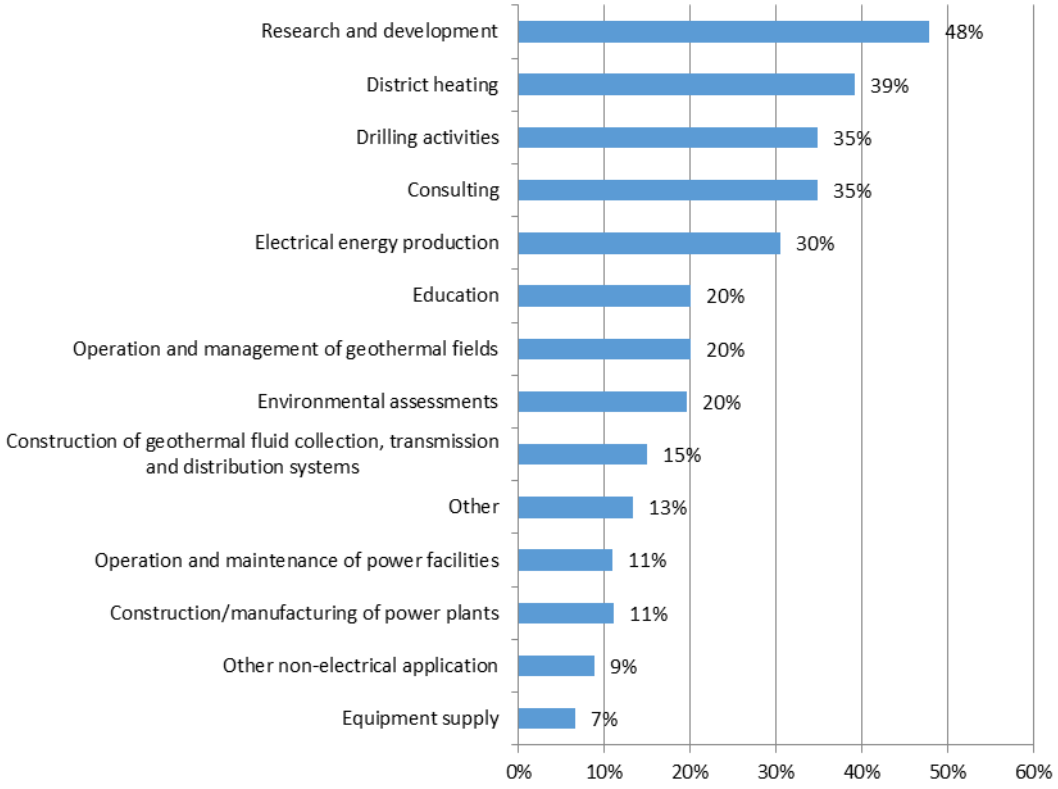

Figure 12 - Types of geothermal activities of institution/organisation/business enterprise. n=46.

Respondents were also asked to identify in which geothermal activities their institution, organisation or business enterprise was involved. Here respondents could choose more than one activity. As can be seen in figure 12, close to half of all respondents reported R&D activities in relation to geothermal energy, and 39% mentioned district heating. Around a third (30-35%) listed drilling activities, consulting, and electrical energy production, and a fifth (20%) were involved in educational activities, operation and management of geothermal fields and environmental assessments. From 11-15% identified construction of geothermal fluid collection, transmission and distribution systems, operation and maintenance of power facilities, construction/manufacturing of power plants, as well as other geothermal activities not listed in the figure above. Those included PR, conferences, financing of geothermal projects, exploration and heat exchangers. Fewer than 10% were involved in equipment supply or other non-electrical application, such as heating, and business development for cascaded use of geothermal fluids, bathing, greenhouses and more.

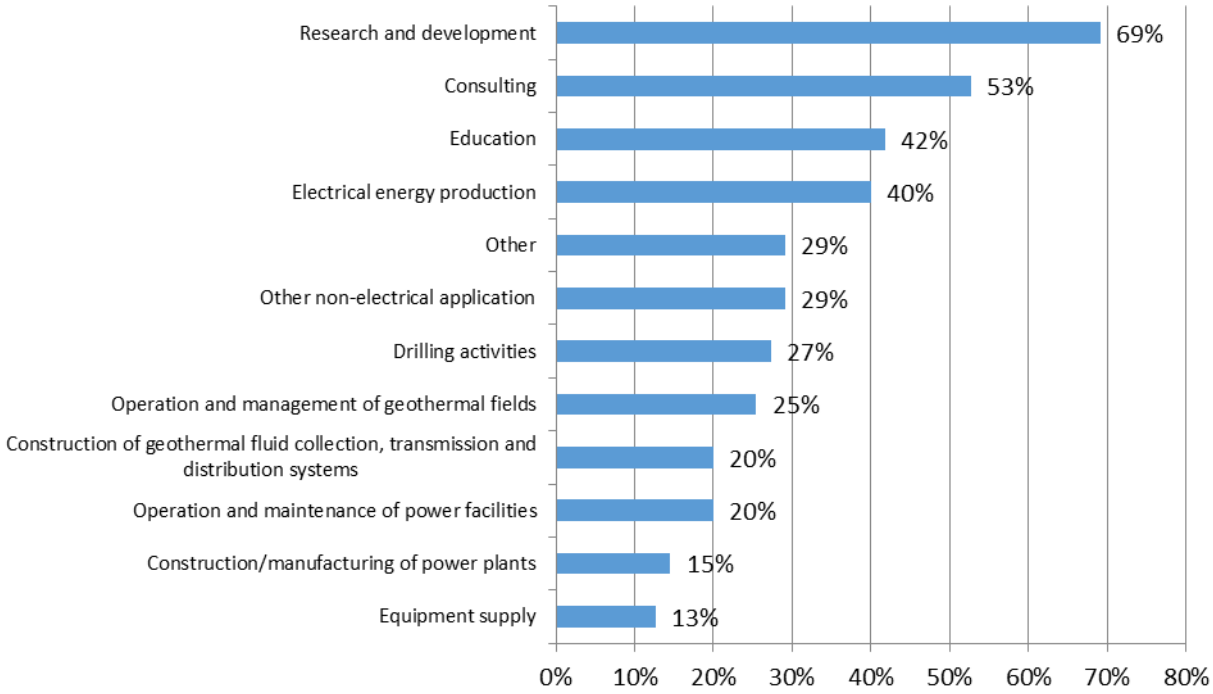

Figure 13 – A reproduced figure from the GeoElec's employment study - 'Types of businesses that companies/organizations are involved in'. n=55.

When comparing these answers with responses to a similar question in GeoElec's employment study from 2013, the most prominent activity in both surveys is research and development (see fig. 12 and 13)[9]. Consulting also ranked high in the GeoElec survey, at no. 2 with a 53% share, compared to no. 3-4 in the current survey with a 35% share. Education, however, ranked at no. 3 with the GeoElec respondents with a 42% share, but is just above midrange in the current survey in the 6th position with 20%. Interestingly, equipment supply was also at the bottom of the list in the GeoElec survey and activities like the operation and maintenance of power facilities, and the construction/manufacturing of power plants were similarly in low positions. The district heating and environmental assessment activities were not included in the GeoElec survey.

[9] GeoElec. (2013). *Employment Study: Solutions on Lack of Skilled Workers in the Geothermal Sector & Results of the Questionnaires*. Spyros Karytsas (Centre for Renewable Energy Sources and Saving).

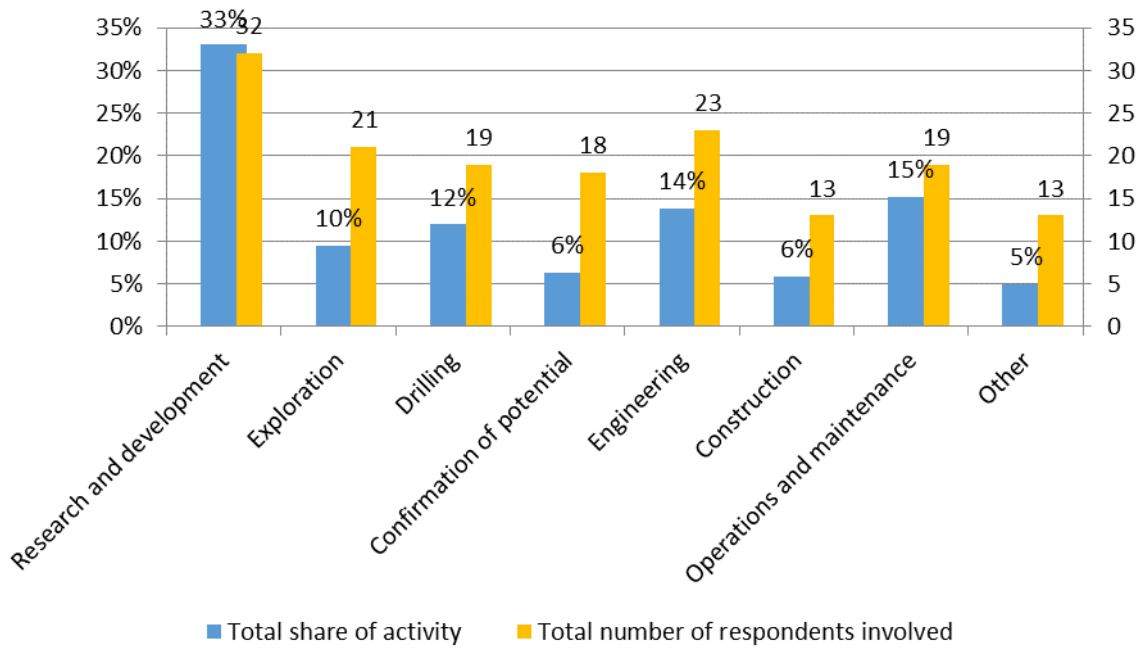

Figure 14 – The position of activity shares and number of respondents on the geothermal value chain. n=44.

The geothermal value chain depicted in figure 14 is a simple description of the process of geothermal activities. It begins with research and development, moves onto exploration, then drilling and subsequently come confirmation of potential, engineering and construction. The last link of chain includes activities in relation to operations and maintenance. Respondents were asked to divide the geothermal activities of their institution/organisations/business enterprise onto the geothermal value chain, assigning each link of the chain/activity a share of involvement in percentages. When viewing the total shares of all respondents for each activity, it becomes evident that the greatest involvement is in R&D (33%). This of course corresponds with the previous answers to the question on geothermal activities. Around 10-15% was assigned to exploration, drilling, engineering and the final process of operations and maintenance. Only 6% were allocated to confirmation of potential and construction, and 5% to other activities not presented on the chain.

When simply viewing the numbers of how often each activity was chosen, and not the extent of involvement, it becomes clear that respondents seem to be concerned with diverse activities, rather than being solely focused on one. Thirty-two respondents are in some way involved with R&D, and in all the other activities the number of respondents range from 13 to 23. This is confirmed when examining how many activities each respondent listed, as most (28) chose three or more activities on the value chain. Ten respondents were involved in two

activities and only six had a specific focus on one area. Half of those with one specific operations reported R&D activities, whereas the other three were involved in drilling, engineering, and operations and maintenance.

3.2.2 Human Resources within Participants' Institution/Organisation/Business Enterprise

Respondents were asked to provide information on the number of employees working within their institution/organisation/business enterprise at the end of 2013. All in all, around 60 thousand employees were reported working in the 42 institutions/organisations/business enterprises that answered the question. The number of employees varied greatly, some entities only having one individual, whereas the largest number reported was 42,500.

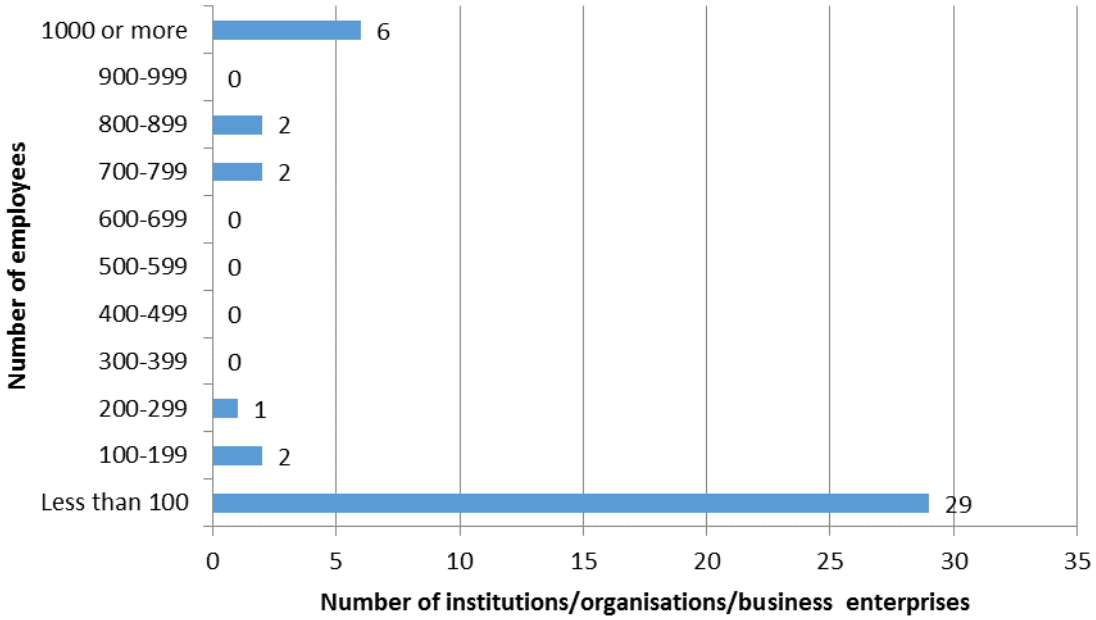

Figure 15 - Distribution of respondents' institution/organisation/business enterprise by number of employees (headcount). n=42.

When examining the distribution of respondents' institution/organisation/business enterprise by the number of employees working on geothermal activities, it becomes apparent that the majority of respondents come from institutions/organisation/business enterprises with less than 100 employees (69%). Further examining this size category shows that out of the 29 entities in question, 18 have 10 or fewer employees.

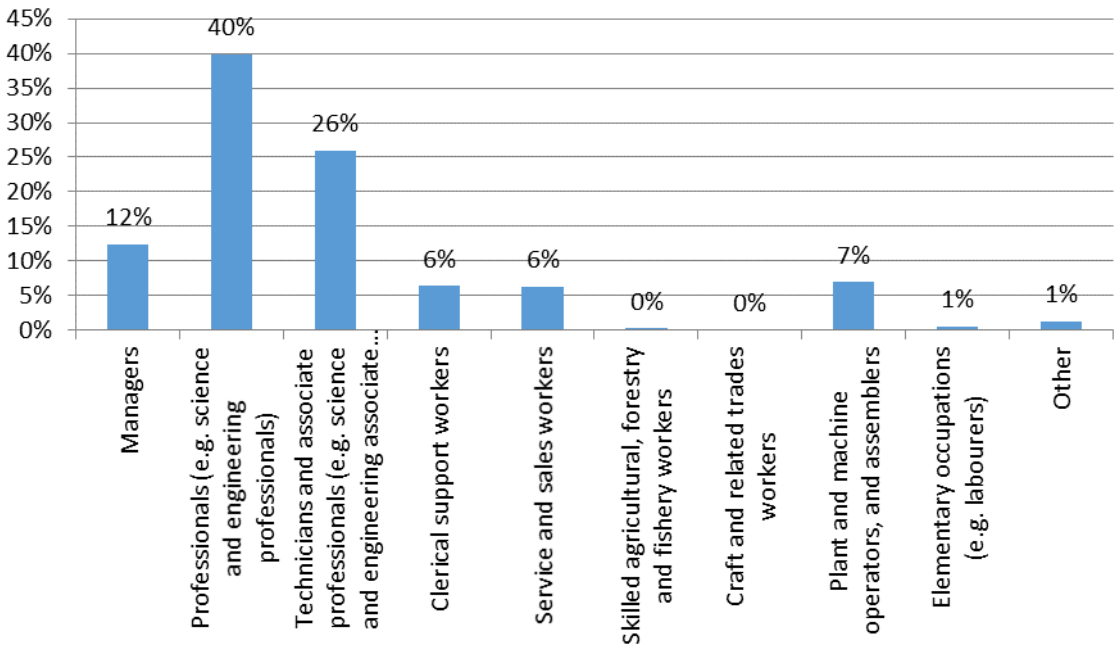

Figure 16 Categorization of geothermal employees by the International Standard Classification of Occupations. n=39.

Respondents were then asked to categorise their geothermal employees by the International Standard Classification of Occupations. Out of the roughly 60 thousand employees within the institutions/organisations/business enterprises, only 714 employees were classified as working on geothermal activities. However it is noteworthy that five respondents with over 43.500 employees according to the former question did not respond to this question. Out of those that did respond 40% of employees working on geothermal activities worked as professionals, e.g. science and engineering professionals, 26% as technical or associate professionals and 12% as managers. About 7% were classified as plant or machine operators, and assemblers. Both clerical support workers, as well as service and sales workers, comprised 6% of classified employees. Only 1% worked at elementary occupations, such as labour work, or other unclassified occupation. Merely two employees of geothermal activities were reported working as skilled agricultural, forestry and fishery worker and no employee was reported working as craft related trades worker.

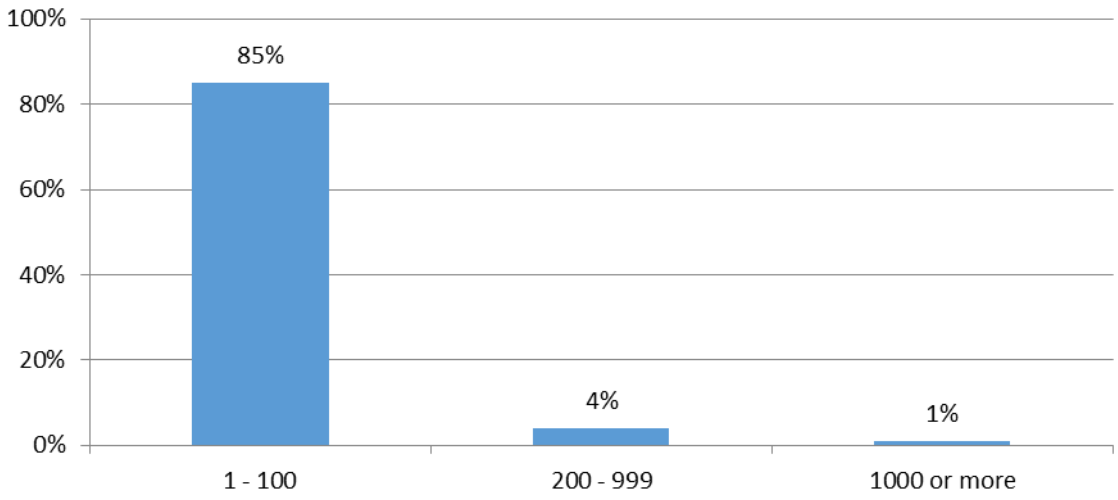

Figure 17 Average proportion of employees working on geothermal activities categorized by total number of employees (headcount). n=36.

As a result of the two previous questions the average proportion of employees working on geothermal activities within the institutions/organisations/business enterprises that responded to both questions can be calculated (see fig. 17). In total the average proportion of personnel dedicated to geothermal activities within the responding group is around 62%. However merely 4% of the total number of employees work on geothermal activities within the responding group. A clear difference between smaller and bigger institutions/ organisations/business enterprises average proportions can be seen in figure 17. Respondents with 100 or less employees on average have 85% of their personnel working on geothermal activities, thereof all the employees (100%) of nineteen out of twenty-six respondents. Workplaces with between 200 and 999 employees only have about 4% of their personnel dedicated to geothermal activities. And workplaces with over 1000 employees have just 1% of their personnel working in the geothermal sector.

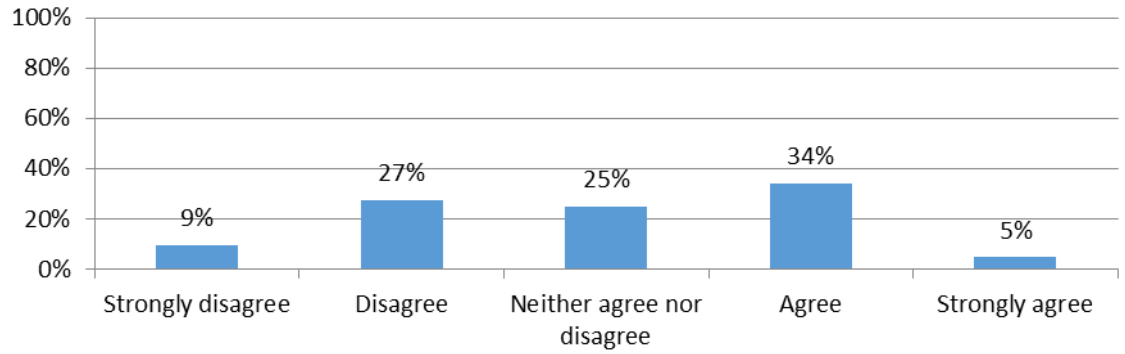

Figure 18 My institution/organisation/business enterprise is lacking personnel with specialised skills and knowledge in geothermal activities. n=44.

When the respondents were asked whether their institution/organisation/business enterprise was experiencing a lack of personnel with specialised skills and knowledge in geothermal activities the answers were evenly divided between those who agreed and disagreed. Respondents who either agreed or strongly agreed comprised 39%, whereas those who disagreed or strongly disagreed were 36%. About 25% did neither agree nor disagree.

Those respondents who did report a lack of personnel with specialised skills and knowledge in geothermal activities were probed for further information and asked to identify which professions and/or skills were most needed within their institution/organisation/business enterprise (see table 8). Professions with direct link to geothermal activities were mentioned, such as geophysicists, geologists, geomechanics, drilling supervisors, reservoir modellers and turbine specialists. In terms of skills and knowledge, the need for knowledge on structural geology was listed. The need for engineers was also reported, and one respondent mentioned in particular the need for an R&D engineer to work on new techniques and tools application for the geothermal industry, instead of relying on current measurement solutions developed for the oil and gas sector. Specific engineering skills or knowledge of plants, surface equipment and reservoir were also listed. Other professions such as project managers, information and dissemination professionals, and computer scientists were also mentioned and the abilities to communicate risks and understand technology. One respondent simply added that most professions were needed within her/his institution/organisation/business enterprise.

Profession	Skills and Knowledge
Engineers. Engineers experienced in geothermal science. Specialised R&D engineers. Operation and maintenance engineering	Communication abilities, understanding of the technology but also of the risks and how to communicate them.
Experienced geologists in geothermal science. Hydrogeologist.	Engineering for plants - surface equipment. Reservoir engineering.
Geomechanics.	Structural geology
Geophysicists (e.g. seismics)	Seismic interpretation
Drilling supervisor.	Geothermal modelling
Turbine specialists.	
Reservoir modellers.	
Project manager.	
Information and dissemination professionals.	
Computer scientists.	
Geothermal funding expert	

Table 8 - Those professions and skills/knowledge needed within respondents' institution/organisation/business enterprise. n=15.

3.2.3 Human Resources within the Geothermal Sector

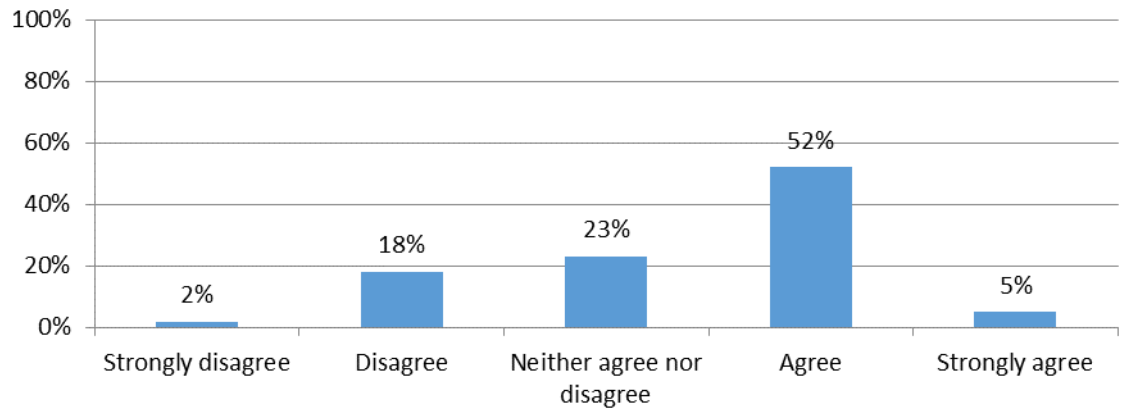

Figure 19 - In general, the geothermal sector is lacking personnel with specialised skills and knowledge in geothermal activities. n=44.

When asked if they believed the geothermal sector to be lacking personnel with specialised skills and knowledge in geothermal activities in general, the majority of respondents either agreed or strongly agreed (57%). In total 20% were in disagreement (2% strongly). About 23% of respondents neither agreed nor disagreed with the statement.

Interestingly, respondents seem to see the geothermal sector as suffering from lack of specialised personnel in general, although this is not the majority opinion when asked specifically about their own institution/organisation/business enterprise (38%). One might wonder if this is simply due to the fact that these are only the opinions of a small and established fraction of the sector, or that the lack is in some way a general consensus within the sector that all have agreed upon but are not necessarily experiencing themselves.

Furthermore, the GeoElec Employment Study posed a similar question, where respondents were asked whether the geothermal sector was suffering from a lack of skilled workers on one hand, and the lack of skilled scientists/researcher on the other hand. The answers for both groups were rather similar, with half of respondents neither agreeing nor disagreeing, 22-25% disagreeing or strongly disagreeing, nor 25-28% agreeing or strongly agreeing.[10] Interestingly, in comparison to the survey reported here, these results are much less decisive. However, they are rather in line with the results obtained from the question that specifically asked about respondents' own institution/organisation/business enterprise in terms of lack of personnel.

3.2.4 Factors Contributing to the Lack of Human Resources

Those respondents who believed there be to be a lack of human resources within the geothermal sector were then asked to identify which factors they perceived to be of importance in these regards. Respondents were presented with 17 individual factors, which were then categories into three groups; educational factors, policy and sectorial factors, and industry factors.

[10] GeoElec. (2013). Employment Study: Solutions on Lack of Skilled Workers in the Geothermal Sector & Results of the Questionnaires. Spyros Karytsas (Centre for Renewable Energy Sources and Saving).

3.2.4.1 Educational Factors

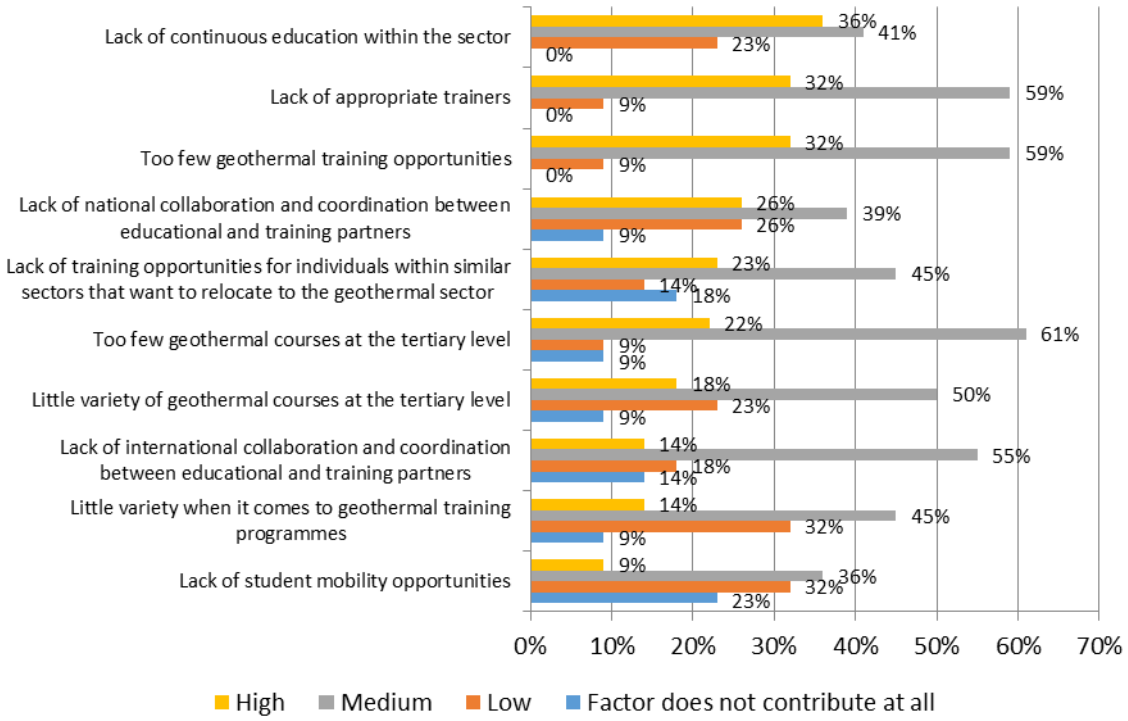

Figure 20 Educational factors contributing to the lack of human resources within the geothermal sector. n=22-23.

Examining which education factors respondents believed to be of high importance, the lack of continuous education (36%), too few geothermal training opportunities (32%) and the lack of appropriate trainers (32%) scored the highest (see fig. 20). When the shares for those factors deemed high and medium importance were combined too few geothermal training opportunities (91%), lack of appropriate trainers (91%) and too few geothermal courses at the tertiary level (83%) had the highest scores (see fig. 24).

3.2.4.2 Policy and Sectorial Factors

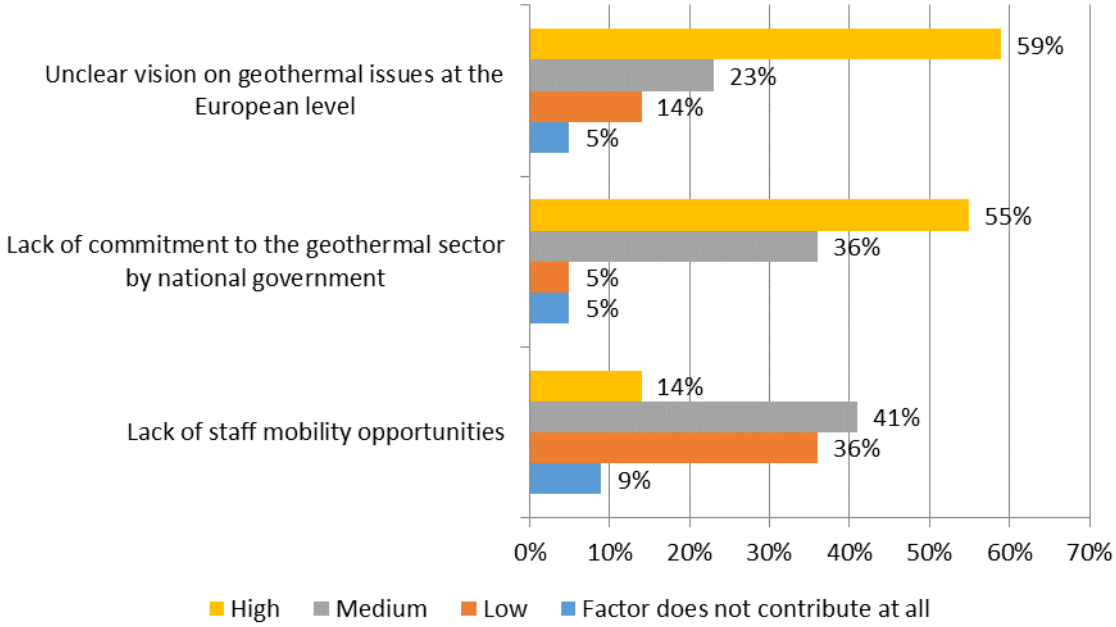

Figure 21 Policy and sectorial factors contributing to the lack of human resources within the geothermal sector. n=22.

Three factors were identified as pertaining to either policy issues or issues specific to the sector. Of those unclear vision on geothermal issues at the European level (59%) and lack of commitment to the geothermal sector by national government (55%) scored the highest (see fig. 21). When the shares for those factors deemed high and medium importance are combined in figure 24, those same factors had the highest scores (82% and 90% shares).

3.2.4.3 Industry Factors

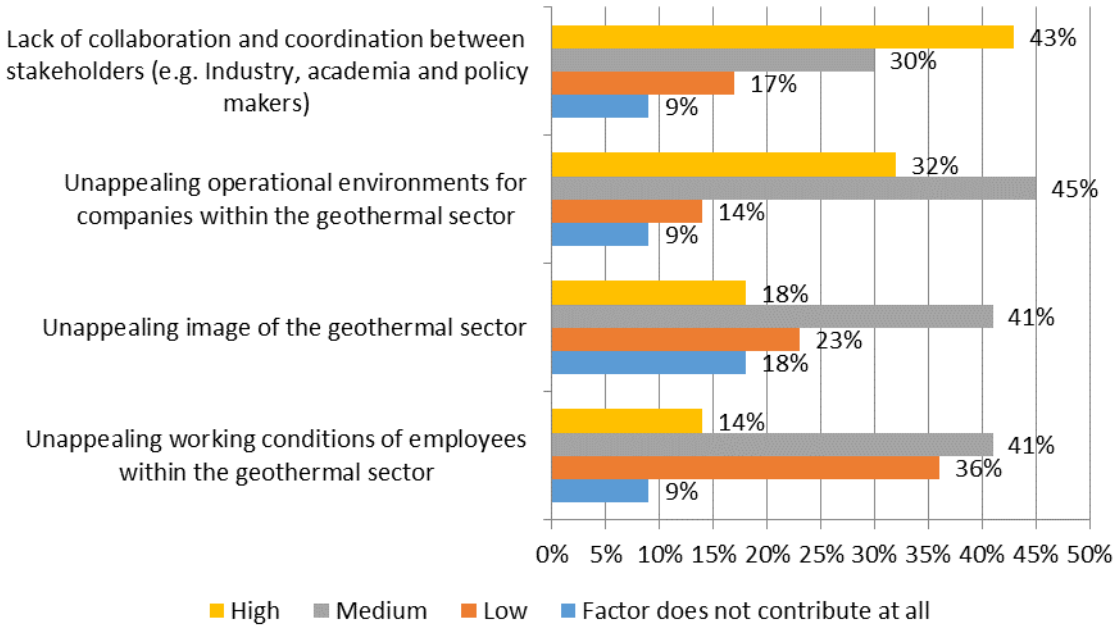

Figure 22 Industry factors contributing to the lack of human resources within the geothermal sector. n=22-23.

Four industry factors were identified as possible contributors to the lack of human resources within the geothermal sector (see fig. 22). Of those four the lack of collaboration and coordination between stakeholders, such as industry, academia and policy makers, had the highest score (43%), along with unappealing operational environments for companies within the sector (32%). When the shares for those factors deemed high and medium importance are combined in figure 24, those same factors had the highest scores (77% and 73% shares).

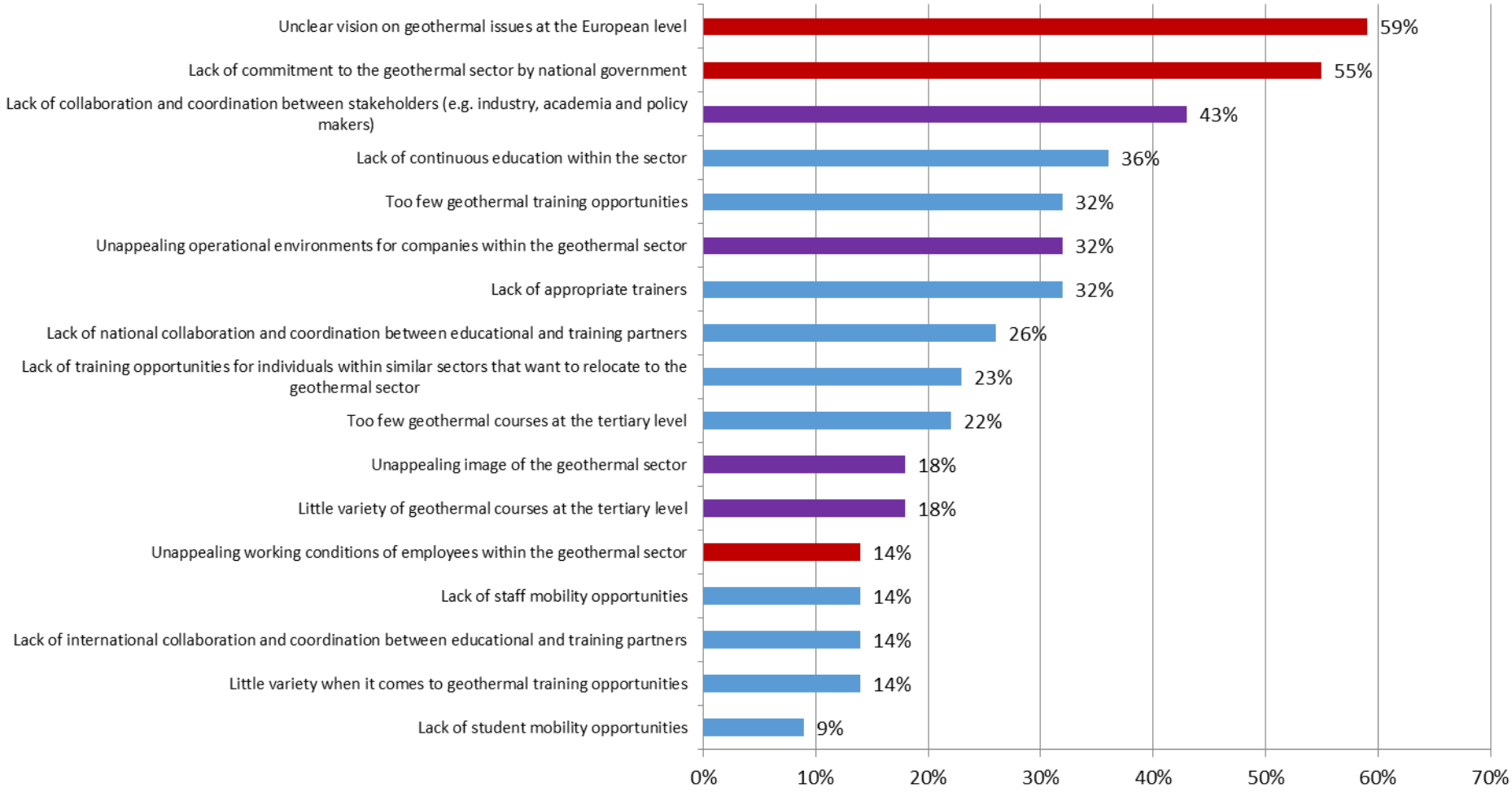

Figure 23 Factors deemed of high importance as contributors to a lack of human resources within the geothermal sector. Educational factors are coloured blue, policy/sectorial factors red and industry factors purple-

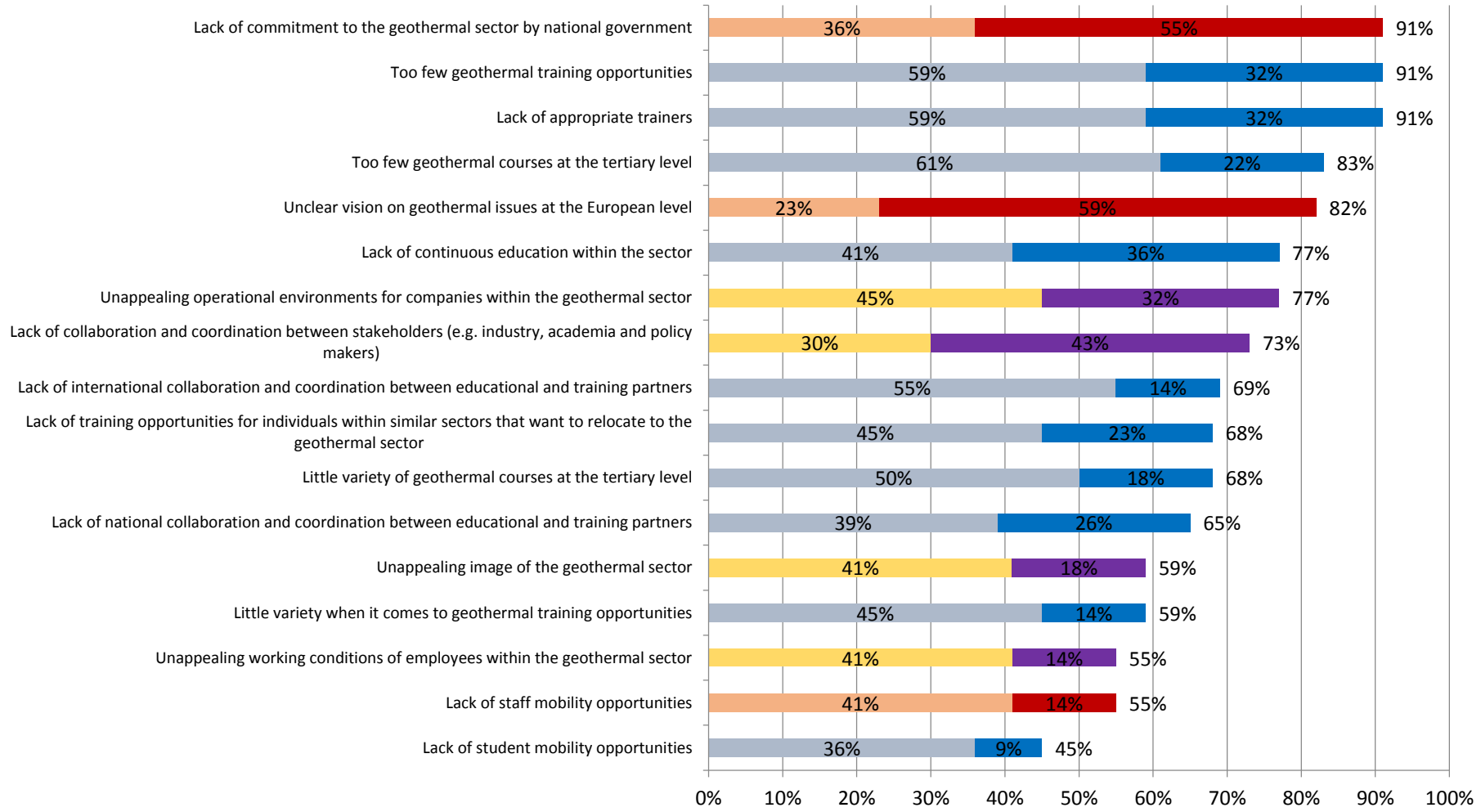

Figure 24 Factors deemed of medium and high importance as contributors to a lack of human resources within the geothermal sector. Educational factors are coloured blue, policy/sectorial factors red and industry factors purple.

First part of the column represents the share of respondents who believed the factor to be of medium importance and the latter part the share of respondents who believed the factor to be of high importance.

Figure 23 lists all factors and the share of respondents who deemed the factors to be of high importance. The first two factors with the highest scores amongst respondents pertain to geothermal policy, i.e. unclear vision of geothermal issues at the European level (59%) and lack of commitment to the geothermal sector by national government (55%). The third highest factor is an industry factor: lack of collaboration and coordination between stakeholders (43%). Following those are three educational factors: lack of continuous education within the sector (36%), too few geothermal training opportunities (32%) and lack of appropriate trainers (32%), and an industry factor: unappealing operational environments for companies within the geothermal sector (32%).

Correspondingly, figure 24 lists all the factors, but here the share of respondents who deemed the factors to be of high and medium importance have been combined. This changes the landscape slightly, although three out of the five top factors from figure 23 are still ranked amongst the top five. The top three factors are divided between a geothermal policy factor: lack of commitment to the geothermal sector by national government (91%), and two educational factors: lack of appropriate trainers (91%), which was not present in the top five in figure 23, and few geothermal training opportunities (91%). Thereafter comes another educational factor concerning too few geothermal courses at the tertiary level (83%), also not present in the top five in figure 23. Lastly, the top factor from before, unclear vision of geothermal issues at European level (82%) ranks at number five.

Respondents of the survey were also asked to identify other factors they believed might contribute to the lack of human resources within the geothermal sector. The oil and gas sector was mentioned with regards to higher salaries and being more attractive to potential human resources. This suggests a possible lack of competitiveness of the geothermal sector when it comes to competing for human resources. Lack of funding, both in regards to deep and shallow geothermal activities, was reported as a factor contributing to the sector not being favourable. In addition, a complete cultural gap between those two sectors was listed. Also, issues regarding public acceptability, lack of knowledge on the geothermal energy and environmental sustainability were mentioned, which hints at a potential low visibility or knowledge of the sector in society. Marketing factors, such as low return on investments for operators, too few projects and market and business discontinuity in most countries, were also mentioned. Furthermore, a lack of knowledge of opportunities was reported, as well as too few courses with specific emphasis on geothermal conditions for drilling.

3.2.5 Possible Actions for Meeting the Need for Human Resources

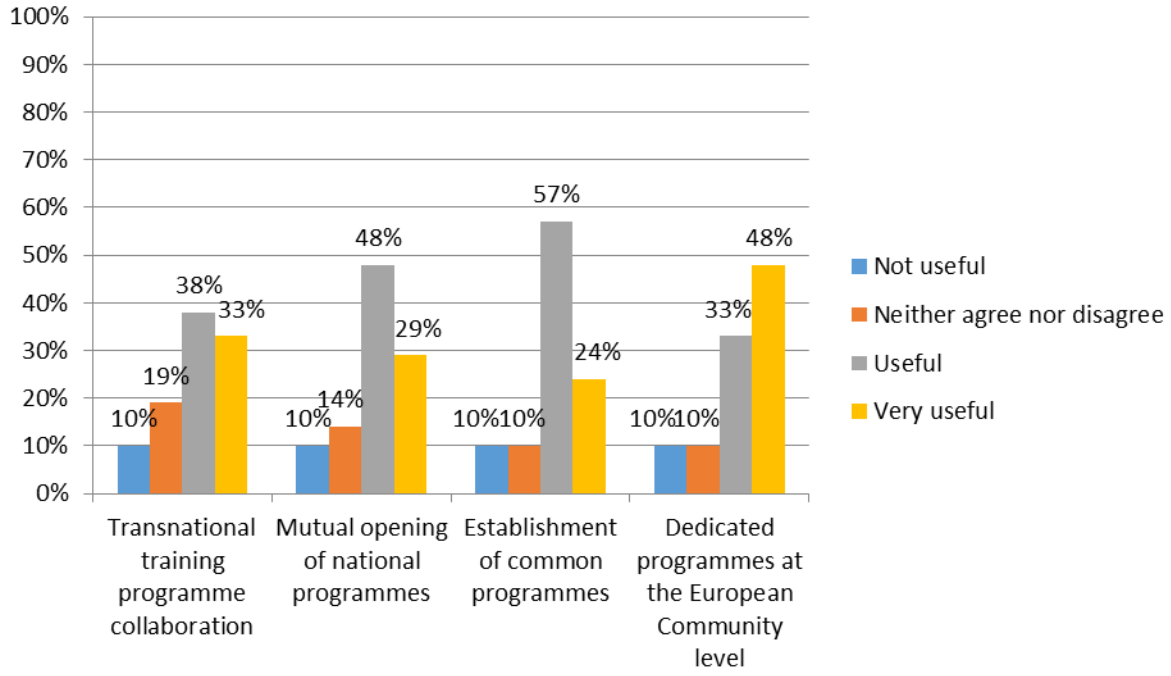

Figure 25 How useful do you believe the following actions would be in closing knowledge and training gaps within the geothermal sector? n=21.

When asked about possible actions for meeting the need for human resources, respondents' answers were rather uniform (see fig. 25). The options presented were: transnational training programme collaboration; mutual opening of national programmes; establishment of common programmes; and dedicated programmes at the European Community level. The majority of respondents believed all the actions to be either useful or very useful (71-81%), with the dedicated programmes at the European Community level option scoring highest in the "very useful" category (48%). Respondents were also offered to leave additional suggestions of possible actions. Establishing and supporting common projects was mentioned, as well as the involvement of international agencies (e.g. UNECO) and a common international consortium of industries. The transfer of knowledge and sharing of human resources with the oil and gas sector was suggested, and the establishment of long-term R&D programmes mentioned in that context. Here the financing was said to be key, and financial support from either national or international public or private funds would be an advantage in any negotiations. Lastly, training on environmental sustainability was seen as a possible action to meet human resources needs.

3.2.6 Future Outlook

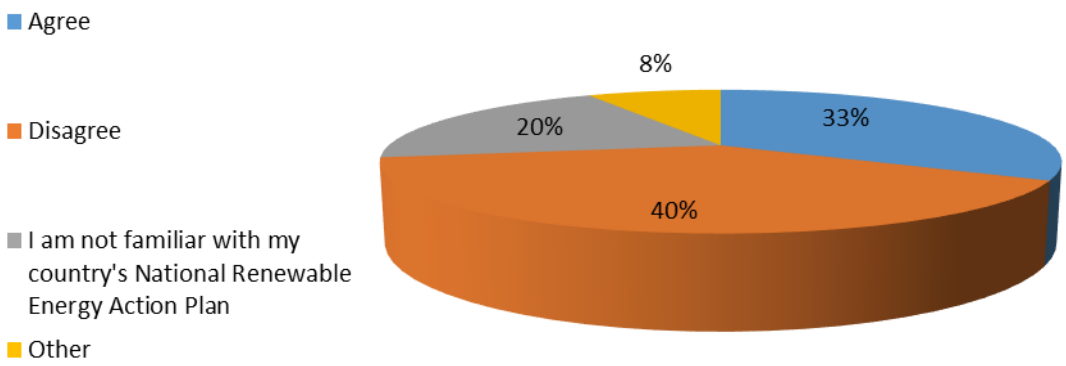

Figure 26 The current supply of human resources within the geothermal sector in my country will be able to meet the long term ambitions for the use of geothermal energy, as stipulated in my country's National Renewable Energy Action Plan. n=40.

All respondents were asked to contemplate the future outlook of human resources in the sector. Here they were asked whether they foresaw that current human resources would be able to meet the long-term ambitions for the use of geothermal energy, as it is stipulated in their country's National Renewable Energy Action Plan (NREAP). Around 33% of respondents believed that the current supply was enough, whereas 40% disagreed (see fig. 26). Interestingly, a fifth of respondents were not familiar with their country's NREAP, and were therefore unable to determine whether the current supply of human resources would suffice to reach the goal therein. Three respondents chose the "other" option (8%). One commented that the long-term validity of NREAP was unclear, and another pointed out that in his/her country's NREAP actually contained a reduced role for geothermal energy with respect to other renewables, as well as its potential.

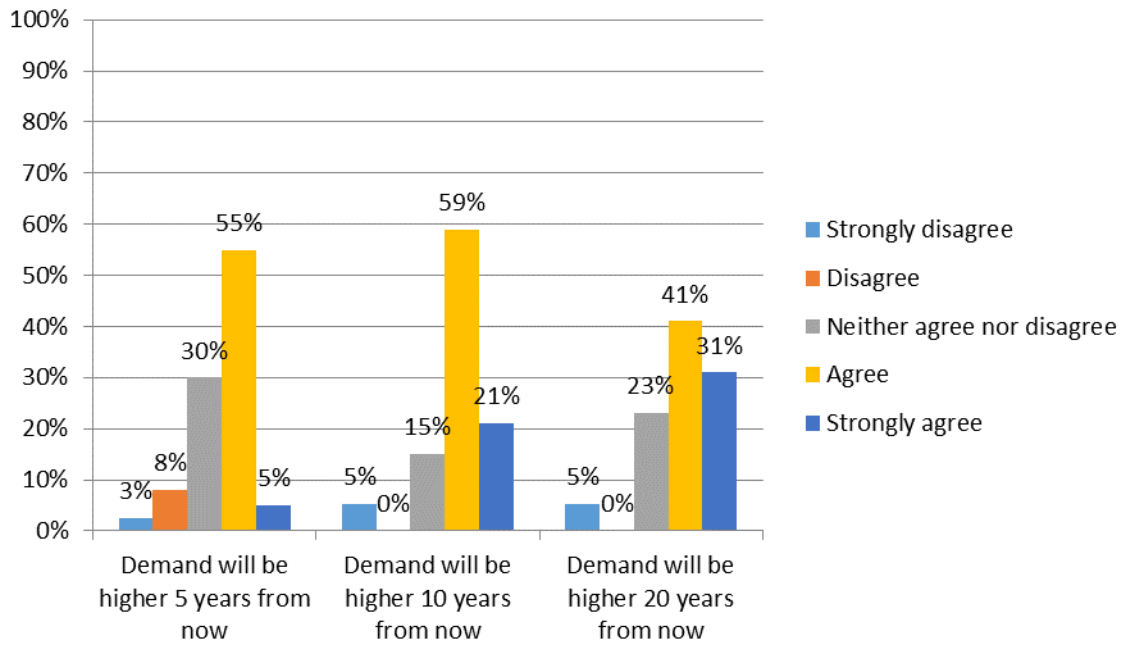

Figure 27 Demand for personnel with specialised skills and knowledge in geothermal activities will be higher 5, 10 or 20 years from now. n=39-40.

Finally, respondents were asked about the future demand for personnel with specialised skills and knowledge in geothermal activities. There seemed to be a general consensus amongst respondents that the demand for such personnel would be higher in 5, 10 or 20 years from now, as 60-80% of respondents either agreed or strongly agreed. The same results were reported in GeoElec's Employment Survey, where an even larger majority of respondents believed that employment in the geothermal sector would be higher 5, 10 or 20 years from now, with 86-97% agreeing or strongly agreeing with the statement. Respondents in that survey also agreed or strongly agreed when asked whether the demand for highly skilled workers in the geothermal sector was rising (78%). [11]

When asked about which skills or professions would be mostly needed, respondents listed a whole variety of professions and skills. One even went so far as to answer "all". Various engineering skills were listed, as well as drillers and skills related to drilling, which were also quite prominent. Geologists and hydrogeologists were mentioned, as well as technicians. Respondents also reported other non-geothermal specific skills, such as dissemination, promotion and public outreach. For a complete list of all professions/skills reported please refer to table 9. Lastly, one respondent pointed out that the lack was actually not of people within the sector working on geothermal activities, but

[11] GeoElec. (2013). Employment Study: Solutions on Lack of Skilled Workers in the Geothermal Sector & Results of the Questionnaires. Spyros Karytsas (Centre for Renewable Energy Sources and Saving).

there was rather a lack of people in the position of ordering geothermal energy, such as cities, builders etc.

Profession	Skills and Knowledge
Designers of low enthalpy geothermal systems.	Research and development.
Specialists (long-term).	Skills to bring investments into geothermal.
Exploration geologist/geophysicist.	Exploration.
Drilling operators. Technicians for the drilling/maintenance of wells.	Drilling.
Holistic managers (short term); general managers (midterm). Managers with knowledge of geothermal project funding	Engineering for geothermal plants; reservoir engineering; engineering office (with both thermal needs of buildings and 'geologic/hydrogeologic' skills); mechanical and electrical engineers.
Operation & maintenance technicians.	System analysis for integration of geothermal energy in the heat and power supply.
Geologists; Hydrogeologist.	Resource assessment.
Plant and machine operators and maintainers	Plant technological development.
Design engineers	Dissemination and promotion; public outreach.
Installer and maintainer (WHP & drills).	

Table 9 - Future needs of professions and skills with regards to geothermal activities. n=18.

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5 APPENDIX I – Students and Education in the Geothermal Sector Survey Outline

Thank you for taking the time to complete this survey on student numbers and education in geothermal energy. Your participation in this survey is completely voluntary and you are free to withdraw from the survey at any point. Should you have questions regarding the Geothermal ERA-NET project, please consult the projects website www.geothermaleranet.is or your local ERA-net partner. Should you have any questions regarding this particular survey, please contact the Icelandic Centre for Research - RANNIS at eva.diego@rannis.is (until 1 July) or sigurdur@bjornsson@rannis.is (between 2-11 July). Thank you very much for your time and support, your feedback is highly important to us. Important note on saving survey data: Please note that the survey does not offer respondents to navigate backwards but respondents are able to save their answers and come back at another time. Respondents are then sent a new link to the survey via an e-mail address they provide. Data is saved up to the page on which the respondents click on the Save and Continue Later button. When respondents click on the continuation link in their e-mail, they will be taken to the next page just after the page on which they clicked on the Save and Continue Later button. It is, therefore, important that you complete the page on which you decide to click Save and Continue. You can also start the survey again from the beginning by using the link you received in the initial e-mail invitation. Please start with the survey now by clicking on the Continue button below.

5.1.1 Background Information

1. Please select the location of your institution.

- Croatia
- France
- Germany
- Greece
- Hungary
- Iceland
- Italy
- Macedonia
- Netherlands
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Switzerland
- Turkey
- Other

2. Name of institution:

5.1.2 Geothermal Courses and Final Projects

3. How many geothermal courses does your institution offer and how many ECTS (European Credit Transfer & Accumulation System) credits do those courses constitute?

	Number of geothermal courses	Number of ECTS credits in geothermal courses
Bachelor or equivalent (ISCED6)	❑	❑
Master or equivalent (ISCED7)	❑	❑
Doctor or equivalent (ISCED8)	❑	❑

4. In which language are the courses conducted?

5. We would highly appreciate if you could provide us with course titles and descriptions of the geothermal courses at your institution in English. You can either do this by writing into the field below or upload a text document.

6. How many students (headcount) were registered in geothermal courses during the following academic years?

	Bachelor or equivalent (ISCED6)	Master or equivalent (ISCED7)	Doctor or equivalent (ISCED8)
2013-2014	❑	❑	❑
2012-2013	❑	❑	❑
2011-2012	❑	❑	❑
2010-2011	❑	❑	❑
2009-2010	❑	❑	❑

7. How many theses, dissertations and/or final projects with a special geothermal focus were

completed at your institution during the following academic years?

	Bachelor or equivalent (ISCED6)	Master or equivalent (ISCED7)	Doctor or equivalent (ISCED8)
2013-2014	❑	❑	❑
2012-2013	❑	❑	❑
2011-2012	❑	❑	❑
2010-2011	❑	❑	❑
2009-2010	❑	❑	❑

5.1.3 Future Student Prospects

8. Which of the following statements best describes the development of students registered in geothermal courses within your institution?

1. My institution foresees an increase in the number of students in geothermal courses by 2020.
2. My institution foresees a decrease in the number of students in geothermal courses by 2020.
3. My institution foresees neither an increase nor a decrease in the number of students in geothermal courses by 2020.

Respondents who foresaw an increase continued on to the next question, those who foresaw a decrease were sent to question 11 and those who neither foresaw an increase nor decrease were transported to question 13.

9. How many students (headcount) do you estimate will be registered in geothermal courses at your institution in 2020?

	Number of students
Estimated number of Bachelors or equivalent graduates (ISCED6) in 2020:	❑
Estimated number of Masters or equivalent graduates (ISCED7) in 2020:	❑
Estimated number of Doctoral or equivalent graduates (ISCED8) in 2020:	❑

10. Is there a particular reason your institutions foresees an increase in the number of students registered in geothermal courses?

Respondents go on to question 12.

11. How many students (headcount) do you estimate will be registered in geothermal courses at your institution in 2020?

	Number of students
Estimated number of Bachelors or equivalent students (ISCED6) in 2020:	❑
Estimated number of Masters or equivalent students (ISCED7) in 2020:	❑
Estimated number of Doctoral or equivalent students (ISCED8) in 2020:	❑

12. Is there a particular reason your institutions foresees a decrease in the number of students registered in geothermal courses?

13. How do you perceive the development in student numbers in geothermal courses will be up until 2050? For example, do you foresee a steady increase, a decrease of students or fluctuations in student numbers?

14. Which factors do you believe will most likely affect the development? For example, factors pertaining to the geothermal industry, academia or policy making within the sector etc.

5.1.4 Development of Geothermal Education and Training

15. Looking ahead until 2020, which statement best describes the foreseeable development of geothermal courses at your institution?

1. My institution plans to increase the number of geothermal courses in the next 6 years.
2. My institution plans to decrease the number of geothermal courses in the next 6 years.
3. At this point, my institution has no plans to change its current geothermal course offering in the next 6 years.
4. Do not know.

Respondents who foresaw an increase continued on to the next question, those who foresaw a decrease were sent to question 17, those whose institution had no plans or did not know went straight to question 18.

16. What kind of courses is your institution planning on introducing? For example, which sub-

fields, educational level etc.

Respondents go on to question 18.

17. What are the main reasons your institution plans to decrease its geothermal course offering?

5.1.5 Geothermal Programmes

18. Does your institution offer whole programmes that are entirely dedicated to geothermal energy?
    1. Yes.
    2. No.

Respondents who agreed carried on to the next question, those who did not were sent to question 22.

19. How many are the geothermal programmes offered at your institution at the following academic levels?

	Number of programmes
Doctoral level	❑
Masters level	❑
Bachelors level	❑

20. Do you foresee that your institution will increase its offering of programmes entirely dedicated to geothermal energy in the next 6 years?
    1. Yes.
    2. No.

21. Is there a particular reason why your institution does or does not foresee an increase in offering of such programmes?

Respondents go to question 24.

22. Do you foresee that your institution will offer such programmes in the next 6 years?
    1. Yes.
    2. No.
    3. Do not know.

23. Is there a particular reason why your institution does or does not foresee offering such programmes?

5.1.6 Mobility Opportunities

24. Are there specific mobility opportunities available at your institution for students and/or staff members who are focusing or want to focus on geothermal energy?
    1. Yes.
    2. No.

25. Do students at your institution that are focusing on geothermal energy in their studies, make use of any of the following European mobility programmes?
    1. Do not make use of any European mobility programmes.
    2. Erasmus+.
    3. Marie Curie Actions - Research Fellowship Programme.
    4. Other mobility programmes? Either European or national/international?

26. Do staff members at your institution that are focusing on geothermal energy, make use of any of the following European mobility programmes?
    1. Do not make use of any European mobility programmes.
    2. Erasmus+.
    3. Marie Curie Actions - Research Fellowship Programme.
    4. Other mobility programmes? Either European or national/international?

27. Do you feel that there is a need for more mobility opportunities for your students and/or staff members in the geothermal field?
    1. Yes.
    2. No.

28. Contact Information

We would like to ask your permission to contact you again should any further questions arise during the processing of the data. If you accept, please leave your e-mail address below.
Email Address

29. If you would like to contribute to or amend the summary of geothermal courses at your institution as presented in the Geothermal ERA-NET report, please provide an additional or amended text below:

6 APPENDIX II – The Status and Development of Human Resources within the Geothermal Sector Survey Questions

Thank you for taking the time to complete this survey on human resources within the geothermal sector. Your participation in this survey is completely voluntary and you are free to withdraw from the survey at any point. Should you have questions regarding the Geothermal ERA-NET project, please consult the projects website www.geothermaleranet.is or your local ERA-net partner. Should you have any questions regarding this particular survey, please contact the Icelandic Centre for Research - RANNIS at eva.diego@rannis.is (until 1 July) or sigurdur.bjornsson@rannis.is (between 2-11 July). Thank you very much for your time and support, your feedback is highly important to us. Important note on saving survey data: Please note that the survey does not offer respondents to navigate backwards, but respondents are able to save their answers and come back at another time. Respondents are then sent a new link to the survey via an e-mail address they provide. Data is saved up to the page on which the respondents click on the Save and Continue Later button. When respondents click on the continuation link in their e-mail, they will be taken to the next page just after the page on which they clicked on the Save and Continue Later button. It is, therefore, important that you complete the page on which you decide to click Save and Continue. You can also start the survey again from the beginning by using the link you received in the initial e-mail invitation. Please start with the survey now by clicking on the Continue button below.

6.1.1 Background Information

1. Please select the location of your institution/organisation/business enterprise (headquarters).
   - France
   - Germany
   - Hungary
   - Iceland
   - Italy
   - Netherlands
   - Portugal
   - Slovakia
   - Slovenia
   - Switzerland
   - Turkey
   - Other

2. Please identify the sector of your institution/organisation/business enterprise.
   - Business Enterprise Sector
   - Government Sector
   - Higher Education Sector
   - Private Non Profit Sector
   - Other

3. In which types of geothermal activities is your institution/organisation/business enterprise involved?

Electrical energy production
District heating
Other non-electrical application
Drilling activities
Construction of geothermal fluid collection, transmission and distribution systems
Construction/manufacturing of power plants
Operation and management of geothermal fields
Operation and maintenance of power facilities
Environmental assessments
Research and development
Education
Equipment supply
Consulting
Other

4. How would you divide the geothermal activities of your institution/organisation/business enterprise when you view the geothermal value chain? Please fill in percentage share below (e.g. 10, 30, 45 etc.) so that the total number adds up to 100.

- Research and development _____
- Exploration _____
- Drilling _____
- Confirmation of potential _____
- Engineering _____
- Construction _____
- Operations and maintenance _____
- Other _____

6.1.2 Human Resources within Your Institution/Organisation/Business Enterprise

5. How many individuals were employed at your institution/organisation/business enterprise at the end of 2013? Please provide both a headcount and full-time equivalents (FTE).

Headcount:	❑
Full-time equivalent:	❑

6. Please identify the number employees working on geothermal activities and how you would categorise them. For further elaboration on each occupational category, please press here or follow the accompanying link in each category.

	Headcount	Full-time equivalents
Managers	❑	❑
Professionals (e.g. science and engineering professionals)	❑	❑
Technicians and associate professionals (e.g. science and engineering associate professionals)	❑	❑

Clerical support workers	❑	❑
Service and sales workers	❑	❑
Skilled agricultural, forestry and fishery workers	❑	❑
Craft and related trades workers	❑	❑
Plant and machine operators, and assemblers	❑	❑
Elementary occupations (e.g. labourers)	❑	❑
Other	❑	❑

7. Please state your level of agreement with the following statement:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My institution/organisation/business enterprise is lacking personnel with specialised skills and knowledge in geothermal activities.	❑	❑	❑	❑	❑

Respondents agreed or strongly agreed continued on to the next question, those disagreed, strongly disagreed or neither/nor were sent to question 9.

8. Which professions/skills are mostly needed with regards to geothermal activities within your institution/organisation/company?

6.1.3 Human Resources within the Geothermal Sector

9. How strongly do you agree or disagree with the following statement?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
In general, the geothermal sector is lacking personnel with specialised skills and knowledge in geothermal activities	❑	❑	❑	❑	❑

Respondents agreed or strongly agreed continued on to the next question, those disagreed, strongly disagreed or neither/nor were sent to question 16.

6.1.4 Factors Contributing to Lack of Human Resources

10. How important are the following educational factors in contributing to the lack of human

resources in the geothermal sector? Please identify degree of importance.

	Factor does not contribute at all	Low	Medium	High
Too few geothermal courses at the tertiary level	❑	❑	❑	❑
Little variety of geothermal courses at the tertiary level	❑	❑	❑	❑
Too few geothermal training opportunities	❑	❑	❑	❑
Little variety when it comes to geothermal training opportunities	❑	❑	❑	❑
Lack of appropriate trainers	❑	❑	❑	❑
Lack of continuous education within the sector	❑	❑	❑	❑
Lack of training opportunities for individuals within similar sectors that want to relocate to the geothermal sector	❑	❑	❑	❑
Lack of national collaboration and coordination between educational and training partners	❑	❑	❑	❑
Lack of international collaboration and coordination between educational and training partners	❑	❑	❑	❑
Lack of student mobility opportunities	❑	❑	❑	❑

11. How important are the following policy or sectorial factors in contributing to the lack of human resources in the geothermal sector? Please identify degree of importance.

	Factor does not contribute at all	Low	Medium	High
Lack of staff mobility opportunities	❑	❑	❑	❑
Lack of commitment to the geothermal sector by national government	❑	❑	❑	❑
Unclear vision on geothermal issues at the European level	❑	❑	❑	❑

12. How important are the following industry factors in contributing to the lack of human resources in the geothermal sector? Please identify degree of importance.

	Factor does not contribute at all	Low	Medium	High
Unappealing image of the geothermal sector	❑	❑	❑	❑
Unappealing working conditions of employees within the geothermal sector	❑	❑	❑	❑
Unappealing operational environments for companies within the geothermal sector	❑	❑	❑	❑
Lack of collaboration and coordination between stakeholders (e.g. industry, academia and policy makers)	❑	❑	❑	❑

13. Are there any other factors you believe might contribute to the lack of human resources within the geothermal sector?

6.1.5 Possible Actions for Meeting the Need for Human Resources

14. How useful do you believe the following actions to be in closing knowledge and training gaps within the geothermal sector?

	Not useful	Neither nor	Useful	Very useful
Transnational training programme collaboration	❑	❑	❑	❑
Mutual opening of national programmes	❑	❑	❑	❑
Establishment of common programmes	❑	❑	❑	❑
Dedicated programmes at the European Community level	❑	❑	❑	❑

15. Are there other actions you believe might aid in meeting training needs and closing knowledge gaps within the geothermal sector?

6.1.6 Future Outlook

16. Do you agree or disagree with the following statement? The current supply of human resources within the geothermal sector in my country will be able to meet the long term ambitions for the use

of geothermal energy, as stipulated in my country's National Renewable Energy Action Plan?

1. Agree
2. Disagree
3. I am not familiar with my country's National Renewable Energy Action Plan
4. Other

17. How strongly do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Demand for personnel with specialised skills and knowledge in geothermal activities will be higher in 5 years from now.	❑	❑	❑	❑	❑
Demand for personnel with specialised skills and knowledge in geothermal activities will be higher in 10 years from now.	❑	❑	❑	❑	❑
Demand for personnel with specialised skills and knowledge in geothermal activities will be higher in 20 years from now.	❑	❑	❑	❑	❑

18. If you foresee a demand in the future, which professions/skills do you believe will be mostly needed with regards to geothermal activities in the future?

6.1.7 Contact Information

We would like to ask your permission to contact you again should any further questions arise during the processing of the data. If you accept, please leave your e-mail address below.

Geothermal ERA-NET
Orkugarður - Grensásvegur 9 - 108 Reykjavík- Iceland - Tel. +354 569 6000 - Fax: +354 568 8896
www.geothermaleranet.is, os@os.is