Competence Requirements Questionnaire

Summary report **Intellectual Output 4**

1 Introduction

The structure of geothermal studies, the competences of future engineers, the need for personnel of a certain profile today, but also in the near future, was shared with interested parties in the form of a questionnaire. The questionnaire was developed and sent to stakeholders of geothermal energy training programmes to ensure that the Geo3EN competence matrix is in line with the needs of industry and research, but also to obtain information about the structure and type of employers to help students gain an idea of the future work environment.

The questionnaire was prepared using Google Forms software. It is divided into three groups of questions:

1. The first set of questions referred to general information about the stakeholder company, its activities, number and education of employees, the share of geothermal engineers working in the company, etc.
2. The second group of questions was the central part of the questionnaire in which stakeholders needed to rank the competences according to their importance for the institution.
3. The last part of the questionnaire referred to the stakeholder opinion on the competence list and current and future needs for highly educated geothermal energy personnel.

The Geo3EN competence requirements questionnaire was initially prepared in English, but each partner subsequently translated it into the native language in order to make it easier for interested parties to fill it out. When creating the survey, the principle of best practice was used, that filling in should not take longer than 10-15 minutes with clearly defined questions and unequivocal answers. The types of questions used were multiple choice, open-ended questions, dropdown lists, etc. The questionnaire contains a total of 21 questions, the first group 7 questions, the second group 9 questions (competences are divided in nine categories), and the third group 5 questions.

The link to the questionnaire is:

https://docs.google.com/forms/d/e/1FAIpQLSeEHWyJFb2WzWpOflWfl0_RpbidDd-7PBqBHod57VtkLc7rhA/formResponse.

In France, 14 participants completed the survey, in Germany 31, and 7 in Iceland and Croatia 7 participants.

Figure 1: The introductory page of the questionnaire

2 Geo3EN Competence Requirements Questionnaire outline and results

The questionnaire was finished in October 2020, and stakeholders had the option of completing it until March 2021, depending on the country and the date of the consultation between the partners and the stakeholders. The questionnaire was sent by e-mail or distributed through the websites of professional societies (e.g. German Geological Society). Consultations were held via video conference platforms such as Ms Teams or Zoom. The consultations served to present the results of the survey, but also to further discuss the goals of the Geo3EN project and the Master study of geothermal engineering.

The survey was anonymous, but participants could enter their information if they wanted to.

Stakeholders to whom the questionnaire was sent included all following (including associated partners, the list is not exhaustive):

- Association Française des Professionnels de la Géothermie,
- Electricité de Strasbourg Géothermie,
- Pôle de compétitivité AVENIA,
- Vermilion,
- ENOGIA,
- DALKIA,
- ENGIE,
- European Geothermal Energy Council (EGEC),
- International Geothermal Association (IGA),
- European Technology and Innovation Platform on Deep Geothermal (ETIP-DG),
- H. Anger´s Söhne Bohr- und Brunnenbaugesellschaft mbH,
- Züblin Spezialtiefbau GmbH,
- GeoThermal Engineering GmbH,
- Stadtwerke München GmbH,
- Überlandwerk Groß-Gerau GmbH,
- Bundesverband Geothernmie e.V.,
- Pfalzwerke geofuture GmbH,
- EnergieAgentur NRW,
- HEP (Hrvatska elektroprivreda) d.d.,
- INA d.d.,
- Croatian Geological Survey,
- Croatian Chamber of Economy,
- Energy Institute Hrvoje Požar,
- Iceland Geothermal,
- ON Power,
- HS Orka,
- Landsvirkjun and Veitur, etc.

2.1 General information about the stakeholder institution and employees

In this first part of the questionnaire, the questions were related to the main activities of the institution, number, profile and education of employees. The questions and answers by individual countries are presented in tables 1-6.

The questionnaire covered a wide range of institutions' activities with engineering, research, consultancy and project management being the most represented (Table 1). On the other hand, activities related to power plant, operation, maintenance and construction were less represented. Operation and maintenance of the power plants are one of the most important parts in the chain of production and use of geothermal energy which is also recognized in the Geo3EN project where ISP students visited many power plants and got information about their operation. That is why many power plants were contacted to fill out the questionnaire, but unfortunately their response was somewhat lower. The fewest responses were from utilities, large energy companies, which can also be seen in Table 2, where small and medium-sized enterprises dominate. Thus, it is reasonable that most of these enterprises provides engineering and consultancy services with project management being the inherent part of their work. Research institutes are also represented to a large extent, because apart from often cooperating with universities, it is in their interest to get quality students with the desired competences and therefore there were many responses from their side as well.

Table 1: What are the main activities of your institution? (You may select more than one activity.)

	France	Germany	Iceland	Croatia
Power plant operation	2	4	3	2
Design	3	8	1	1
Maintenance	3	3	1	0
Construction	2	3	1	0
Drilling	4	7	1	0
Engineering	6	8	3	2
Analysis and computer simulation	4	7	2	3
Utility	0	4	2	1
Regulation	0	9	1	0
Research	6	7	4	4
Education	2	3	2	3
Consultancy	4	17	3	2
Project management	5	11	5	1

Table 2: How many employees does your institution have?

	France	Germany	Iceland	Croatia
Less than 10	5	9	0	2
Between 10 and 50	7	14	1	1
Between 50 and 100	0	2	2	1
Between 100 and 1000	0	4	4	3
More than 1000	2	1	0	0

The Geo3EN project and the Master's study were conceived as an international cooperation between partner institutions, and according to Table 3, it can be seen that this approach is in line with today's business, because a large part of the institutions operates outside their residence country, and an even larger part of them has an international cooperation.

The business of companies that filled out the survey in Germany, France and Iceland is mostly related to geothermal energy (Table 4 and Table 6), while in Croatia the situation is opposite, and geothermal energy is represented very little. The reason for this is that there are generally not many investments in geothermal energy in Croatia. However, in the future this should change due to the significant geothermal potential. In continental Croatia there are many health resorts and spas that use geothermal resources, and there is also a recently opened binary geothermal power plant Velika 1. Several institutes in Croatia have active research projects in geothermal energy.

Table 3: The institution operates:

	France	Germany	Iceland	Croatia
In the country of residence	6	17	4	4
In the country of residence and Europe	3	6	0	1
In the country of residence and worldwide	5	7	3	2

Table 4: What percentage of the institution's activities is related to the field of geothermal energy?

	France	Germany	Iceland	Croatia
Less than 25%	4	9	0	6
Between 25% and 50%	2	4	1	0
Between 50% and 75%	1	5	2	1
More than 75%	7	12	4	0

In accordance with the previous results that the survey responses are dominated by small consulting firms and research institutes, it was confirmed that the majority of employees have a higher education (Table 5). Geology/geological reservoir engineers, mechanical engineers and environmental engineers are the most represented employee profile (Table 6). There are also many project managers who lead projects and contract jobs. Surprisingly, there are very few computer engineers. Probably because it is assumed that they do not have enough engineering skills to help with the business. Nevertheless, this does not mean that existing employees do not need computer skills, but it is assumed that engineers today know how to use dedicated software, 3D models, numerical simulations, etc., which are necessary for the successful execution of projects. It is also an important topic in the Geo3EN project, in which computer technologies are used extensively in curriculum development where many courses consist of computes exercises, simulation and modelling.

Table 5: What is the percentage of employees with a Master or equivalent (dipl.-ing., etc.) degree?

	France	Germany	Iceland	Croatia
Less than 25%	3	7	1	0
Between 25% and 50%	2	7	3	4
Between 50% and 75%	2	3	1	1
More than 75%	7	13	2	2

Table 6: What is the general profile of the engineers or equivalent working for the institution? (You may select more profiles.)

	France	Germany	Iceland	Croatia
Geology/Geological reservoir engineers	8	24	6	2
Mechanical engineers	3	10	5	2
Electrical engineers	1	7	4	4
Civil engineers	2	4	3	3
Chemical engineers	3	4	3	0
Mining engineers	0	11	0	0
Computer engineers	2	4	1	2
Environmental engineers	2	11	2	4
Petroleum engineers	1	1	0	0
Project managers	4	7	6	0
Data scientists	1	6	2	0

2.2 Ranking of competences

The central part of the questionnaire was the ranking of competences in which the participants ranked the competences according to the importance for their institution. Competences were divided in nine categories: mathematical-scientific fundamentals, project management and soft skills, types and use of geothermal energy, exploration and analytical methods, software tools, reservoir engineering, drilling and completion, integrated energy system design, power and heat plant design and operation. Each competence was accompanied by a five-point scale indicating its importance. The numbers had the following meanings:

1 - Not important

2 - Little important

3 - Important

4 - Very important

5 - Highly important

The full list of competences is shown in Figure 1.

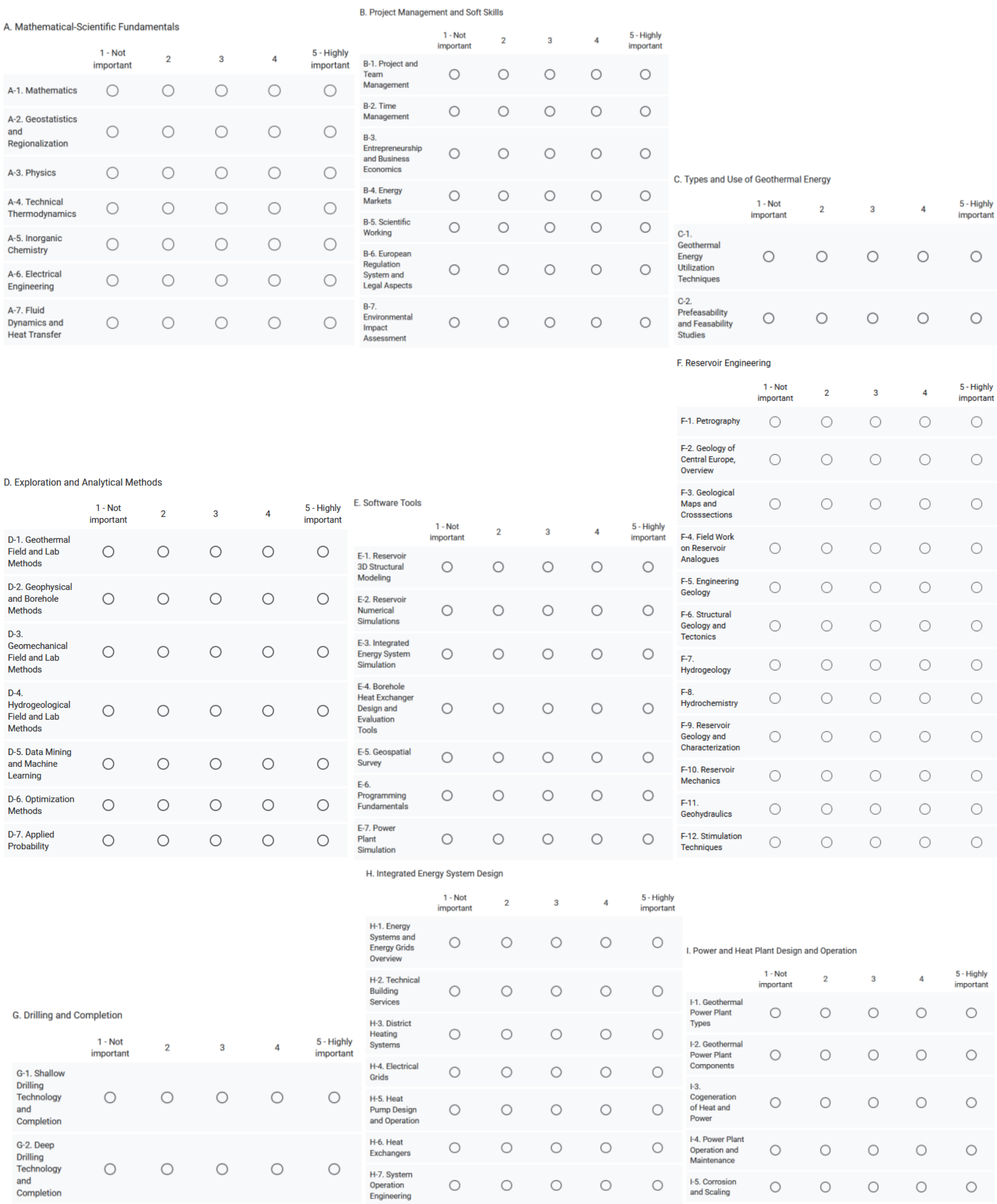

Figure 1: List of competences

Detailed results of the questionnaire on the importance of competences are described in the IO1 summary report on the competence matrix. Therefore, only the conclusions of that report are given here. Stakeholder responses showed that future graduates will have to master the following skills:

- on the scientific and technical aspects, have knowledge of the whole chain of research, exploration, development of geothermal reservoirs including in particular: geology, production techniques and how to sell it, exploration, consulting and geo-consulting (geothermal site detection, exploration methods, field, geophysics, physical laboratory measurements, etc.), drilling techniques in geothermal science, techniques for producing energy with low temperature water/shallow geothermal energy systems, geothermal power plants: operators/maintenance/design/material preparation/learning to repair, environmental monitoring and stakeholder engagement: awareness raising/communication;
- soft skills: entrepreneurship: creating/working in geo-startups, communication between different professions, like any good engineer, knowledge of regulations and legislation in the geothermal industry, to engage a work ethics, multilingual and multi-cultural environment.

2.3 Competences of current and future geothermal engineers

This final part of the questionnaire contained five questions:

1. Are there any competences important for the institution that are not on the list?
2. Which of the competences listed in the previous section of your institution's employees could be further improved?
3. Which of the competences listed in the previous section are the easiest to find on the labour market?
4. Which of the competences listed in the previous section are the most difficult to find on the labour market?
5. What competences do you think will be the most important in the next 10 years?

Overall, there were many different responses here, so the following considerations represent general tendencies and conclusions only.

Regarding the competences missing from the list, two trends were observed. First, many participants stated that seismology should be introduced because of its direct link with drilling techniques and exploration of geothermal deposits. Life cycle assessment was mentioned as a tool helping to quantify environmental impact assessment of a geothermal energy production and utilization. Second, it is necessary to devote more time to explain regulatory and legal framework for geothermal exploration and exploitation. Competences such as approval management, financing of geothermal projects, insurance, human resources management, standardization and decision-making are listed among others. These competences are essential because the regulatory framework in respect of the exploration and development of geothermal energy is in many countries either not existing or fragmented with provisions located in the various sectors of legislation. There is no particular regulatory administrational authority in geothermal matters which causes complications for developers to secure exploration licenses and exploit the reservoir and also contributes to increased financial risk for the investors. It is therefore of great importance to explore the possibility of creating certain industry standards for licenses and agreements in the field of geothermal exploration, utilisation and the production of electricity from geothermal resources.

It was interesting to notice that the answers to the second (Which of the competences listed in the previous section of your institution's employees could be further improved?) and third (Which of the competences listed in the previous section are the easiest to find on the labour market?) questions were quite similar. Two groups of competences were listed here: mathematical-scientific fundamentals and project management and soft skills. It turned out that there are a lot of graduates in scientific fields (mathematics, physics) on the market, but that their knowledge is not sufficient to participate in complex geothermal projects. Project and team management was most often cited as a competence that should be improved, although it is not difficult to find employees of this profile on the market.

In Germany and France, geological graduates were listed as the profile that is the easiest to find on the market, given that the stakeholders were mostly from the field of geology, while in Croatia, those were electrical engineers because many students completing studies in electrical engineering profiles are employed in companies that often have projects related to geothermal energy. In Germany, electrical engineers were mentioned as a profile which is the most difficult to find on the labour market. Data mining and machine learning and European regulation system and legal aspects are two additional competences that were mentioned as not easy to find on the market. Again, the problem of regulatory framework is recognized as difficult to solve.

Most of the competences that stakeholders think will be important in the next ten years are related to computer skills and numerical simulations (software tools, programming, reservoir simulation and 3D structural modelling, machine learning, artificial intelligence, information technologies, neural networks, etc.). In addition, reservoir engineering, reservoir mechanics, drilling and completion technologies were also mentioned. Therefore, computer and information technologies, as well as exploration and exploitation of reservoir, are recognized as competences that geothermal graduates will have to possess in the near future in order to be successful in their professional careers.

3 Discussion

Fifty-nine stakeholders completed the Geo3EN Competence Requirements Questionnaire (14 in France, 31 in Germany, 7 in Iceland and 7 in Croatia). Most of them perform activities in the field of engineering, research, consultancy and project management. Activities related to power plant, operation, maintenance and construction were less represented. Most responses to the survey were given by small and medium-sized enterprises with significant international cooperation and a large number of employees with a higher education. The business of companies that filled out the survey in Germany, France and Iceland is mostly related to geothermal energy, while in Croatia the situation is opposite, and geothermal energy is represented very little. Geology/geological reservoir engineers, mechanical engineers, environmental engineers and project managers were the most represented employee profile.

Results of the questionnaire showed that graduates in scientific fields (mathematics, physics), project and team managers can be easily found on the labour market, but their knowledge and skills could be further improved. Seismology and regulatory and legal framework for geothermal exploration and exploitation are the competences that should be included in the Geo3EN curriculum because many stakeholders believe that they are important and because they lack personnel with these competences. Regarding the near future, stakeholders anticipate that graduates with computer skills (software tools, programming, reservoir simulation and 3D structural modelling, machine learning, artificial intelligence, information technologies, neural networks, etc.) and reservoir engineers will be most in demand.