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ISE and the Energy Industry: Reviews of the Present and Discussion of Future Relationships

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ABSTRACT

The Iceland School of Energy (ISE), has been teaching a graduate program in renewable energy since 2008. The ISE by necessity, structure and ownership has a close relationship with the energy industry in Iceland. After 10 years of operation, the ISE decided to take a closer look at university-industry relationship in the form of a 42-question survey targeted at Icelandic energy industry employees. The aim of this report is to investigate relationship with industry that is meaningful to curricula development, research and graduate success.

The majority of respondents thought that graduate programs in Iceland should focus on Iceland's energy strengths, mainly geothermal, hydropower, renewable energy along with the addition of wind power. Out of all energy sectors the third biggest predicted future growth was in the geothermal sector.

Engineering is the discipline that will need the most graduate students in the future, followed by data science/computing and natural and mathematical science. Private energy companies will hire the most graduates in the future valuing energy system modeling as the most important technical skill and practical experience as the most important non-technical skill.

Geothermal educators need to remain cognizant of the requirement for numeracy and modeling skills. Resource assessment and resource management involve integration of many datasets into various models, for instance geological, geophysical conceptual, and reservoir models.

Practical experience has always been of importance in geothermal training, and its continuing significance means geothermal courses should continue to include internships and other means for students to gain work and practical experience in geothermal utilization.

1. INTRODUCTION

An interdisciplinary program for graduate students has been available in Iceland since 2008. The program was originally called Reykjavik Energy Graduate School for Sustainable Systems (REYST) but in 2013 it was rebranded into the Iceland School of Energy (ISE). ISE is jointly owned by Reykjavík University, Reykjavík Energy and Iceland GeoSurvey. The ISE by necessity has a close relationship with the energy industry in Iceland. However, after 10 years of operation the ISE decided to take a closer look at university-industry relationship.

The aim of the study was to investigate perception and values of those in the energy industry that are meaningful to energy education, academic relationships and the success of a higher education program in energy. The results from the questionnaire will subsequently be considered when modifying curricula at the Iceland School of Energy.

In November 2018 an online questionnaire targeting energy industry employees was distributed within 18 companies in Iceland. Those companies are all working in energy related projects in one way or another, e.g. distributers, consultancies, producers, etc. The purpose of the questionnaire was to gauge personal opinions of energy employees on selected energy related topics.

This paper presents a brief background to Iceland's renewable energy industry, followed by a brief review of literature on graduate renewable energy education as well as a concept called "academic success". It is followed by an overview on the methodologies used and presentation and discussion of the results from the questionnaire.

2. BACKGROUND

2.1 National background

Iceland's energy has been increasingly supplied from renewable sources since the 1940's. In 2017, 81% of all energy came from renewable energy sources (Hagstofa Íslands, n.d.). With increased focus on renewable energy world-wide, successful implementation of renewable energy education programs is becoming increasingly important.

Iceland has a Master Plan for Energy that details and categorizes undeveloped areas for energy production. The largest contributor by far is hydropower, contributing around 73%, and the second largest being geothermal, contributing ~27%. A miniscule amount of energy is contributed by fossil fuel generators (as emergency generators in remote areas) and wind energy.

In 2017, 10.3 million people were employed globally in renewable energy. Solar photo voltaics are the biggest part, employing 3.37 million people, followed by bioenergy (3.06 million) and large hydropower (1.51 million). The wind industry employed 1.15 million people in 2017. IRENA estimates that jobs in the renewable sector could rise to 23.6 million jobs in 2030 and 28.8 million jobs in 2050 (IRENA, 2018). Thus it is reasonable to expect a significant demand for graduates with training in renewable energy.

2.2 Academic success and determining success factors

The term "academic success" has been used extensively in literature, although the description may vary between articles. York, Gibson, & Rankin, (2015) developed a conceptual model based on extensive research on the term of "academic success". That model can be used to better assess "academic success" and that concept entails, more precisely, the success factors within the conceptual model.

Determining the success factors of a higher education program is important both for quality monitoring and to satisfy the needs of all players. Most of the success factors in the conceptual model are student centric, but some can be attributed to the higher education program. Those are the factors that the higher education program can improve to raise the overall academic success of the program. That can be done by making the program more relevant to current topics and by close partnership/relationship with the renewable energy industry. By gathering input from the industry with regards to current topics, different energy types and graduate skills, the higher education program may be bettered to the benefit of all players; students, the graduate program and potential future employers. Therefore, it can directly affect how successful the graduate program is with respect to how many boxes of the conceptual model are fulfilled (York, Gibson, & Rankin, 2015).

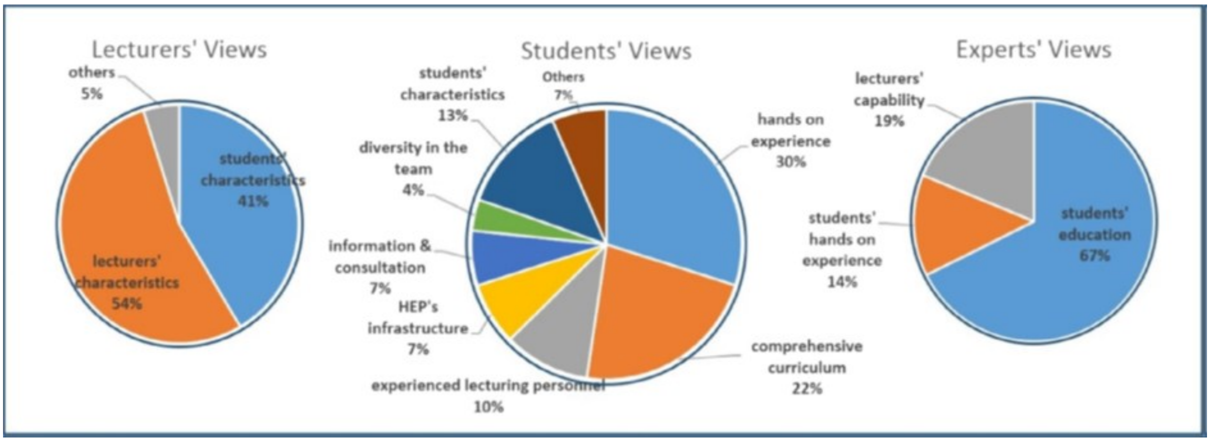

Figure 1:–"Success factors in higher education" (Holtorf, Brudler, & Torío, 2018).

This approach might not be relevant due to it being location specific. Iceland is a relatively small country where the universities have a working collaboration with industry. Making performing a very industry specific questionnaire feasible especially considering the willingness of participants and higher ranking employees who distributed the questionnaire within each company.

By identifying success factors the higher education program can use input from industry employees to improve existing curricula. That would entail updating the curricula to encompass current, relevant topics, and what/if industry employees think should be taught in Iceland.

Success factors refer to self-set goals (one or many) and positively influencing those goals. (Holtorf, Brudler, & Torío, 2018) asked three groups of stakeholders what their self-set goals were and assessed the success factors involved with regards to a higher education program. The success factors were either endogenous (the stakeholder is responsible for influencing the success factor) or exogenous (not influenced by the stakeholder). Summarizing the three groups of stakeholders; student think most success factors are exogenous rather than endogenous, experts listed no endogenous success factors, lecturers thought student's success factors are 41% endogenous but thought that the greatest overall success factor were the lecturers themselves, see Figure 1. Therefore, from the perspective of lecturers they themselves have the greatest influence on success factors in higher education programs and it is on their shoulders to make sure that the course selection, topics and concepts are of the most relevance and importance. It is also worth taking note that the capability of lecturers does not necessarily lead to exemplary graduate students. The students themselves have a varied view on the success factors involved in a higher education program, hands on experience being the biggest one. Experts seem to view the student's education as the most important thing.

2.3 Renewable energy education and industry

Renewable energy topics have not yet completely found their way into standard curricula and are rather represented in separate courses. That might be because of recent popularization of renewables and global demand for renewable energy. Currently there is a lack of widely agreed good quality textbooks, and coverage of topics might be dependent on, or biased towards the expertise of the available teachers. Renewable energy education often consists of courses that cover the basic concepts of each renewable energy source, without offering either wider content or the opportunity to specialize (Kandpal & Broman, 2014). For example: renewable energy course material in Turkey was often driven by the expertise of available teachers rather than industry demand (Acikgoz, 2011).

A mismatch between industry and the education system was highlighted in (Lucas, Pinnington, & Cabeza, 2018) where they used the IRELP (IRENA Renewable Energy Learning Partnership) database alongside expert interviews to identify the skill gap between industry and the education system. Additionally, they found a mismatch in the suitability of curricula in higher education programs and the industry where higher education courses lack more hands-on training. They also highlighted the importance of vocational training as a valuable form of education.

To decrease the skill gap between industry and renewable energy education (Kandpal & Broman, 2014) it is “necessary to periodically seek input from the industry about (a) any gaps between existing and desired levels of renewable energy education and training, (b) important courses for professional already employed in the field of renewable energy and (c) required skills and knowledge with the new entrants to renewable energy industry” (Kandpal & Broman, 2014).

Furthermore, the importance of industry is emphasized in (Malamatenios, 2016) as training programs and educational material should be provided by industry to better assist educational institutions to bridge the skills gap of renewable energy education and industry.

Adding two renewable energy courses to a conventional engineering degree would not provide the students with enough knowledge after their degree (Acikgoz, 2011).

Lastly, internships were emphasized in (Gutiérrez, Ghotge, Siemens, Blake-Rath, & Pätz, 2018) as well as industry contact in renewable energy. By having industry contact by way of internships or by pursuing a thesis topic outside university the professional development of graduate students might be increased. Practical lessons are highly valued and (Acikgoz, 2011)

3. METHODOLOGIES AND RESULTS

3.1 Methodologies

The second part of this project was creating a questionnaire that gauged the opinions of renewable energy industry personnel on various different energy fields. The sections of the questionnaire here cover:

- 1) General questions (age, gender, work experience, etc.) to later use as filters for the rest of the questionnaire.

- 2) Thoughts on different energy sectors in Iceland

- 3) Thoughts on various energy and university related topics.

The third part of this project was to present the questionnaire to industry personnel and convince them to take part in the project. That consisted mainly of talking to high ranking employees or directors and convincing them of the merit of the project. The fourth part of the project was to compile and analyze the data from the questionnaire.

The questionnaire was built intermittently over a month long period. A team within the Iceland School of Energy helped with the revision of the questionnaire where every question, answer and answer types were analyzed.

3.2 Results

The following section presents selected questions and significant variables from the survey. A total of 69 respondents partook in the survey, with an estimated response rate of about 17%.

The first question asked in the survey asked what gender the respondent was. 15 (22.06%) were women and 53 (77.94%) were men, one respondent did not answer this question. This result is representative of the actual proportion of women/men in Iceland’s energy workforce which is about 26% (Konur í orkumálum, 2017).

No respondent was under 20 years of age and most respondents were between 30 and 40 years of age. Interestingly, a normal curve is not represented on the age graph as might be expected. Lower values at either ends on the graph were expected since most respondents in this questionnaire had a higher level of education resulting in them not joining the workforce until they were closer to their thirties. The retirement age in Iceland is 67 years’ old which explains the other end of the graph. The dip in the 40-50 age range might have something to do with the recession in 2008. That age range should have joined the workforce around 2003-2008 and a proportion of that generation might have been laid off when the recession hit.

The background of respondents was mostly in engineering. That might be representative of the actual jobs available in the energy industry or representative of engineers perceiving surveys as quantitative data collection and being more responsive to participation requests.

Most respondents to the questionnaire had a higher level of education, a master’s degree or doctorate. That was expected as the survey specifically targeted that demographic within the energy industry.

Specialists were the most prevalent of all respondents to the questionnaire followed by managerial positions and executive. Three respondents chose the other option and wrote: “engineer”, “specialist and managerial position”, “corporate office and safety manager”. That might be due to the categories not being descriptive enough or a translation gap might exist when it comes to categorizing hierarchy within companies.

The largest portion of respondents have worked for more than 15 years in the industry. A dip can be seen in the 10−15 year work experience category which correlates to Figure 2 where the age of respondents was asked. Those people would have entered the workforce at the age of 25−35 which would coincide with the economic crash of 2008.

Most respondents to the survey work for a state owned commercial company, followed by private companies and government/regulatory companies. As with question 5 a translation gap or wording of categories might have confused respondents or perhaps the ownership of energy companies in Iceland is unclear. 9 respondents chose the other option and can be grouped into: 4 work for a municipality owned company, 4 for a power company and 1 for a state owned energy supplier.

From the questionnaire the typical size of energy companies in Iceland can be seen. As Landsvirkjun, Orkuveitan and Landsnet all employ between 100−1000 employees.

28 respondents out of 67 have lectured or supervised at a university which is indicative of a high level of industry engagement in graduate energy education in Iceland. That is also represented in existing literature as was mentioned in Chapter 2.

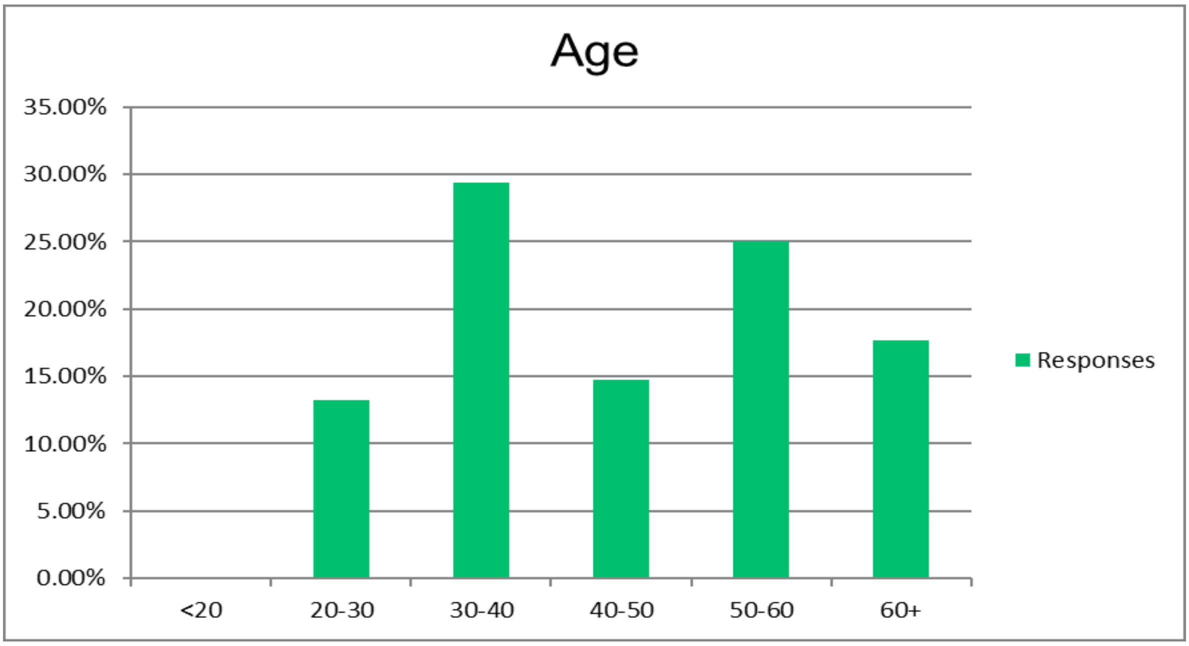

Figure 2: Age.

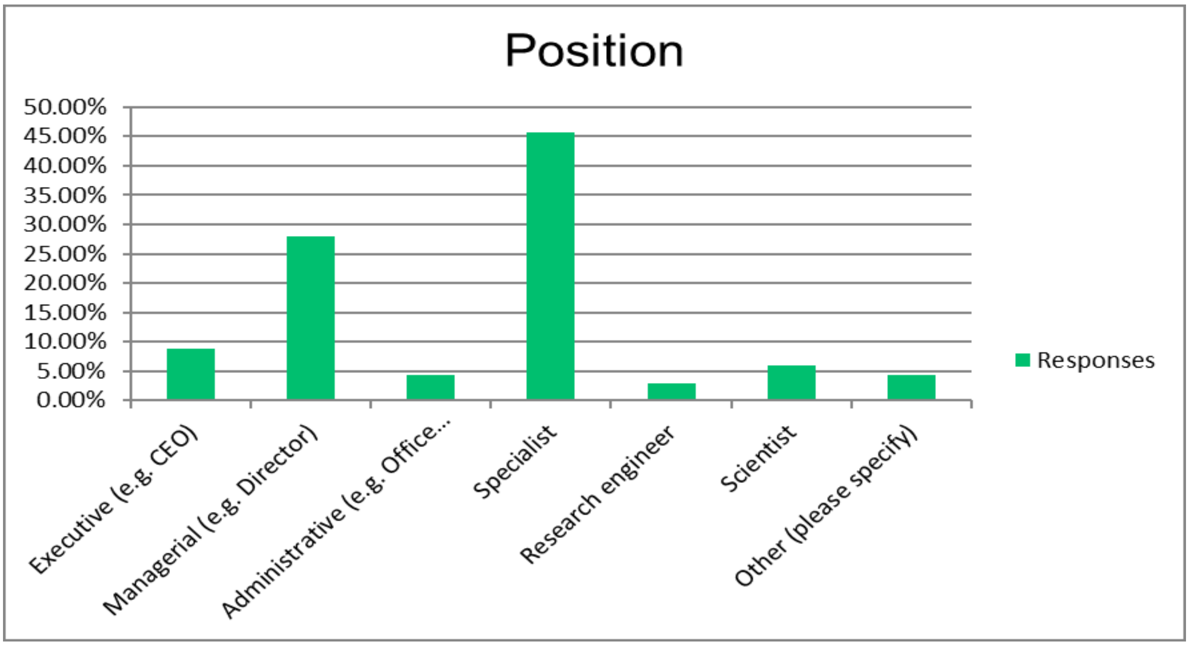

Figure 3: Position.

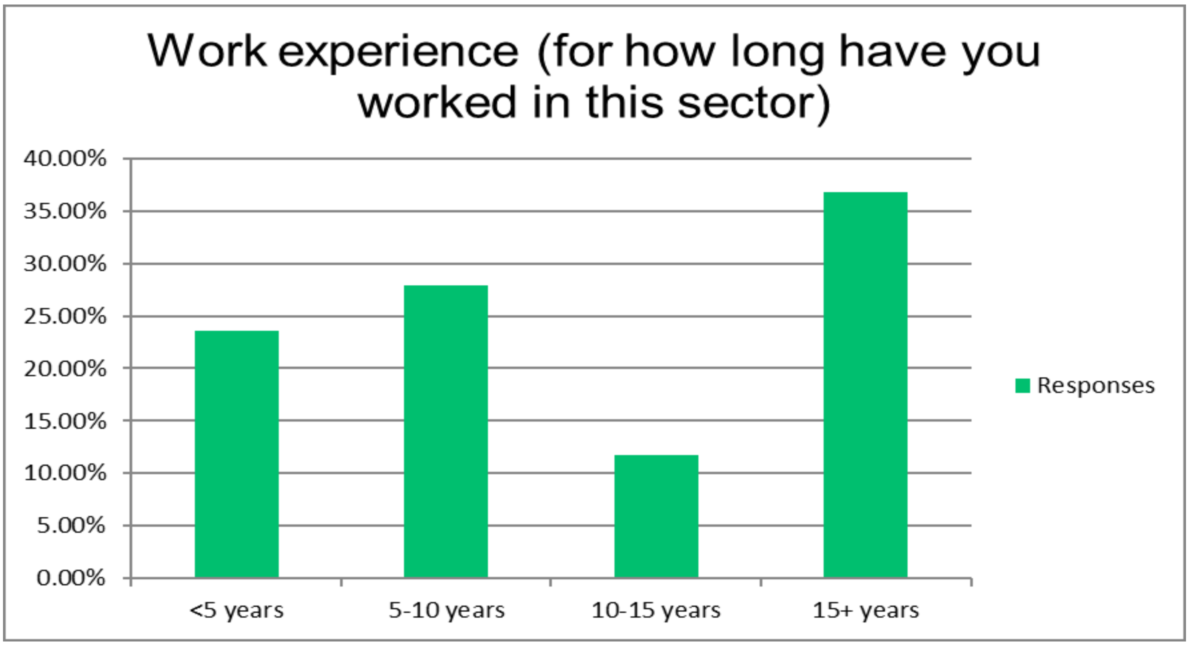

Figure 4: Work experience.

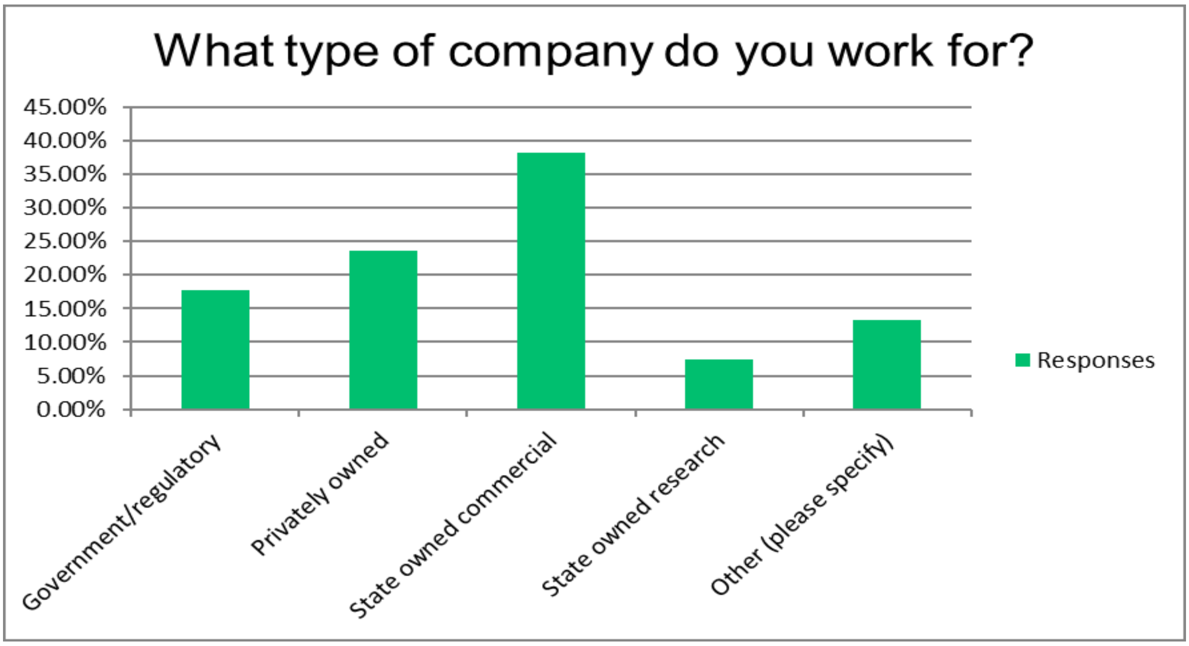

Figure 5: Company type.

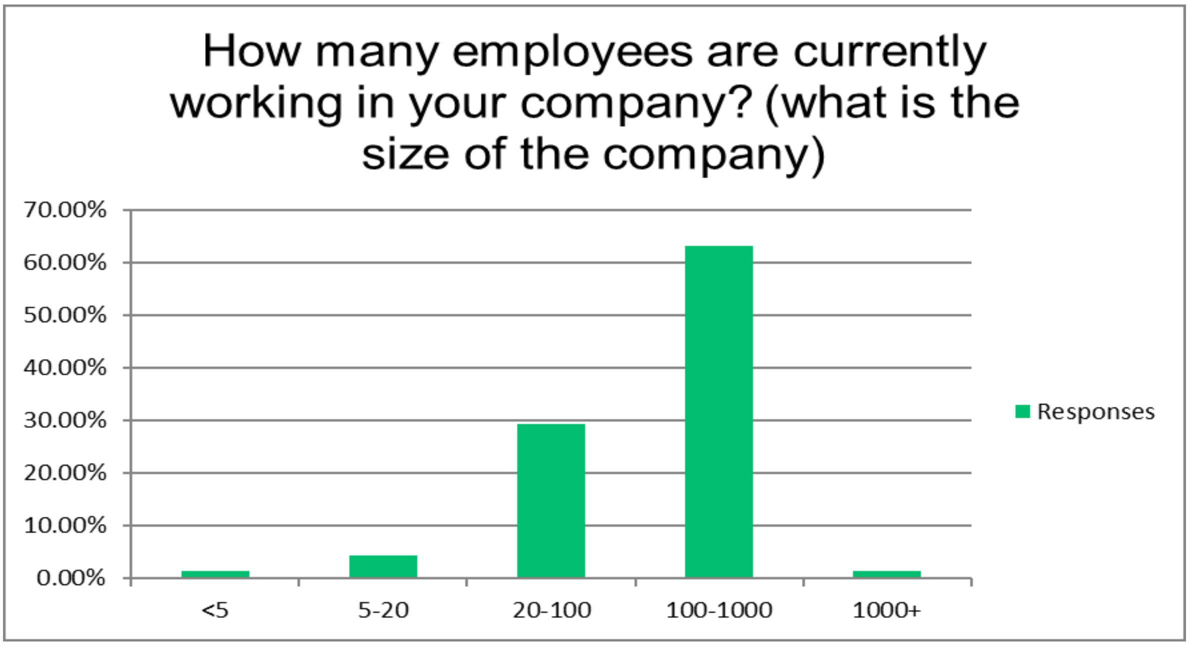

Figure 6: Company size

Select questions from survey

For Figure 7 and other questions in this study, the authors decided to allow respondents to check multiple answer boxes. That was to not constrain experts into selecting the most obvious answer but rather gauge the range of how they valued every category. Additionally, it is worth mentioning that removing the constraint of having only one vote might devalue the significance of each checkbox in turn. The most popular answers are all the established sectors in Iceland, mainly geothermal, hydropower and renewable energy, followed by electricity and power systems as well as energy project management. Additionally, innovative energy solutions are worth mentioning as a strength due to local design solutions and side products in Icelandic energy projects. The two people who chose other wrote: O&M know how and employee loyalty, environmental science.

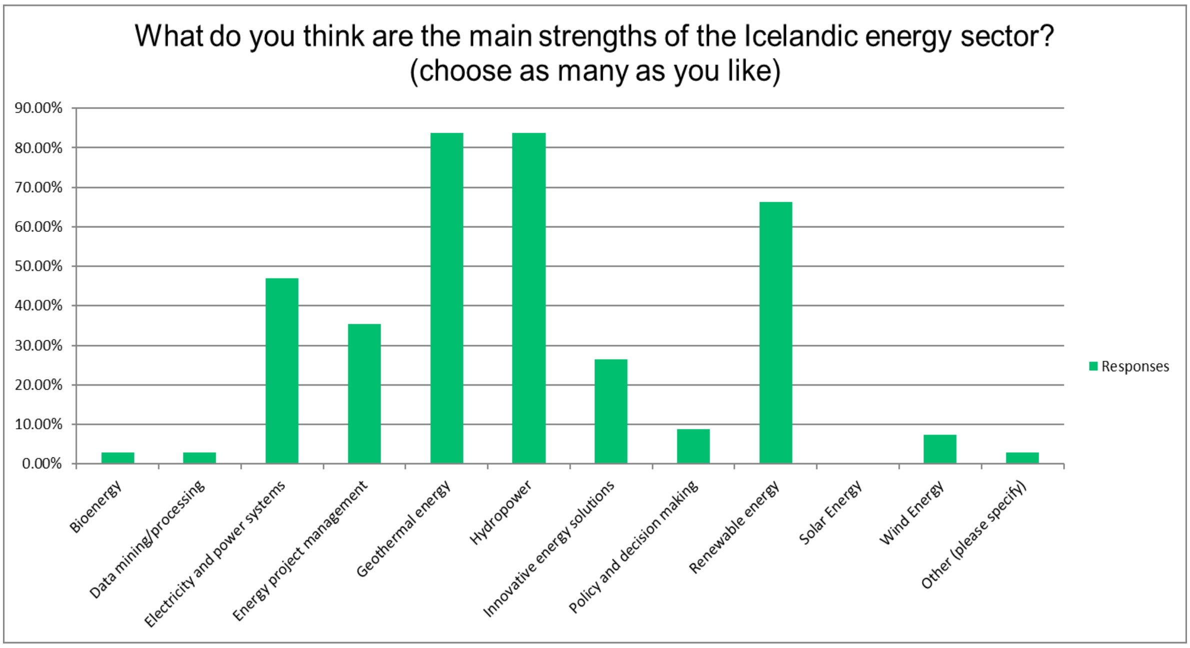

Figure 7: Iceland's energy strengths.

As with Figure 7 the respondents were not limited to only one vote. Similar to Figure 7 the respondents chose the Icelandic energy strengths as a focus for studies in Iceland. Geothermal, hydropower, innovative energy solutions, energy project management, electricity and power systems and renewable energy all scored around 50% or above. Wind energy is not listed as a strength in Iceland yet scored high in this question, indicating a potential strength for the Icelandic energy industry. Moreover, environmental science scored just under 50% and should therefore be considered. The environmental science option was lacking in Figure 7 revealing a lack of continuity within the questionnaire. Lastly, the respondent who chose the other option wrote: "Tidal and wave power. Additionally, all respondents who were scientists think geothermal should be a focus for studies in Iceland. Most executives would like electricity and power systems, energy project management, geothermal and hydropower to be taught in Iceland.

Executives and scientists believe in data science/computing more than anyone else and executives believe in internet/communication technologies to energy more than anyone else. In conclusion, most participants that had the greatest work experience wanted wind to be focus for studies in Iceland.

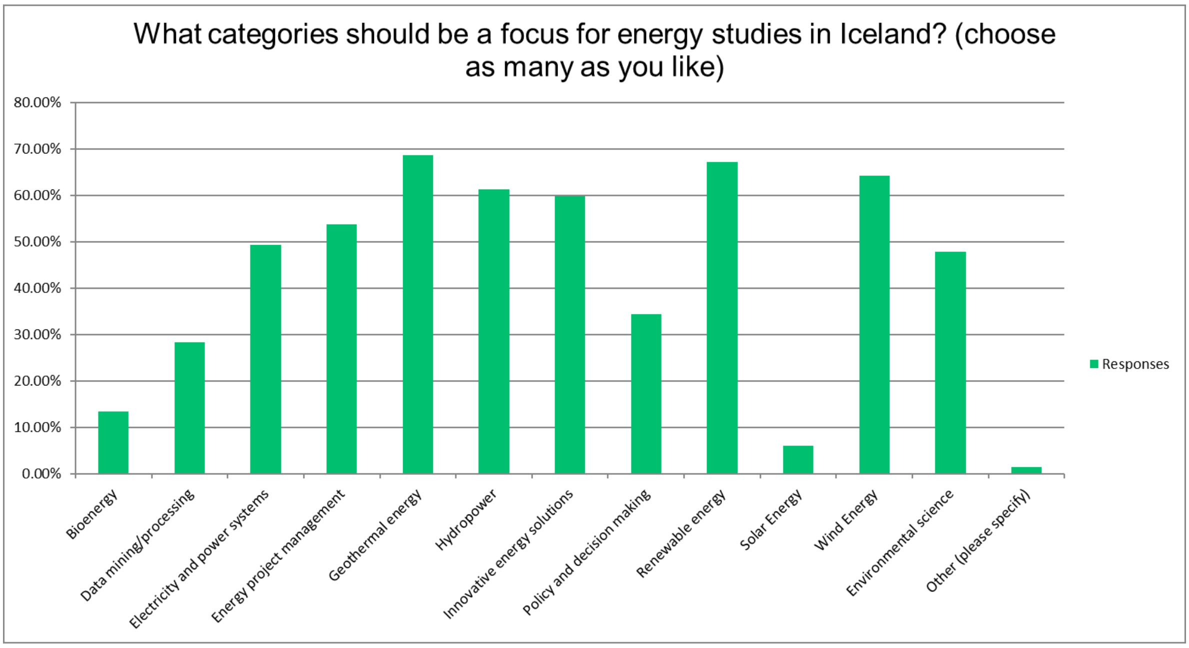

Figure 8: Focus for studies in Iceland.

Figure 9 suffered from a lack of definition as "future" is not specifically defined leaving an open interpretation of the word, e.g. near future or 100 years from now. That being said the biggest future growth in Iceland is predicted in wind energy. Wind energy has not been prevalent in Iceland so far but plans have been proposed by Landsvirkjun to build a wind farm near Búrfell. However, that has not come to fruition yet as it still has challenges to overcome. Environmental science scores second highest and might be related to growing global warming concerns or a greater public environmental consciousness. Geothermal energy has the third biggest expected growth in Iceland. That was most prevalent among respondents with 10-15 years of work experience as 75% of them believe that geothermal energy will have the biggest growth in Iceland.

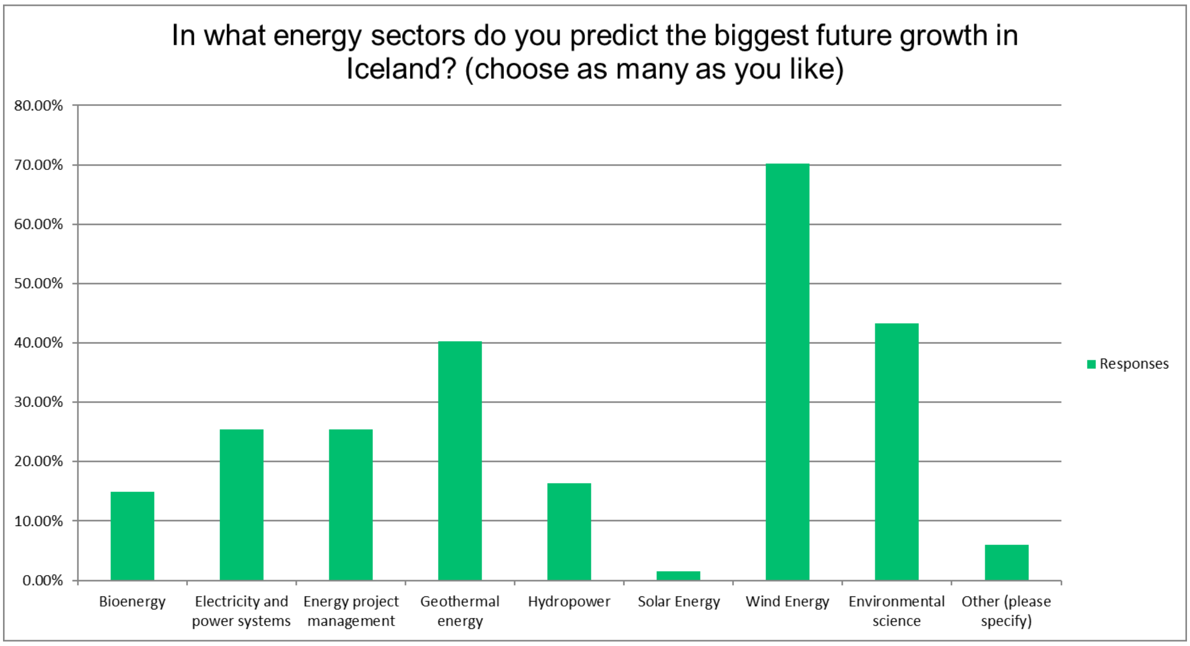

Figure 9: Predicted growth.

Questionnaire respondents believe that the biggest future energy demand in Iceland will come from light industry, indicating that the industry in Iceland will grow. The second largest growth will come from electric vehicles which is in line with current social trends regarding emissions and global warming consciousness. Moreover, it seems that the Icelandic energy industry is not optimistic regarding the interconnection cable to Europe. Additionally, it seems that respondents believe that Iceland's current strengths in energy will meet future energy demand with the only addition being wind power. Almost no respondents believe that solar energy or bioenergy will be important in meeting future energy demand.

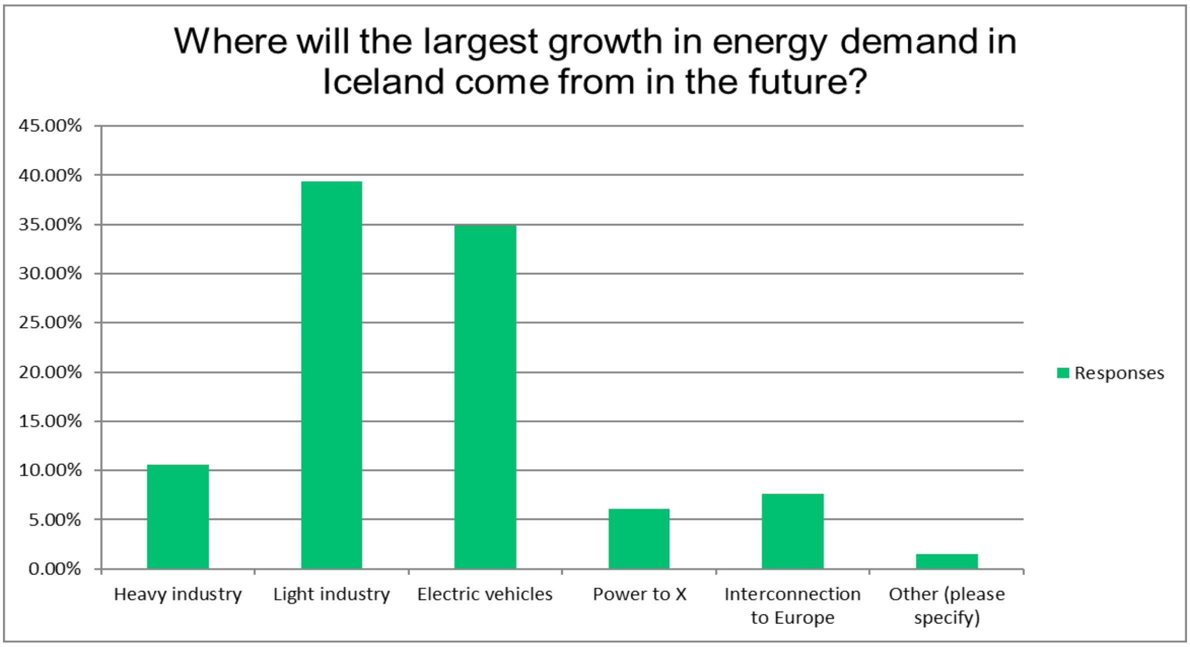

Figure 10: Energy demand.

Engineering will have the biggest need for master's level graduates in Iceland. Most of the respondents to the questionnaire were engineers, but no matter what background the respondents had, they all chose engineering. The second and third most popular categories were data science/computing and natural and mathematical science. The answers seen on Figure 11 might be a representation of the types of jobs available in the energy industry. One question in the questionnaire had the respondents rank categories to get a hierarchy of potential future graduate energy employment. This proved to be the wrong choice of action since the question did not provide useful results and all categories scored similarly.

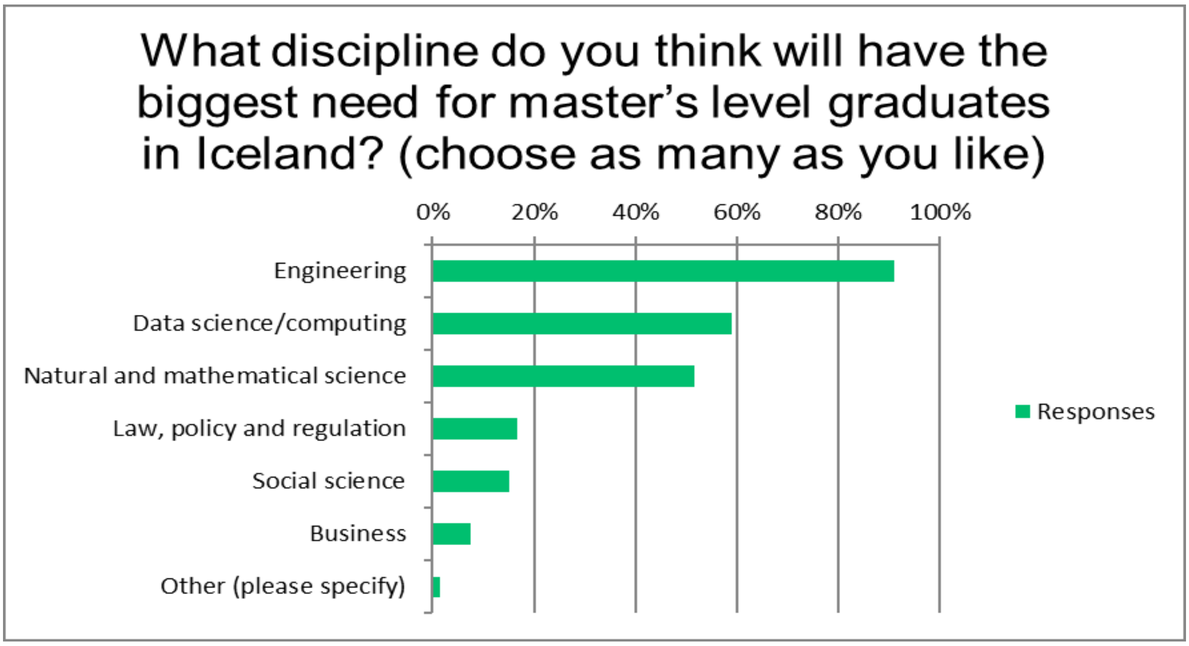

Figure 11: Discipline.

Figure 12 produced expected results from the respondents with regards to earlier questions within the questionnaire, namely Figure 11. The most popular categories with respondents are all related to the top categories from Figure 11, engineering, data science and natural and mathematical science. Additionally, Figure 12 may not have encompassed enough categories or not been clear enough since 5 respondents chose the 'other' category and wrote: "CO2 accounting", "math, chemistry, physics, programming, and a specialization in a field such as; solid state physics, electronics, aerodynamics, hydrodynamics, solid mechanics, or chemical engineering", "energy system modeling and resource knowledge", "general programming skills", "natural science like physics and chemistry".

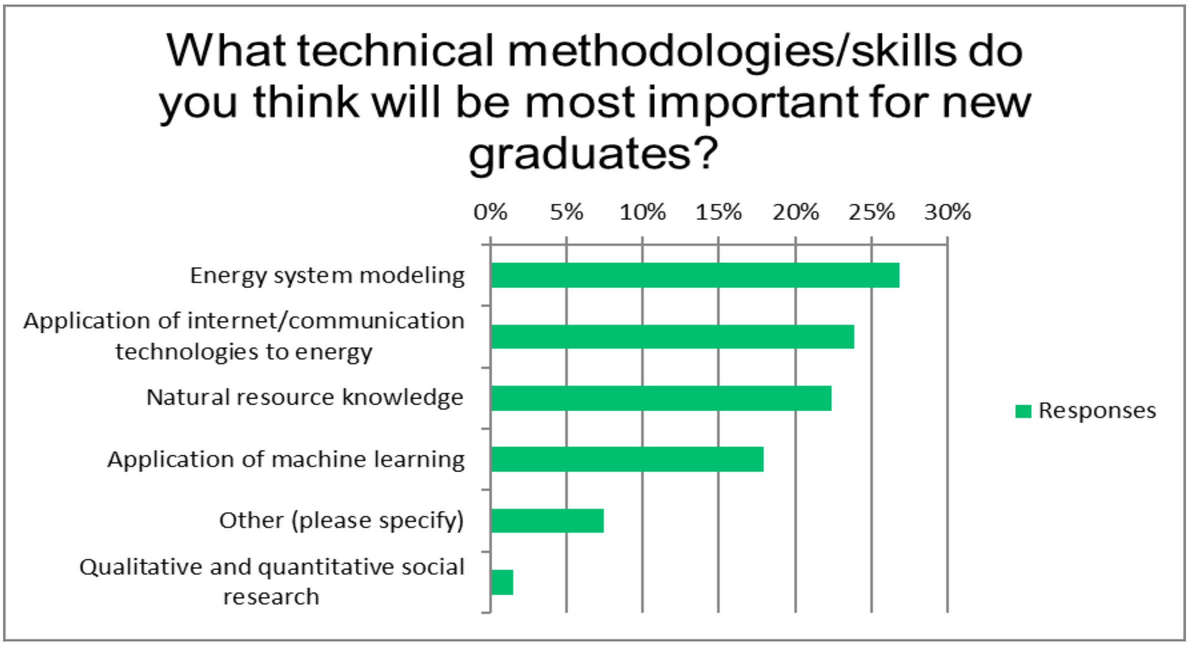

Figure 12: Methodologies/skills

The results from Figure 13 match what can be found within existing literature and Chapter 2. Practical experience is the highest valued non-technical skill by the questionnaire respondents. The second largest category was the ability to adapt to change which might be indicative of the nature of projects being worked on in the energy industry. Communication/public relation are also highlighted as important.

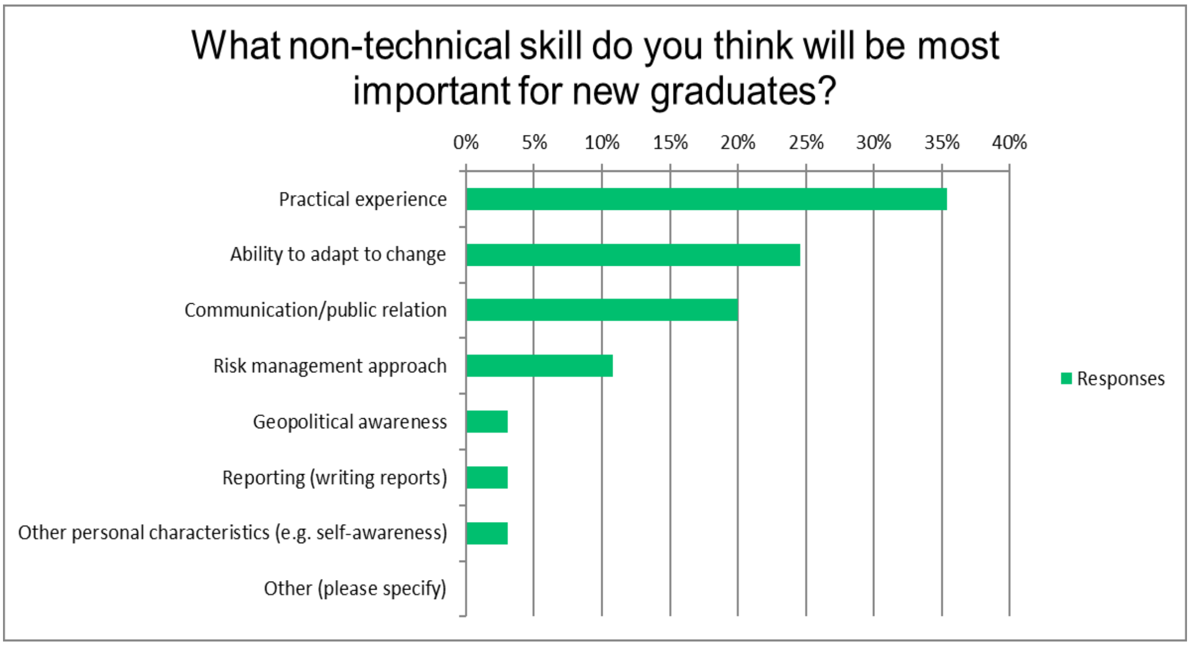

Figure 13: Non-technical skill.

5. DISCUSSION

From the content of this report it is clear that the renewable energy industry is willing to contribute to the bilateral flow of information by participating in an energy related university questionnaire such as this one.

Overall, a varied selection of energy topics should be taught in energy studies in Iceland. Out of all topics, only bioenergy and solar energy were rated as locally unimportant. Geothermal, hydropower, wind energy and renewable energy were all considered important as were energy efficiency and power systems. Additionally, the majority of participants thought graduate energy education should be mostly specialized with some interdisciplinary courses.

The majority of participants think the biggest energy need in the future will come from light industry, electric vehicles come in second. In order to meet that demand hydropower and wind power will be most important followed by geothermal energy. Participants think that the biggest need for graduate students in energy will be in the transmission/infrastructure or the environmental/social sectors. Even though participants think there will be need for graduates in the environmental/social sectors they do not seem to think there's a need to teach social sciences. Engineering is the discipline that will need the most graduate students in the future, followed by data science/computing and natural and mathematical science. Private energy companies will hire the most graduates in the future valuing energy system modeling as the most important technical skill and practical experience as the most important non-technical skill. When employing new graduates their Icelandic skill might be of importance since there seems to be a split opinion on whether it is required or not.

6. CONCLUSION

This project aimed to investigate energy industry relationship with the ISE and their input on curricula development. From this questionnaire it is apparent that the majority of industry personnel would be willing to contribute to graduate university education in one way or another and the bilateral flow of information is considered important. Iceland's energy strengths should still be the main focus for studies in Iceland and Iceland's geothermal sector is expected to grow. Private energy companies will hire the most graduate in the future with a high demand for engineers and graduates with mathematical and modelling abilities. Out of all non-technical skills, practical experience is the most important highlighting the need for internships and real-life experience for graduate students to better prepare them for the transition into the working environment.

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