МОНГОЛ УЛСЫН ШИНЖЛЭХ УХААН ТЕХНОЛОГИЙН ИХ СУРГУУЛЬ
БАРИЛГА, АРХИТЕКТУРЫН СУРГУУЛЬ

Advanced Curriculum on Energy Efficient Buildings in Extreme Continental and Sunny Climate

Report on the needs of updating/creating bachelor/master/short term training courses in Mongolian Universities

2020

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1 Introduction and Background

1.1 BACKGROUND AND MOTIVATION

Mongolia is a transition country, which since 1990s has experienced a profound socio-economic transformation from soviet-style socialism and planned economy to democracy and free markets. Following a massive decline of the nation's GDP in the 1990s, Mongolia started into the new millennium with high rates of economic growth that were largely driven by a booming mining sector. The heavy dependence of the national economy (and the government budget) on mining bears considerable risk for Mongolia's social and economic development. Another challenge for Mongolia's further development is the region's extreme continental climate; in Ulaanbaatar, which is the world's coldest capital city, winter temperatures regularly drop to -40°C and below. A massive inflow of population in recent years resulted in overburdened infrastructures and severe levels of environmental degradation. The social, technical and financial challenges for Ulaanbaatar's development will in the future require an integrated approach which besides investments also includes the transfer and development of suitable technical solutions and capacity building.

1.2 COLLABORATIVE PROJECT

The work presented in this report was implemented as an initial stage of the collaborative project between Lund University (LU), Talinn University of Technology (TalTech), Mongolian University of Science and Technology (MUST), German-Mongolian Institute of Resources and Technology (GMIT) and Mongolian University of Life Sciences (MULS). This project is funded by European Union.

1.3 CURRENT ENERGY EFFICIENCY AND HIGHER EDUCATION SCENARIO IN MONGOLIA

For the effective implementation of the project, partners should understand the current situation in Mongolia in the fields of Energy efficiency and Higher Education. Consequently, to provide overview of the relevant fields, brief information on Energy Efficiency and Higher Education is presented in this section.

1.3.1 ENERGY EFFICIENCY IN MONGOLIA

Energy plays a crucial role in the development of a country including industrialization, expansion of economy, natural conservation, climate change, sustainable development and many others. Furthermore, understanding the weaknesses and strengths of energy sector of Mongolia is important in successfully implementing the CEBEC project. Consequently, to explain the current energy situation of Mongolia, three key elements were presented in this section including energy resources, energy efficiency in buildings and energy efficiency in Ger Areas.

Mongolia's main energy resource is coal (93.5%) with a relatively small amount of energy from wind power mills, solar panels, hydropower, oil and wood. According to the Ministry of Energy, Mongolia has a total of 8 power plants built in 1960s-1980s with the capacity of 1116 MW, which supplies the country's demand of electricity and heating. In 2016 electricity consumption reached its highest demand of 975 MW and its 21% was supplied from foreign power plants, implying the possibility of energy supply deficiency in near future. With the rapid increase of mining sector development and urbanization of cities and provinces, from 2005 to 2010 energy demand increased four

times compared with previous years. Accordingly, since 2005 Mongolian Government took several measures to reduce the coal dependency and set goal to increase the use of renewable energy to 20% by the year of 2020 and 30% by the year of 2030. Mongolia has a vast uninhabited land with a potential for constructing large wind power mills and solar panels. According to the study conducted in 2001 with the support from Renewable Energy Laboratory of Energy Department of USA, Mongolia has a wind energy resource of 160 000 km^2 area. It means that Mongolia can produce about 2.5-trillion kW/h energy annually. For the solar energy, 70% of Mongolia's territory comprises of a steppe and Gobi desert, where sunny period is about 2900-3000 hour annually and solar energy intensity is about 4.5 kWh/m^2.

As of year 2018, total of 6 700 companies are operating and about 76 600 people are working in the construction sector. Related with the mechanical movement of citizens from countryside to Ulaanbaatar city, the demand of constructing new buildings and reconstructing the existing ones is growing, as the older apartments, schools and hospitals constructed during soviet period is poorly insulated and reaching its serviceability limit. According to UNDP report, from the year of 2020 to 2030 about 140,000-household new apartments will be constructed, simultaneously increasing the energy demand and the need for improving energy efficiency in buildings. As of year 2015, construction sector consumed 8.64 GW of energy and emitted 4.94 million ton of CO_2 into the air with the continuous growth annually.

Mongolia is one of the emptiest countries in the world, but the capital city of Ulaanbaatar is densely populated accommodating nearly half of its population. Surrounding the city center of Ulaanbaatar, Ger Areas comprising of small households

and traditional Mongolian houses not connected to the central drainage and heating system occupies more than half of the city's inhabited territory. To stay warm, these households burn raw coal during harsh winter reaching up to -40°C, resulting in massive air and soil pollution in the city. Most of the houses in Ger Areas are self-built without following any norms and standards in constructing and insulating. Consequently, to tackle these problems Government of Mongolia with the support of World Bank, Asian Development Bank and many other foreign non-governmental organizations has taken several long-term and short-term measures. However, environmental pollution in Ger Areas is still a huge problem in Mongolia that needs urgent attention, as it causes numerous health problems.

To sum up, the following conclusions can be made from abovementioned facts:

1. Mongolia is rich in renewable energy resources and is planning to increase renewable energy supply in near future, implying the demand of professionals and experts in the relevant field.
2. Construction sector is expanding with the mechanical growth of population in Ulaanbaatar. Existing buildings are energy inefficient and emitting large amount of CO_2 into the air; buildings to be constructed in future will be energy inefficient if not properly designed and insulated. To make future buildings energy efficient, engineers and experts in charge of design needs to be trained.
3. Ger area causes a huge environmental problem in Mongolia, which needs an urgent measure from government, professionals and engineers.

1.3.2 HIGHER EDUCATION IN MONGOLIA

After the transition of economic and political system in 1990s, the education sector of Mongolia remained unchanged almost until 2000s as most of the educators, schools, universities and other institutions kept the old soviet style teaching, researching and educating. Most of the laboratory equipment, teaching materials and facilities brought from Soviet Union in 1970s and 1980s were not updated until the late 2000s. Furthermore, with the economic decline in 1990s, many educators left their job and started doing small businesses to survive during transition period, causing human resources problems and creation of numerous low quality private universities and colleges in Mongolia. Although reforming education system obviously takes long time and massive financial resources, Government of Mongolia is taking some measures to enhance the facilities and transfer technology from developed countries since 2010. However, there are still considerable amount of courses, programs and curricula that follows the outdated old soviet style textbooks, teaching and laboratory.

In the year of 2017 Mongolian Government approved set of policies in the field of Science and Education, which emphasizes the importance of research and sets a goal to make the universities research-oriented rather than teaching only oriented. In the framework of these policies, public universities took some actions to encourage professors, lecturers and researchers to conduct more research and publish scientific papers despite the lack of laboratory equipment and facilities. Moreover, number of students in master or doctorate program is relatively low compared with bachelor program due to deficiency of strong graduate programs addressing existing problems in the engineering fields and meeting labor market demand. In addition, courses in bachelor

program do not provide necessary research skill sets to help students conduct research in future.

To sum up, the following conclusion can be made from aforementioned facts:

1. Mongolia's higher education is in the process of shifting from teaching oriented system to research-oriented system.

2. To become research-oriented university, curricula (lab equipment, courses, textbooks, lecturers' ability, etc.) need to be updated.

1.3.3 EXISTING PROGRAMS

Currently School of Civil Engineering and Architecture - Mongolian University of Science and Technology, German-Mongolian Institute of Resources and Technology and Mongolian University of Life Sciences offers the following programs in undergraduate and graduate level studies related with energy efficiency and renewable energy.

Name of University	Program name	Level of study
School of Civil Engineering and Architecture, Mongolian University of Science and Technology	Heating Supply and Ventilation	Undergraduate and Graduate
German-Mongolian Institute of Technology		
Mongolian University of Life Sciences		

1.3.4 ROLE OF CEBEC PROJECT

CEBEC project is dedicated to updating/creating bachelor/master/short term training courses to deepen the understanding and develop skill sets of students and professionals working in the field, so that they will be able to tackle problems addressed

in this section in an effective way. The courses to be developed will educate the students on improving energy consumption of the buildings by applying energy efficient measures and the concept of renewable energy. Moreover, some of the courses will enhance students' ability to conduct research and write scientific papers independently.

2 Survey Methodology

2.1 OBJECTIVE OF THE SURVEY

In order to study the need for updating/creating bachelor/master/short term training courses in the field of renewable energy and energy efficient building, a survey was developed. The main objective of this survey was:

- To understand the employers' perspective/opinion on the need of updating/creating courses
- To identify the important skill sets that employer is looking for

2.2 STRUCTURE OF THE SURVEY

The questionnaire (Appendix) was modified from European Union funded project CIMCEB (Master of Engineering in Renewable Energy) that consisted of 4 main parts including Information about the organization/company, Needs, Requirement and Competencies and General position about the project.

Information about the organization/company

This part was intended to collect data on type of organization/company, number of employees and position of the respondent. These data were required to ensure right respondents were included in the analysis.

Needs

This part was intended to find out need of graduates specialized in Renewable Energy, Building Energy Efficiency, Environmental Engineering and number of graduates working in the relevant field and organization/company's plan of recruitment over the next five years.

Requirement and competencies

In this part respondents were asked to identify the professional, methodological and personal competencies that organizations/companies look for when recruiting graduates.

General position about the project

This part was intended to find out if the proposed courses in bachelor/master/short term training courses is relevant to the organization/company and if they are willing to cooperate by providing internships and receiving training from our universities.

3 Results

To obtain a reasonable result that can represent the employers from different sectors, a total of 87 responses were collected from private companies, non-governmental organizations and governmental institutions. The list of organizations participated in the survey is presented in Table 2. The survey was conducted using questionnaire and respondents included employers and employees holding various positions such as CEOs, chief executive officers, leader engineers, senior engineers, architects, researchers, consultants, general managers, monitoring officers, directors, deputy heads and private contractors.

Table 2. List of companies/organizations

No.	Name of Organization	Brief comments
1	Ministry of Construction and Urban Development	Policy maker of construction sector of Mongolia
2	Construction Development Center	Focuses on developing construction norms and standards in Mongolia
3	Urban Planning and Development Department of UB Municipality	Focuses on developing urban planning documents/visions/strategies in different cities and provinces of Mongolia
4	Ministry of Education, Culture, Science and Sports	Policy maker of education sector of Mongolia
5	Mongolian Association of Civil Engineers	Organizes short-term and mid-term trainings for professional and consulting engineers in various fields of civil engineering
6	Mongolian Association of Construction Designers	Organizes short-term and mid-term trainings for professional and consulting engineers specialized in construction drawing and design
7	GIZ	Non-governmental organization working on various projects related with Energy Efficiency of Buildings
8	MCS Group	One of the biggest companies in Mongolia doing businesses in mining, construction, communication, food and etc.
9	Nomin Construction Development Group	One of the biggest construction companies in Mongolia, building many apartment complexes and multi-purpose buildings
10	Power Plant IV	Public (governmental) company, which provides most of heat and electricity supply of Ulaanbaatar city
11	MONCON LLC	One of the biggest construction companies in Mongolia mainly focused on apartment construction
12	GCR LLC	One of the biggest companies operating in mining and construction sector of Mongolia
13	Megalokomotive LLC	Medium-sized construction company focused on construction, building materials and metal structures
14	Khurel Ordon LLC	Medium-sized construction company

15	Khurd Group	One of the biggest construction companies in Mongolia, which constructed many apartment complexes and trading centers in Ulaanbaatar
16	Hurd Group	Medium sized companies specialized in sanitary engineering
17	Beren Group	One of the biggest companies operating in mining, construction, real-estate, food and etc.
18	Delgermurun Construction	Small sized company specialized in sanitary engineering and construction
19	MBU Construction	Medium sized construction company
20	Gegagrand Construction	Small sized construction company
21	Dinnovation Architecture LLC	Small sized structural drawing and architectural planning company
22	Senzo Architecture	Medium sized architectural drawing company
23	Toonot Grand LLC	Small sized architectural drawing company
24	Gobi Travel LLC	Medium sized architectural drawing and construction company
25	Oyu Tolgoi LLC	One of the biggest mining companies in Mongolia
26	Energy Resources LLC	One of the biggest mining companies in Mongolia
27	Mongolyn Alt Corporation (MAK)	One of the biggest companies doing businesses in construction, mining, material producing and aviation.
28	Asian Development Bank Project	Small sized project unit working in construction sector of Mongolia
29	Newcom Group	One of the biggest companies doing businesses in wind power mills, communications, trade and etc.
30	Construction Materials Research Center	Conducts research in construction materials, investigating its properties.
31	Talin Yazguurtan Mongol LLC	Small sized construction company
32	Barilga.MN	Small sized company working in the construction informatics and journalism

3.1 INFORMATION ON ORGANIZATIONS

Respondents to the survey include representatives from different sectors such as ministries, energy sector private and governmental companies, construction companies, construction material producing companies, mining companies and non-governmental organizations, which play an important role in the economy and sustainable development of the country. The survey intended to make a good mix from both policy makers and private industries to obtain a clear prospect on the needs of future labor market in the fields of renewable energy and building energy efficiency.

Figure 1 depicts types of organizations/companies that participated in the survey. Approximately 49% of the respondents were construction company CEOs, senior engineers, managers, quality control officers, architects, designers and human resources team representatives, who largely influence the future of labor market. About 28% of respondents were from governmental organizations or policy makers who determine the

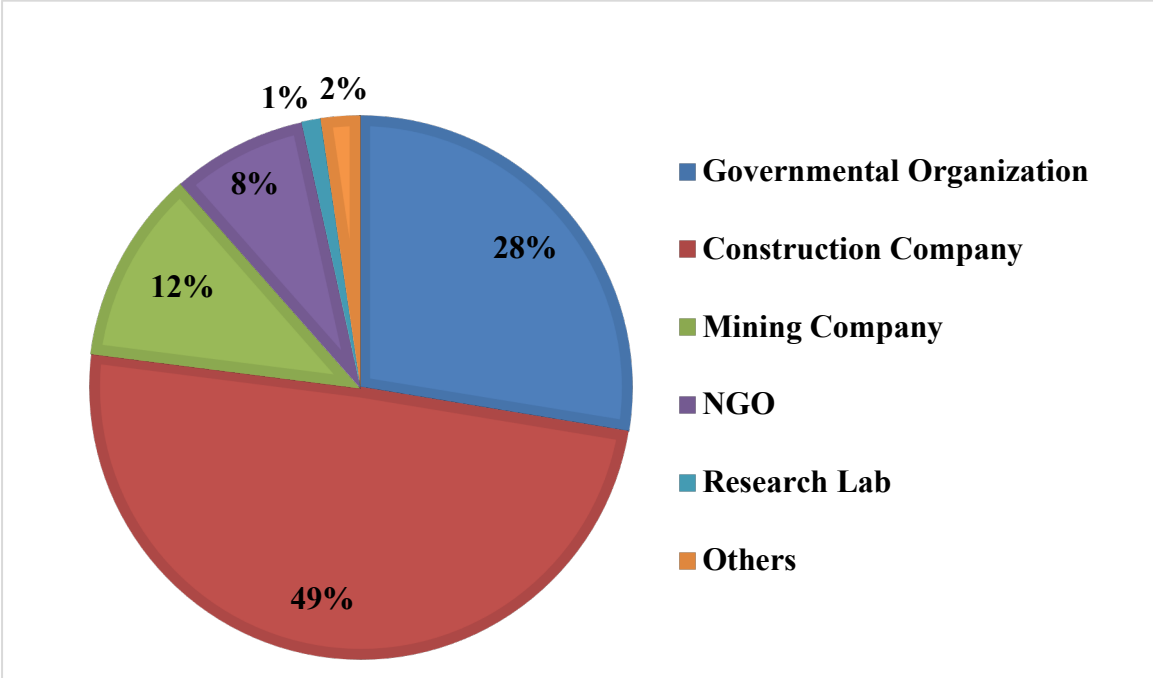

Figure 1. Type of organizations/companies

paradigm or vision of the urban planning, new renewable energy/energy efficiency projects, norms and standards in the construction and energy sector of the country. Although not directly related to building energy efficiency and renewable energy, mining sector is the main player in the economy and labor market of Mongolia, which employs construction engineers, environmental engineers, energy auditors and others. Consequently, 12% of the respondents were CEOs, engineers and managers from mining companies. About 8% of the respondents were NGOs, who are working to alleviate environmental problems existing in the country and who trains consulting and professional engineers already working in the market.

Figure 2 represents the size of the organizations/companies participated in the survey. The size of organization was categorized based on the number of employees. The respondents were grouped into three sectors: small, medium and large. The organizations having less than 20 employees were categorized as small sector, 20-100 employees as

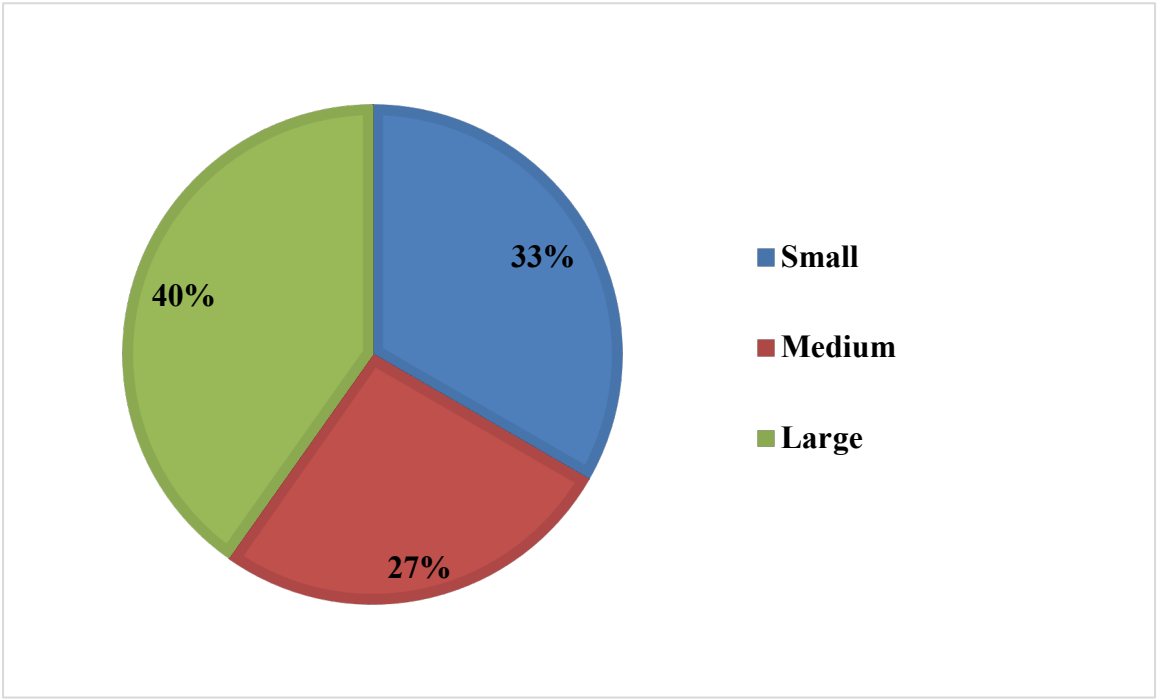

Figure 2. Size of organizations/companies

medium sector and more than 100 employees as large sector. According to Figure 2, 40% of the respondents belong to category “large”, 27% to category “medium” and 33% to category “small”. The sizes of the organizations show that the country is having variation in different economic activities and they have variation in the concept of energy efficiency and renewable energy.

3.2 NEEDS

To determine the future needs and demands of the labor market in the fields of Energy Efficiency, Renewable Energy and Environmental Technology, number of employees currently working in the organization/company specialized in the relevant fields, difficulty in finding the experts/engineers and planned positions for the next 5 years in the relevant fields were asked from respondents. From Figure 3, it is apparent that majority of companies does not have workers in the fields of Energy systems, Energy

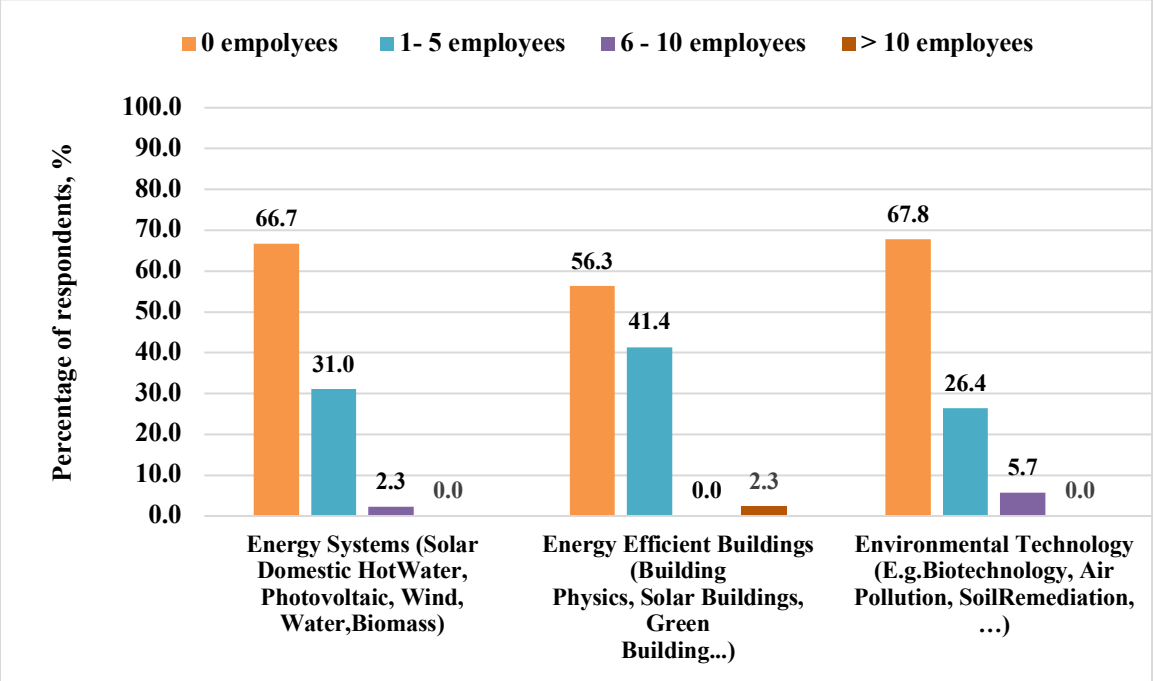

Figure 3. Number of employees in the relevant fields

Efficient Buildings and Environmental Technology, implying the immaturity of companies/organizations in the fields of energy efficiency and renewable energy. Around 97% of the organizations surveyed does not have or have few employees working in the energy systems and energy efficient buildings. Moreover, about 90% of the organizations does not have or have few specialists/engineers working in the environmental technology field. The situation of having very less employees or no employees in the field of energy systems and energy efficiency of buildings were mainly attributed to the lack of experts in those fields.

Figure 4 depicts the current demand of graduates in the fields of Energy Efficient Buildings, Energy Efficiency, Renewable Energy, Environmental Engineering and Climate Change. Apparently, the highest demand of graduates (76%) is in the field of Energy Efficient Buildings followed by Energy Efficiency, Environmental Engineering, Renewable Energy and Climate Change.

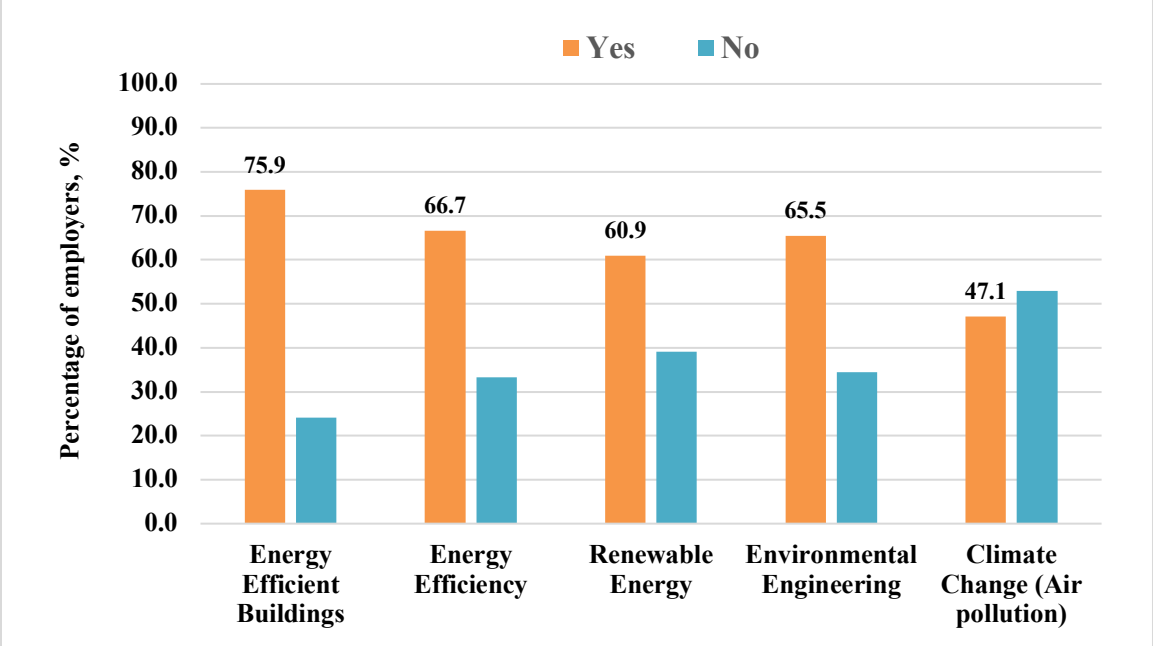

Figure 4. Demand of graduates in different fields

According to Figure 5, organizations/companies experience difficulty in finding graduates in the fields of Energy Efficient Buildings (70.1%), Renewable Energy (60.9%), Environmental Engineering (60.9%), Energy Efficiency (57.5%) and Climate Change (56.3%). Furthermore, it is evident from the chart that current programs/curricula in universities cannot supply enough number of professionals in the relevant fields to the industry.

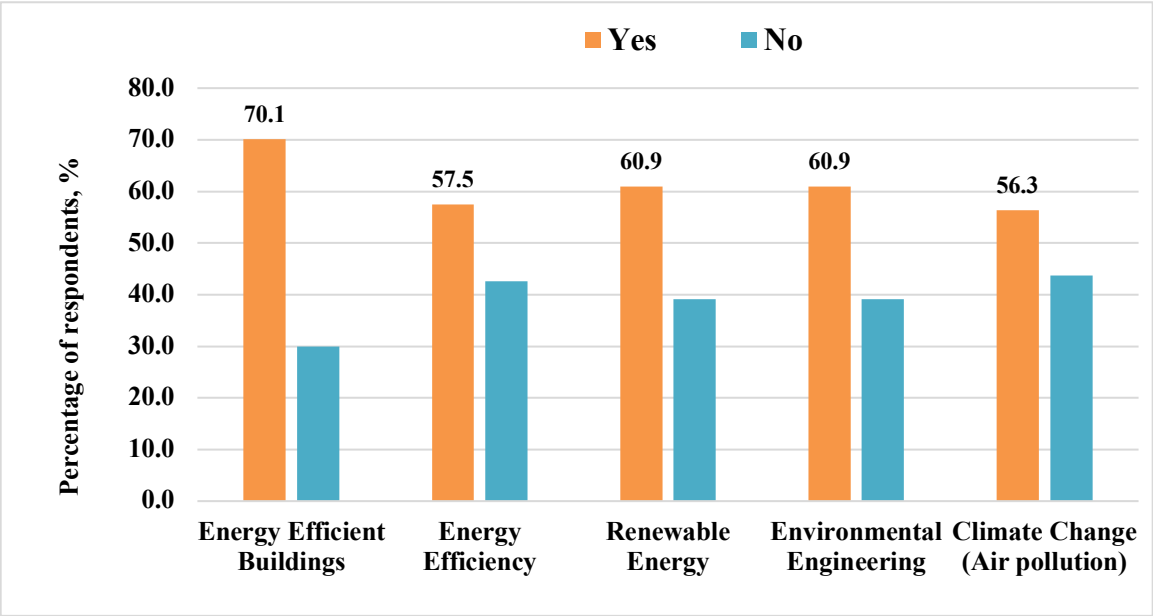

Figure 5. Difficulty finding graduates in the relevant fields

Figure 6 shows the number of employees that companies/organizations are planning to hire in the next 5 years in the fields of Energy Systems, Energy Efficient Buildings and Environmental Technology. Accordingly, the highest demand for the next 5 years is in the field of Energy Efficient Buildings. Moreover, the sustainability and the progress of the curricula/courses to be developed by three universities would largely depend on the labor market of graduates. The survey result indicates that the need of

professionals and experts in energy efficiency in buildings, renewable energy and environmental engineering for the next 5 years are going to increase in the coming years and preparing graduates with special knowledge in these fields is crucial in mutual collaboration between industry and education sector of Mongolia.

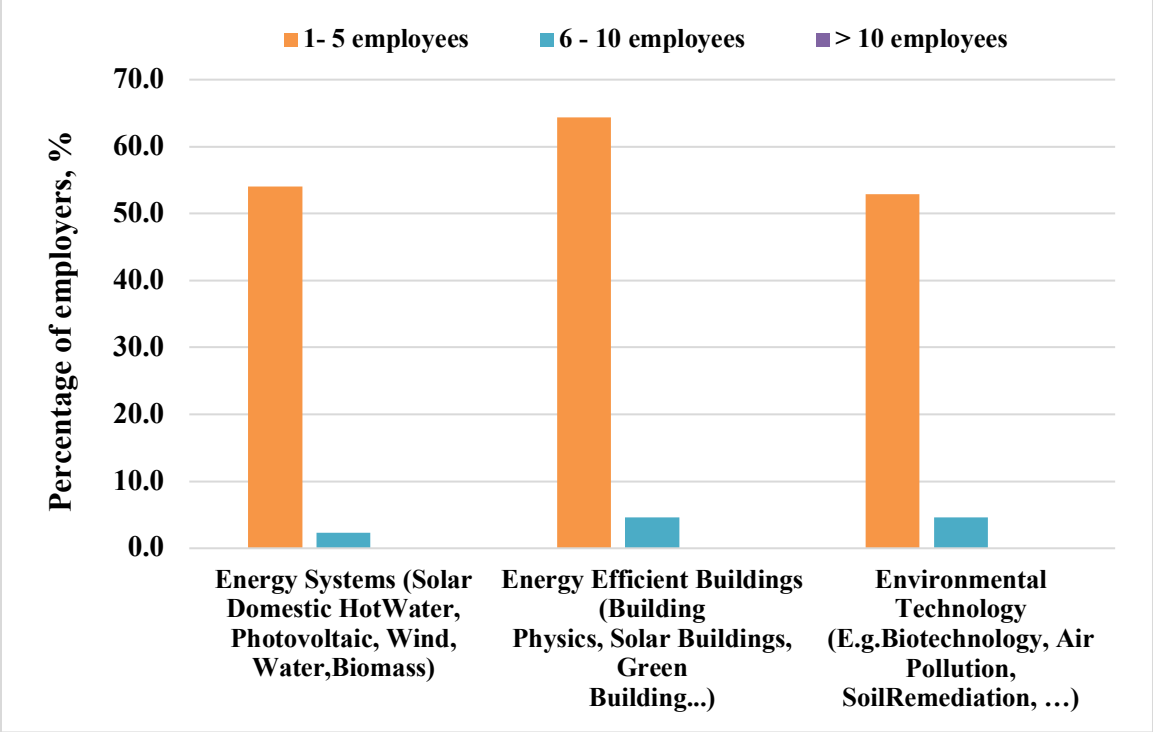

Figure 6. Planned positions for the next 5 years

Lastly, company/organizations' interest in CEBEC project, which will update/create bachelor/master/short term training courses, were asked. Approximately 89% of companies/organizations expressed their interest in our program/courses, as illustrated in Figure 7.

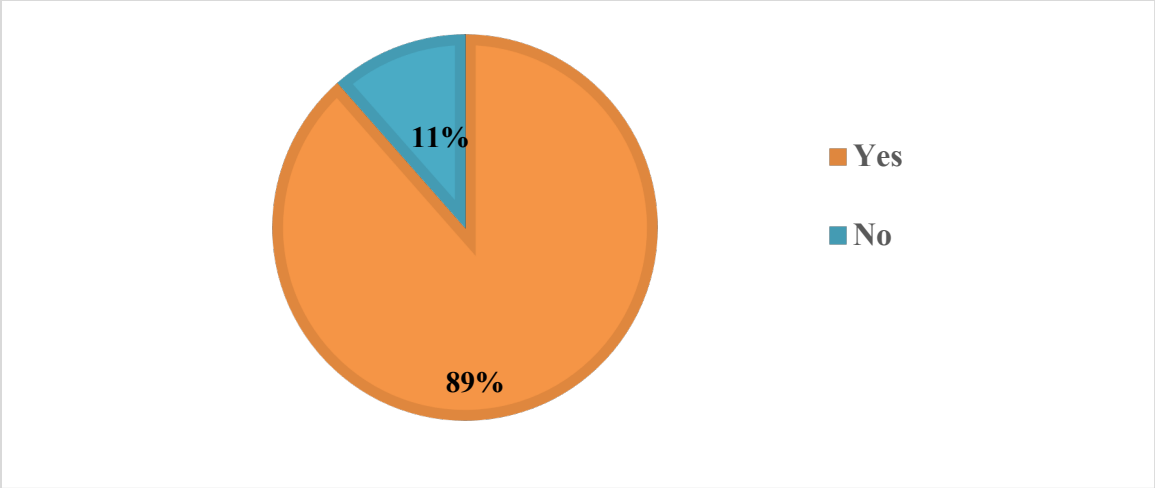

Figure 7. Company/Organizations in courses/programs in Building Energy Efficiency and Renewable Energy

3.3 REQUIREMENT AND COMPETENCIES

In order to find out about the qualifications/requirements that organizations and companies look for when hiring employees specialized in the Energy Efficient Buildings and Renewable Energy, the questions were divided into three subcategories including:

- Professional competencies (which assists in determination of relevant professional skills that can be acquired by specific courses and the organization/company is looking for)
- Methodological competencies (which assists in determination of relevant methodological skills that meets the demand of the labor market such as programming on Matlab, LabView, etc)
- Personal competencies (which assists in determination of the important personal skills like teamwork, communication and etc.)

Courses presented in the Professional Competencies comprises of six different types, including Fundamental knowledge in natural science, Fundamental technical knowledge, Applied technical knowledge, Fundamental economical knowledge and Fundamental language skills. Among the types of courses, Fundamental Language Skills (93.1%) and Applied Technical Knowledge (89.7%) are the ones that companies/organizations consider to be important for their employees to have. Fundamental Language Skills include English Writing, Doing Research in English, Technical English and Spoken English courses, from which Technical English and Spoken English are considered as the most important ones for employers. Applied technical knowledge consists of Renewable Energies, Heating, Ventilation, Air Conditioning, Building Physics, Hydraulics Engineering and Environmental Engineering courses.

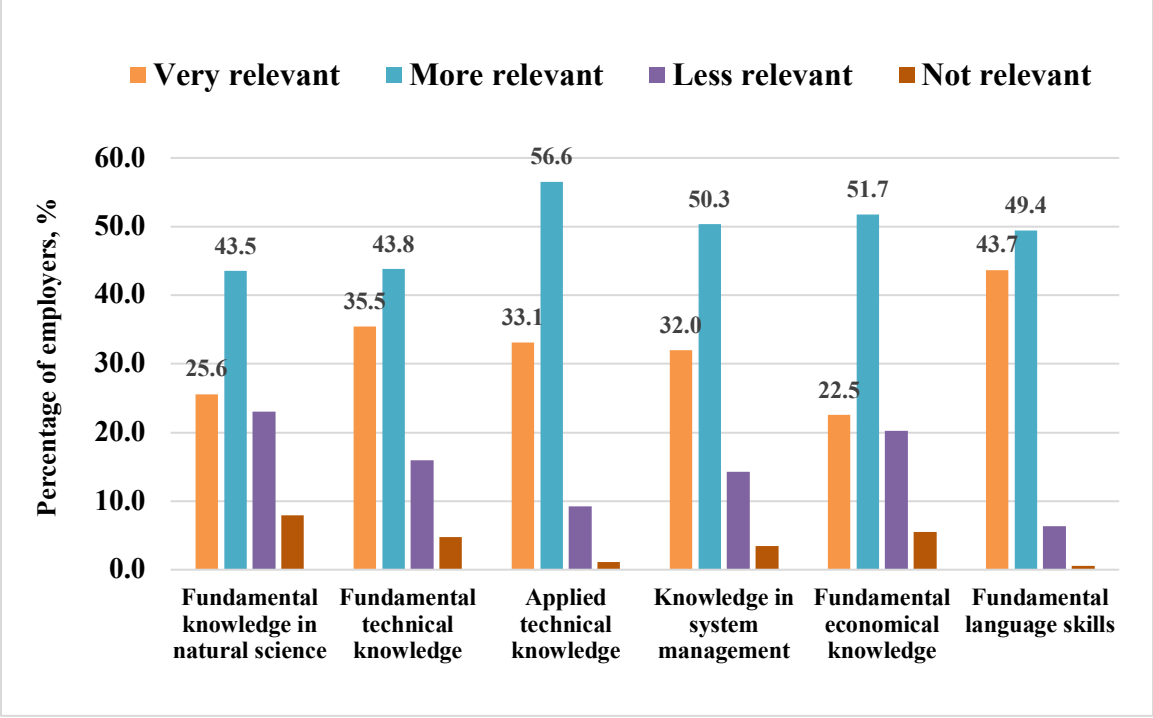

Figure 8. Importance of professional knowledge

As programming skills are becoming an attractive qualification, employers/respondents were asked to evaluate the importance of ability of working on programs that are widely used in Building Energy Efficiency and Renewable Energy such as Matlab, LabView, TRNSYS and others. According to Figure 9, Modelling is considered as the most relevant and important skill compared with others.

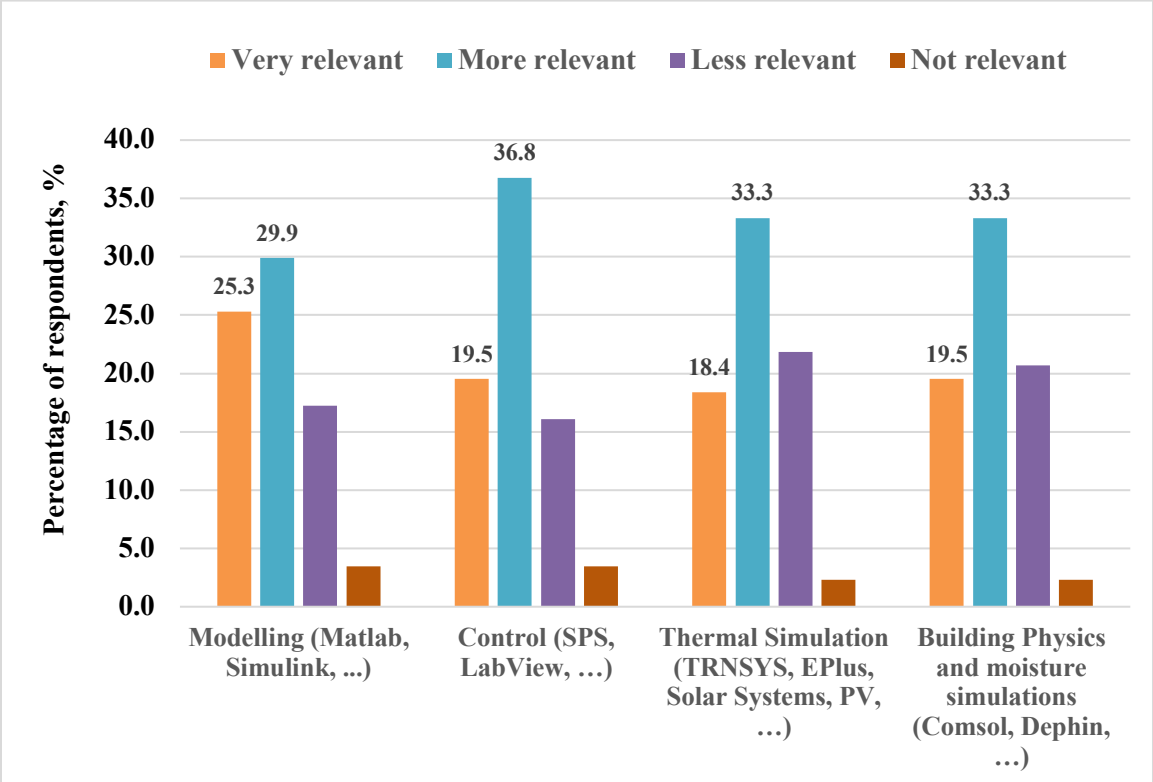

Figure 9. Importance of Methodological knowledge

Personal competencies included teamwork, communication skills, negotiation skills, presentation techniques, social skills and flexibility. Among these teamwork and communication skills were considered to be the most important ones when hiring an

employee, as shown in Figure 10. Therefore, when updating/creating courses, it is crucial to address these skills to improve the quality of programs.

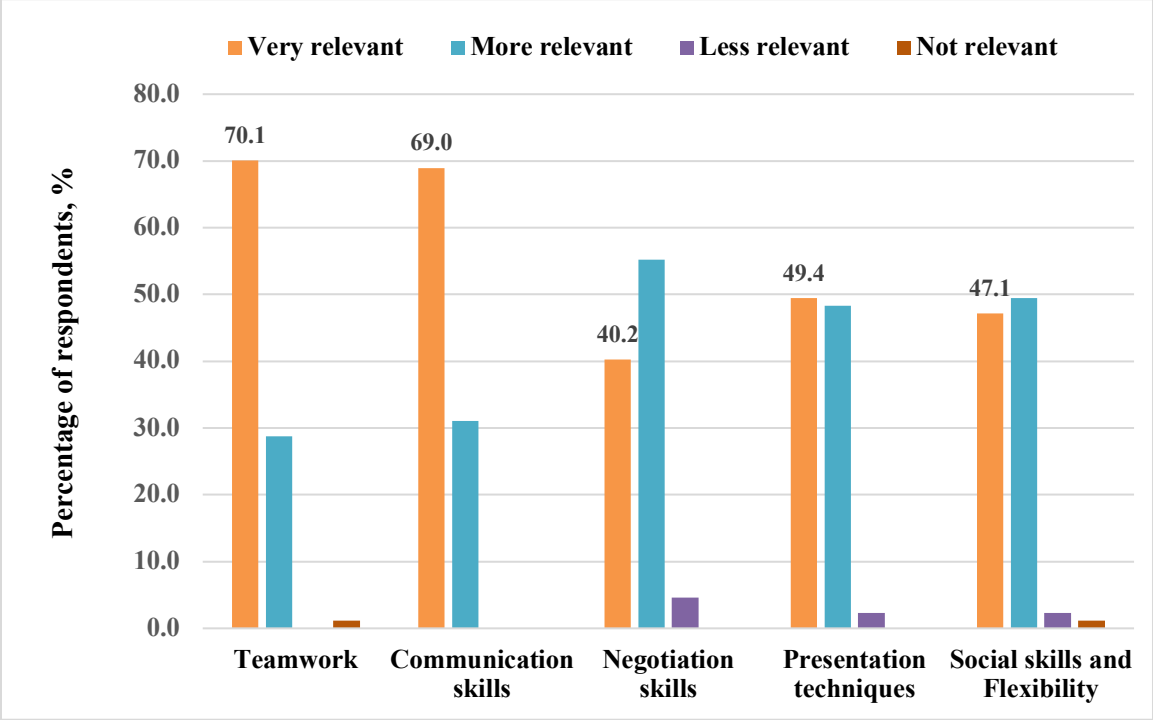

Figure 10. Importance of Personal skills

In addition to professional, methodological and personal competencies, trainings organized by companies/organization on their own was determined. About 60% of employers responded that they do not organize any trainings and the remaining 40% organize trainings in the following fields:

- Building Energy Efficiency
- Building Materials Green Technology
- Cost analysis and budget of construction projects
- Information Technology
- Professional Trainings

- Structural foundation stability
- Leadership training
- Urban planning
- Personal development trainings
- Safety
- Norms and Standards
- Project Management

As CEBEC project is planning to develop short term training courses for professionals already working in the industry, respondents were asked to evaluate if their employees lack skill in the fields of Energy Systems, Energy Efficient Buildings and Environmental Technology. Figure 11 depicts the lack of skills of current employees, which is almost the same in the relevant fields.

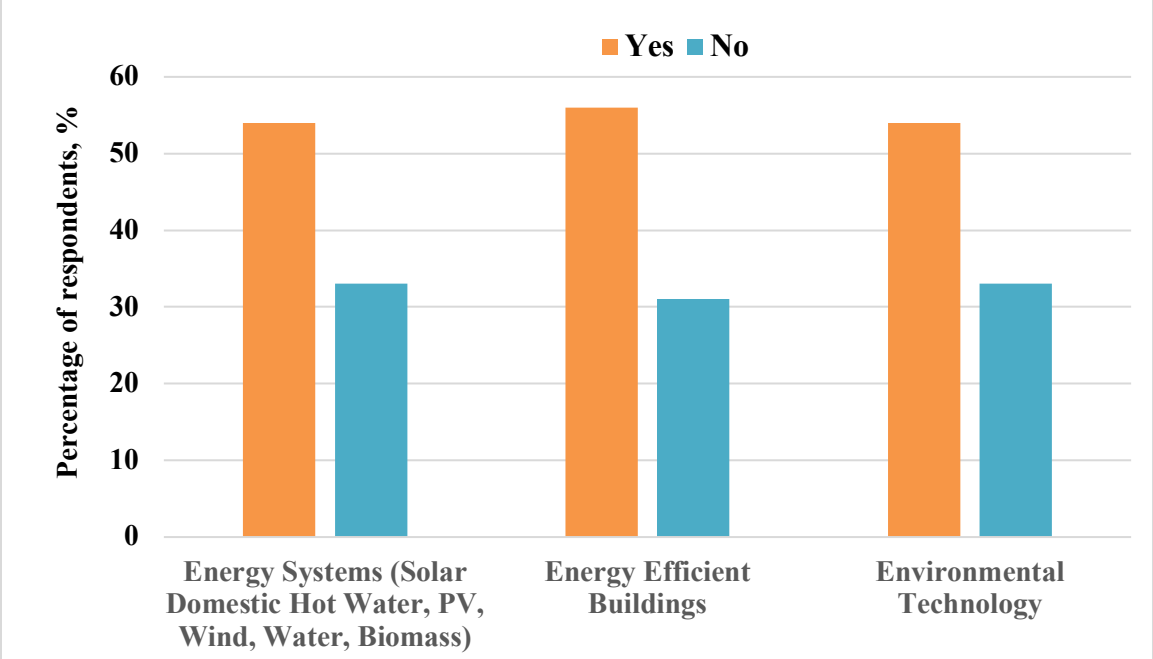

Figure 11. Lack of skill of current employees

Figure 12 illustrates the company/organization's plan for expanding their business to new sector. Approximately 66% of respondents do not plant to expand their businesses and 34% of respondents plant to start new business in the following sectors:

- Design of Energy Efficient Buildings
- Construction Material Production
- Construction Material Trading
- Education
- Mining
- Heat storage, battery storage
- Consulting
- Engineering drawing
- Renewable energy equipment trading
- Trading and Service
- Energy Systems
- Energy Efficient Heating Systems
- Tourism
- Construction
- Real Estate

Additionally, respondents were asked to give their opinion on potential labor market expansion in the upcoming years. Around 65% of respondents claimed that Energy Efficient Buildings professionals will be popular in future. The organizations shared their thoughts on the idea of implementing the CEBEC project in the country. The respondents are optimistic that the program can produce graduates with qualified

expertise in the field of Energy Efficient Buildings and Renewable Energy who will get easily employed in various organizations.

3.4 GENERAL POSITION ON THE NEW/UPDATED BACHELOR/MASTER/SHORT TERM TRAINING COURSES

The participants of the survey were asked if they agree that the new/updated bachelor/master/short term training courses in Energy Efficient Buildings and Renewable Energy meets the labor market demand of Mongolia. More than 70% of respondents totally agreed or agreed with the statement, as shown in Figure 12.

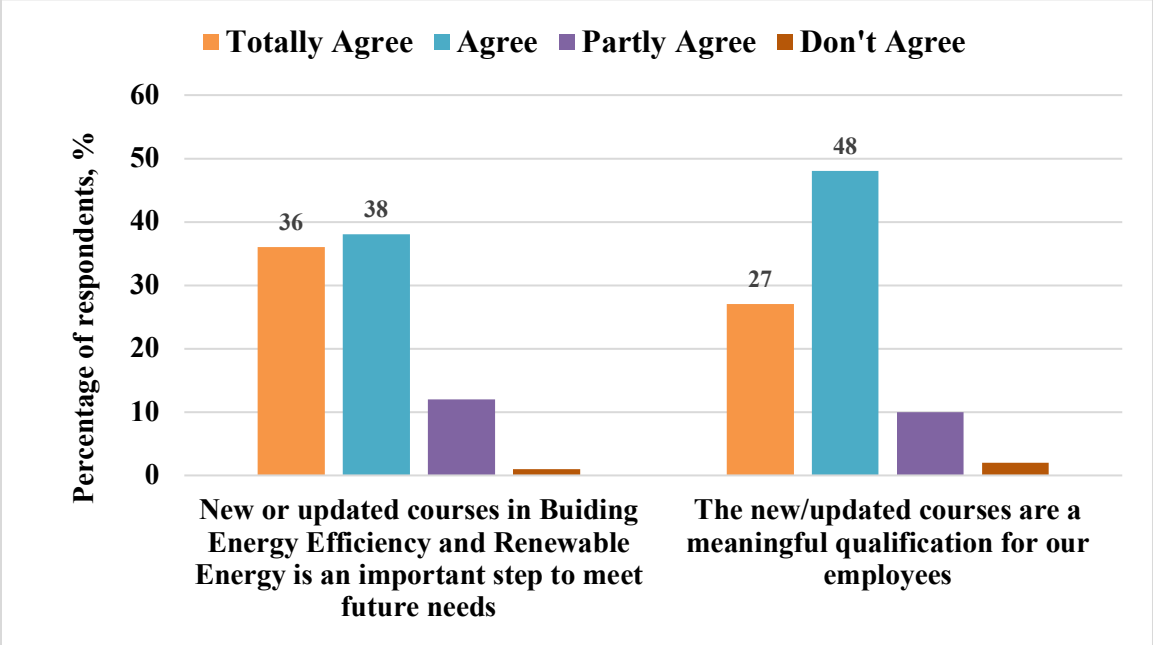

Figure 12. General position of respondents on CEBEC project

Besides, 68% of companies/organizations expressed their interest in providing internship to students and 27% of them are willing to advise master and bachelor students' graduate thesis collaboratively. Some of respondents suggested to help in organizing field trips to their construction/working sites.

4 Summary and Conclusion

The survey intended to include representatives from many sectors to have a good understanding on the future of labor market of Energy Efficiency and Renewable Energy. After analyzing the results of the survey and taking adequate notes of the comments and recommendations, the following conclusions can be made:

1. Currently, companies/organizations do not have or have very few workers in the fields of Energy Efficiency and Renewable Energy despite they consider that experts in these fields will be on demand in the upcoming years. Moreover, they expressed difficulty in finding experts/professionals in the relevant fields.
2. Respondents consider that job demand in Energy Efficient Buildings will be higher compared to Energy Systems and Environmental Technology, although not showing dramatic difference among these fields.
3. Respondents acknowledged that currently employed workers/engineers in their companies/organizations lack skills in the fields of Energy Efficient Buildings, Energy Systems and Environmental Technology and very few of them organize trainings to cover up these anomalies. This shows the potential demand on developing short term courses for industry.
4. Companies/organizations prefer their future employees to have adequate knowledge in Fundamental Language Skills (Technical English, Spoken English, etc.) and Applied Technical Knowledge (Renewable Energy, Building Physics, etc.). Moreover, they consider that ability of working on modelling programs is an important factor when hiring. Additionally, teamwork and communication are

important personal competencies, which can be incorporated when developing new/updated courses during CEBEC project.

5. Overall respondents of the survey are positive that CEBEC project can develop new/updated bachelor/master/short term courses that can meet labor market demand of Mongolia.

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