DESL

Co-funded by the Erasmus+ Programme of the European Union

Developing Energy-Efficient and Smart Lighting Education in Vietnam & Myanmar

Need Assessment Report

Vietnam

VGU Vietnamese-German University

Contents

Abbreviation

EESL	Energy-efficient and smart lighting
GHG	Greenhouse gas
CFL	Compact Fluorescent Lamp
VGU	Vietnamese-German University
HCMUT	Ho Chi Minh City University of Technology
EIU	Eastern International University
TDMU	Thu Dau Mot University
LED	Light-emitting diode

1. Introduction

1.1. Background

Energy-efficient and smart lighting (EESL) leads to enormous enhancements in energy issues and human life. Lighting accounts for 19% of the world's energy use and 6% of all greenhouse gas (GHG) emissions. Smart lighting helps people remotely control cooling, heating, lighting and appliances, minimizing unnecessary light and energy use. It therefore saves a lot of energy as well as provides a level of comfort and convenience. However, the future success of lighting significantly depends on the involvement of stakeholders and stakeholders' communities. In smart lighting, utilizing natural light to reduce the use of man-made lighting is also considered. On the other hand, changing people's habits when using some applications for which the technology development has achieved enough automatic level is not less important.

There are several reasons that EESL has not been developed and applied. In many areas, incandescent lamps, or florescent tube lamps are usually used while they are less efficient compared to the today available Compact Fluorescent Lamp (CFL), LED lamps. Lack of awareness in users and lack of government policies to phase out inefficient lamps; and lack of proper courses in colleges and universities focusing energy efficient lighting are ones of the important reasons. There are no proper energy management techniques like sensors and control circuits are available in most of the buildings. In a country, the industry must have developed to a certain level to provide enough devices, systems, and solutions. Enough and appropriate courses must be offered to train students in universities and colleges in several programs. Training modules are to be devised for engineers and technicians working in the field of lighting and illumination.

1.2. Energy efficient lighting scenario in Vietnam

The energy consumption in Vietnam has rapidly increases, with annual growth rate of over 12%, in the last decade. GHG emissions and GHG emissions per capita have increased nearly 3 times in a decade. Vietnam used to be an energy exporting country, however, since 2015, has become a net energy importer. It is expected that the import share of total primary energy supply is due to increase to 37.5% in 2025 and 58.5% in 2035. Electricity accounts for an increasing share in the final energy consumption mix, and electricity demand is expected to grow by 8% annually on average until 2035.

Consequently, the demand of technologies, devices, and solutions of EESL in Vietnam is enormous. The scale of the lighting market in Vietnam reached $420 million with the annual growth rate of 20.6%. The Vietnamese smart-lighting market is expected to get a revenue of

over $60 million in 2020. This data is presented in the latest report of LEDinside, a leading platform for LED, LED lighting, and LED Market Research under TrendForce. One of the reasons for the fast development of the smart lighting market in Vietnam is the fast economic growth, urbanization, industrialization, and increasing infrastructure construction.

In addition to the participation of foreign giants like Philips or Panasonic, domestic companies such as Dien Quang Lamp JSC or Rang Dong are also trying to introduce domestic products. LED imports into Vietnam increased by 91% in volume compared to 2017, and 3,761 companies imported 592.8 million LEDs, reaching a turnover of $286.3 million. However, according to data from the Chinese customs, twice as many LEDs were exported to Vietnam than the above statistics, worth about $600 million. Therefore, Vietnam is a tremendous market for LED products.

In the EESL area, the policy and legal systems in Vietnam are incomplete eventhough they play an important role in supporting LED industry. According to researchers from the Vietnam Lighting Association (VLA), the policy and legal systems can create a healthy competitive environment by a system of standards and norms for LED products. According to the representative of the Directorate for Standards, Metrology And Quality of Vietnam (STAMEQ) under the Ministry of Science and Technology, although there have been many TCVN (Vietnamese standards) for LED lighting, Vietnam still has yet to issue technical regulations for LED lighting products.

In addition, Vietnam needs laboratories to test and assess quality standards. The authorities also need to strengthen the quality inspections of products circulating in the market, and strictly penalise counterfeits. For long-term sustainability, the state also needs a solution to connect reputable LED manufacturing enterprises with electronics or mechanical engineering companies to create a closed value chain, promoting Vietnam's LED industry.

1.3. Training in Vietnam

In Vietnam, Vietnamese- German University (VGU) covers few chapters in lighting as part of an Electrical Engineering course. Similarly, Ho Chi Minh City University of Technology (HCMUT), Eastern International University (EIU), and Thu Dau Mot University (TDMU) offer a course covering some lighting concepts. None of the partner institutions in Vietnam offer courses that would train the students to design efficient lighting, to analyze economic and environmental sustainability in lighting, to integrate lighting control and daylighting, use of simulation software for efficient design, quality control of lighting components and systems etc. There is also need of laboratory facilities, equipment and skilled technical staff to provide practical education on smart and efficient lighting systems.

1.4. About this report

The report presents the awareness status and the need assessment of lighting expert as well as the lighting course. Section 1 briefly introduces scenario in the EESL area in the world and Vietnam with focusing on training courses in Vietnam. Section 2 describes the questionnaire survey, existing courses in member Vietnamese universities, and presents the interviews with experts. Section 3 presents the awareness assessment of smart lighting while sections 4 and 5 present the need assessment of technical experts and courses at academic institutions, respectively. Section 6 presents and analyzes the findings of the assessment and section 7 concludes the report.

2. Data Collection Method

2.1. Questionnaire survey

The questionnaires were prepared by the 4 universities in Vietnam (HCMUT, VGU, TDMU, and EIU) with the comments of the experts in the DESL project. The survey was conducted with the participation of students, teachers, employers, researchers, engineers, salespersons, and officers related to the field of lighting and illumination. The participants in the survey are categorized into the following three groups:

- Group-I: Engineer, Teacher, Manager and Researcher;
- Group-II: Student and Alumni;
- Group-III: Employee, Salesperson, Architect and Officer.

The same questionnaires were used for all groups via the online survey using Google Form. The survey data were collected and analyzed by VGU using Microsoft Excel.

The number of participants in the survey is presented in Table 1. A total of 199 participants responded to the survey, of which 54% of Group-I, 42% of Group-II and 3% of Group-III.

Table 2.1. The number of participants in the survey in Vietnam

Group ID	Number of participants (n)	Percentage of participants (%)
Group-I: Engineer, Teacher, Manager and Researcher	108	54.3

Group-II: Student and Alumni	85	42.7
Group-III: Employee, Salesperson, Architect and Officer	6	3
Total	199	100

The median age of participants in each group is shown in Fig 2.1. The participants in Group-I (median age of 22) are 10 years younger than the ones in Group-II and Group-III (median age of 32).

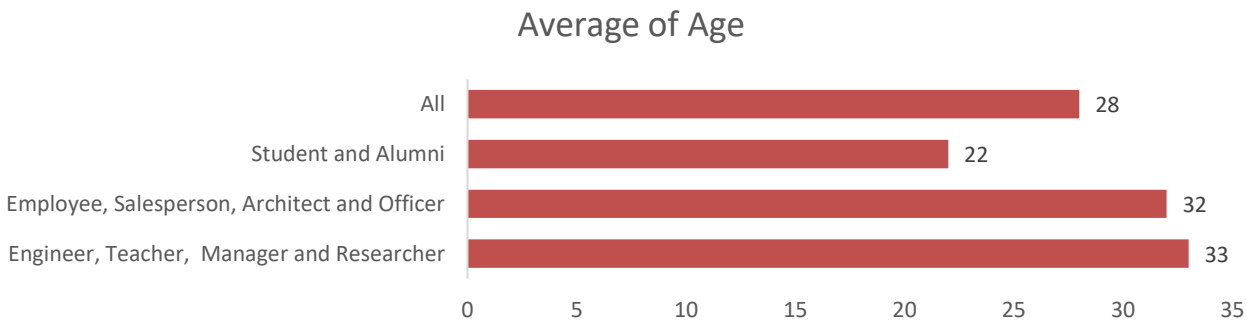

Fig 2.1. The median age of participants in each group.

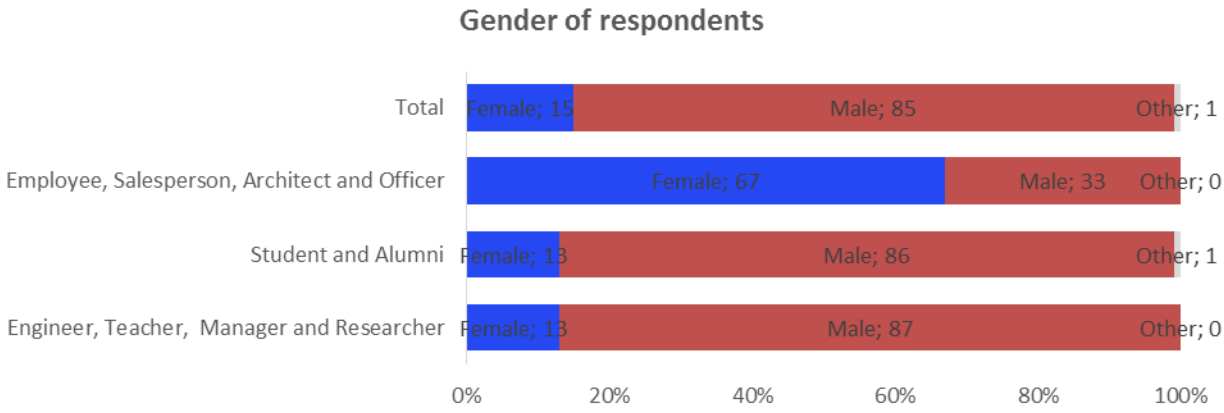

Fig 2.2. The percentage of participants in each group by gender.

The percentage of participants in each group by gender is presented in Fig. 2.2. Almost participants in Group-I and Group-II are male (86%) while the percentage of female participants

in Group-III is higher than male (33%). However, there are only a few participants in Group-I (6 people).

2.2. Survey of existing universities courses

The survey of different university courses was done. The existing curricula of under-graduate and graduate programs from the 4 universities in Vietnam (HCMUT, VGU, TDMU, and EIU) were studied and the existing courses related to illumination and lighting were identified.

2.3. Interviews with experts

Some lighting experts from Industry, including Dien Quang JSC., Vi Light JSC. and Signify company, which are very famous in providing energy-efficient lighting products in Vietnam and Netherlands, shared their experience and perspectives in smart lighting design and solutions at the DESL workshop held at VGU (Vietnam) in March 2020. Besides, some technical and lighting experts from Universities in Vietnam and European also contributed to the interviews. Their suggestions and recommendations on energy efficient lighting were considered in design of lighting courses in Vietnam. The information of lighting experts for the Interview is shown in Table 2.2.

Table 2.2. Information of lighting experts in Universities and Industry for Interviews

No.	Organization name	Information of expert (Name/ working position/ Email)
1	Signify Company https://www.signify.com/	M.Eng. Ngo Tan Cang Technology Director of Signify ngo.tan.cang@signify.com
2	Dien Quang JSC https://dienquang.com/en	Mr. Dang Tien Minh Technology Director of Dien Quang JSC minhdt@dienquang.com
3	Vi Light JSC https:// www.vi-light.com	Mr. Vuong Quan Truong CEO of Vi Light JSC oliver.vuong@vi-light.com
4	Aalto University https://www.aalto.fi/en	Dr. Pramod Bhusal Lighting expert pramod.bhusal@aalto.fi

5	University of Ljubljana, Slovenia https://www.uni-lj.si/eng/	Dr. Grega Bizjak Lighting expert
6	Vietnamese- German University https://vgu.edu.vn/en	Dr. Ha Thuc Vien Vice President of VGU
7	Ho Chi Minh city University of Technology http://www.hcmut.edu.vn/en	Assoc.Prof. Phan Quoc Dung Vice Dean- Faculty of Electrical -Electronics Engineering pqdung@hcmut.edu.vn
8	Eastern International University https://eiu.edu.vn/en	Dr. Phan Van Vinh EIU Phillips Lighting Lab vinh.phan@eiu.edu.vn
9	Thu Dau Mot University http://en.tdmu.edu.vn/	Dr. Nguyen Ho Quang Vice Dean

The content of the interview relates to the needs of learners and lighting companies, the advice of lighting experts from industry on supplementary contents that engineers need to be trained to meet the company's needs; and finally, some advices on developing related courses with European quality.

In general, the experts' feedback is recorded as follows:

- With the development of LED lighting in recent years in Vietnam and around the world, there has been a high demand for training courses on smart lighting and energy efficiency technologies.
- In addition to the university's basic training on lighting, engineers need further understanding and insights into the products on the market, technical specifications and economic analysis for lighting projects. Companies are willing to support the university in providing practical knowledge and experience through seminars and internships.
- In order to reach the European course standard, European universities are expected to share didactic materials with Vietnamese higher education institutions and support in elaborating and designing new contents for smart lighting courses at Vietnamese universities. "We need to think about building a training program for lighting engineers in near future."
- Organizing training courses and issuing joint certification between universities and lighting companies makes the courses more attractive to students.

3. Awareness Assessment of Energy Efficient Lighting

The awareness assessment of the energy efficient lighting was carried among the following 3 target groups related to lighting: Group-I (Engineer, Teacher, Manager and Researcher), Group-II (Student and Alumni) and Group-III (Employee, Salesperson, Architect and Officer). Based on the questionnaires filled by the participants, the awareness of energy efficient lighting among the different target groups were determined.

As presented in Fig.3.1, the most participants in Group-I claim that the adoption of energy efficient lighting technologies is a challenge due to high initial cost of energy efficient products (37%). However, the percentage of participants in Group-I choosing the important challenge due to lack of knowledge and awareness, lack of qualified human resource and lack of energy efficient lighting products and systems in local market is the same. The similar results were received for all participants in the survey. In conclusion, it is shown that the initial cost of energy efficient products is the most challenge for adoption of energy efficient lighting technologies in Vietnam.

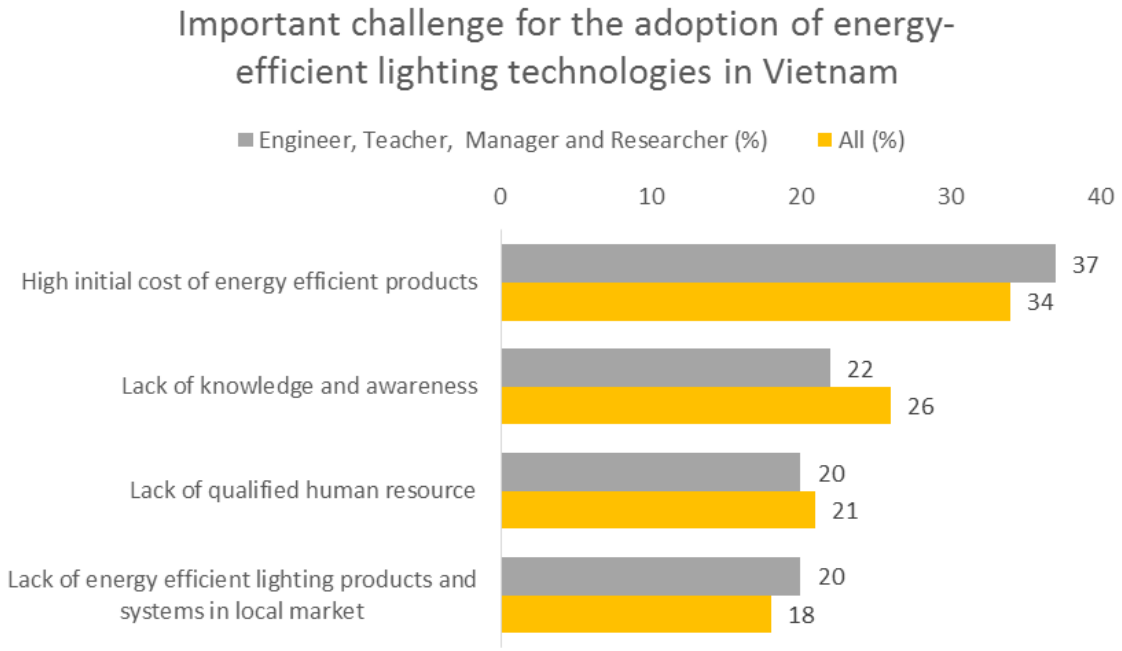

Fig. 3.1. Important challenges for adoption of energy efficient lighting technologies in Vietnam

4. Need Assessment of technical experts in lighting

The questionnaire was sent to stakeholders to assess the human resource needs of the lighting and energy-saving industries. The following is the results and a detailed analysis of the data obtained.

4.1. Requirement and availability of technical experts

There are many companies working in the in the field of lighting manufacture, sales, installation and distribution. Many of them are working for indoor as well as outdoor lighting. The requirement of technical experts for these companies varies as per their work and projects. As depicted in Fig. 4.1 46% of the companies require electrical engineers with basic lighting knowledge, 31% of the companies require technicians with basic lighting knowledge, 26% requires technical experts capable of assembly and installation, and 20% of the companies are in need of lighting experts/engineers.

As presented in Fig.4.2 34 % of the companies claim that there are very few numbers of technicians available in the lighting area and are hard to find. However, 35% of experts say that it is easy to find workers for lighting industry, and 24% of experts think that it is available but expensive.

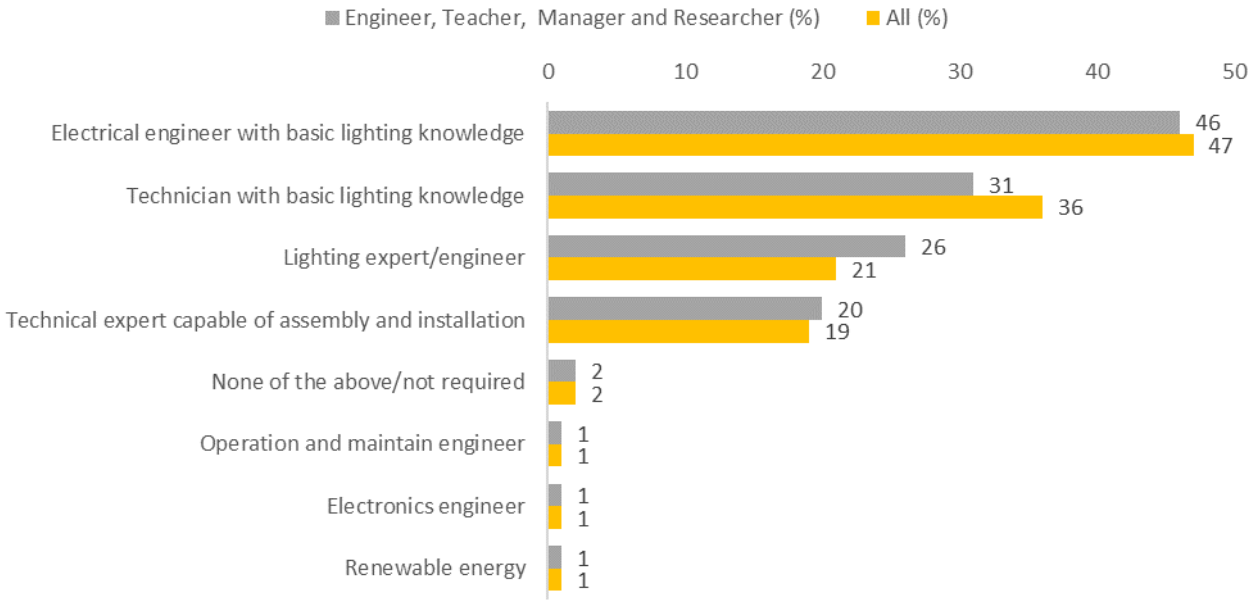

Fig. 4.1 Required levels of technical expert in companies

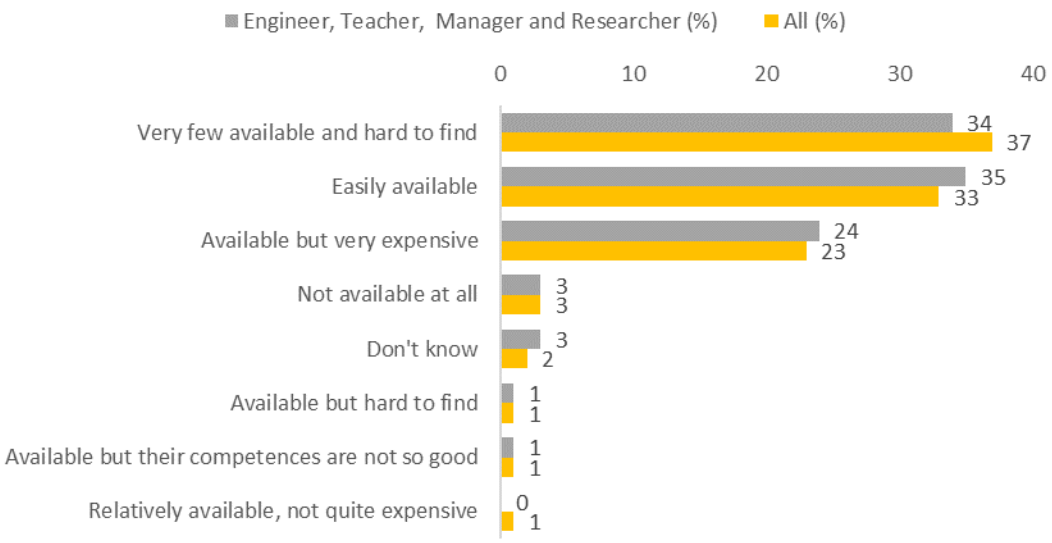

Fig. 4.2 Availability of local lighting engineers and technicians for hiring in Vietnam.

4.2. Important challenge for the adoption of energy-efficient lighting technologies in Vietnam

Fig. 4.3 shows the challenges of applying effective lighting technology in Vietnam. 37% of experts think that the high cost of purchasing energy efficient equipment is an obstacle to the application of new technology. Besides, about 22% of experts think that there is a lack of awareness about energy saving, as well as a lack of human resources in the field of lighting.

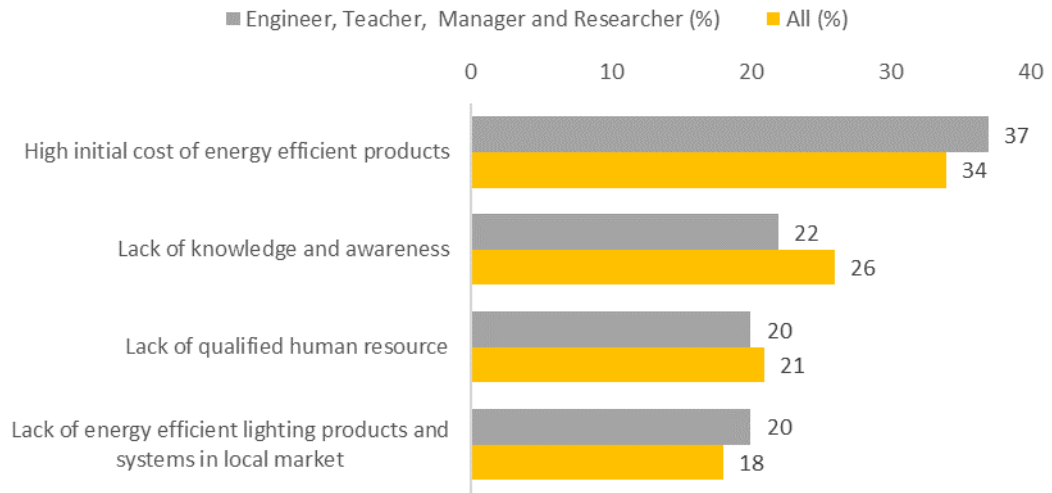

Fig. 4.3 Important challenge for the adoption of energy-efficient lighting technologies in Vietnam.

5. Need Assessment of Courses at Academic Institutions

The artificial lighting use is increasing day to day in our society and so is the requirement of technical experts. They are few personnel working in the lighting field and in most of requirements electricians do all the design and lighting planning task. There are very few people trained for lighting works and most of the universities in Vietnam do not have proper courses on energy efficient lighting design.

5.1. Current courses on lighting available at various universities

Currently, the field of lighting is taught at universities in Vietnam through subjects such as lighting engineering, energy management and architecture. However, these modules have only presented a part of lighting concepts, not really intensive.

5.2. Requirement of New Course in Energy Efficient Lighting

Figure 5.1 show that 79% of experts think lighting technology should be taught in electrical engineering training programs for undergraduate, 50% of ideas for electrical engineering graduate and 44% for civil engineering of undergraduate.

This proves that the demand for lighting technology training in university is huge.

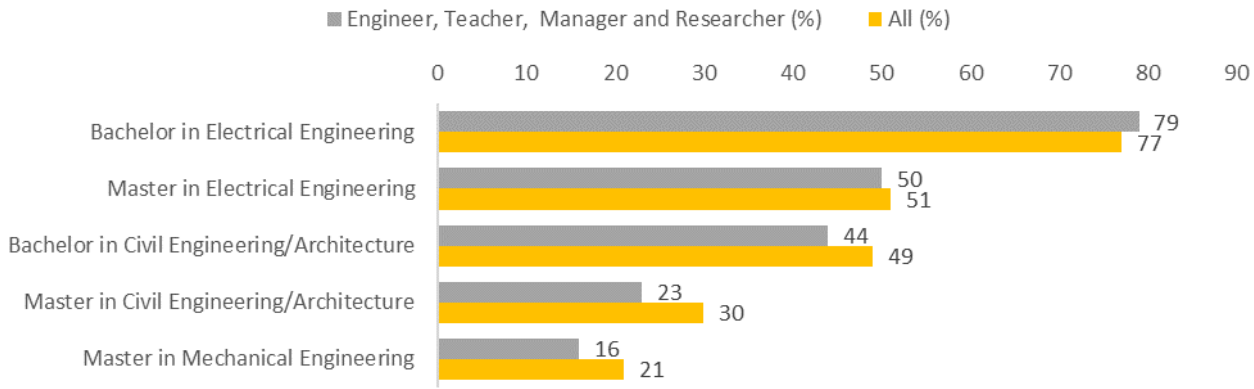

Fig. 5.1 Programs which lighting courses should be provided.

Figure 5.2 shows the subjects that need to be taught. According to the survey, 60% of experts think that it is necessary to teach subjects of Energy Effiency and Smart Lighting, 28% of experts think that it is necessary to teach Lighting Design and Application.

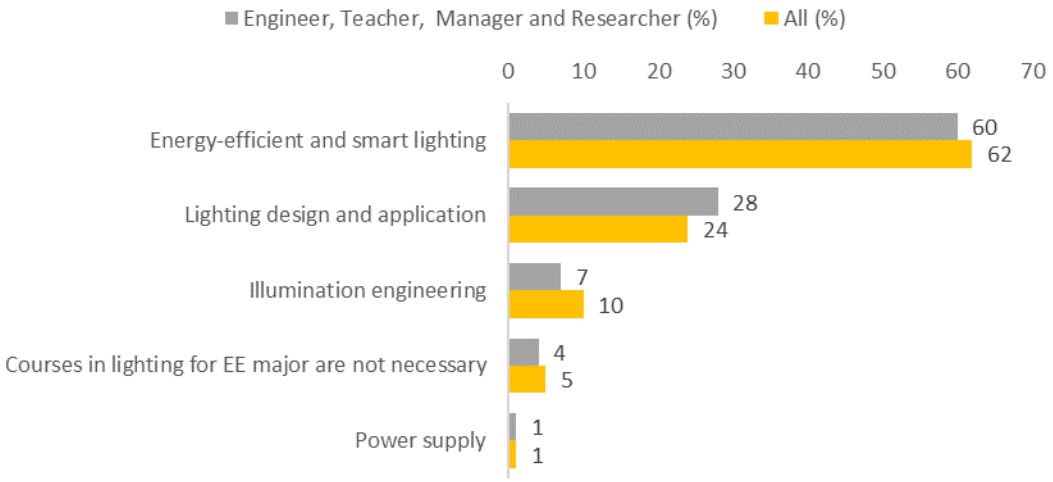

Fig. 5.2 The most important course for Electrical Engineering major.

When surveyed about the most important devices for Lighting lab for Electrical Engineering major most of the teachers, graduates and employers suggested having the following lighting devices as Fig. 5.3.

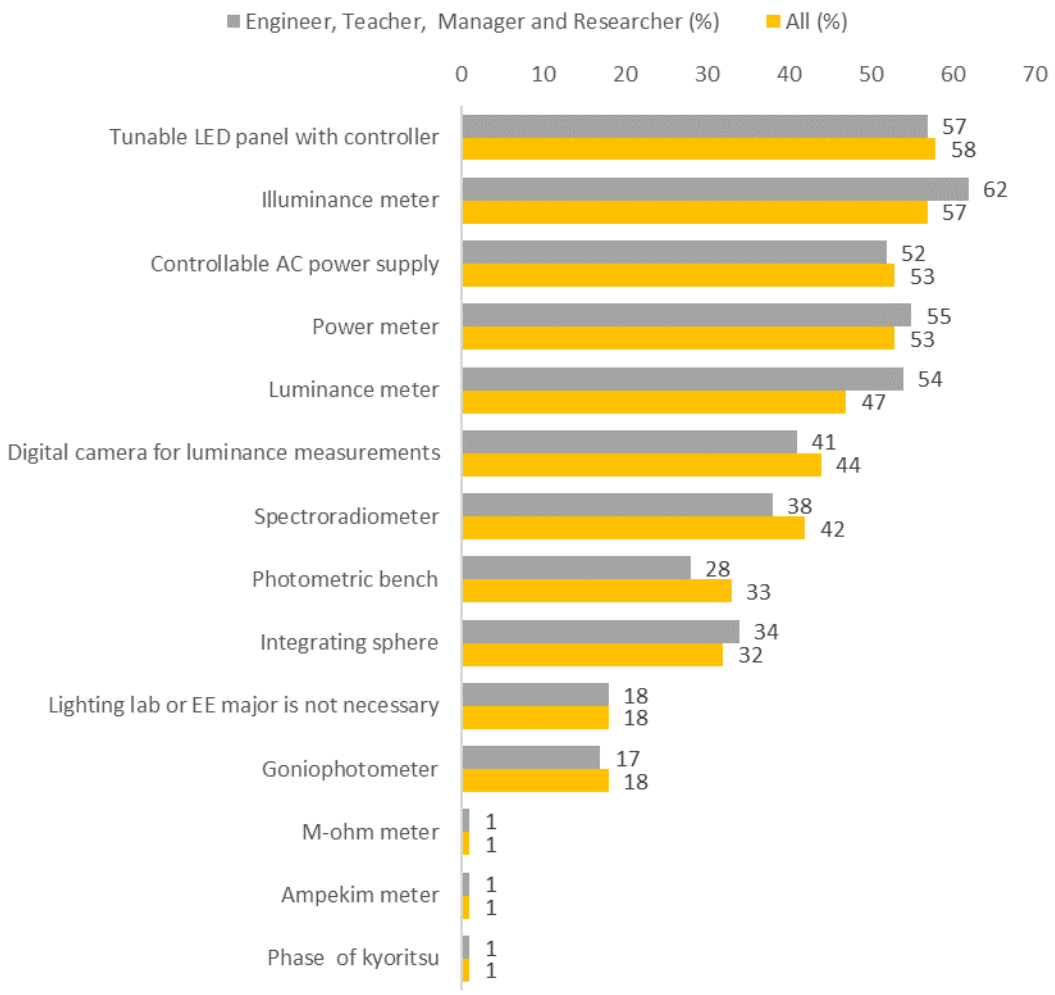

Fig 5.3 The most important devices for Lighting lab for Electrical Engineering major.

Expected learning results of lighting technology subject, according to experts, the skills that learners need to gain as priority order from 1 to 10 from top (Fig. 5.4):

1. Design lighting.
2. Perfom measuarement of light sources and luminaires characteristics.
3. Use basic terms in illumination engineering.
4. Compute energy performace of lighting.
5. Perform measurement of quality of lighting.

6. Perform lighting simulation.
7. Perform life cycle cost calculation.
8. Use different lighting control.
9. Describe the light color characteristics.
10. Incorporate daylight in lighting design

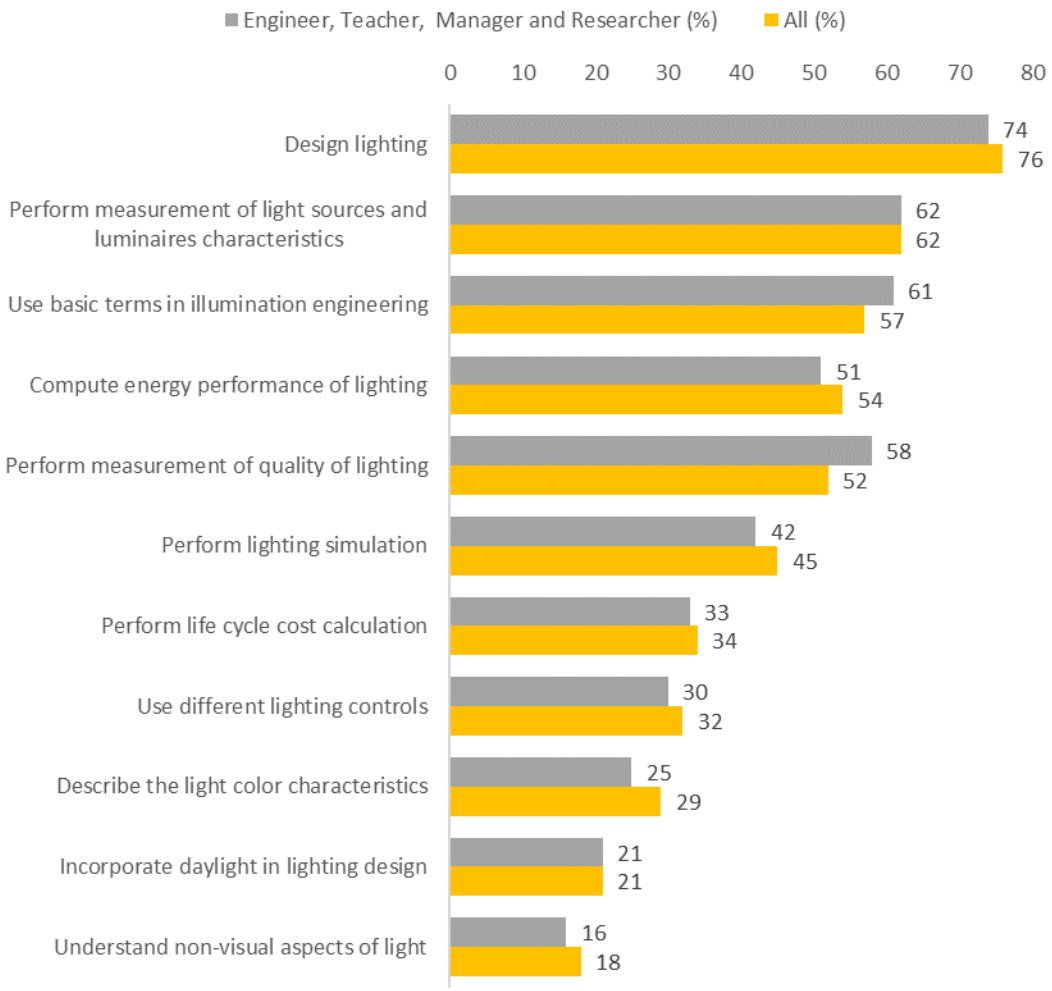

Fig 5.4 The most important learning outcomes for Illumination Engineering course.

And here is a list of the contents that need to be taught in Lighting Engineering as priority order from 1 to 10 from top (Fig. 5.5):

1. Lighting Control
2. Energy Effiency
3. Basic of Lighting
4. Measurement of light
5. Indoor Workspace lighting
6. Lighting design through simulation
7. Light and colors
8. Visual and non-visual aspects of light
9. Light resources
10. Lighting economics

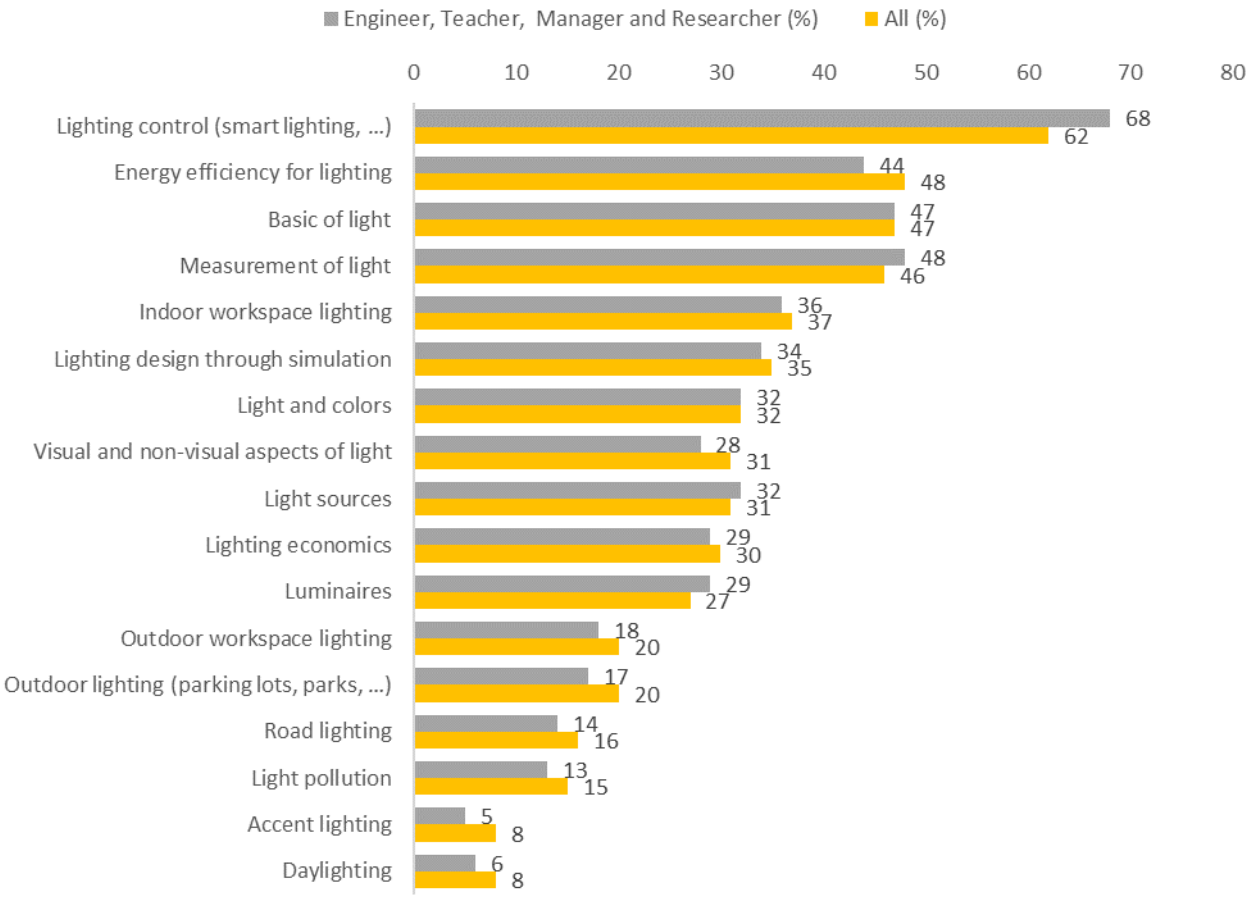

Fig 5.5 The most important contents for Illumination Engineering course.

Content	Engineer, Teacher, Manager and Researcher (n)	All (n)	Engineer, Teacher, Manager and Researcher (%)	All (%)
Visual Light	67	124	62	62
Dialux	71	119	66	60
Luxicon	35	72	32	36
Calculux	40	64	37	32
Relux	33	62	31	31
Ulysse	17	34	16	17
AGI32	13	28	12	14
Cariboni	13	23	12	12
Revit	1	1	1	1
Induflux	1	1	1	1

Fig 5.6 The most important Softwares for designing and simulating in Illumination Engineering.

6. Findings of the Assessment

The survey was conducted among the three target groups including (1) Engineer, Teacher, Manager and Researcher; (2) Student and Alumni and (3) Employee, Salesperson, Architect and Officer to assess the needs of energy efficient lighting in Vietnam and point out some major outcomes related to this technical area. The outcomes are on general awareness, need of technical experts, need of energy efficient lighting courses and the most important devices for Lighting lab.

6.1. General Awareness

Based on the survey, some awareness of energy-efficient lighting technologies is summarized as follows:

- Approximately 35% of total national electricity in Vietnam is consumed by lighting.
- Fluorescent tube lamp is more dominant in Vietnam compared to incandescent lamps, CFL, LED lamps or others. In recent years, the use of LED lamps in Vietnam has increased rapidly due to economic and environmental benefits. In 2014, Vietnamese companies produced less than 1% of the domestic LED market and today they account for 49% of the domestic lighting market.

- LED lighting technology can reduce energy usage by 50% to 80% compared to Florescent (FL), high-intensity discharge (HID) lamps and traditional incandescent lamps.
- Most of the participants in the survey stated that they were aware of energy efficient lighting management.
- 37% in the survey claim that the adoption of energy efficient lighting technologies is a challenge due to high initial cost of the products.
- 22% think that due to lack of knowledge and awareness, and 20% state that due to lack of qualified human resource.

6.2. Requirement of technical experts

The following major findings were drawn from the survey conducted about the need of technical experts in the field of lighting:

- 46% of the companies require electrical engineers with basic lighting knowledge, 31% of the companies require technicians with basic lighting knowledge, 26% requires technical experts capable of assembly and installation, and 20% of the companies are in need of lighting experts/engineers
- 34 % of experts think that there are very few numbers of technicians available in the lighting area and are hard to find, 35% of experts say that it is easy to recruit workers for lighting industry, and 24% of them claim that the workforce is available but expensive.
- 37% of experts think that the high cost of purchasing energy efficient equipment is the barrier to implement the energy-efficient lighting technologies in Vietnam. Besides, about 22% of ideas say that there is a lack of awareness about energy saving, as well as a lack of human resources in the field of lighting
- 79% of experts think that lighting courses should be taught for the Bachelor in Electrical Engineering programs, 50% of ideas for Master in Electrical Engineering programs and 44% for Bachelor in Civil Engineering.

6.3. New courses on energy efficient lighting

The requirement of new course on energy efficient and smart lighting, or training program for graduates working in lighting area is found to be most. The major findings from the survey for the course need assessment are as below:

- The current courses being taught incorporates basic of illumination, light sources and luminaires, lighting design.
- According to the survey, the lighting topics to be included in the new course could be prioritized as below:

1. Lighting Control
2. Energy Effiency
3. Basic of Lighting
4. Measurement of light
5. Indoor Workspace lighting
6. Lighting design through simulation
7. Light and colors
8. Visual and non-visual aspects of light
9. Light resources
10. Lighting economics

- Based on the survey, the skills that learners need to gain in priority order from 1 to 10 are as below:

1. Design lighting.
2. Perfom measuarement of light sources and luminaires characteristics.
3. Use basic terms in illumination engineering.
4. Compute energy performace of lighting.
5. Perform measurement of quality of lighting.
6. Perform lighting simulation.
7. Perform life cycle cost calculation.
8. Use different lighting control.
9. Describe the light color characteristics.

10. Incorporate daylight in lighting design

- 60% of experts think that it is necessary to teach subjects of Energy Efficiency and Smart Lighting, 28% of ideas say that Lighting Design and Application should be provided.

6.4. Important devices for Lighting lab

In addition to the design of training courses and course contents, it is also important to choose the equipment for lighting laboratories to effectively support the course delivery and make best use of investment costs. From the survey, most important lighting devices were summarized as follows:

1. Tunable LED panel with controller
2. Illuminance meter
3. Luminance meter
4. Power meter
5. Digital camera for luminance measurements
6. Spectroradiometer
7. Photometric bench
8. Integrating sphere

It should be noted that the equipment such as: Digital camera for luminance measurements, photometric bench is quite expensive (more than 50,000 USD), so with the funding to be invested, the beneficiary universities need to consider selecting appropriate and affordable equipment for their laboratories.

7. Conclusion and Recommendations

7.1. Conclusion

In addition to collecting participants' surveys via the Google form, the survey team also conducted interviews with the experts in this field. The needs assessment is a crucial step before developing proper courses and training contents on energy efficiency and smart lighting at Vietnamese universities. The results of the survey indicate that the courses and training contents are designed based on the requirements of local needs and lighting markets in Vietnam. The most significant contents of the course would be lighting design, smart lighting,

energy efficiency for lighting, measurement of light while other necessary aspects would be light and colors, light sources, and lighting economics.

Beside the design of the courses and course contents of universities in accordance with the needs of learners and the lighting market, the survey also provided practical facts and background to help Vietnamese universities to select proper lighting equipment for their laboratories.

7.2. Recommendation

The proposed courses and course contents should be carefully discussed to combine and take advantage of the existing experience of the EU and Vietnam in energy efficient and smart lighting to transfer the applicable knowledge from Europe to Vietnam where the energy saving potential is huge; and collaboratively explore novel approaches in educating highly qualified specialists in energy efficient and smart lighting. Training modules are suggested to be developed focusing the current needs and the future growth of energy efficient lighting technology to achieve expected learning outcomes at Vietnamese higher education institutions. In addition, increasing the support and involvement of lighting companies in the project are recommended to facilitate the teaching and learning activities so as to improve the knowledge and experience of the teaching staff and students to meet practical needs.

HCMUT proposed two new courses which are Smart lighting, Light and experience while other universities such as VGU, EIU, and TDMU suggested new courses such as Lighting design and Application, Energy Efficient Smart Lighting, Smart lighting system, Lighting Control. The contents of these courses are consistent with the survey results. However, smart lighting is rather new, and Vietnamese universities have not had many specialized courses on this topic. They really expect that European partners can share with them relevant didactic materials at European universities as well as consulting Vietnamese partners when designing the course contents. Apparently, in order to teach these courses to students, the lecturers should have professional expertise and good research experience in this area, which Vietnamese universities somehow lack of. European partners' support in training Vietnamese lecturers during the project lifetime is also another recommendation needing to be considered.

The survey also suggested some courses that an engineer working in lighting area should take after graduating from Electrical Engineering major such as: Advanced Lighting Design, LED advanced technologies and applications, Lighting project management. These specialized courses can be provided in a short intensive period of about one month to help engineers have deeper knowledge about lighting to meet the needs of industry in reality.

8. Acknowledgement

We would like to express our deep gratitude to the European Union's Erasmus+ program for funding this valuable DESL project. Our grateful thanks are also extended to all project members from Ho Chi Minh City University of Technology, Thu Dau Mot University, Eastern International University, and the Vietnamese-German University – Vietnam who have greatly contributed to this report. We would also like to express our sincere appreciation to the European partners from Eindhoven University of Technology, The Netherlands and University of Ljubljana, Slovenia for their comments and suggestions on the questionnaires and surveying method. The advice given by European colleagues has been a big help in finalizing the questionnaire. Last but not least, we would like to thank Dr. Pramod Bhusal, the project coordinator from Aalto University for his valuable contribution during developing the survey questions and his advices for this survey report.

APPENDIX

Survey Questionnaires for Academic Program

The survey has been given online in Google form with the content below.

Personal Information

Gender: male, female, other;

Age: _____

Which of the following categories best represents you: student, teacher, employer, researcher, engineer, salesperson, manager, governor, others.

General Information:

- ✓ *The questionnaires are intended to get the best feedback from stakeholders to aid the process of designing appropriate syllabus/course modules to be delivered to students/trainees at universities or training centers.*
- ✓ *The collected data will be maintained confidential. Contact details are for record purpose only.*
- ✓ *For any clarification/queries please contact chan.ttd@vgu.edu.vn.*

Please skip questions in which you feel not sure.

1) Which levels of technical expert below are required in your institutions/companies?

☐ Technician with basic lighting knowledge
☐ Electrical engineer with basic lighting knowledge
☐ Technical expert capable of assembly and installation
☐ Lighting expert/engineer
☐ Others, please propose:
_____

2) How are local lighting engineers and technicians available for hiring in your country?

☐ Easily available
☐ Available but very expensive
☐ Very few available and hard to find
☐ Not available at all
☐ Others, please propose:
_____

3) What is the most important challenge for the adoption of energy-efficient lighting technologies in your country? (Please select only one option.)

- ☐ Lack of knowledge and awareness
- ☐ Lack of qualified human resource
- ☐ High initial cost of energy efficient products
- ☐ Lack of energy efficient lighting products and systems in local market
- ☐ Others, please propose:

  _____

4) Please choose all programs below you think in which lighting courses should be provided.

- ☐ Bachelor in Electrical Engineering
- ☐ Bachelor in Mechanical Engineering
- ☐ Others, please propose:_____

  _____

- ☐ Master in Electrical Engineering
- ☐ Master in Mechanical Engineering
- ☐ Master in Civil Engineering/Architecture

5) Please select the most important one among the courses below for Electrical Engineering major.

- ☐ Illumination engineering
- ☐ Lighting design and application
- ☐ Energy-efficient and smart lighting
- ☐ Courses in lighting for EE major are not necessary
- ☐ Others, please propose: _____

6) Please select 5 most important devices for Lighting lab for Electrical Engineering major

- ☐ Integrating sphere
- ☐ Spectroradiometer
- ☐ Power meter
- ☐ Controllable AC power supply
- ☐ Tunable LED panel with controller
- ☐ Illuminance meter
- ☐ Goniophotometer
- ☐ Luminance meter
- ☐ Photometric bench

☐ Digital camera for luminance measurements
☐ Others, please propose: _____
☐ Lighting lab or EE major is not necessary

7) Please choose 5 most important learning outcomes for Illumination Engineering course.
After successfully completing the course, the students will be able to:

☐ Use basic terms in illumination engineering;
☐ Perform measurement of light sources and luminaires characteristics;
☐ Perform measurement of quality of lighting;
☐ Describe the light color characteristics;
☐ Design lighting;
☐ Perform lighting simulation;
☐ Compute energy performance of lighting;
☐ Perform life cycle cost calculation;
☐ Use different lighting controls;
☐ Understand non-visual aspects of light;
☐ Incorporate daylight in lighting design;
☐ Others, please propose:
_____

8) Please select 5 most important contents for Illumination Engineering course

☐ Basic of light
☐ Measurement of light
☐ Visual and non-visual aspects of light
☐ Light and colors
☐ Light sources
☐ Luminaires
☐ Lighting control (smart lighting, …)
☐ Indoor workspace lighting
☐ Outdoor workspace lighting
☐ Outdoor lighting (parking lots, parks, …)
☐ Accent lighting
☐ Road lighting
☐ Daylighting
☐ Lighting design through simulation
☐ Energy efficiency for lighting
☐ Lighting economics

☐ Light pollution
☐ Others, please propose: _____

9) Please select 3 most important Softwares for designing and simulating in Illumination Engineering.

☐ Visual Light
☐ Luxicon
☐ Dialux
☐ Relux
☐ Ulysse
☐ Calculux
☐ Cariboni
☐ AGI32
☐ Others, please propose: _____

10) Please suggest any courses that an engineer working in lighting area should take (after graduating from Electrical Engineering major).

_____
_____
_____

11) Please list 3 most important projects which are a collaboration between an academic institution and an industrial company that you have participated in.

_____
_____
_____

If willing, you can provide your personal information below.

Name _____ email: _____ Phone No.: _____

Name of the organization_____ Position at organization_____