IOE-EQ

INTERNET OF ENERGY - EDUCATION AND QUALIFICATION

Project Number: 2017-1-IT01-KA202-006251

Labour market analysis in relation to Internet of Energy: required skills and competences

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Contents

Introduction

The modern digital society relies on a constantly growing energy consumption. The U.S. Energy Information Administration has estimated that energy consumption across the world will increase 56% by 2040 (1). Although several countries are investing more and more in green energy and renewable resources, the traditional energy transmission and distribution infrastructures are overloaded and often inadequate, with a consequent inefficient use of the power systems. It is nowadays essential to develop the electric networks and systems according the new paradigms. Intelligent systems, distributed power sources, and smart grids are considered the next future of electric systems. In this regard, a new term Internet of Energy (short IoE) is appearing, which means intelligent interconnection of energy networks components, devices, suppliers, and loads via the Internet.

IoE is therefore a cross-sector topic strictly connected to the Internet of Things (IoT), communication systems, but also to the smart grid and low carbon technologies. It is relevant for the Industry 4.0 strategies as well as for the Energy Strategy 2050. So, the AIOTI, the European Alliance of IoT Innovation promoted by the European Commission, has a specific Working Group on Smart Energy and several other on IoE connected topics to boost the diffusion of this innovative technology in enterprises. However, although the IoT technologies are quickly growing, the IoE development is slower than expected. Main limits to the diffusion of the IoE technologies seem to be the lack of professionals in the related sector and the low level of knowledge of the technology.

The identified needs at the European level were the starting point for the Erasmus+ project 'Internet of Energy – Education and Qualification', which aims at qualifying professionals in using and managing IoE technologies and applications. Nine partners from Italy, Spain, Germany, Greece, Portugal, and Lithuania will jointly create training courses in IoE and offer them as open educational resources to all interested in.

Of course, the design and delivery of training courses for specialists needs to be aligned with their real demands. To this end, the project team investigated the state of play of IoE applications in Europe through comprehensive empirical research. Its main findings are contained within this report, entitled *Labour market analysis in relation to IoE: required skills and competences.*

The unique feature of this report is the presentation of real voices from European companies highlighting their demands and expectations in relation to IoE. Thus, the report contains valuable information for enterprises who may reflect upon introducing IoE. Based on the report findings, the project team will favour a tailor-made learning process mirroring the most required skills and competences, and therefore contribute to the increased employability of potential trainees.

1. Research methodology

As a research method, the quantitative online-survey has been designed and implemented in several European countries by means of the tool LimeSurvey. To this end, a valid online-based questionnaire[1] including a total of 15 questions was primarily developed in English, translated in six further languages (German, Italian, Spanish, Portuguese, Greek, and Lithuanian) in order to collect data concerning the companies' situation in connection with IoE (basically focusing on questions such as knowledge/awareness of IoE, related risks and problems, missing skills and competences, needs for pedagogical support).

The questionnaire was primarily distributed via web within six project partner countries, which were Greece, Germany, Italy, Lithuania, Portugal, and Spain, during the period February to June 2018. However, enterprises from other European countries were also invited to complete the questionnaire.

The target audience for the research were Europe's companies and research institutes acting at the interface between the energy and IT sectors (e.g., energy supply and distribution, manufacture of smart home appliances and smart meters, industrial building services, automotive industry, manufacture of charging stations for electric vehicles, ICT/software development). Also, potential survey candidates were, due to cross-cutting features of IoE, professionals from different areas such as corporate governance, energy management, (electrical) engineering, finance and investment management, ICT, software development, IT security. This approach helped to distinguish the different needs of target groups and therefore, to address them with corresponding training courses later.

The respondents were reached in two ways: they were either contacted directly by the project teams through emails or personal calls, or indirectly through newsletters and cooperation partners, who forwarded the online-survey to the end users. The benchmark of at least 500 respondents had been originally set. A total of 512 companies fully completed the questionnaire. At the same time, a quite high number of non-completed questionnaires was indicated (315 in total). However, these answers were not considered when assessing the final survey results.

The participation in the survey by country is shown in Figure 1:

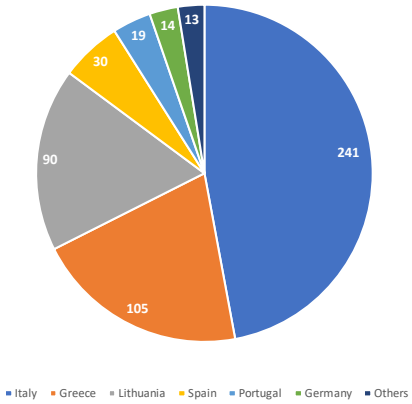

Fig. 1: Countries' participation in the survey (n = 512, in absolute figures)

[1] The full questionnaire in English can be found in Appendix A.

As can be seen from the Fig. 1, the most answers were provided by Italian companies (241 responses), followed by Greece (105 responses), and Lithuania (90 responses). A surprisingly low participation of German companies (only 14 answers) might be explained by the fact that German enterprises are traditionally overwhelmed with different research surveys and therefore do not have sufficient capacities to respond accordingly. The origin of 13 responses within "Others" cannot be traced back: these 13 questionnaires were distributed worldwide through international networks using the English survey link. However, the corresponding answers were considered when evaluating final results.

The research team consisted of nine project partners from six European countries, Germany, Italy, Lithuania, Portugal, Greece, and Spain who operate in the HEI, research and enterprise sectors.

The leading research partner was Fachhochschule des Mittelstands FHM (www.fh-mittelstand.de), Germany, who was responsible for the questionnaire design, technical survey implementation, administration, and monitoring, results evaluation, and composing the final report on labour market needs in IoE.

Other research partners who provided valuable contributions to the questionnaire development and promoted the survey within their countries and networks were:

1. National Research Council (www.cnr.it), Naples, Italy (project applicant);
2. National University of Distance Education (www.uned.es), Madrid, Spain;
3. MAG S.R.L. (www.mag-innovation.net), Rome, Italy;
4. Cedel educational group (www.cedel.it), Rome, Italy;
5. EVM group (www.evm.net), Santa Cruz de Tenerife, Spain;
6. Kaunas Science and Technology Park (www.kaunompt.lt), Kaunas, Lithuania;
7. Madan Parque (www.madanparque.pt), Caparica, Portugal;
8. Institute of Entrepreneurship Development (www.ied.eu), Larissa, Greece.

This team structure ensured that the interests and views of all the different stakeholders were considered when designing the questionnaire and addressing the target audience.

2. Survey results

The research findings are presented mainly by using diagrams, which contain the scores provided by respondents when completing the online-survey, either in percentage or in absolute figures. The diagrams also contain textual interpretations of the relevant findings related to the survey objectives.

The results are reported in the same order that the related questions were formulated in the survey. To aid for better understanding, the survey results are divided into several thematic sub-sections.

As the survey results should be used for designing qualification profiles which are supposed to be exploited by European companies in general regardless of their countries of origin, this report also focuses on the presentation of the accumulated needs of all respondents, and not by country.

2.1. Statistical data about respondents

Firstly, the survey sample is described, with relevant statistical data about the company such as type, branch, and geographical location as well as about the job role of the respondents (questions 1 – 4 of the survey).

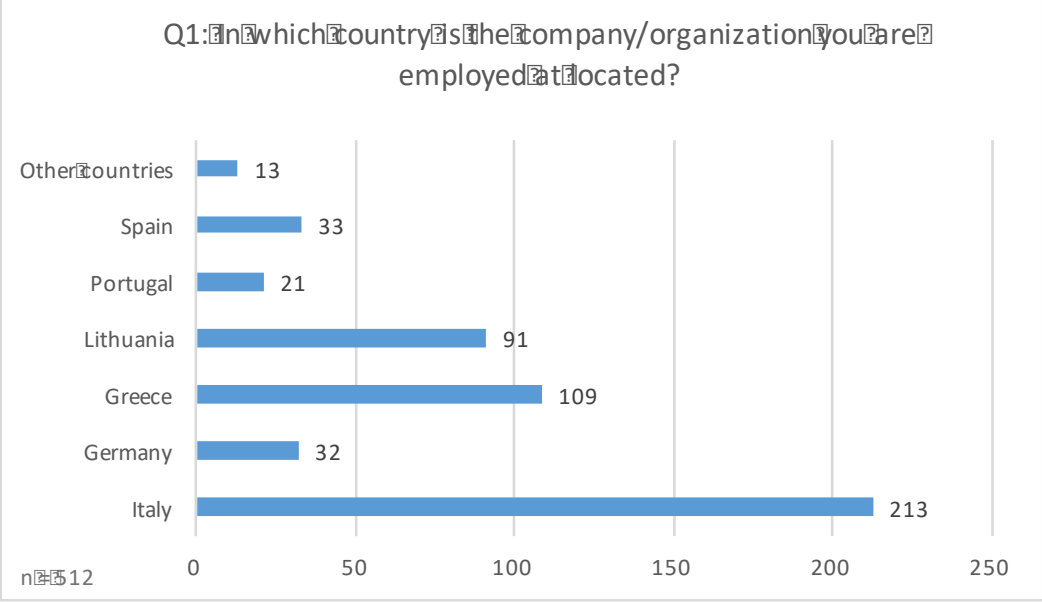

Fig. 2: Geographical location of companies (n = 512, in absolute figures)

As can be expected, the companies are mostly located in one of the project partner countries where the survey was undertaken. Again, the most companies are concentrated in Italy (213 answers), since Italy provided the highest number of filled in questionnaires. However, place of companies' location does not

automatically correspond with the numbers provided in Fig. 1 (compare with Fig. 1). That means, i.e., respondents from Italy have their businesses in Germany.

Following countries were named among other countries: Czech Republic, Switzerland, United Kingdom, Luxembourg, Poland, Ecuador, Denmark, Sweden, Bulgaria, and Kenya.

Fig. 3 demonstrates areas, where the companies operate, as follows:

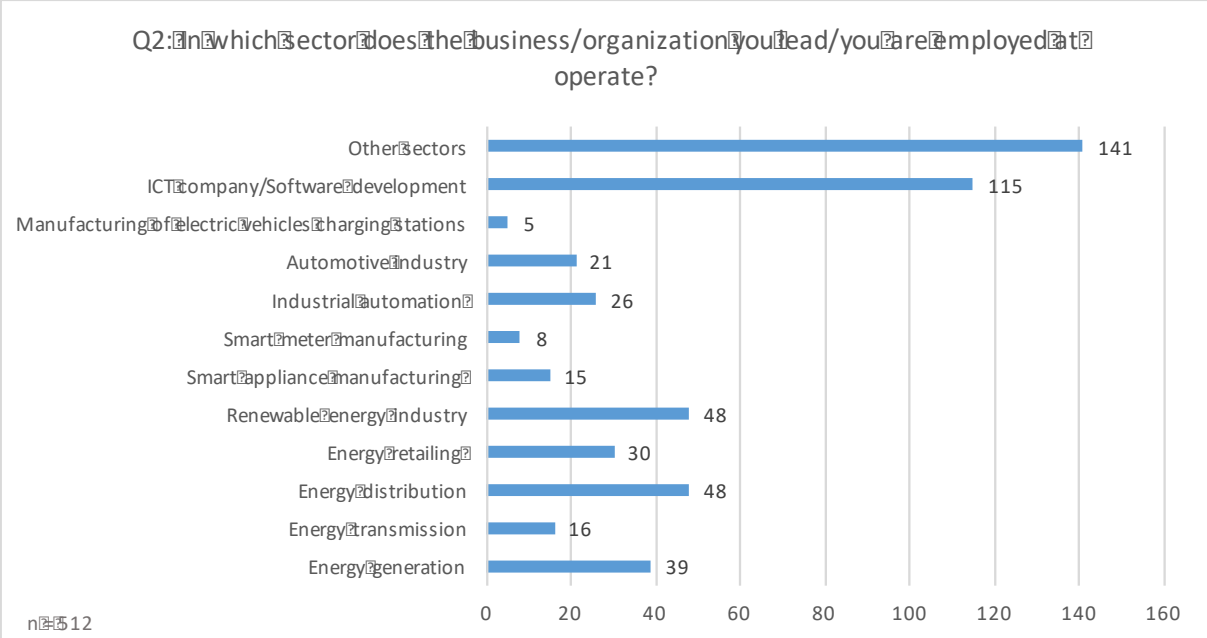

Fig. 3: Sector of companies' operation (n = 512, in absolute figures)

From the pre-defined options, the most answers were received from ICT and Software Development sector (115 responses). Therefore, it might be expected that the most IoE needs will be associated with Information and Communication Technologies. The second highest answers are equally represented by Renewable Energy and Energy Distribution companies (48 answers), followed by Energy generation enterprises (39 answers) meaning that energy sector is interested in the survey topic, too.

Other sectors are represented, according to the Fig. 3, with the highest score (141 answers). When analyzing the related comments of respondents concerning their sectors of operation, it is evident that many of them do not have clear links to the survey topic, such as advertising, finance, health, (wholesale) trade, pharmaceutical, insurance, export promotion, agriculture, furniture industry, food industry. Therefore, it can be expected that this group of respondents completed the survey either after the question 5 or after the question 10 (s. the Appendix 1).

However, among the comments under the option Other Sectors there are many sectors, which might be of relevance for the survey, such as consulting (energy efficiency, renewables), manufacturing of electrical

equipment, systems & networks, maintenance/installation of electrical systems, research institutes, telecommunications, aerospace, public administration.

The next question asked for companies' size. According to the Fig. 4, all company sizes are represented in the survey. The most respondents were, following the definition of the European Commission (2), small companies (170 answers), followed by large companies (133 answers). 122 companies were tiny companies employing less than 10 employees. Therefore, the survey results might be of relevance for all company sizes in Europe.

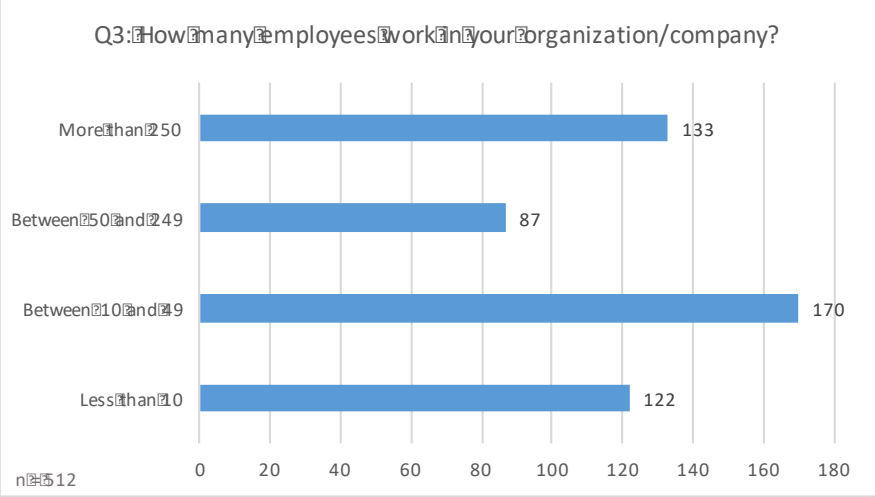

Fig. 4: Size of companies (n = 512, in absolute figures)

The respondents had different job roles, as Fig. 5 demonstrates:

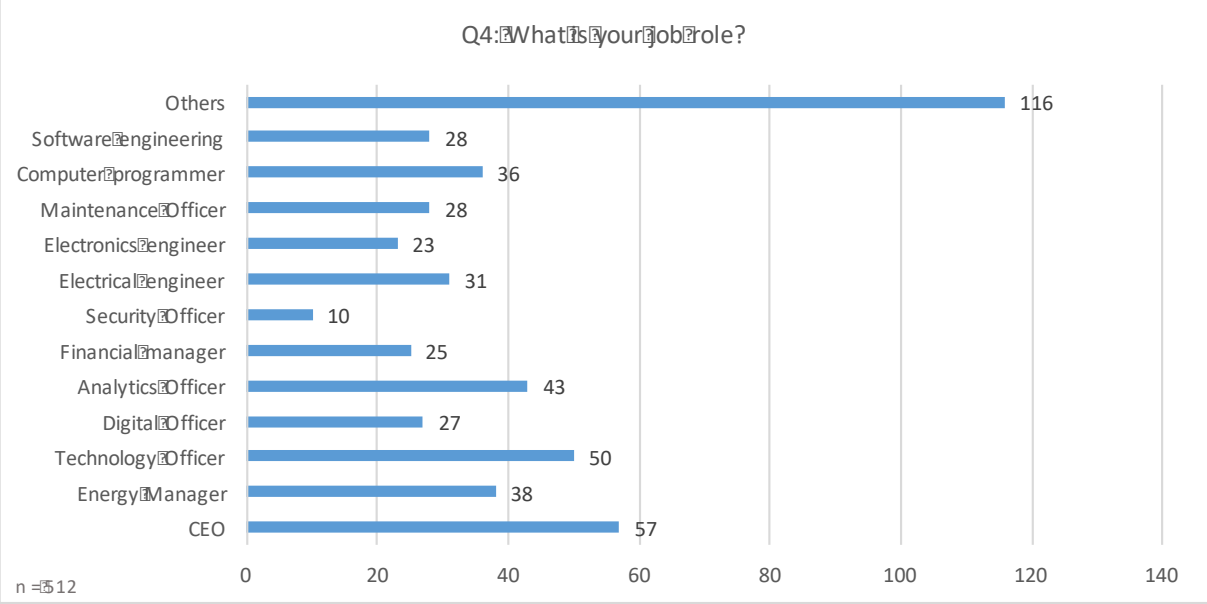

Fig. 5: Job roles of respondents (n = 512, in absolute figures)

From the pre-defined options, the main survey respondents were CEO/general company managers (57 answers), closely followed by Technology Officers (50 answers). Also other job profiles linked to IT, engineering, and financial issues, were represented.

Again, the most answers were provided in the field Others (116 responses). However, when analysing corresponding comments, it is evident that many of these job roles are identical with those pre-defined in the survey (i.e. CTO = Technology Officer, General Manager/Business owner = CEO, CAD designer = Software Engineer, Maintenance coordinator = Maintenance Officer, Power Trading Analyst = Analytics Officer).

Other job roles of respondents, in addition to the pre-defined ones, were project manager, quality manager, business developer, consultant, testing manager, service manager, marketing manager, sales manager. They were relevant for the survey. That means, even if the group Others scored the most points, the related job profiles can still be associated with the survey objectives.

Question 5 directly aimed at identifying a general interest of respondents in using IoE solutions. As Fig. 6 shows, 402 respondents gave a positive answer:

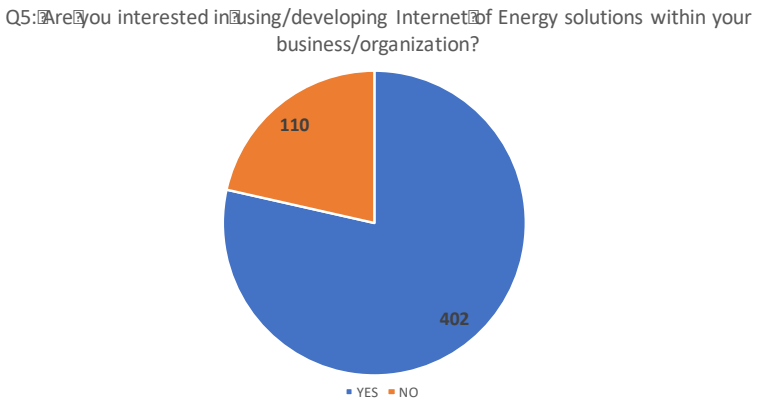

Fig. 6: Respondents' needs in using IoE (n = 512, in absolute figures)

At this point, respondents who provided negative answers (110 persons) were redirected to the survey end. Therefore, only those who answered question 5 positively (a total of 402 respondents) could continue filling in the questionnaire.

2.2. General awareness of Internet of Energy

After having collected statistical data, a set of questions was asked to identify the level of familiarity of respondents with IoE-related terms and concepts. Firstly, a general question was introduced asking about general awareness of IoE (s. Fig. 7):

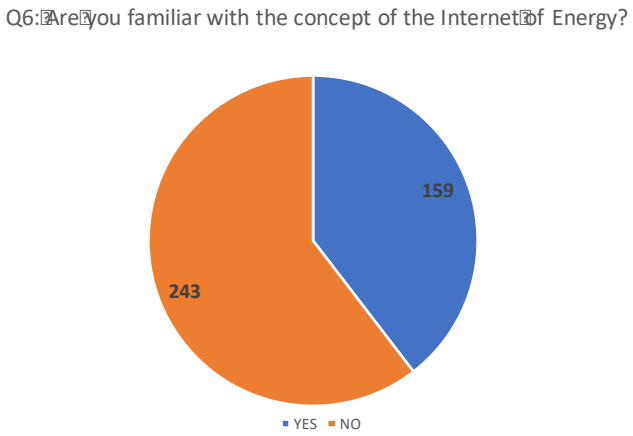

Fig. 7: General awareness of IoE (n = 402, in absolute figures)

As Fig. 7 shows, the majority of respondents (243 answers) are not familiar with the IoE concept. This also corresponds with the observations of the partnership that stressed a quite low IoE awareness in the project rationale.

After this question, the respondents who provided negative answers (a total of 243) were redirected to the question asking for potential skills and knowledge in IoE, which could be of relevance for their companies. The related answers are presented in the Fig. 8:

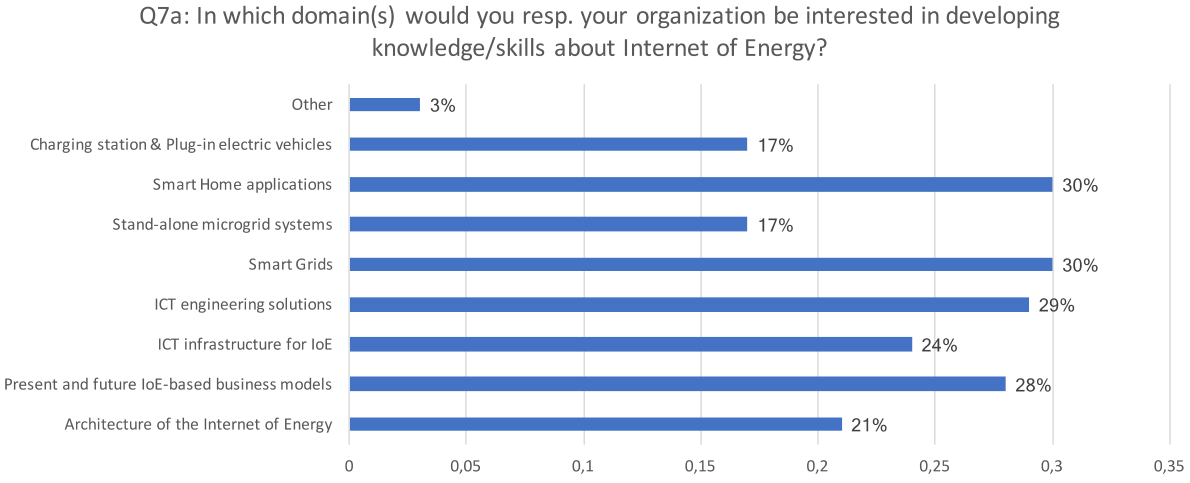

Fig. 8: Estimation of potential needs and skills in IoE (n = 259[2], in %, many answers possible)

According to the Fig. 8, the respondents would have the most needs in learning more about the IoE applications for Smart Home and Smart Grids (both are ranked with 30% of responses). The needs in ICT engineering solutions for IoE are appreciated with 29% of answers, closely followed by expressed needs in

[2] The sample of 259 persons results from summing up the number of respondents who was directly forwarded to the question 7a (243 persons) and the number of respondents who was redirected to the question 7a after the question 10 about job profiles by choosing the option "Others" (s. page 16 of this report, 16 persons).

learning more about present and future IoE-based business models (28% of mentions). It is however remarkable that all pre-defined domains were appreciated by respondents as potential areas for boosting their skills and competences.

Within the option Others, a few additional comments were left addressing the relevance of knowledge of energy online-transfer, interconnections between sectors, Internet of Things, Big Data, advanced analytics, and designing trainings in the area of IoE.

After answering this question, this type of respondents was supposed to finish the survey.

As for the respondents providing a positive answer to the question about the familiarity with the IoE concept (s. Fig. 7, 159 responses), they were suggested to provide a more detailed picture about their existing knowledge about IoE and desired IoE skills by answering next survey questions.

2.3. Current integration of IoE within companies

Firstly, the respondents were asked about their opinions what IoE can be defined through (s. Fig. 9):

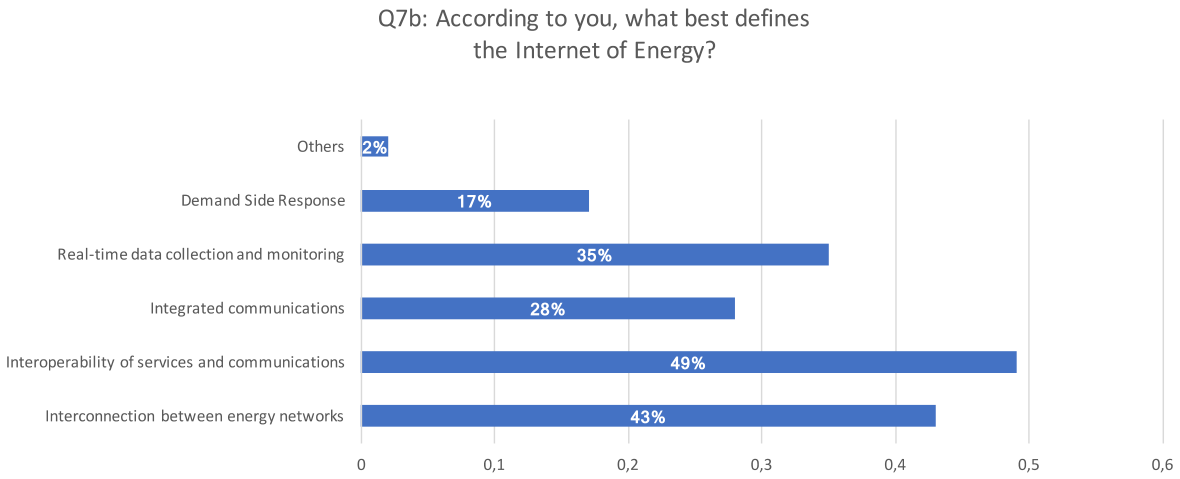

Fig. 9: Definition of IoE (n = 159, in %, many answers possible)

As can be seen from Fig. 9, the interoperability of services and communications and interconnection between energy networks are mostly associated with IoE (49% and 43% of responses accordingly). Thus, for many respondents IoE seems to have strong links to the system engineering and telecommunications. Demand side response obtained only 17% of responses and is therefore a little-known mechanism though it considered a relevant tool towards shifting traditional paradigms of energy consumption and supply (3).

Also, four comments were left defining IoE as follows:

- IoE is a way of promoting the reduction of inefficiencies in existing energy infrastructures, namely by optimizing the performance of the generation, transmission and use of electricity through IoT technology;
- IoE is Smart Energy System synonym;
- IoE means energy efficiency;
- IoE stands for interconnections between sectors.

Then, the respondents were asked whether they already develop or utilize IoE-related solutions or products within their organizations. As Fig. 10 shows, 43% of respondents are engaged with IoE whilst 37% do not use it. However, 20% of respondents despite of non-using IoE plan to introduce related applications in their entities:

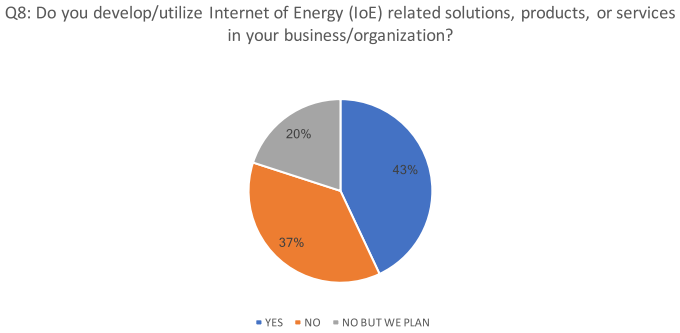

Fig. 10: Current use of IoE-related solutions and products (n = 159, in %)

Depending on the provided results to this query, the respondents were redirected to two different questions. Those who already develop or use IoE-solutions (68 respondents) were additionally asked for more differentiated information about them. Fig. 11 presents the related findings as follows:

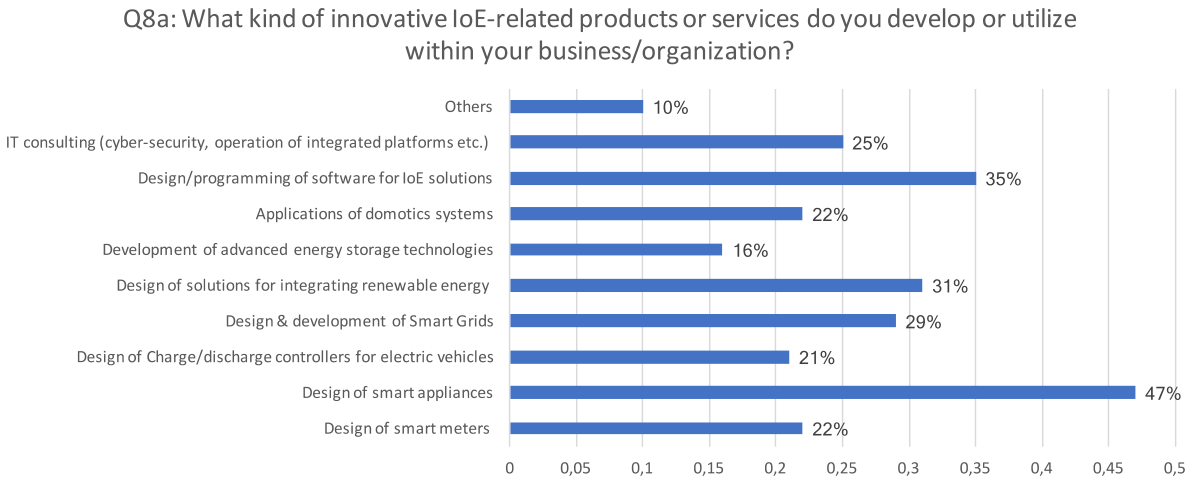

Fig. 11: Type of IoE-related products and services developed and/or used by companies (n = 68, in %, many answers possible)

Thus, as Fig. 11 shows, companies are engaged in the design and development of many IoE applications. They mostly focus on the design of smart appliances (47% of responses), followed by design and programming of software for IoE solutions (35% of mentions) and design and development of smart grids (29%). Considering that most survey respondents represent the ICT sector (s. Fig. 3), these answers, on the one hand, confirm the consistence of the previous responses and, on the other hand, demonstrate a wide range of concrete products offered by companies.

In turn, those who provided answers "No" or "No but we plan" to the question 8 (s. Fig. 10), were requested to indicate the reasons for non-using IoE-solutions, which are presented in the Fig. 12:

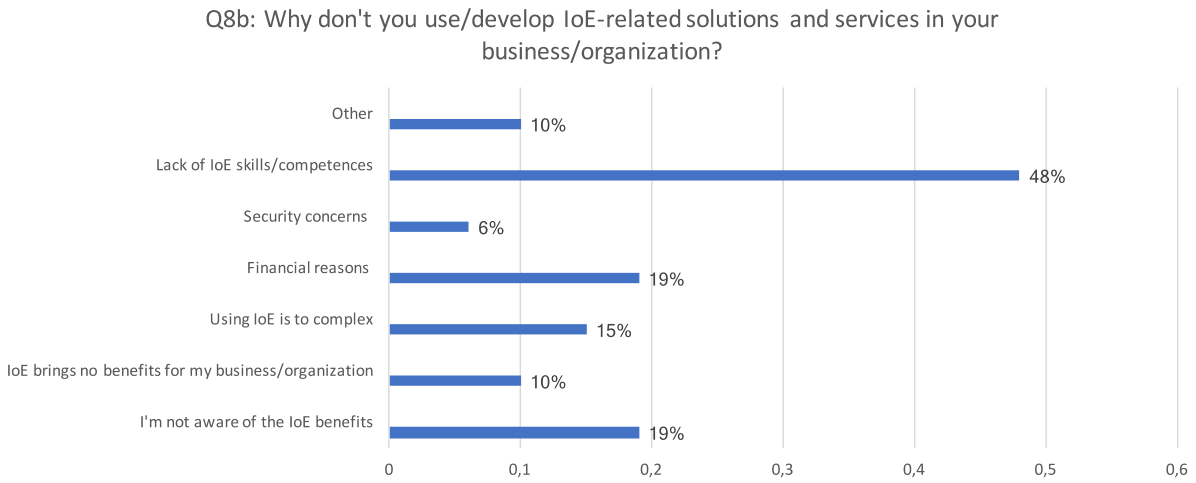

Fig. 12: Reasons for the non-use of IoE solutions (n = 91, in %, many answers possible)

As Fig. 12 clearly states, lack of IoE skills and competences (48% of mentions) is the main obstacle towards introducing IoE solutions in companies. This also justifies the efforts of the project partners towards changing this situation.

Financial reasons and low awareness of the IoE benefits are indicated though but both only with 19% of responses. Quite surprising is a low indication of security concerns (6% of mentions) considering the efforts of European companies towards protecting personal data.

Among other reasons hampering the introduction of IoE the following were mentioned:

- Missing platforms for energy suppliers and buyers;
- Missing vision for a wider applicability;
- Lack of specific projects;
- Other priorities.

After providing these differentiated answers, the respondents were asked to estimate the relevance of the pre-defined skills and competences, which are needed for the design and implementation of IoE-related

products and services. These skills were categorized into five main domains of potential applications as follows:

- Forecasting and management of energy companies;
- Advanced electrical engineering skills and knowledge;
- Advanced industrial engineering skills and knowledge;
- Advanced software engineering skills and knowledge;
- Advanced programming skills and knowledge;
- Other skills and knowledge.

The respondents were required to estimate each knowledge domain on the scale from 0 (not appreciated at all) to 4 (highly appreciated). Fig. 13 demonstrates the aggregated results of their estimations:

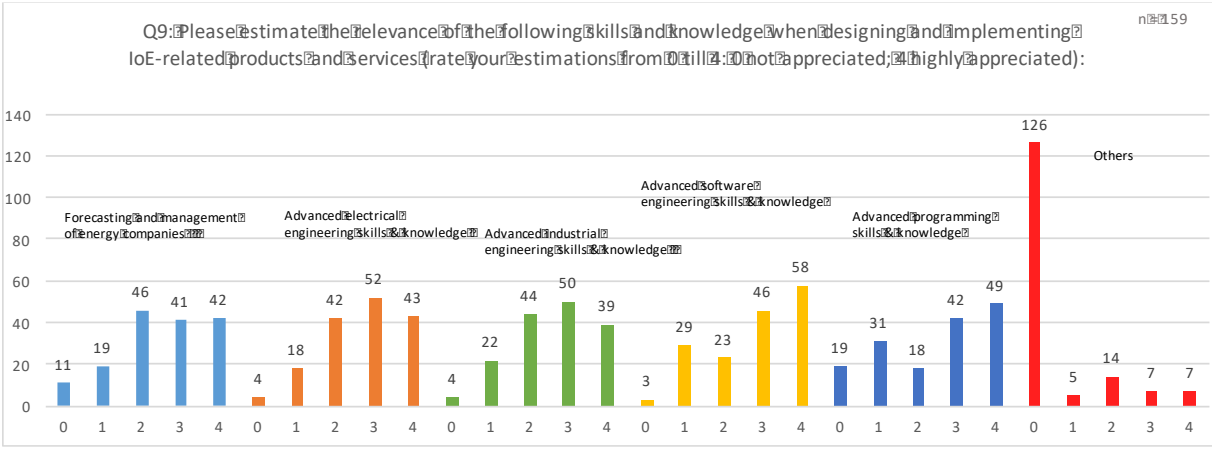

Fig. 13: Estimations of relevance of knowledge domains for IoE (n = 159 (for each domain), in absolute figures)

Fig. 13 gives quite interesting insights into the respondents' vision of the most relevant skills and knowledge for IoE:

- Among the pre-defined five domains, skills related to the software engineering and programming were rated as highly relevant by the highest number of respondents (58 and 49 responses accordingly). It might be not surprisingly considering the ICT sector of operation of most respondents.
- However, advanced electrical and industrial engineering skills are appreciated as quite relevant, too (52 and 50 answers accordingly).
- The relevance of management-related skills seems to be ambiguously appreciated by respondents: from "rather relevant" (46 answers) via "relevant" (41 answers) through to "very relevant" (42 answers).

- Option “not relevant at all” is rated almost for all skills domains with the fewest responses (except of the domain Programming skills and knowledge where 19 respondents do not appreciate these skills at all).
- 126 from 159 respondents believe, the advanced knowledge and skills in the pre-defined domains are sufficient for designing and implementing IoE products and services – they rated the option “Others” with “Not relevant at all”. 33 respondents mentioned the relevance of knowledge of vehicle-to-grid technology (V2G), energy efficiency, communications, cybersecurity, reliable engineering and maintenance, electronic systems, electrical applied mechanics, legal framework and incentives. As can be seen, their answers might be allocated to the pre-defined general knowledge domains. However, the respondents anticipated the next questions aimed at obtaining more differentiated answers about their needs.
- In general, all pre-defined knowledge domains might be addressed when designing IoE trainings.

2.4. In-depth insights into the required IoE skills and competences

With the next set of questions, we intended to learn more about professional needs of respondents in the IoE-related topics depending on their job roles and/or profiles. Based on our approach, the respondents where firstly required to select the pre-defined job areas that best fit the tasks performed by them at their companies. The following picture of the job profiles has emerged, as Fig. 14 shows:

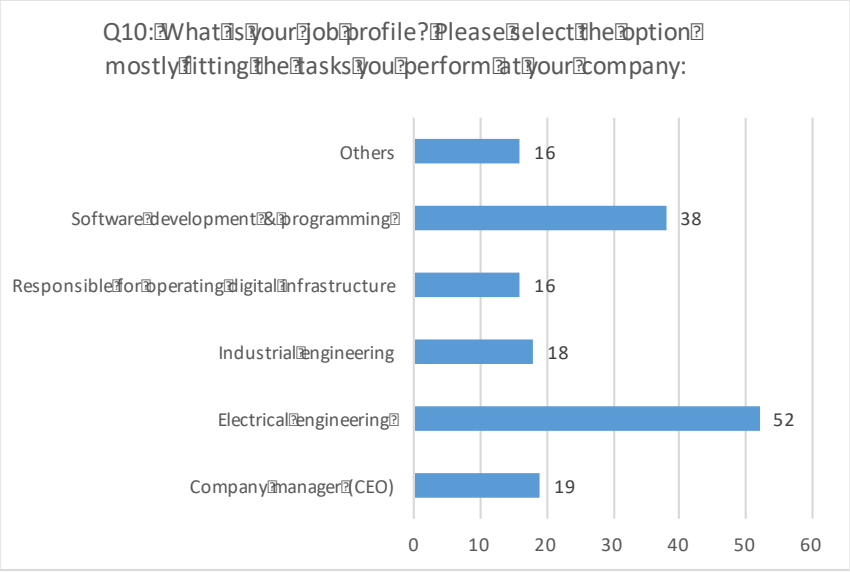

Fig. 14: Job profiles of the respondents (n = 159, in absolute figures)

For each job profile, a special set of questions was prepared in order to learn more about their specific professional needs in the corresponding job area. Therefore, after having answered the previous question,

each respondent was redirected to the next one specially tailored to its job situation. For example, respondents who ticked the option “Company manager/CEO” were forwarded only to the question asking about their professional needs in the domain “Management”, etc.

Respondents who selected the option “Others” (16 persons) were redirected to the question 7a (s. Fig. 8) asking about their potential needs in skills and knowledge about IoE, and after that to the survey end. Based on our approach, other job profiles indicated by the respondents under the question 10, would be of minor relevance for the identification of the most desired IoE skills and competences. However, due to redirection to the question 7a these respondents could indicate their potential needs in IoE, which were considered accordingly.

2.4.1. Desired IoE skills of Company Managers

The respondents of the category Company Manager were required to indicate whether they have professional needs in improving the IoE-related skills and competencies by estimating the relevance of three pre-defined topics on the scale from 0 (not appreciated at all) to 4 (highly appreciated). Fig. 15 demonstrates professional needs of company managers as follows:

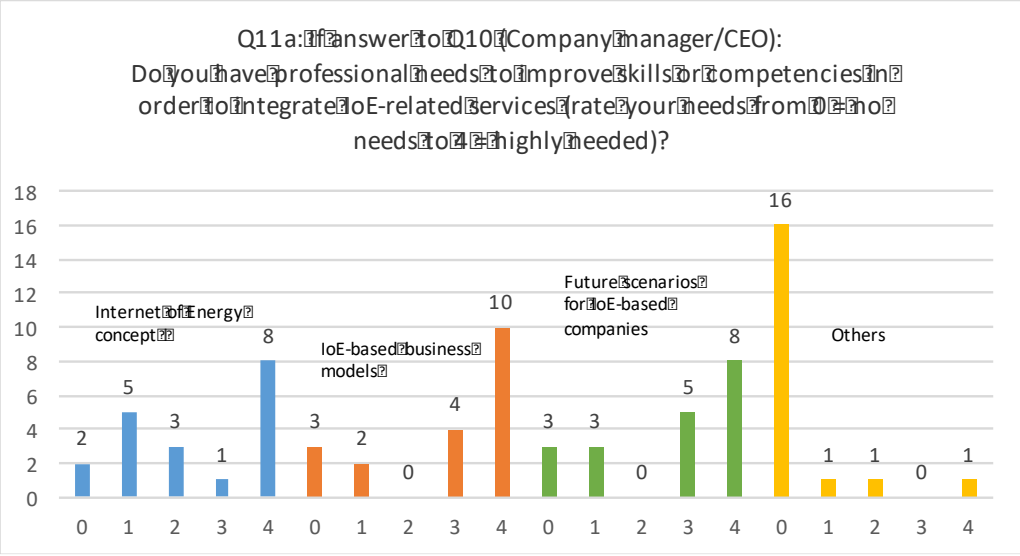

Fig. 15: Professional needs in IoE of company managers/CEO (n = 19, in absolute figures)

- Company Managers seem to have the most needs in the topic “IoE-based business models” (10 answers from 19), closely followed by the equally estimated topics “Internet of Energy concept” and “Future scenarios for IoE-based companies” (each 8 answers were rated with “highly needed”).
- Any other special needs were not appreciated (16 answers were estimated with “no needs” under Others).

2.4.2. Required IoE skills of Electrical Engineers

For the category Electrical Engineers, firstly, four main domains of knowledge were pre-defined, which had to be rated on the scale from 0 (not appreciated at all) to 4 (highly appreciated). The following results were obtained:

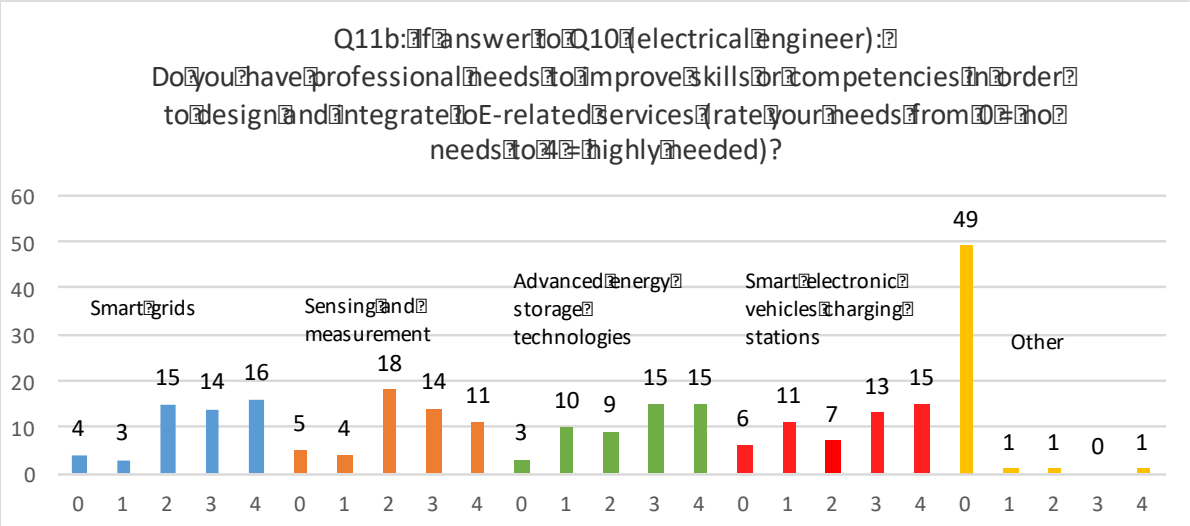

Fig. 16: Professional needs in IoE of Electrical Engineers (n = 52, in absolute figures)

As Fig. 16 shows, all pre-defined domains seem to be relevant for this target group. It is remarkable that the level of needs in each domain is approximately the same (i.e. needs in Smart Grids, Advanced energy storage technologies, and Smart electronic vehicles charging stations are stated as “very relevant” by 15 – 16 respondents; or needs in these domains rated with “Relevant”, are ranged between 13 and 15 responses). Answers “not relevant at all” or “relevant to a little extent” are rather infrequent (on average, 4 resp. 7 responses per level). Any other needs are not identified. Therefore, the pre-defined professional needs of electrical engineers were correctly estimated when designing the questionnaire.

Moreover, the respondent group Electrical engineers were additionally asked to provide more detailed insights within each pre-defined areas of knowledge. Figures 17 – 20 illustrate the differentiated needs of electrical engineers in the domains Smart Grids, Sensing and Measurement, Advanced Energy Storage technologies, and Smart Electronic Vehicles charging stations as follows:

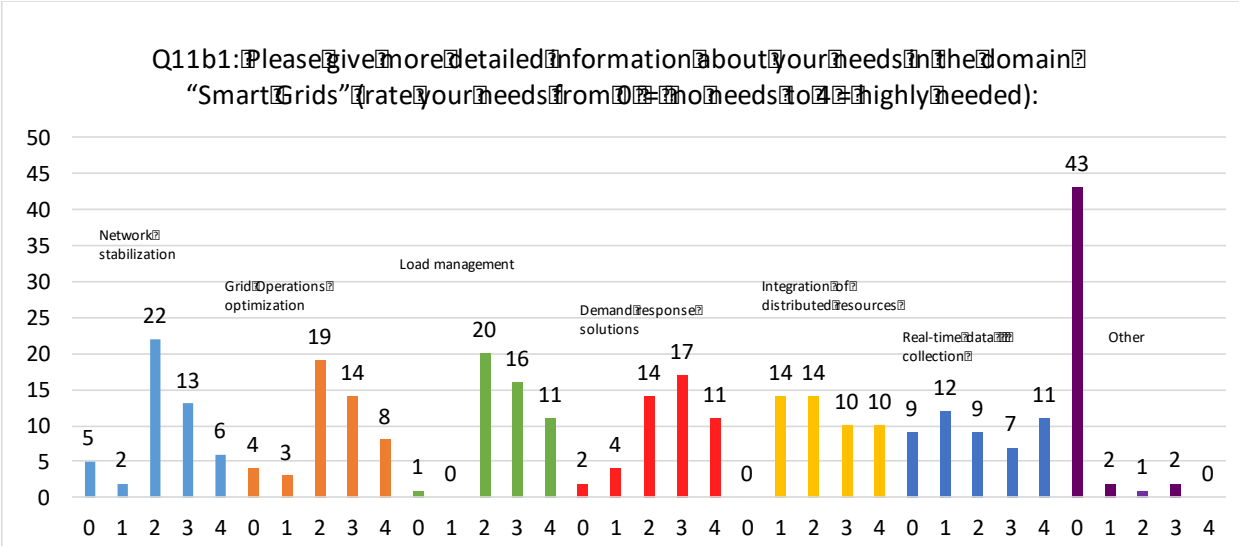

Fig. 17: Needs of Electrical engineers in the domain „Smart Grids“ (n = 48, in absolute figures)

According to the Fig. 17, the specific needs within the domain “Smart Grids” are present though but are estimated to a moderate extent. The most selected option is “rather relevant”, closely followed by “relevant”.

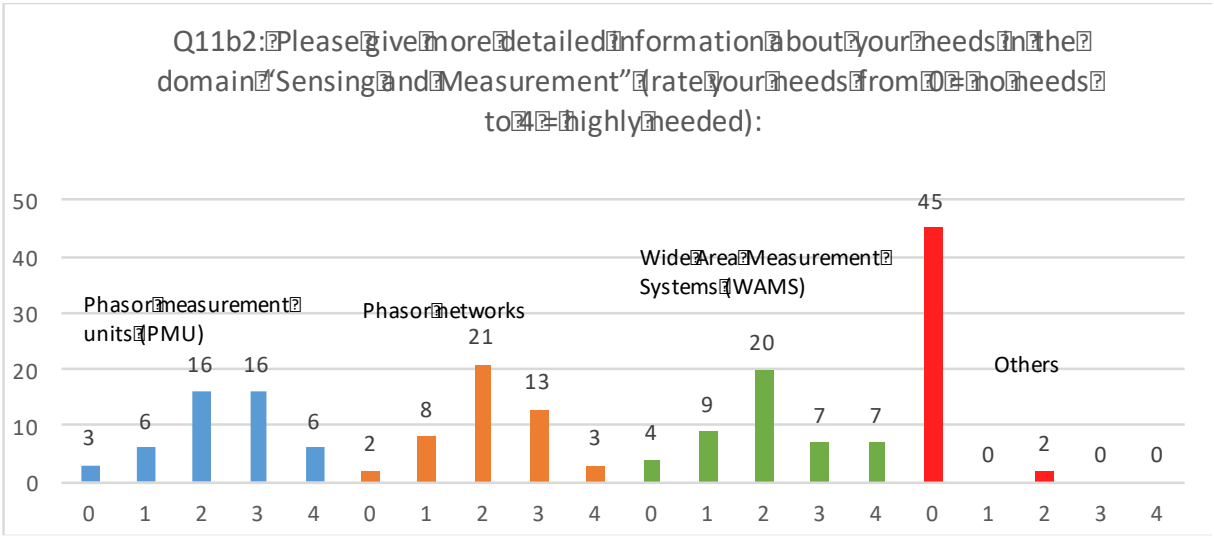

Fig. 18: Needs of Electrical engineers in the domain „Sensing and Measurement“ (n = 47, in absolute figures)

Also the needs in the domain “Sensing and Measurement”, as Fig. 18 demonstrates, are rated by electrical engineers to a moderate extent.

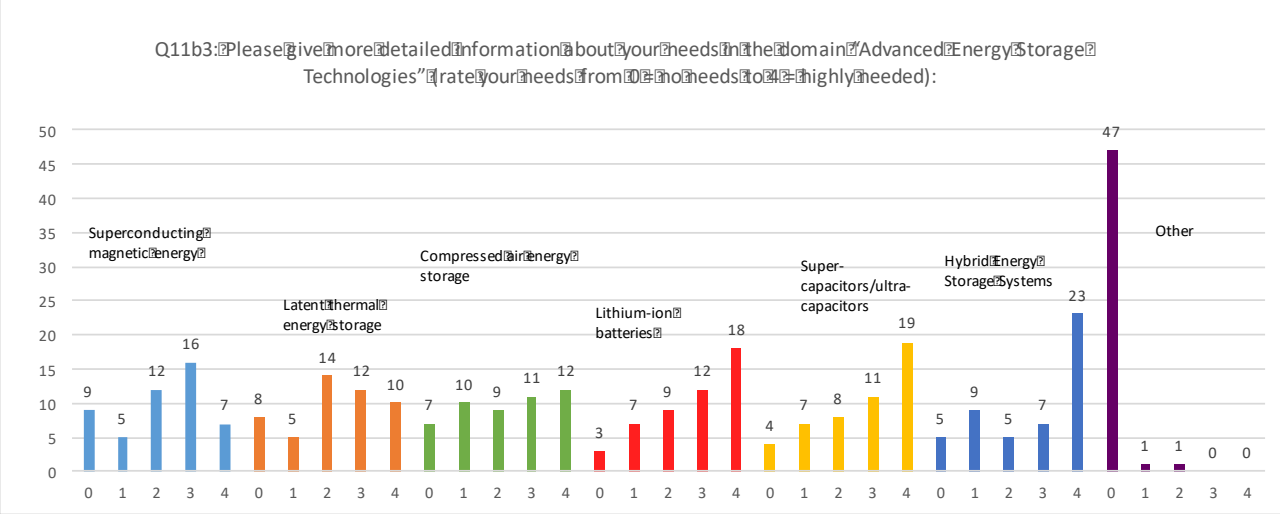

Fig. 19: Needs of Electrical engineers in the domain „Advanced Energy Storage Technologies" (n = 49, in absolute figures)

When expressing their professional needs in the domain "Advanced Energy Storage Technologies", this respondent group, as per Fig. 19, stated the most demands in innovative technologies such as Hybrid Energy Storage systems (estimated as highly needed by 23 respondents), Super/ultra capacitors (19 most appreciated responses), and Lithium-ion batteries (highly needed by 18 respondents). Needs in other technologies are indicated to a lesser extent.

Finally, electrical engineers provided the data about their specific needs in the domain "Smart Electronic Vehicles Charging stations":

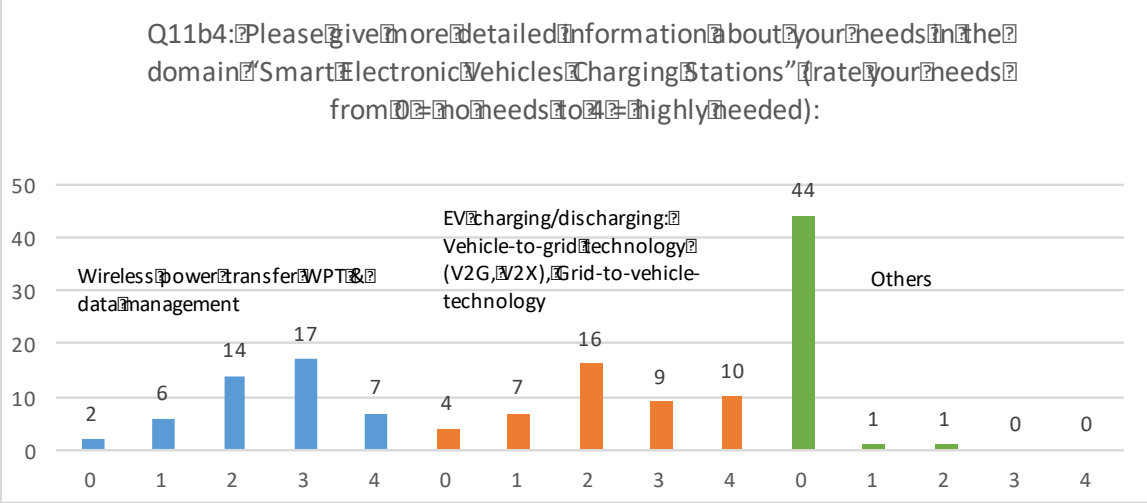

Fig. 20: Needs of Electrical engineers in the domain „Smart Electronic Vehicles Charging Stations" (n = 46, in absolute figures)

Again, as Fig. 20 illustrates, the related needs are mostly rated with "rather relevant" and "relevant".

2.4.3. Professional needs of Industrial Engineers in IoE

The sample of industrial engineers of the survey, which was equal to 18 persons, articulated their needs in the present topics as showed in the Fig. 21:

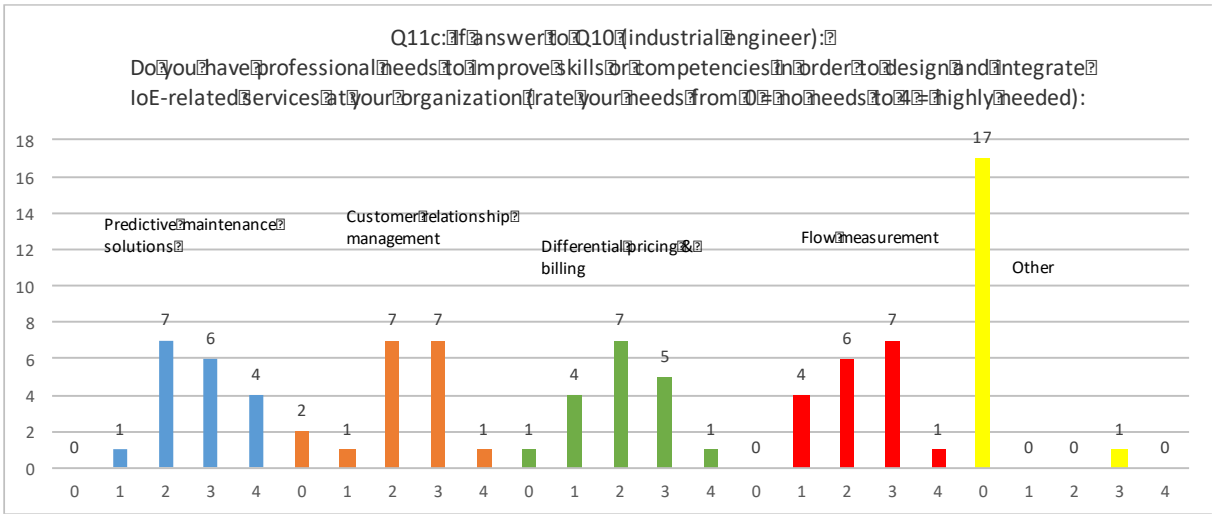

Fig. 21: Professional needs of Industrial engineers in IoE (n = 18, in absolute figures)

It is evident, that the needs of this respondent group in the default areas of knowledge are rated between "relevant" and "rather relevant". Though the option "highly needed" is underrepresented, the option "no needs" appear only once. Thus, topics Predictive maintenance solutions, Customer relationship management, Differential pricing and billing might be considered important elements of future trainings for Industrial Engineers.

2.4.4. Professional needs of Digital Officers in IoE

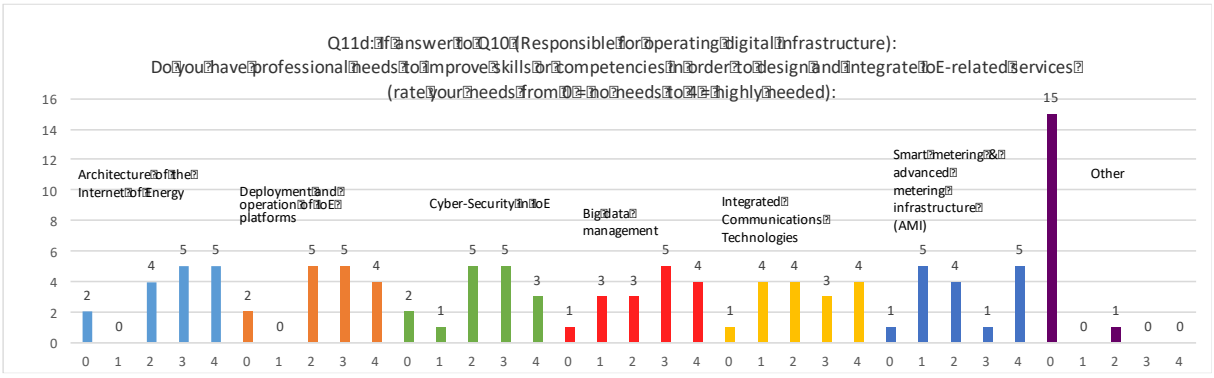

Fig. 22: Professional needs of Digital Officers in IoE (n = 16, in absolute figures)

As Fig. 22 demonstrates, the needs of Digital Officers in the pre-defined topics are prevailingly rated either as “highly relevant” or as “relevant”. Topics dealing with architecture of IoE, Big Data management, deployment and operation of IoE platforms, Cyber-Security could therefore be integrated in the future training courses for this target group.

The relevance of the topic Integrated Communication Technologies is a bit ambiguous: it is equally rated with 4 responses from “relevant to a lesser extent” via “rather relevant” through to “highly relevant”. However, the respondents were additionally asked to provide in-depth insights into the needs linked to the Integrated Communication Technologies. Fig. 23 illustrates the results obtained:

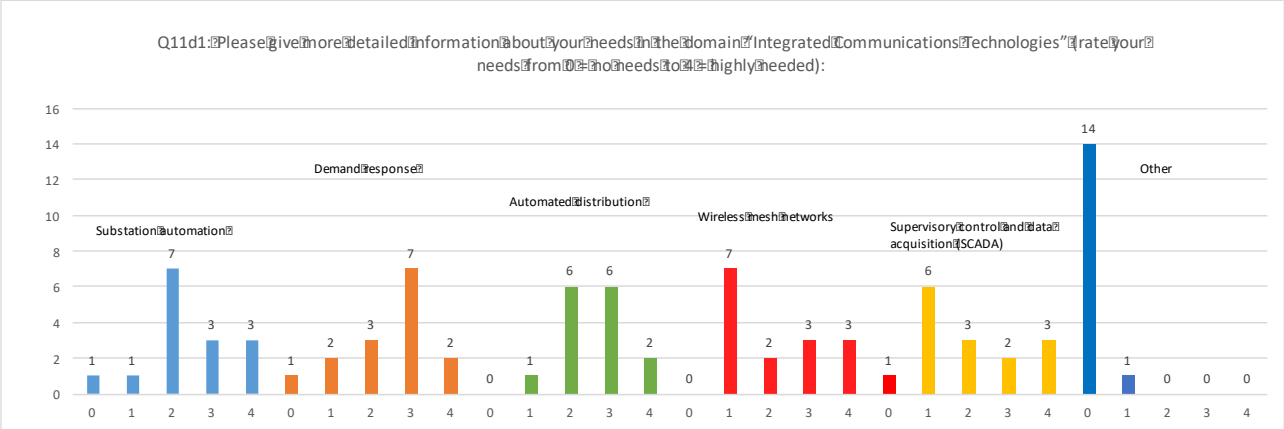

Fig. 23: Specific needs of Digital Officers in the domain “Integrated Communication Technologies” (n = 15, in absolute figures)

As can be seen from the Fig. 23, the option “highly needed” appears to a lesser extent comparing with other options. The topics where the most needs are articulated are Demand response (“relevant”, 7 answers), Automated distribution (in total, 12 responses were received for “relevant” and “rather relevant”), Substation automation (in total, 6 answers were obtained for “highly relevant” and “relevant, and 7 for “rather relevant”).

2.4.5. Professional needs of Software developers/Programmers in IoE

Finally, specific training needs of the respondent group Software developer/Programmer in relation to IoE were explored through the survey. These findings are presented below in the Fig. 24:

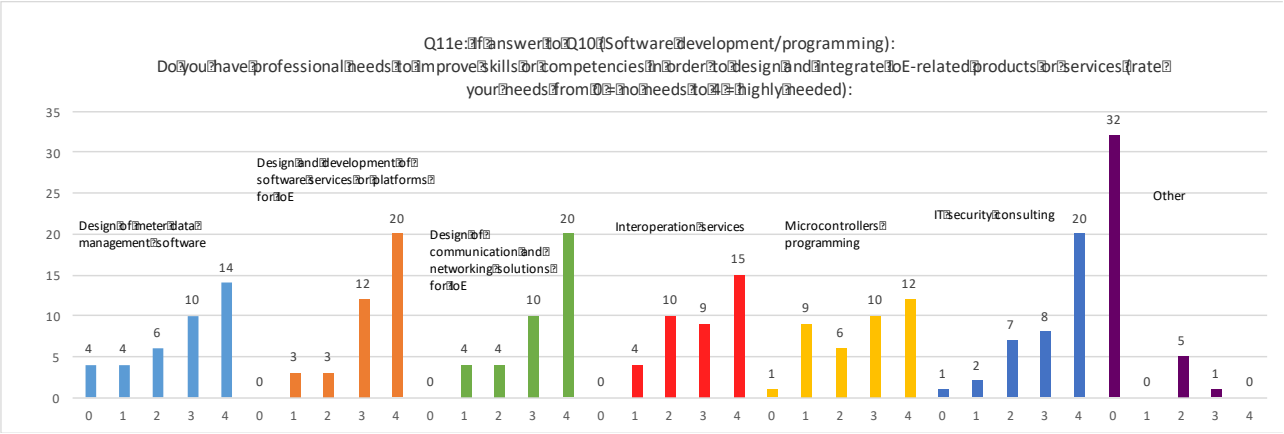

Fig. 24: Professional needs of Software Developers/Programmers in IoE (n = 38, in absolute figures)

As Fig. 24 demonstrates, the answers "highly relevant" were the most frequently ones provided for each pre-defined topic, closely followed by the option "relevant". When summing up the answers provided for these two options for each topic, the most appreciated ones are Design and Development of software services or platforms for IoE (32 answers), Design of communications and networking solutions for IoE (30 answers), and IT security consulting (28 answers) – considering that maximal number of answers per topic was 38. At the same time, the option "no needs" for these topics was mentioned only once. Therefore, these topics must be considered when designing related trainings for this target group.

However, also topics Design of meter data management software and Microcontrollers programming should not be underestimated, too – the needs are still present, as Fig. 24 states.

2.5. Willingness to benefit from the trainings in Internet of Energy

The respondents were asked whether they are interested in participating in the training provisions to be designed and delivered on the topic IoE. The related question could be answered by respondents of all job profiles (company managers, engineers etc.).

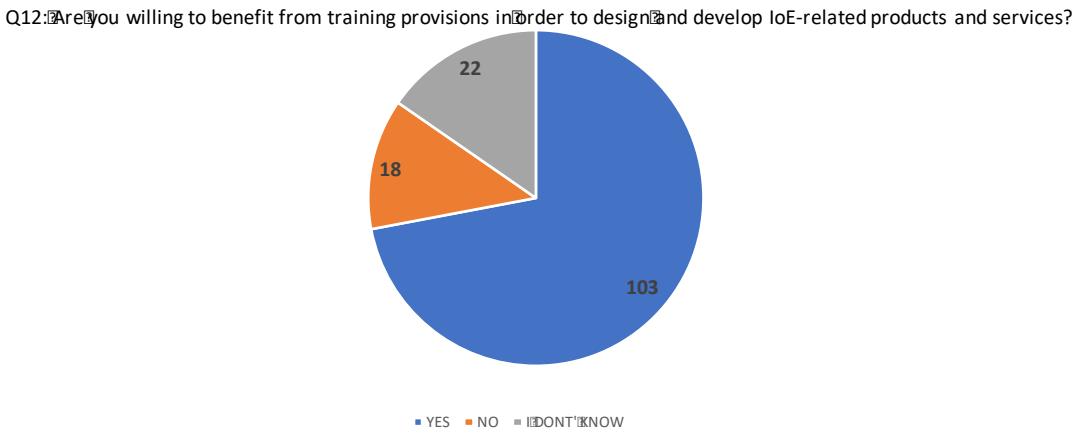

Fig. 25: Willingness to benefit from IoE-related trainings (n = 143, in absolute figures)

As can be seen from the Fig. 25, the most respondents (103 persons what is equal to 72%) are ready to take advantage from trainings in IoE to boost their competencies. 18 respondents (13%) provided negative feedbacks whilst 22 persons (15%) were not sure about this. A clear dominance of positive answers is a valid justification and at the same time a good motivation for the development of related trainings within the project.

2.6. Advantages of Internet of Energy for organizations

One of the survey questions addressed the respondents' vision of the main advantages of IoE to be effectively exploited within their organizations. The obtained results are presented below in the Fig. 26:

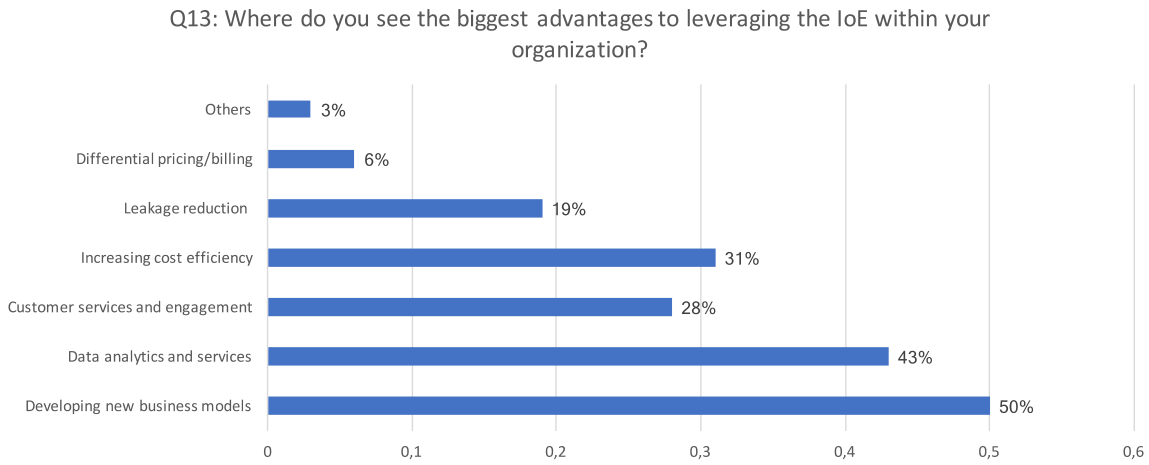

Fig. 26: Areas of the biggest advantages from the IoE exploitation (n = 143, in %, many answers possible)

As per Fig. 26, the most advantages offered by IoE are associated with the development of new business models (50% of mentions). Data analytics and services can benefit from IoE introduction, too (43% of responses). Finally, IoE might favour increase of costs efficiency (31%).

Differential pricing and billing closely linked to the changing paradigm of the energy consumption and supply are not considered business opportunities yet (only 6% of mentions).

Comments left under "Others" focus on accounting, real-time data collection, and optimization of integral solutions.

These answers were relevant for the survey as they helped to understand which business areas could be affected by IoE and, therefore, to adjust the future training courses accordingly.

The last survey question asked whether the organization and/or company the respondents work for did or do participate in the IoE-related projects. As Fig. 27 illustrates, only 10% of respondents (14 answers) were involved in such kind of projects and therefore could benefit from the latest know-how and knowledge in

the field of IoE. The majority of 62% (89 responses) did not participate in IoE projects. This also might be a reason for a quite moderate awareness of IoE.

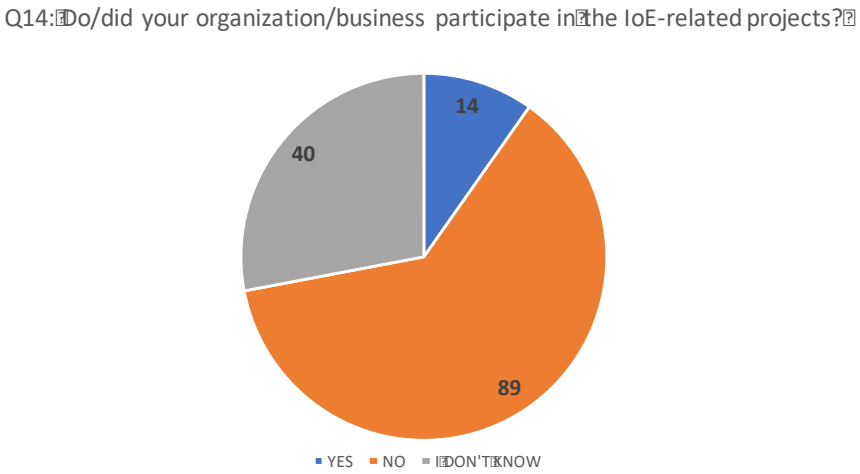

Fig. 27: Participation of companies in IoE-related projects (n = 143, in absolute figures)

At the end of the survey, the respondents were encouraged to leave their own comments about the survey topic. The collection of the most emotional comments is provided below:

- If there are any interesting results on VET or other training levels (courses, teaching materials etc.)? I would be pleased to receive them.
- Nobody needs Internet of Energy!
- How can the data protection be ensured?
- When will energy be replaced with bionics?
- Common glossary for IoE is needed.
- Legal aspects of online energy transfer are needed.
- IoE – what is the difference from smart networks and Internet of Things?
- Internet of Energy – what is it??
- Lack of knowledge!
- Too early to speak about it!
- Would be interesting to learn more about IoE!

Perhaps, these comments can be of help for better understanding needs and concerns of respondents, and therefore for better meeting their expectations.

3. Summary

The online-survey conducted within the framework of the Erasmus+ project Internet of Energy – Education and Qualification provided useful data about the current situation of ICT and energy companies in Europe in the field of Internet of Energy. 512 respondents from Italy, Lithuania, Germany, Greece, Portugal, and Spain participated in the survey and expressed their views, needs and concern related to this innovative solution. Based on research findings, the report Labour market analysis in relation to IoE: required skills and competences has been compiled, which reflects the data obtained and outlines a picture of companies' demands in IoE.

The most relevant conclusions can be summarised as follows:

SAMPLE: the most survey respondents were representatives from ICT and Software Development sector (22%). The second highest respondents group was equally represented by Renewable Energy and Energy Distribution companies (both 9%), followed by Energy generation enterprises (8%). All company sizes were addressed by the survey: 33% of all respondents were small companies which represent the biggest respondent group. Large enterprises were represented with 26%. The companies are mostly located in Italy, Greece, and Lithuania. The most named job roles of respondents were CEO/general company managers, closely followed by technology officers and analytics officers. Also other job roles linked to IT, engineering, and financial issues, were represented.

CURRENT USE OF IOE SOLUTIONS IN COMPANIES: 43% of respondents are already engaged with IoE and develop related products and services. They mostly focus on the design of smart appliances, followed by design and programming of software for IoE solutions and design and development of smart grids.

37% of respondents do not have any experiences with IoE. However, 20% of respondents despite of non-using IoE plan to introduce related applications in their entities.

As main obstacle hampering introduction of IoE companies, the lack of IoE skills and competences is clearly stated (48% of mentions).

GENERAL INTEREST IN AND AWARENESS OF INTERNET OF ENERGY: the majority of respondents (79%) was interested in developing or introducing IoE-based products and services. However, 60% of them were not familiar with the IoE concept.

POTENTIAL NEEDS IN INTERNET OF ENERGY: the respondents who were not familiar with the IoE concept, would have the most needs in learning more about the IoE applications for Smart Home and Smart Grids, ICT engineering solutions for IoE, and present and future IoE-based business models.

SKILL AREAS IMPACTED BY IoE: the survey respondents confirmed the relevance of the following skill areas needed for the successful development and implementation of IoE products and services:

- Advanced software engineering skills and knowledge;
- Advanced programming skills and knowledge;

- Advanced electrical engineering skills and knowledge;
- Forecasting and management of energy companies;
- Advanced industrial engineering skills and knowledge.

The in-depth exploration of staff needs in the above-named skill areas led to the following results:

NEEDS OF COMPANY MANAGER: Company Managers seem to have the most needs in the topics IoE-based business models, Internet of Energy concept, and present and future scenarios for IoE-based companies.

NEEDS OF ELECTRICAL ENGINEERS: Electrical Engineers expressed the most needs in the domain Smart Grids (specifically, in the topics Demand response solutions, Load management, Integration of distributed resources), Advanced energy storage technologies (in particular, in the topics Super- and ultracapacitors, Hybrid energy storage systems, Lithium-ion batteries), and Smart vehicles charging stations with a special focus on Vehicle-to-grid/Grid-to-vehicle technology.

NEEDS OF INDUSTRIAL ENGINEERS: the most appreciated topics for boosting competencies of industrial engineers were Predictive maintenance solutions and Customer relationship and management.

NEEDS OF DIGITAL OFFICERS: Digital officers articulated the most needs in improving skills and knowledge related to the Architecture of IoE, Big data management, and Deployment and operation of IoE platforms.

NEEDS OF SOFTWARE DEVELOPERS/PROGRAMMERS: the most needs of software developers/programmers focused on the design and development of software services or platforms for IoE, Design of communications and networking solutions for IoE, and IT security consulting.

WILLINGNESS TO BENEFIT FROM THE IoE TRAININGS: 72% of respondents were ready to take advantage from trainings in IoE to boost their competencies. This is a valid justification and at the same time a good motivation for the development and delivery of related trainings within the project!

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(1) U.S. Energy Information Administration (EIA) – Independent Statistics and Analysis (2013): https://www.eia.gov/todayinenergy/detail.php?id=12251 (retrieved on 31.07.2018)

(2) Official website of the European commission: GROWTH – Internal markets, Industry, Entrepreneurship, and SMes – What is an SME? http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en (retrieved on 01.08.2018)

(3) Internet of Energy - Making Smart Energy Provision (2016): Paper of Beecham Research and Internet of Business organization.

Appendix A

Questionnaire on the professional needs of specialists in relation to Internet of Energy.

Dear Sir or Madam,

This survey is being carried out within the Erasmus+ project *Internet of Energy – Education and Qualifications* that aims to provide companies with trainings for professionals related to the Internet of Energy*.

The following survey aims to learn more about the labour market needs related to the Internet of Energy. We would like to gather your opinion, knowledge and expectations about this topic. For this purpose, we designed this online-questionnaire that includes 15 questions and therefore takes no more than 10 minutes to complete.

We would be very grateful if you distribute this questionnaire within your organizations to the staff members who are responsible for the general management, energy management related issues, financial issues, digital and IT policy, software development. The answers analysis will play an important role to elaborate tailored courses for professionals about the Internet of Energy.

We guarantee that the information gained will be treated with full confidentiality.

We thank you in advance for your participation to the survey.

*Internet of Energy can be broadly understood as intelligent interconnection of energy networks components, devices, suppliers, and loads via the Internet.

Q1: In which country is the company/organization you are employed at located?

- Italy
- Germany
- Greece
- Lithuania
- Portugal
- Spain
- Other country: which one?

Q2: In which sector does the business/organization you lead/you are employed at operate?

- Energy generation
- Energy transmission
- Energy distribution
- Energy retailing
- Renewable energy industry
- Smart appliance manufacturing
- Smart meter manufacturing

- Industrial automation
- Automotive industry
- Manufacturing of electric vehicles charging stations
- ICT company/Software development
- Other sectors: which one?

Q3: How many employees work in your organization/company?

- Less than 10
- Between 10 and 49
- Between 50 and 249
- More than 250

Q4: What is your job role?

- CEO
- Energy Manager
- Technology Officer
- Digital Officer
- Analytics Officer
- Financial manager
- Security Officer
- Electrical engineer
- Electronics engineer
- Maintenance Officer
- Computer programmer
- Software engineering
- Other: which one?

Q5: Are you interested in using/developing Internet of Energy (IoE) solutions within your business/organization?

- Yes
- No

If (Answer to Q5 = "No") then STOP

Q6: Are you familiar with the concept of the Internet of Energy (IoE)?

- Yes
- No

If (Answer to Q6 is "No") then Q7a

Q7a: In which domain would you resp. your organization be interested in developing knowledge/skills about Internet of Energy (IoE)?

- Architecture of the Internet of Energy
- Present and future IoE-based business models
- ICT infrastructure for IoE
- ICT engineering solutions
- Smart Grids
- Stand-alone microgrid systems
- Smart Home applications

- Charging station & Plug-in electric vehicles
- Other, which one?

After Q7a END

If (Answer to Q6 = "Yes") then Q7b

Q7b: According to you, what best defines the Internet of Energy (many answers possible)?:

- Interconnection between energy networks
- Interoperability of services and communications
- Integrated communications
- Real-time data collection and monitoring
- Demand Side Response
- Others: which one?

Q8: Do you develop/utilize Internet of Energy (IoE) related solutions, products, or services in your business/organization?

- Yes
- No
- No, but we plan

If (Answer to Q8 = "Yes") then Q8a

Q8a: What kind of innovative IoE-related products or services do you develop or utilize within your business/organization? (many answers possible)

- Design of smart meters
- Design of smart appliances
- Design of Charge/discharge controllers for electric vehicles
- Design & development of Smart Grids
- Design of solutions for integrating renewable energy
- Development of advanced energy storage technologies
- Applications of domotics systems
- Design/programming of software for IoE solutions
- IT consulting (cyber-security, operation of integrated platforms etc.)
- Others: which one?

If (Answer to Q8 = "No" or "No, but in future") then Q8b

Q8b: Why don't you use/develop IoE-related solutions and services in your business/organization?

- I'm not aware of the IoE benefits
- IoE brings no benefits for my business/organization
- Using IoE is too complex
- Financial reasons
- Security concerns
- Lack of IoE skills/competences
- Other: which one?

Q9: Please estimate the relevance of the following skills and knowledge when designing and implementing IoE-related products and services (rate your estimations from 0 till 4: 0 not appreciated; 4 highly appreciated):

- Forecasting and management of energy companies [0 1 2 3 4]
- Advanced electrical engineering skills & knowledge [0 1 2 3 4]
- Advanced industrial engineering skills & knowledge [0 1 2 3 4]
- Advanced software engineering skills & knowledge [0 1 2 3 4]
- Advanced programming skills & knowledge [0 1 2 3 4]
- Others: which one?

Q10: Now we would learn more about your professional needs for designing and implementing IoE-related projects depending on your job role. To do so, please firstly select the domains, which fit the tasks you perform at your company:

- Company manager (CEO)
- Electrical engineering
- Industrial engineering
- Responsible for operating digital infrastructure
- Software development & programming
- Others: which one?

If „Others“ then Q7a & END

(Q11a – Q11d are designed in order to obtain details for Q10)

Q11a: If answer to Q10 (Company manager/CEO):

Do you have professional needs to improve skills or competencies in order to integrate IoE-related services (rate your needs from 0 till 4: 0 no needs; highly needed):

- Internet of Energy concept
- IoE-based business models
- Future scenarios for IoE-based companies
- Others: which one?

Q11b: If answer to Q10 (**electrical engineer**):

Do you have professional needs to improve skills or competencies in order to design and integrate IoE-related services (rate your needs from 0 till 4: 0 no needs; 4 highly needed):

- **Smart grids (if yes, which one):**

  - Network stabilization
  - Grid Operations optimization
  - Load management
  - Demand response solutions
  - Integration of distributed resources
  - Real-time data collection
  - Others: which one?

- **Sensing and measurement (if yes, which one):**
  - Phasor measurement units (PMU)
  - Phasor networks
  - Wide Area Measurement Systems (WAMS)
  - Others which one?
- **Advanced energy storage technologies (if yes, which one):**
  - Superconducting magnetic energy storage
  - Latent thermal energy storage
  - Compressed air energy storage
  - Lithium-ion batteries
  - Super-capacitors/ultra-capacitors
  - Hybrid Energy Storage Systems
  - others: which one?
- **Smart electronic vehicles charging stations (if yes, which one):**
  - Wireless power transfer WPT & data management
  - EV charging/discharging: Vehicle-to-grid technology (V2G, V2X), Grid-to-vehicle-technology
  - Others: which one?

- **Other: which one?**

Q11c: If answer to Q10 (**industrial engineer**):

Do you have professional needs to improve skills or competencies in order to design and integrate IoE-related services at your organization (rate your needs from 0 till 4: 0 no needs; 4 highly needed):

- Predictive maintenance solutions
- Customer relationship management
- Differential pricing & billing
- Flow measurement
- Others: which one?

Q11d: If answer to Q10 (**Responsible for operating digital infrastructure**):

Do you have professional needs to improve skills or competencies in order to design and integrate IoE-related services (rate your needs from 0 till 4: 0 no needs; 4 highly needed):

- Architecture of the Internet of Energy
- Deployment and operation of IoE platforms
- Cyber-Security in IoE

- Big data management
- Integrated Communications Technologies:
  - Substation automation
  - demand response
  - automated distribution
  - wireless mesh networks
  - supervisory control and data acquisition (SCADA)
- Smart metering & advanced metering infrastructure (AMI)
- Others: which one?

Q11e: If answer to Q10 (Software development/programming):

Do you have professional needs to improve skills or competencies in order to design and integrate IoE-related products or services (rate your needs from 0 till 4: 0 no needs; 4 highly needed):

- Design of meter data management software
- Design and development of software services or platforms for IoE
- Design of communication and networking solutions for IoE
- interoperation services,
- microcontrollers programming,
- IT security consulting
- Others: which one?

Q12: Are you willing to benefit from training provisions in order to design & develop IoE-related products and services?

- Yes
- No
- I don't know

Q13: Where do you see the biggest advantages to leveraging the IoE within your organization?

- Developing new business models
- Data analytics and services
- Customer services and engagement
- Increasing cost efficiency
- Leakage reduction
- Differential pricing/billing
- Others: which one?

Q14: Do/did your organization/business participate in the IoE-related projects?

- Yes:
  - If yes: which one? (title)
- No
- I don’t know

Q15: Are there any comments, questions, or other remarks related to the IoE you would like to share with us? Please feel free to let them here:

(open space for comments)

End:

Thank you very much for participating to this survey. Your answers will help us better meet your expectations about the Internet of Energy.