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Education for Digitalisation of Energy

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Current and future skill needs in the Energy Sector

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Abstract:

This report aims to provide useful insights concerning current and future skill needs in the energy sector, associated with the digital transformation the sector is currently facing. Several channels are employed to provide a thorough analysis of the industrial needs in skills, knowledge and occupations as well as the corresponding offer from education and training providers, focusing on university and vocational education. The skill demand as expressed by the industry, the current status of employees and the offer provided by education and training providers led to the identification of several skill gaps. The gaps that are identified will serve as input in the development of the Blueprint that will attempt to mitigate the mismatches and foster the digital transformation of the energy sector.

Keywords:

Skills, Knowledge, Occupations, Jobs, ESCO, CEDEFOP, Digitalisation, Energy, Education, Training, Challenges, Skills, Survey

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Definitions, Acronyms and Abbreviations

ESCO – European Skills, Competences, Qualifications and Occupations

EU – European Union

VET - Vocational Education and Training

CEDEFOP - European Centre for the Development of Vocational Training

ISCO – International Standard Classification of Occupations

SAP – System Analysis Program Development

SAS – Statistical Analysis Software

ERP – Enterprise Resources Planning

SCADA – Supervisory Control and Data Acquisition

RTDS – Real Time Digital Simulator

ICT – Information and Communication Technology

EUA – European University Association

EUA-EPUE – European University Association - Energy & Environment Platform

HVE – Higher Vocational Education

CU – Corporate University

DSO – Distribution System Operator

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Executive Summary

Digital transformation of the energy sector is an important challenge, yet a great opportunity in achieving sustainability and efficiency. Due to digitalisation, there is an increasingly need of personnel with adequate skills to adapt and excel in this new era. To this end, the identification of skill gaps is an important step that will foster the necessary actions to mitigate these gaps. The first operational objective of EDDIE is to define a methodology to identify skill gaps for the digitalisation of the Energy sector. By developing a common approach for assessing the current situation and anticipating needs (required skills and level, drawing the occupational profiles in European Skills/Competences Qualification and Occupations – ESCO [1], mobility, etc.) progress will be monitored as well as evolution of the demand and supply of skills.

To be able to identify skill gaps, the EDDIE project developed a methodology that is based on “Skills Intelligence” as it is defined by CEDEFOP [2]. Skills intelligence is the outcome of an expert driven process of identifying, analyzing, synthesizing, and presenting quantitative and/or qualitative skills and labour market information. These may be drawn from multiple sources and adjusted to the needs of different users.

In this direction, relevant occupations were identified with the purpose of extracting information on the recruiting trends in the industry, as well as the associated skills and knowledge that are necessary to succeed in these positions. The analysis drew information from reviews of ESCO, CEDEFOP and recruiting platforms, as well as directly by addressing the industry.

The first step for the identification of skill gaps was the identification of the **skills needed** from the industry to tackle challenges related to digitalisation, as well as to prepare for the digital transformation. The skill demand was addressed via a dedicated survey, which included the level of expertise required for specific skills, as well as the current coverage of those skills in the industry. About 60 prestigious industrial companies responded to the survey providing a clear overview of the skill demand in the energy sector. Moreover, 5 interviews with executives from the industry validated and complemented the survey’s results.

Another crucial parameter to identify skill gaps, is the **skill offer** by Education and Training (ET) providers. This was performed by reviewing several European curricula focusing on both Universities and Vocational Education and Training (VET) institutions. In addition, a new survey was developed to gather information from ET providers regarding the skills and knowledge they provide and the corresponding skill level that a graduate is expected to reach while attending specific study programs. 33 important ET providers responded to the survey. In accordance with the skill demand approach, several interviews to ET providers were carried out to obtain qualitative data. Since education and training can come from different sources, online training platforms were reviewed, and relevant courses and skills were analyzed. Last, industrial training programs and corporate universities were reviewed to see how the industry itself reskills and upskills employees.

An overview of the methodology applied for the identification of skills gaps is presented in Figure 1 Skill gaps identification methodology

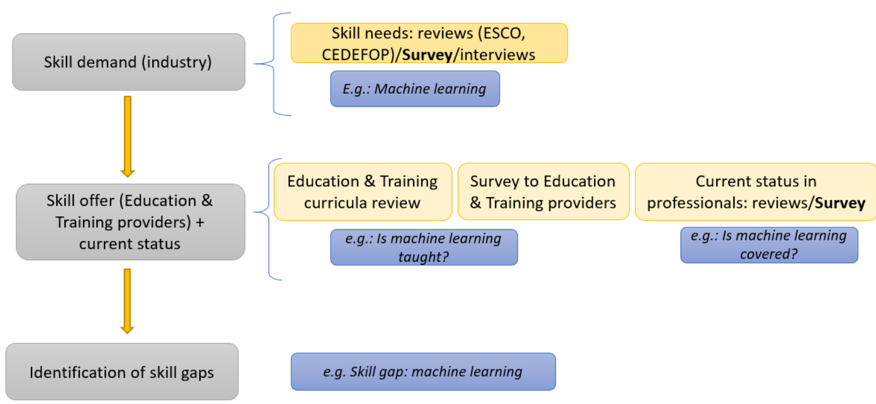


Figure 1 Skill gaps identification methodology

Overall, the performed work indicates that the most significant skills gaps towards digitalisation, as reflected by different types of analysis, converge towards **data management and analysis, big data, cybersecurity, and programming & development competences.** Moreover, the importance of transversal and green skills is also stressed.

1. Introduction

Digitalisation is affecting all areas of economy and society. The energy sector in particular is subject to a deep transformation due to its critical importance in achieving sustainability. The climate change is a clear challenge that our society must address, and the energy sector has a fundamental role. Together with many previous actions, the European Green Deal expresses the response of the EU to climate change setting it as a worldwide leader in this fight.

In addition, today the world is suffering an unprecedent health crisis due to the COVID 19 pandemic. This will impact beyond doubt all economic sectors in the near future. Digitalisation, including telecommunications, is becoming extremely important in order to continue and maintain the status of work. As a result of the pandemic, digitalisation expands in most sections of our society and has also a major effect on the energy sector.

Europe has a unique opportunity to establish global leadership in the energy transition and to shape the future energy systems. Driven by technology innovations as well as by the decarbonisation ambition set by the Paris Agreement and the EU 2050 target. This new architecture enables and supports increasing shares of renewables, energy storage and demand response management, all of which can increase grid flexibility.

The purpose of EDDIE project is the foundation and establishment of a **Sector Skills Alliance to develop an industry-driven Blueprint Strategy for the education and training in the energy sector which is continuously affected by digitalisation. This Blueprint is an industry-driven strategy that will meet and anticipate the skills' demands for the sustainable growth and digitalisation for the European Energy sector.** To meet **major technological, economic and social challenges and changes, it is vital to** anticipate the skills demands for the sustainable growth and digitalisation of the European Energy sector, and to provide adequate training fostering cooperation among all stakeholders harmonised throughout Europe. The Blueprint strategy will establish a sustainable framework that allows to define and update educational programs responding to industry changes and to increase the attractiveness of the energy sector as a career choice. It will consider interdisciplinary green and soft skills, social sciences and humanities economics and gender dimension.

This project will set the ground for a new generation of technicians, engineers and researchers who are able to use, develop, improve and deploy new energy technologies, in order to contribute to the digitalisation of energy, and the energy transition. Moreover, the European energy education and research providers will improve their competences and will play a central role in forming partnerships with industry, policy makers and societal actors.

The EDDIE project proposes an innovative strategic approach for education in the European energy sector as an industry-driven movement. Skills will emerge as a need of practical application instead of the classic approach, from fundamentals to application. This will be materialised in the educational Blueprint Strategy for the Digitalisation of the Energy value chain (BSDE) and will be demonstrated and validated in a pilot environment. An interdisciplinary approach is also sought, including green and soft skills, social science, economics, and gender dimension, and by looking for synergies and collaboration with other blueprints and training initiatives through Europe. The involvement of professionals will be key for the success of the Blueprint, improving the attractiveness of the Energy sector by using participatory approaches and Information and Communication Technologies (ICT) methodologies.

In this framework the identification of mismatches between the skill demand of the industry and the skill offer from education and training providers is crucial, as it is the first important step for the development of the Blueprint strategy that will help foster the digital transformation in the energy sector.

1.1. Structure of the document

The document is structured as follows:

Section 2 deals with existing occupations that are relevant to the digitalisation of the energy sector. Data are drawn from reviewing the European Skills, Competences, Qualifications and Occupations (ESCO) [1] framework and the European Center for the Development of Vocational Education (CEDEFOP) [2], openings in digital recruiting platforms as well as from direct inputs from the industry through 5 interviews.

Section 3 focuses on identifying skills and knowledge that are currently needed in the energy sector towards the digital transition. A first classification of skills and knowledge is performed through ESCO analysis which provides input, among other, in the design of a dedicated survey/questionnaire. The questionnaire is directly addressing industrial stakeholders and is attempting to assess the level of expertise needed in several digitalisation related skill sets. Transversal and green skills are also identified.

Section 4 presents an analytical review of the skills and knowledge offered by education and training providers throughout Europe. The analysis draws data and information from several channels. The Action Agenda in Energy Transition for European Universities by the European University Association (EUA) is reviewed to analyse the structure and content proposed to be adopted by European Universities to foster the energy transition. Moreover, university and VET curricula are reviewed in the context of the digital transformation to identify the digital areas and specific skills addressed to serve as input in the skill gaps identification methodology. Industrial training programs & corporate universities are also addressed to track the work done by the industry itself for upskilling or reskilling their employees. Digital platforms are also means of educating and training professionals and thus they are reviewed to identify the relevant ones and their digitalisation related content. A dedicated survey and its results are also presented in this section, which directly address education and training providers assessing the level of expertise offered for the specific skills and skill-sets that are used in the industry survey. This will enable direct matching which will produce insights on skill gaps.

Section 5,deals with the mapping of skill demand and skill offer to produce the skill mismatches that the EDDIE project will attempt to mitigate, in order to foster the digital transformation of the energy sector.

The document is concluded with the conclusions and annexes containing more detailed tables with information regarding the analysis presented in this work.

2. Relevant existing occupations

2.1. Overview

European Union (EU) identified and classified the relevant professional occupations, skills and qualifications in European Skills, Competences, Qualifications and Occupations (ESCO)[1] to support job mobility across Europe. "A common language" for the labor market on subjects like employment, education, and training, ensures an efficient collaboration for employers (companies), job seekers, training providers and education bodies/institutions.

Nowadays, we are witnessing a continuous discrepancy between current and future demand of abilities for multiple working domains, while digitalisation and technological changes are transforming the way we live, and we do our jobs. The digitalisation of the energy sector request rapid transitions from the present level of information to a higher one, and from one occupation to another, forcing people to continuously upskill and reskill. Therefore, one of the main objectives of EU is to address these gaps that the fast-changing labor market is facing.

One of the reasons for conducting an ESCO review is that this EU level tool connects the two major pillars for sustainable growth of the EU – employment and education. Thus, for the education providers, ESCO can be of use to describe the expected learning outcomes of their curricula and to understand the labor market trends and future skills needs better. The ambition of EU Commission is for ESCO to become a digital enabler of labor market mobility and the European classification for job mobility.

The goal for reviewing ESCO together with the European Centre for the Development of Vocational Training (CEDEFOP) [2] a decentralized agency that supports and contributes to the development of European Vocational Education and Training (VET) policies, is to identify and highlight the main jobs related and relevant for the energy sector as they are defined now together with the associated skills and knowledge required for such jobs. Additionally, the review of ESCO aims at identifying skills gap in occupations specific to energy sector in the new paradigm of digitalisation and energy transition and for creating a context for providing the right competences to the market.

CEDEFOP identifies and anticipates future skill needs and potential skill mismatches. It provides high quality evidence on trends in the labour market and skill needs by producing regular skill supply and demand forecasts for Europe and analysing the potential labour market mismatches and imbalances. CEDEFOP also investigates skill and competence needs in selected sectors, has collected its own European data on skills and jobs and is currently working on collecting and analysing data on skill demand using online job postings.

At this stage of the research process, both ESCO and CEDEFOP platforms were studied for finding the most relevant knowledge, skills and occupations linked to energy sector in the paradigm of the new era of digitalisation of energy services and processes. Because Knowledge and Skills are abilities that can be confused, it is important to mention the exact significance of each term. *Knowledge* generally refers to a "theoretical" aspect about a given topic and is something that can be obtain through many forms, from hearing a conversation, to reading a book, or through education processes. While the *Skills* refer to something "practical" and implies the application of the theoretical information. Usually, Skills are acquired due to experience. And the last term, occupations, leaves no room for interpretation, representing the actual job titles.

2.1.1. ESCO analysis

ESCO occupations

On ESCO portal the relevant listed categories for energy sector are: Managers; Professionals; Technicians and Associate Professionals; and Plant and Machine Operators and Assemblers. Therefore, the Annex 1: ESCO knowledge, skills, and occupations, Table 54, Table 55, Table 56, Table 57 presents the findings for these four categories by providing General Classification; Narrow Classification; Description; Related Skills and Associated/Related Knowledge.

For example, in Annex 1 Table 54 for General Classification: Production and Specialized Services Managers; Professional Services Managers; Professional Services Managers Not Elsewhere Classified, it can be found Energy Manager at the Narrow Classification column with its associated Description: "Energy managers coordinate the energy use in an organization, and aim to implement policies for increased sustainability, and minimization of cost and environmental impact." The Related Skills: Advise on heating systems energy efficiency; analyse energy consumption; compose energy performance contracts; develop energy policy and the Associated/Related Knowledge: Electrical Power Safety Regulations; Electricity Consumption; and Energy Efficiency, occupy the last two columns of the table.

Regarding the categories for energy sector, the Technicians and Associate Professionals are also on the list. The General Classification presents: Science and engineering associate professionals; Physical and engineering science technicians; Civil engineering technicians. For example, at Narrow Classification it can be found Energy Analyst, with the Description: „Energy analysts evaluate the consumption of energy in buildings owned by consumers and businesses. Energy analysts suggest efficiency improvements". The Related Skills regarding this domain are: „Analyse energy consumption, carry out energy management of facilities & Promote sustainable energy", and Associated knowledge: Energy and Renewable Energy.

The last domain: Plant and machine operators and assemblers with General Classification: Plant and machine operators and assemblers; Stationary plant and machine operators; Mining and mineral processing plant operators. For the Narrow Classification: Dewatering technician with the Description: „Dewatering technicians install and operate pumps, spares, pipe ranges, and vacuum dewatering systems to collect and remove liquids and chemicals.". The relevant Related Skills are the following: Collect samples and manage storage tanks with Related knowledge: „Chemistry".

The same principle is applied to all categories.

Below can be found Table 1 with some of the most relevant existing occupations available also in Annexes.

Table 1 – Relevant Existing Occupations

General Classification	Narrow Classification	Description	Related skills	Associated knowledge
Production and specialized services managers	Energy manager	Energy managers coordinate the energy use in an organization, and aim to implement policies for increased sustainability, and minimization of cost and environmental impact.	Advise on heating systems energy efficiency, analyze energy consumption, compose energy performance contracts, develop energy policy.	1. electrical power safety regulations 2. electricity consumption 3. energy efficiency
Production and specialized services managers	Chief technology officer	Chief technology officers contribute to a company's technical vision and lead all aspects of technology development, according to its strategic and growth direction.	Administer ICT system, coordinate technological activities, define technology strategy, establish an ICT customer support process.	1. ICT project management 2. decision support systems
Teaching professionals	Data scientist	Data scientists find and interpret rich data sources, manage large amounts of data, merge data sources, ensure consistency of datasets.	Collect ICT data, deliver visual presentation of data, design database scheme, develop data processing applications, interpret data.	1. data mining 2. data models 3. information categorization information extraction
Technicians and associate professionals	Electromechanical engineering technician	Electromechanical engineering technicians are responsible for building, installing, testing and maintaining the electromechanical equipment, circuits and systems.	<u>Assemble electromechanical systems, fasten components & Inspect quality of products.</u>	1. Electric drives 2. Electrical machines 3. Electricity
Science and engineering associate professionals	Electrical transmission system operator	Electrical transmission system operators transport energy in the form of electrical power. They transmit electrical power from generation plants to electricity distribution stations.	<u>Ensure compliance with electricity distribution schedule</u>, <u>manage electricity transmission system.</u>	1. Electricity

The occupations identified after the ESCO analysis cover activities from different areas of the value chain of the energy, but a critical focus is needed on the ones related to energy efficiency, ICT development, data handling, technologies, equipment maintenance and distribution and transmission systems as stressed pillars in the process of digitalisation of the energy sector.

2.1.2. CEDEFOP analysis

CEDEFOP provides a set of tools that present analytical data regarding sectoral skills, knowledge and occupations drawn from the ESCO and ISCO databases. The toolset analyses job openings in Europe drawn from several job advertising platforms for each country. The required skills and competences are analysed and presented in several charts, providing useful insights. The EDDIE project can benefit from the use of such tools to help identify relevant occupations and skill needs in the energy sector, considering digitalisation. It is also possible to support the CEDEFOP's approach by providing data and information from EDDIE's field analysis and review, considering the surveys and interview conducted.

The CEDEFOP toolset has been reviewed for the purpose of identifying relevant data and link EDDIE's efforts with CEDEFOP's initiative. Through the tools one can achieve the following:

- identify relevant occupations in energy, digitalisation of energy etc. specific to countries/regions/groups of countries.
- Anticipate and match skills: collecting and analysing data on skill demand using online job postings.
- Digitalisation and the future of occupations: project analyses the impact and drivers of automation, robotics, artificial intelligence, and other digital technologies on employment and changing skill needs of jobs.
- European skills and jobs (ESJ) survey: Addressing skill mismatch carried out in the EU28 Member States, examines drivers of skill development and the dynamic evolution of skill mismatch in relation to the changing complexity of the tasks and skills required in people's jobs.

An overview of the tools provided and the data that we can obtain is presented in the following paragraphs.

Countries and occupations

This tool provides an analysis Tool for Europe on the occupations (on ISCO 1-digit and ISCO 2-digit levels [3] employers ask for in online job advertisements.

Most job ads are for high-skilled occupations (managers, professionals, and associate professionals), but medium- and even low-skilled occupations are also extensively posted online. The online job advertisements were gathered between 1 July 2018 and 31 December 2019. Data presented are based on a robust methodology using big data and machine learning techniques.

For example, one can extract the data for any country and create a data table which shows the percentage of job advertisements in each sector.

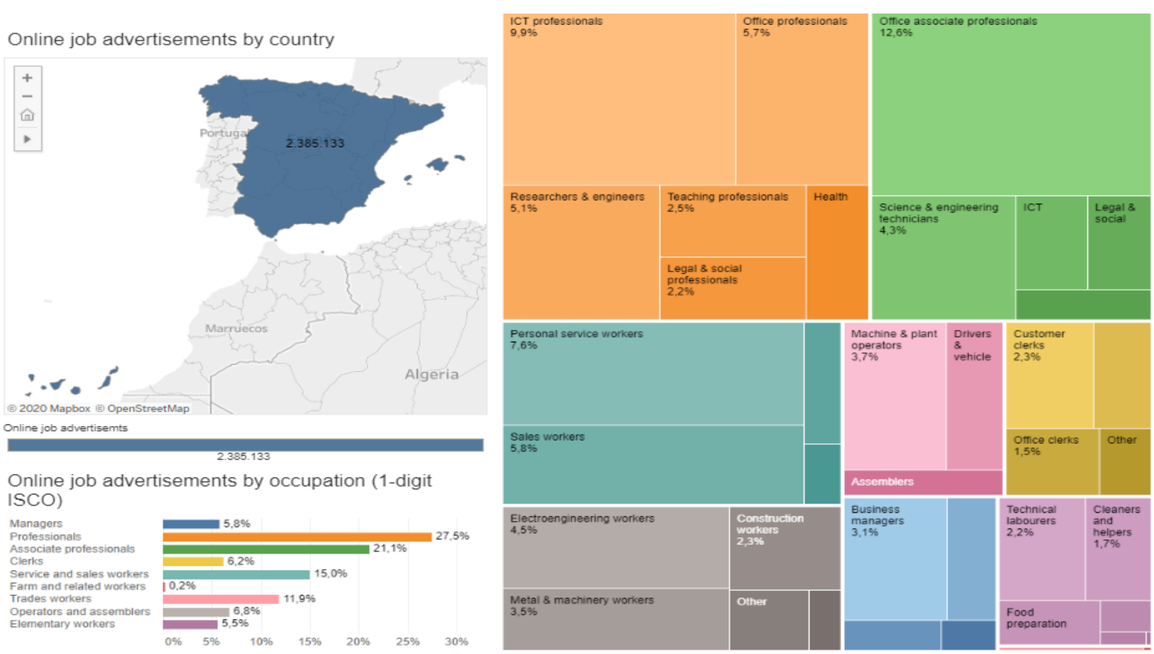


Figure 2 Diagram of the CEDEFOP Tool "Countries and occupations". Spanish case

Another tool presents the analysis for specific occupations per sector which addresses skill mismatch in the EU28 Member States or in a specific country:

Skills in occupations

This specific tool also integrates all the countries in the EU28 Member States. The following dashboard presents skills requirements within selected occupations. Skills are classified using ESCO version 1 [1]

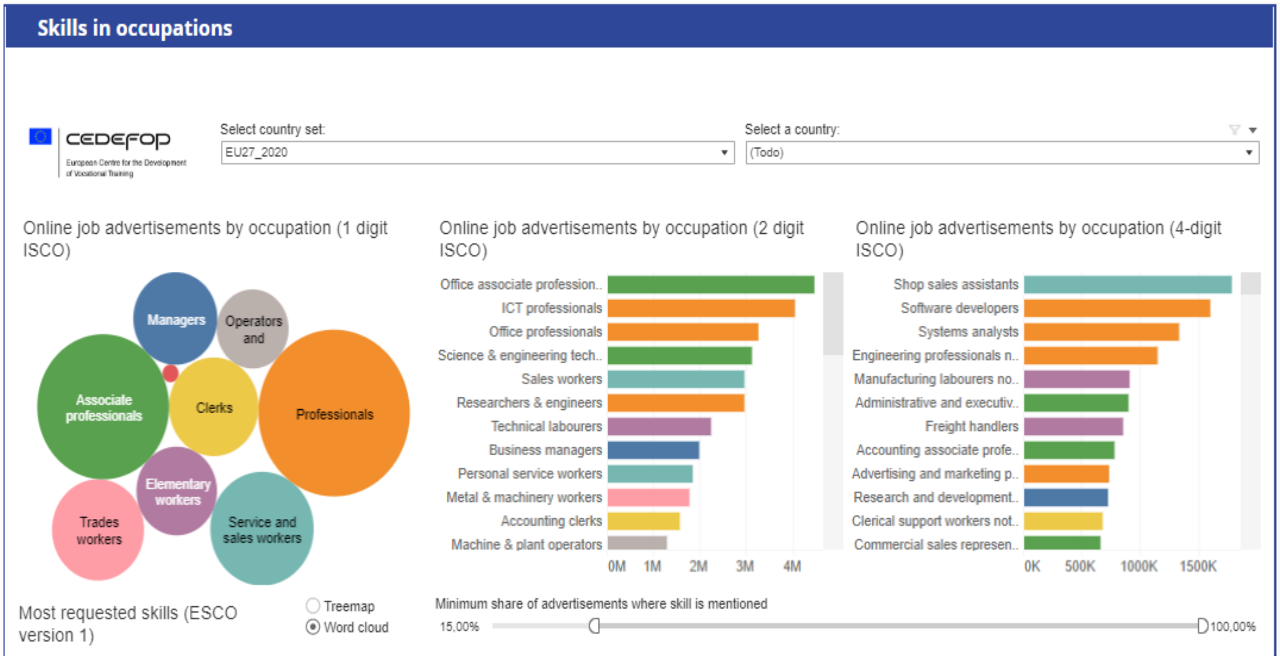


Figure 3 Diagram of the CEDEFOP Tool "Online jobs advertising by Occupations"

One can select a set of occupations and can present all the skills related to that occupations.

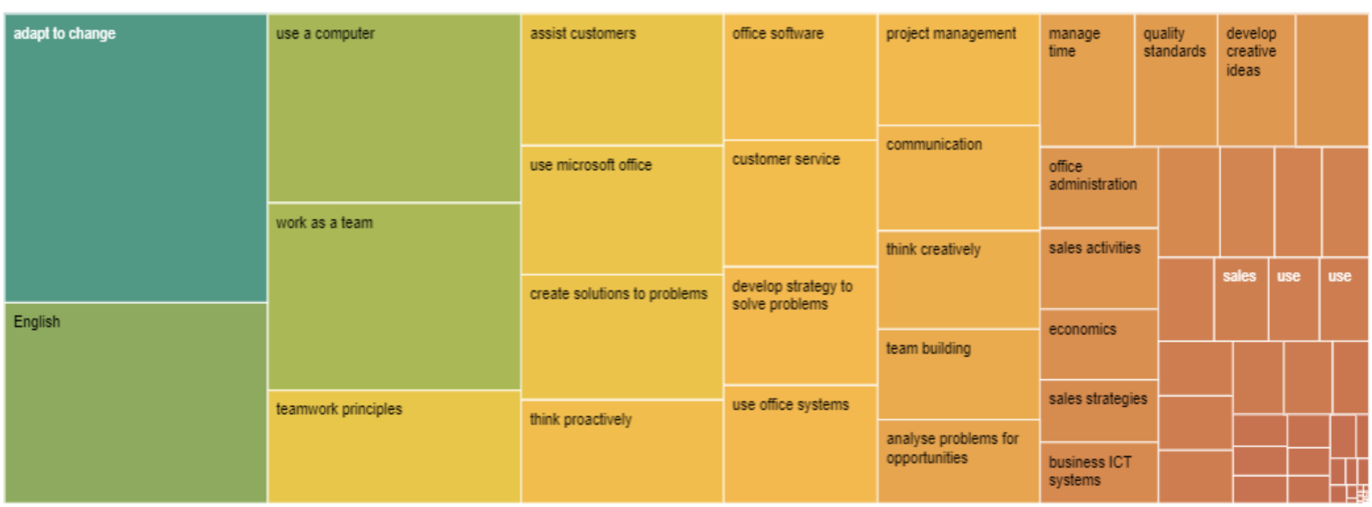


Figure 4 Diagram of the CEDEFOP Tool "Skills in occupations"

For example, the following table shows the filtered related skills from the EU members that are more relevant in the energy sector

Table 2 Filtered Related skills according to ESCO version 1 classification

General Classification		Specific Classification	Related skills
Technicians and associate professionals (Occupation 1-digit ISCO)	Science and engineering technicians (Occupation 2-digit ISCO)	Physical and engineering science technicians (Occupation 4-digit ISCO)	- energy market - energy sector policies - energy efficiency - develop strategy to solve problems - analyze problems for opportunities - create solutions to problems - manufacturing processes - machinery products - engine components - engineering processes - electrical wiring plans

The most relevant skills to specific occupations or sectors can also be presented:

Table 3 shows the most relevant skills for a specific occupation, given the percentage of the repeated skills according to the online job vacancies registered on the data base.

Table 3 Most relevant or repeated skills on Physical and engineering science technicians occupation

Skill (ESCO v1)	Online job vacancies	Skill Vacancies (%)
manage time	76189	24,75%
English	121621	39,50%
engineering processes	114321	37,13%
use a computer	79124	25,70%
quality standards	132644	43,08%
work independently	84863	27,56%

Sectors and occupations

This tool allows the visualization of the number of online job advertisements for ISCO 2-digit occupations for all economic sectors and countries.

This tool enables checking or visualizing the most demanding job advertisements by sectors within the countries in the EU28 Member States.

For example, the most demanding job advertising from scientific and technical activities in Germany are presented in the following figure.

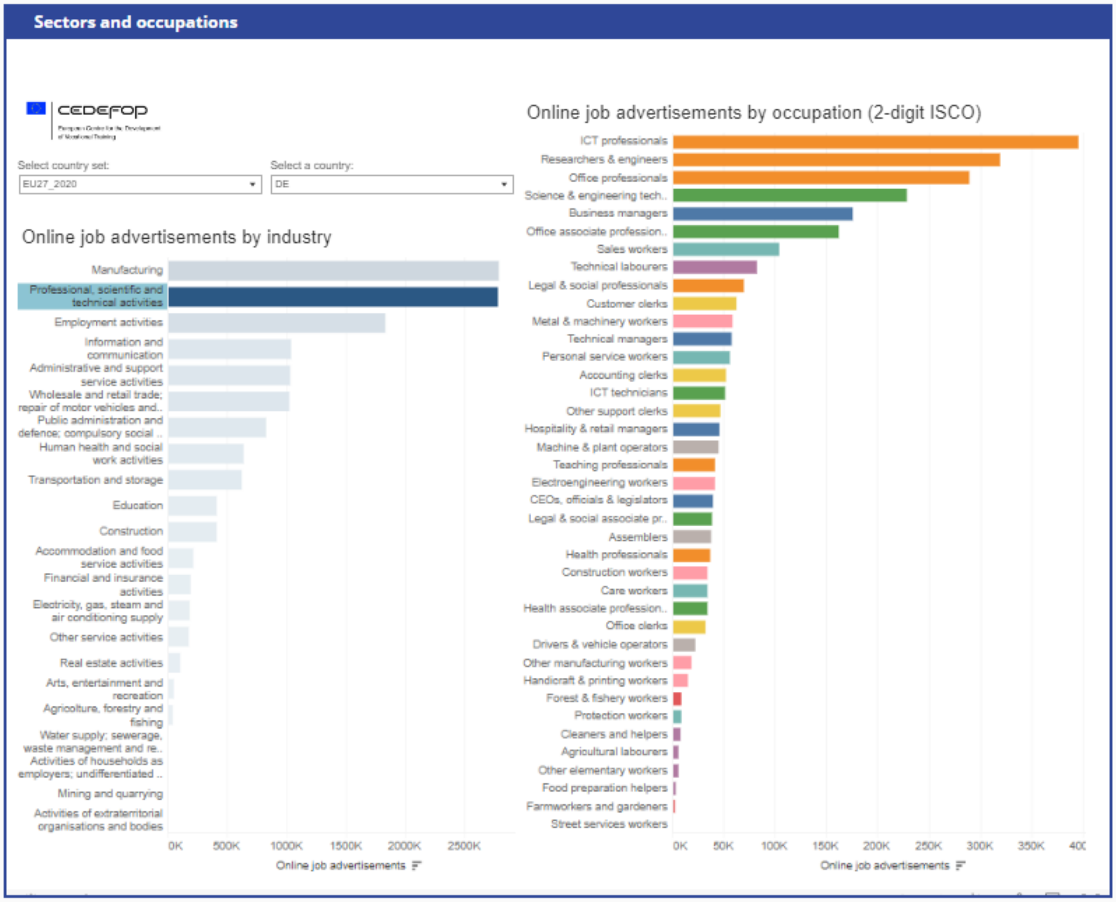


Figure 5 Diagram of the most demanding job advertising from scientific and technical activities in Germany

This visualization allows to display online job advertisements per sectors. The sectors are classified according to NACE rev. 2 [4]

Analysing the CEDEFOP toolset generates useful information for the EDDIE's project goals. Some key observation from the analysis are presented below:

- The relevant skill demand using online job postings that are presented in CEDEFOP tools are in accordance with ESCO.
- There are several tools in CEDEFOP that can provide useful and recent data on job advertisement sand most relevant skills for countries and sectors
- CEDEFOP tools has shown the data potential and provide information to help interpret labour market developments such as energy and digitalisation sectors.
- As it is mentioned in the website[5] the expanded version of Skills-OVATE will be released by the end of 2020, so it will be possible to work with more data and continue developing further analysis in energy and other sectors.

2.2. Digital recruiting platforms

To complement and have a more updated version for the review of relevant occupations, a search was conducted using LinkedIn to identify to what extent the digitalisation in the energy sector is reflected in the job listings in four countries (Sweden, Greece, Spain and Germany) and the level of degree that is required for them. The aim is to have a grasp of the tools that someone must possess realistically to be employed in the energy sector in a technical position.

For each country separately, the search was performed using the word “energy” as keyword in order to bring forward job listings that are written in English and are about the energy sector. The results that were included are the ones that are written in English, belong to a relevant industry like manufacturing wind turbines, batteries etc. and have digital skill in their requirements section. We did not include results about internships or theses, results from non-relevant departments like sales and positions with a vague description. For each country we collected the first tens of the most relevant results. The full data are listed in the Annex 2: LinkedIn occupations

The first remark is that although the listings are from the energy sector, there are many openings that require a degree in Computer Science rather than an engineering degree. This is especially true in Germany where the listing from companies in energy sector that do not require an engineering degree are almost half in the sample that was considered. Also, it is worth noted that positions relevant to Computer Science do not always require a degree, but a demonstration of the skills needed, and relevant working experience suffice.

Moreover, it is evident that it is becoming essential for an engineer to be familiar with various software tools. Suites like SAP for company management and SAS for statistical analysis are frequently listed. Almost all listings require the knowledge of MS Office suite or mention that part of the job is the ability to create reports, handle, and present data. Many of the positions that require an engineering degree also require the knowledge of simulation tools like Matlab, AutoCAD, PSCAD, PowerFactory, RTDS and FEMM or more specific to the sector tools like Flex5, Altium and others.

Even though cybersecurity is a particularly important aspect of every profession that requires handling data, very few job listings state relevant skills as requirements. Some communication protocols that are widely used in the industrial environment like SCADA, Modbus, MQTT, Ethernet, RS232, RS422 and RS485 are commonly required.

Finally, the need to be part of a large team is reflected in the use of tools like GIT, organization methods like Lean and Agile (mostly Scrum) that enable the effective communication among the co-workers and cloud solutions like Azure. For the Computer Science relevant jobs, the programming languages that are more common are Python, Java and C++ (object oriented).

The above remarks emphasize the fact that the energy sector industry has a need for employees that are not only proficient in their respective field but also to possess skills like Enterprise Resource Planning (ERP) programs, programming, cloud tools, simulation programs and others as a result from the digitalisation of the sector.

2.3. Feedback from industry

To complement and validate the analysis for occupations and since EDDIE project’s methodology is industry driven when addressing skill mismatch, dedicated questions were addressed during vis-à-vis interviews with key stakeholders in the energy sector. Five representative Distribution System Operator (DSO) companies in five different member states were interviewed in order to gain the perspective of the industry and receive individual opinion of the companies. These interviews also help to validate the initial content gathered through the survey during the year. The main objective of the project is to enable the matching between the current and future demand of skills necessary for the digitalisation of the energy sector. For this reason, it is important to search the direct dialogue with the industry as often as possible for the EDDIE consortium.

The industry is aware of the discrepancy of Job market and Job Posting. The qualification of the candidate is assessed through multiple factors and not limited on his/her acquired skills or academic grade alone. A suitable candidate who is trained for example in cloud services and digital platforms but has no knowledge on how to apply those trades into energy business, is a mismatch found often in the market. With the increased number of integrated sectors and the consequential interdisciplinarity of all job occupations, the energy sector is forced to assess in more than just the field of study. The skills which companies are searching for and what can be delivered by the traditional study fields of candidates are drifting apart. But this development cannot be generalized on to the overall situation. According to the HR representatives in the DSO sector, a lot of the new hirings and the younger generation are affiliated with new technologies due to their daily lives and personal interest. Hard programming skills are still a product of education and training, but a wider understanding and familiarity in general digital skills can be seen. What System Operators still need is a clear terminology of the sector innovations and deferrization between tools and actual skills. **Instead of promoting new tools and innovation alone, they wish to see them brought in relation with actual problems and examples**. **The understanding of digital platforms alone is not going to help a market-based balancing of the grid. Just in combination with actual understanding the energy market**

and its regulation these knowledges have a significant impact on the work and can help to solve current problems. Therefore, companies are not detecting a vast number of candidates with a mismatch of their knowledge and actual job, that must be corrected with huge investments and training after hiring. Job postings are often specified on a single and focused task, that is depended on the skill set of the unit. The hired person is complementary to the team and just smaller adjustment should be required to make him/her able to execute his/her future task. Generally, all of the asked experts express their focus on a fast and efficient onboarding, which can just be handled with a detailed selection process at the start.

Biggest challenges in the upskilling process can be summarized by the word integration. The same phenomenon which applies in the networks, integrating new user behaviors, new electricity uses, new generations and new human resources, are also the integration topics which are challenging current system operators and facilitators in the market. An expert in an area, must be able to understand the events outside of his bubble, meaning his obligations and field of work. The industry sees the ability to anticipate trends and the integration those challenges into the style of working and adjusting to them as important. Transfer knowledge, technology assessment and the ability to understand tasks and effects, to the extend to question them if necessary is the most important skill needed. Especially for higher positions to understand the strategy of the company and have foresight about the challenges in the following years. Digitalisation is a factor that visualises this need for one part of the sector. Since partly companies are overwhelmed keeping up with the development and giving each branching the necessary focus to touch all solutions.

Current and future trends in occupations

The industry sees it rather difficult to pinpoint future trend with actual job occupations. All of the interviewed companies expressed that it is highly important to build the connection between technology and deployment site. **The best example is blockchain technology, seeing its high potential, its actual benefit and estimated number of use cases remains unknown**. Even though there are some benefits in peer-to-peer business cases, it may not have the prophecy impact on the industry. The industry needs more security of planning and a neutral glance to the modern world. Also, a detailed selection process on specific job requirements is needed for the company. Instead of assessing all new trends when they occur, the industry sees reachable solutions and improvements of current used technologies more important to for the general staff.

Without a specific use case such technologies are solely applicable in research units. It is more about how to deal with digitalisation and understanding the process behind it than singular technical skills. To achieve an autonomy upskilling of the employees and create an interest for their own in these topics. Bearing in mind the activities in the field of sustainable development, such additional skills that should be put more emphasis are precisely those related to ecology, waste management, skillful use of resources, saving energy, water, etc. Along with the development and implementation of IT tools in the company, it will also be necessary to educate employees on how to use them. Creating high motivation with enjoyment and interest in the job and direct outcomes.

2.4.Conclusions

Based the ESCO and CEDEFOP analysis it is visible that the identified Occupations (with related knowledge and skills) found reflect a market labor framework that can be improved.

From the results of the analysis one major direction for advancing should be based upon the European Green Deal objectives. For meeting the goals of decarbonizing the energy sector and achieving higher levels of energy efficiency for buildings, transportation, or industries, the present, but especially the future workforce needs to master both digital and green skills.

Another direction that is also reflected in Table 1 refers to ICT developments, considering the telecommunication and information processing as basic elements in the technological issues of the digitalisation process. In addition, data handling abilities with corresponding job positions are emerging as the amount of information collected by the sensors, smart meters and through other channels from the energy systems is increasing. A **mandatory word associated with data is 'cybersecurity'** as for building a sustainable distribution system as well as a common ground based on trust between the producers and consumers. Therefore, more occupations targeting all facets of cybersecurity must be considered on the labor market. Starting from the huge amount of data generated a two-way ramification can be made. The first refers to **smart and efficient use of this information through machine learning algorithms**. As a result, occupations covering **artificial intelligence techniques** should be part of the future jobs lists. The second one leads to regulatory aspects of processing the data that are not yet clear.

And because all the occupations suggested above would not be relevant without a functional and optimized grid, **occupations involving technology, equipment maintenance, power electronics,** etc. that make the continuous update of the energy system in the new paradigm of digitalisation has to be brought into discussion. **Most of these jobs are currently existing, but they must be correlated also with the new challenges as, for example, the high rise of renewable energy sources into the network.**

Considering all of this, examples of new job profiles that can emerge are **green energy technician; CO2 energy efficiency building inspector; pollution specialist; charging station technician; grid cybersecurity specialist; grid data specialist; grid data regulatory specialist; etc.**

Regarding the necessary qualifications to adapt to this changing framework, the industry itself indicated that usually, a most favored candidate brings experience and the ability to easy learn new technical innovations, combined with logical thinking and the ability to quickly analyze (e.g., dispatch center). Moreover, when a new technology goes beyond the standard package of tools used in a company, it is important that the employee acquires such knowledge on his own. The same applies to new job profiles, that don't exist in the company; instead of getting trained by experienced colleagues, newcomers need to acquire the necessary information to do the job and also pass on certain skills to the rest of the team.

However, to do his/her job properly, he/she should mobilize himself/herself to acquire knowledge on this subject. Depending on what new solutions, devices or software will be implemented by the company in the future, employees will need targeted knowledge. However, the most important skill is the ability to quick assimilate it, focus on change, deal with the challenges that arise with new devices, but also the ability to find necessary information in this area and use them in efficient way. It is not about understanding all new technologies into detail, but always to know where to find information and how to acquire it and to share such information with others. The ability to prepare oneself, especially if the topic is not fully known at the beginning.

3. Analysis of the skills and knowledge needed in the industry

3.1. Overview

This section is devoted to addressing knowledge and skills that are currently needed in the industry, considering digitalisation. Trends in skills and knowledge needs are identified through several channels. European frameworks like the ESCO and CEDEFOP are reviewed to extract information on the topic at hand. Moreover, a dedicated survey and several interviews are utilized to obtain an overview of the status in the industry and future trends in skills and knowledge demand.

3.2. ESCO analysis

ESCO Analysis for knowledge

ESCO platform works like an online database tool accessible freely for anyone interested in the topic. Due to its internal organization in: Knowledge, Skills/Competences and Qualifications, the Knowledge is the first pillar addressed. This main category unfolds in multiple layers like: agriculture, forestry, fisheries and veterinary; arts and humanities; business, administration and law; education; engineering, manufacturing and construction; generic programmes and qualifications; health and welfare; information and communication technologies; natural sciences, mathematics and statistics; services; social sciences, journalism and information.

To narrow and focus the study on the energy sector and on the digitalisation of this sector, only the following sub-categories were selected: engineering, manufacturing, and construction; information and communication technologies; and natural sciences, mathematics, and statistics. By taking a closer look, as you can see in the Annex 1: ESCO knowledge, skills, and occupations, Table 47, the general classification of Engineering and Engineering Trades has two titles selected from the numerous available lists on the ESCO platform, namely the Electricity and Energy and Electronics and Automation.

Once the attention was directed to the relevant areas (presented in the first two columns of the table) the research went in the last layer of classification. For each Narrow Classification that can be found in the third column of the Table 47 its Description and Related Occupations (last two columns of the table) were included. For example, in Engineering and Engineering Trades; Electricity and Energy, a Narrow Classification is Energy, with the next Description: “Power capacity in the form of mechanical, electrical, heat, potential, or other energy from chemical or physical resources, which can be used to drive a physical system” and the following Related Occupations: solar energy engineer, energy analyst, hydropower technician, gas distribution engineer, energy engineer.

Another example is in Engineering and Engineering Trades; Electronics and Automation General Classification, with the Narrow Classification as Vehicle Electrical Systems, with the next Description: “Know vehicle electrical systems, including components such as the battery, starter, and alternator. Understand the interplay of these components to resolve malfunctions.” and the following Related Occupations: vehicle technician, engine designer, automotive electrician.

In the case of Information and Communication Technologies domain, the General Classification, Information and Communication Technologies (ICTS) has two chosen titles: Computer Use and Database and Network Design and Administration. The results can be found in the Table 48

For the last domain, Natural Sciences, Mathematics and Statistics, the General Classification Natural Sciences, Mathematics and Statistics has been separated in three titles: Environment; Mathematics and Statistics; and Physical Science. The information identified for this section is also present in Table 49

Knowledge is an important part of the abilities needed on the labor market, but it is not enough. For this reason, the analysis goes further to ESCO Skills collection.

Below can be found Table 4 with some of the most relevant knowledge available also in Annexes.

Table 4 – Relevant Knowledge

General Classification	Narrow Classification	Description	Related skills Associated/Related knowledge
Electricity and energy	Electrical power safety regulations	Compliance with safety measures for working in installation, operation, and maintenance of constructions/equipment from the generation, transmission, and distribution of electrical power.	Wind turbine technician, power lines supervisor, energy systems engineer, electrical power distributor, power distribution engineer, energy manager.
Electricity and energy	Energy market	The trends and major driving factors in the energy trading market, energy trades methodologies and practice, and the identification of the major stakeholders in the energy sector.	Waste treatment engineer, energy engineer, power plant manager, energy systems engineer, energy trader, solar energy engineer, energy analyst
Electronics and automation	Automation technology	Set of technologies that make a process, system, or apparatus operate automatically using control systems.	Electronics and automation vocational teacher, automation engineer, power production plant operator
Electronics and automation	ICT infrastructure	The system, network, hardware and software applications and components, as well as devices and processes that are used to develop, test, deliver, monitor, control or support ICT services.	System configurator, ICT product manager, ICT capacity planner, ICT system analyst, ICT system administrator, ICT networking hardware
Computer use	Web application security threats	The attacks, vectors, emergent threats on websites, web applications and web services.	ICT security technician, ethical hacker

The knowledge identified during ESCO analysis cover critical abilities related to regulatory aspects, ICT development, market energy understanding, automation technology, and cybersecurity.

ESCO Analysis for skills

This main category of Skills also unfolds in multiple layers like communication, collaboration, and creativity, information skills; assisting and caring; management skills, working with computers; constructing and working with machinery and specialized equipment.

To restrict the study and to highlight the relevant areas focusing on the energy sector and the digitalisation of all processes and services, only the following sub-categories were underlined as they were the most relevant examples for lack of synergies for the digitalisation of the power sector: information skills, management skills, working with computers and working with machinery and specialized equipment. Annex 1: ESCO knowledge, skills, and occupations Table 50, Table 51 Table 52

Regarding each skill it was necessary to include a short Description and Related Occupations. For a better understanding, an example is detailed here: in subcategory Information skills, interpreting technical documentation and diagrams, a narrow classification is Interpret electrical diagrams, with the Description: „ Read and comprehend blueprints and electrical diagrams; understand technical instructions and engineering manuals for assembling electrical equipment; understand electricity theory and electronic components". The relevant Related Occupations are electrical equipment inspector, electrical drafter and panel tester.

In the field of Management skills, developing objectives and strategies, the Narrow Classification is „Develop strategy to solve problems". Related to the description, this is: „Develop specific goals and plans to prioritize, organize, and accomplish work", matching with the occupation „manage artistic career".

Regarding the category of Working with Computers, the Narrow Classifications is „Use digital device operating systems". The short Description is: „Use the functions and tools provided by the operating systems to access resources and run applications". The relevant Related Occupations are digital assistant and data center operator.

Finally, the domain of Working with machinery and specialized equipment, which is very vast, with the general classification „Operating pumping systems or equipment". The Narrow Classification is: Check water pressure, with the Description: „Check the water pressure in a water circulation system, using a built-in gauge or by attaching a water pressure gauge onto a pipe. The Related Occupations are irrigation system installer and sprinkler filter.

We have noticed that Knowledge and Skills are intricately connected, and they are an important part of the labor market. The research part goes further and, we will clarify the field of ESCO occupations.

Below can be found Table 5 with some of the most relevant skills available also in Annexes.

Table 5 – Relevant Skills

General Classification	Narrow Classification	Description	Related occupations	Associated or Related knowledge
Managing Information	Manage data	Administer all types of data resources through their lifecycle by performing data profiling, parsing, standardization, identity resolution	Software manager, database integrator and data quality specialist.	Audit techniques
Estimating resource needs	Identify energy needs	Identify the type and amount of energy supply necessary in a building or facility.	Renewable energy sales representative, energy analyst, energy systems engineer & energy conservation officer	Energy
Monitoring developments in area of expertise	Keep up with digital transformation of industrial processes	Keep up to date with digital innovations applicable to industrial processes. Integrate these transformations in the company's processes aiming for competitive and profitable business models.	Chemical production manager, mechanical engineer & industrial engineer.	Digitalisation of industrial market
Setting up computer systems	Integrate system components	Select and use integration techniques and tools to plan and implement integration of hardware and software modules and components in a system.	Telecommunications engineering technician	ICT system integration, Hardware components
Operating energy production or distribution equipment	Manage electricity transmission system	Manage the systems which ensure the transmission of electrical energy from electricity production facilities to electricity distribution facilities.	Power distribution engineer & Electrical transmission system operator	Electricity

The skills identified after the ESCO analysis cover data manging, identification of energy needs, keeping up with digital transformation of industrial processes, integration of system components and managing the electricity transmission system.

After reviewing CEDEFOP, it was noticed that it extracts data for skills and knowledge from the ESCO databases, so the analysis includes relevant information from the ESCO framework only.

3.3. Skill needs

3.3.1. Survey to industry

To be able to generate realistic results regarding skill needs in the energy sector it is important to get an overview of the industry and gather direct feedback from stakeholders in the sector. To this end, a survey was designed and distributed to several prestigious industrial stakeholders throughout Europe. **60 companies** provided valuable insights from their professional experience regarding skill needs in the different sectors of the energy industry.

In order to get diverse results in terms of geographical location, type of company, size, sector of operation the target group had to be designed accordingly. Nevertheless, the concept of addressing the challenges should focus on reference companies such as associations and best-practice organisations to get valuable insights without having excessive lists of relevant stakeholders. The data collected should be of quality and of adequate quantity in order to have a statistically significant sample. To achieve this, each partner had to go through his contacts and approach those he deemed most relevant. The energy system subsectors were defined according to the ETIP SNET Vision 2050, as Electricity, Oil& Gas, Heat & Cooling and Digital/data. Also, their respective type was considered (Generation, System Operator, Market etc.).

The final list of stakeholders that received the survey consists of 132 organisations, 100 having as main sector of operation the power sector, 19 in Oil & Gas, 3 in Heating & Cooling and 10 Digital/Data. Most of the respondents operate in various sectors and have more than one operational focus, so good representation is achieved. Out of them 60 organisations responded to the questionnaire. The following figures present the demographic representation of the answers.

Figure 6 Answers distribution per country

At which sector(s) does your organization operate in? (You can choose more than one if applicable)

	Answers	Ratio
Oil&Gas	12	20.00 %
Heating and Cooling	7	11.67 %
Power	52	86.67 %
Digital/Data	19	31.67 %
Other	6	10.00 %
No Answer	0	0.00 %

Figure 7 Distribution of answers by sector

Which of the following can best describe your organization? (You can choose more than one if applicable)

	Answers	Ratio
Generation	13	21.67 %
Network (DSO, TSO etc)	27	45.00 %
Retailer	9	15.00 %
Service provider (Consultant, aggregator etc)	18	30.00 %
Manufacturer	7	11.67 %
Other	7	11.67 %
No Answer	0	0.00 %

Figure 8 Distribution of answers by type of operation

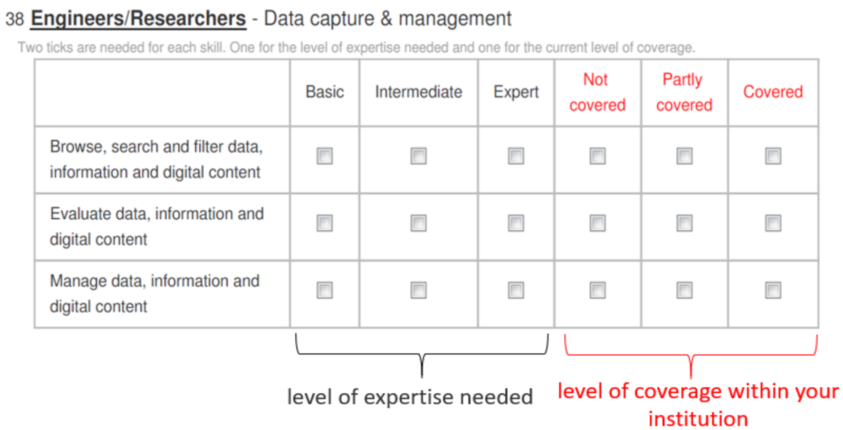
Through reviews like the ESCO analysis in the previous section and by using EDDIE's industrial partners' experience, a collection of skill sets, each consisting of specific skills, were defined to be assessed through the survey. Four skill sets were used each of whom is divided in specific skills, namely the skill-sets are listed:

- "Data capture & management",
- "Analytical methods",
- "Computing tools & platforms"
- "Programming, development and technology related"

Moreover, **transversal, and green skills** were included. The participants were asked to provide information on these skills for three categories of staff:

- managers/administration
- engineers/researchers
- technicians/specialists

For each skill, participants were asked to select the level of expertise needed at this skill within the company and for the specific staff category while also answering what is the current coverage status for this skill. An example is presented in Figure 9.


38 Engineers/Researchers - Data capture & management

Two ticks are needed for each skill. One for the level of expertise needed and one for the current level of coverage.

	Basic	Intermediate	Expert	Not covered	Partly covered	Covered
Browse, search and filter data, information and digital content	☐	☐	☐	☐	☐	☐
Evaluate data, information and digital content	☐	☐	☐	☐	☐	☐
Manage data, information and digital content	☐	☐	☐	☐	☐	☐

Figure 9 Example of survey question

The results that are presented in this work are obtained from the survey that was distributed in the industry to address challenges and skills in the energy sector towards digitalisation. The first part, referring to challenges was presented in the report D2.1 Current challenges in the energy sector and state of the art in education and training" [6] while in this work the focus is on skills. The complete list of questions can be found at the survey available at EDDIE's website [7] as well as Annex 2 of D2.1 "Current challenges in the energy sector and state of the art in education and training" [6].

The results considering the skill demand from the industry are presented in the following paragraphs and figures. For each skill only the intermediate and expert levels are presented since trough the analysis the intention is to address the high expertise level needed. The missing percentages in the figures refer mostly to basic expertise and also to the missing answers (e.g., when a skill presents 80% Intermediate and Expert combined, the rest 20% may be 15% Basic level and 5% didn't respond at all).

Data capture and Management

The first skill set addressed is the "Data capture and Management" which consists of the following skills:

- Browse, search and filter data, information, and digital content
- Evaluate data, information, and digital content
- Manage data, information, and digital content

Figure 10 shows the industry's demand of expertise which is high in every skill of this skillset (>80% Expert and Intermediate Level Combined) for the staff category of "Managers/Administration".

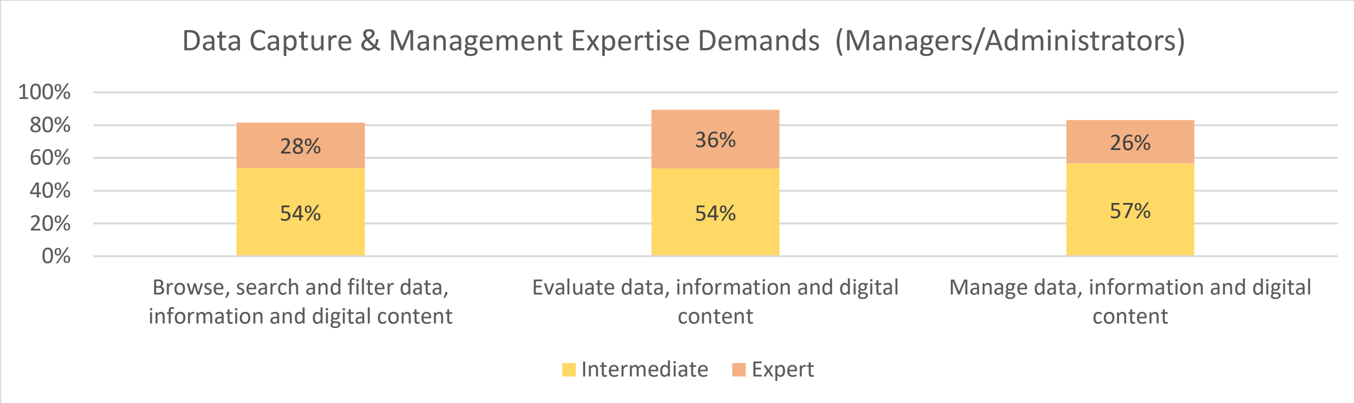


Figure 10 Data Capture and Management Expertise Demands for Managers and Administrators

Figure 11 presents the expertise demand for the same skill set for "Engineers/Researchers" and shows that there is particularly high expertise needed for this staff category. "Intermediate" and "Expert" expertise demand combined reaches beyond 90% while more than 60% of the participants indicate the require expert knowledge in this skill sets from engineers and researchers.

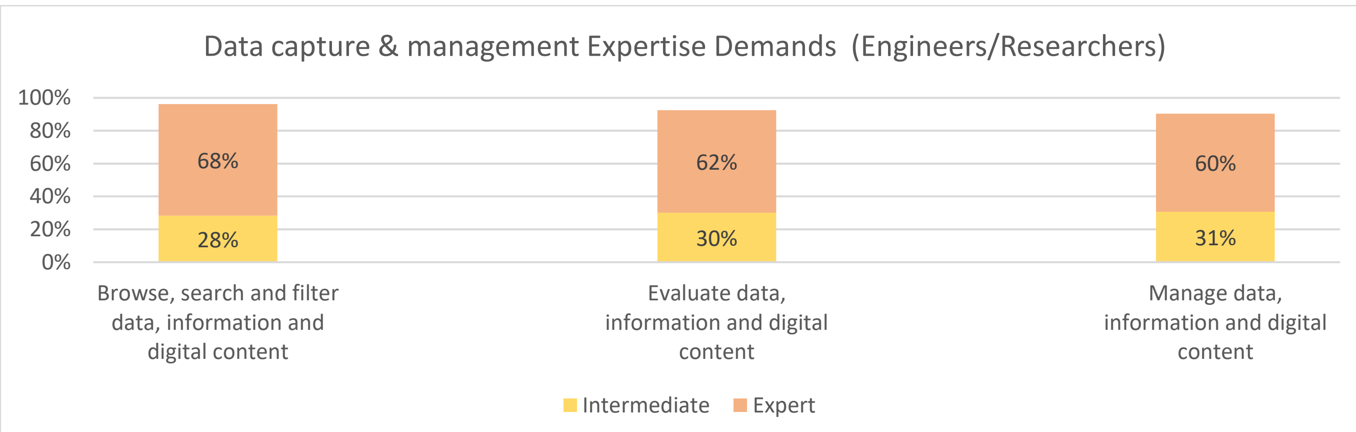


Figure 11 Data Capture and Management Expertise Demands for Engineers/Researchers

The last staff category addressed refers to the "Technicians/Specialists" where we observe that there is also high expertise demand in this skill set, relatively lower than the previous category, yet still quite high.

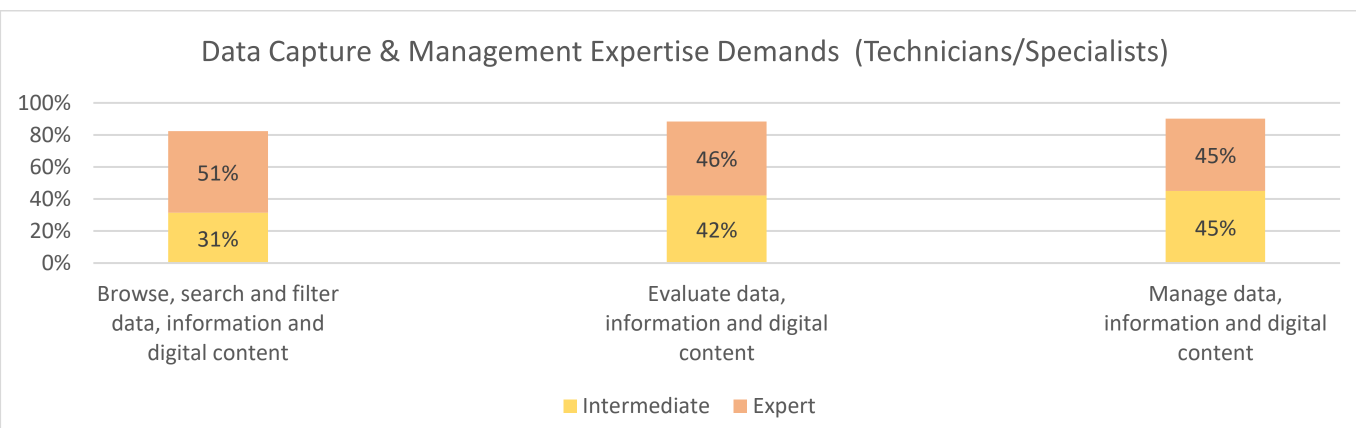


Figure 12 Data Capture and Management Expertise Demands for Technicians/Specialists

As far as the Data Capture & Management skillset is concerned, it can be concluded that **every staff category examined demand high level of expertise in every skill in this skillset**. The **highest percentages** of Intermediate and Expert level of expertise demands can be observed in the **"Engineers/Researchers** ". Each category showcases a different most needed skill, yet the demand profiles are similar.

Analytical methods

The Analytical Methods skillset involves the following skills:

- Application of statistical methods
- Mathematical optimization
- Application of data mining approaches
- Perform big data analysis
- Report analysis results
- Predictive modelling/analysis

As it can be observed from Figure 5, **the industry demands moderate level of expertise in this skillset for managers/administration since there are several skills that demand <50% of Expert and Intermediate Level Combined**. In addition, the skill **"Report Analysis Results" showcase the highest demands of high-level expertise (28% Expert / 45% Intermediate)** which stands out from many of the skills as significantly higher. The lowest percentages of Intermediate and Expert combined can be observed in the skills "Mathematical optimization", "Application of data mining approaches" and "Perform big data analysis".

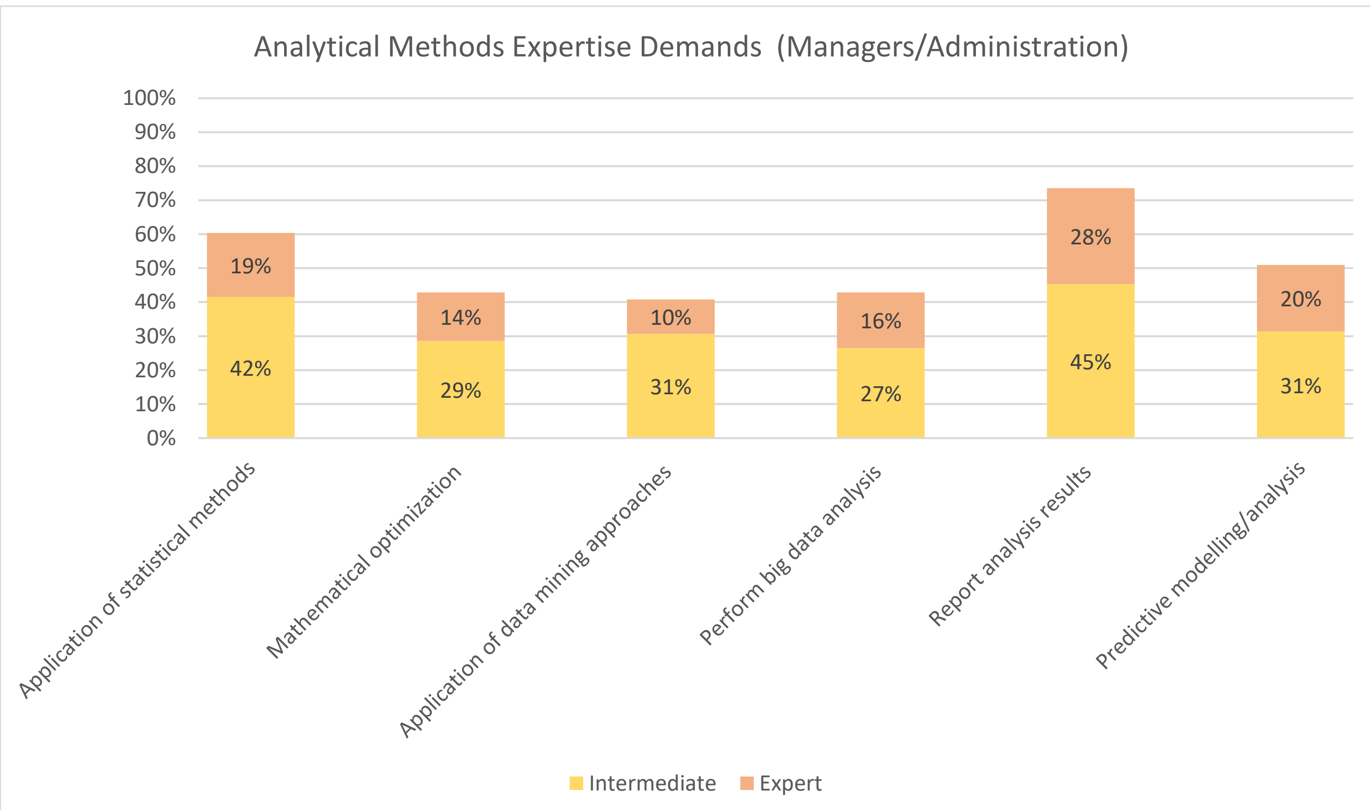


Figure 13 Analytical methods for Managers/Administration

Looking at Figure 14 it can be observed that **the industry demands high level of expertise in every skill of this skillset (>80% Expert and Intermediate Level Combined for engineers/researchers)**. Furthermore, the skills "Mathematical Optimization" and "Report Analysis Results" showcase the highest demands of high-level expertise. Finally, the skill "Application of Data Mining Approaches" is the least demanded by "Engineers/Researchers" but it still showcases a high percentage of Intermediate and Expert combined.

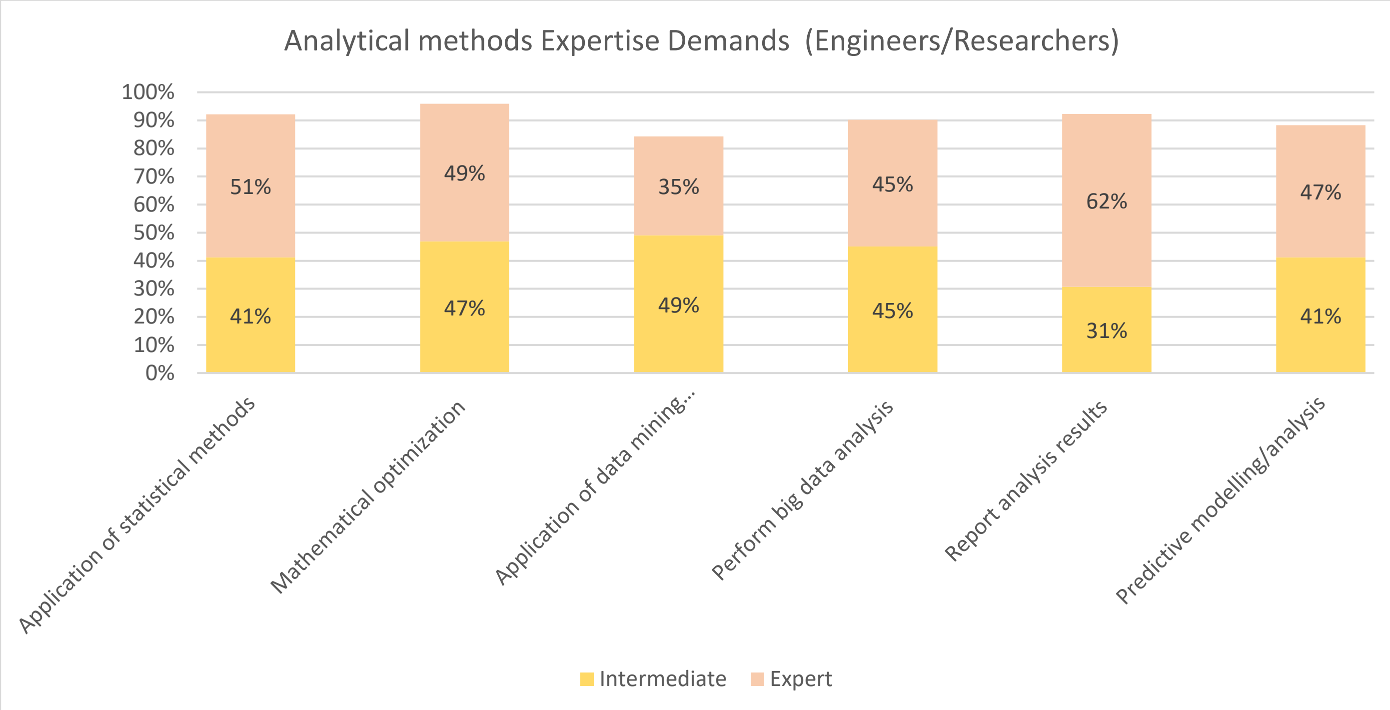


Figure 14 Analytical methods for Engineers/Researchers

As it can be seen on Figure 15, **the industry demands high level of expertise in almost every skill in this skillset (>65% Expert and Intermediate Level Combined) for technicians/specialists**. Finally, the skills "**Application of statistical methods" and "Report Analysis Results**" showcase **the highest demands** of expertise while the skill "Application of Data Mining Approaches" is the least demanded by "Technicians / Specialists".

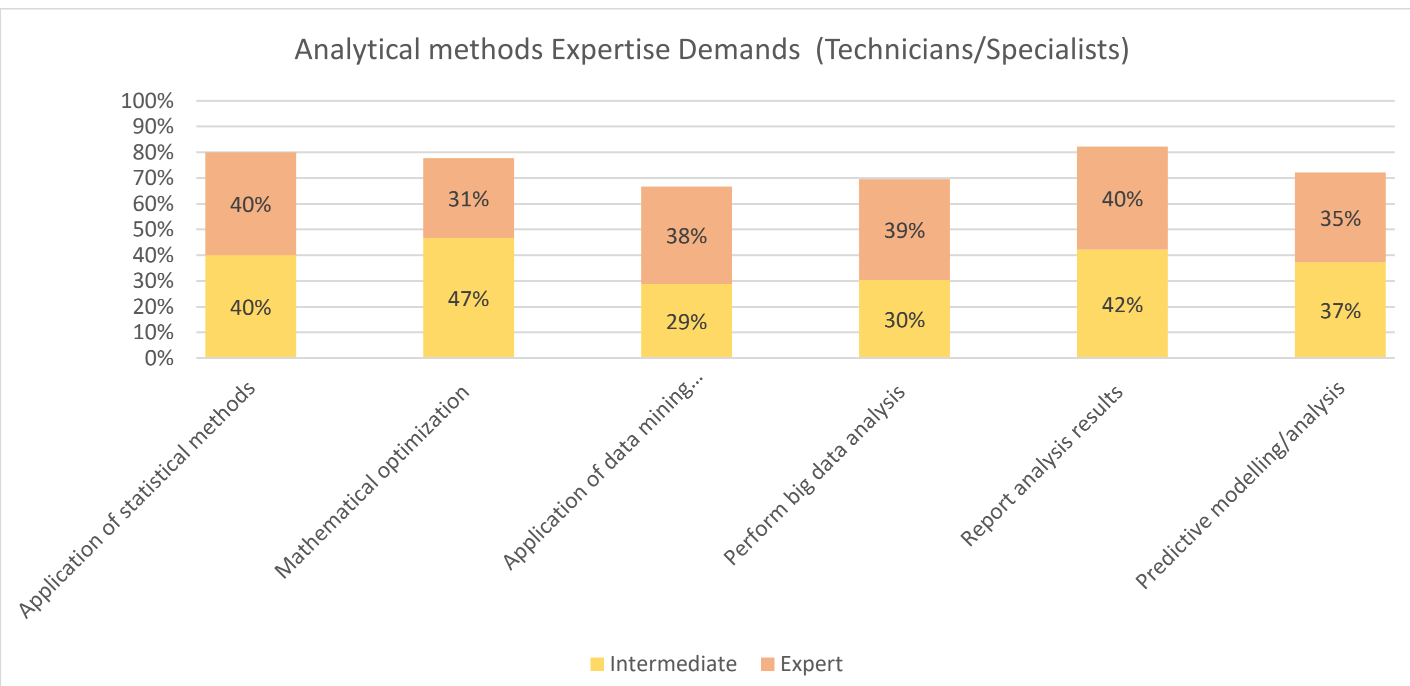


Figure 15 Analytical methods for Technicians/Specialists

In conclusion, **the expertise demand showcases the highest percentages in the category "Engineers/ Researchers" and "Technicians / Specialists".** In addition, the "Report Analysis Results" skill showcases high expertise demands in all categories while the skill "Application of Data Mining Approaches" is the least demanded by all specializations. The skill "Mathematical Optimizations" showcases a high expertise demands in comparison with the other skills in the "Engineers/Researchers" category which is not the case in the other two categories.

Computing Tools and Platforms

The next skill set comprises of the following skills, that reflect the overall knowledge of employees regarding computing tools and platforms.

- Usage of high-performance computing resources and high availability systems
- Accessing, analysis and visualization of data
- Accessing, analysis and visualization of data on cloud infrastructures
- Managing security and privacy issues on digital platforms
- Administration of hardware infrastructure (web servers, workstation etc)
- Use of simulation tools
- Use of distributed software systems

Looking at Figure 5 we observe a **moderate level of expertise demand** in this particular skill set for managers/administration as less than 50% of the participants indicated they require a high level of expertise in almost every skill. The skill *"Accessing, analysis and visualization of data"* showcase the highest demand of high level expertise while the *"Administration of hardware infrastructure"* is the less demanded skill.

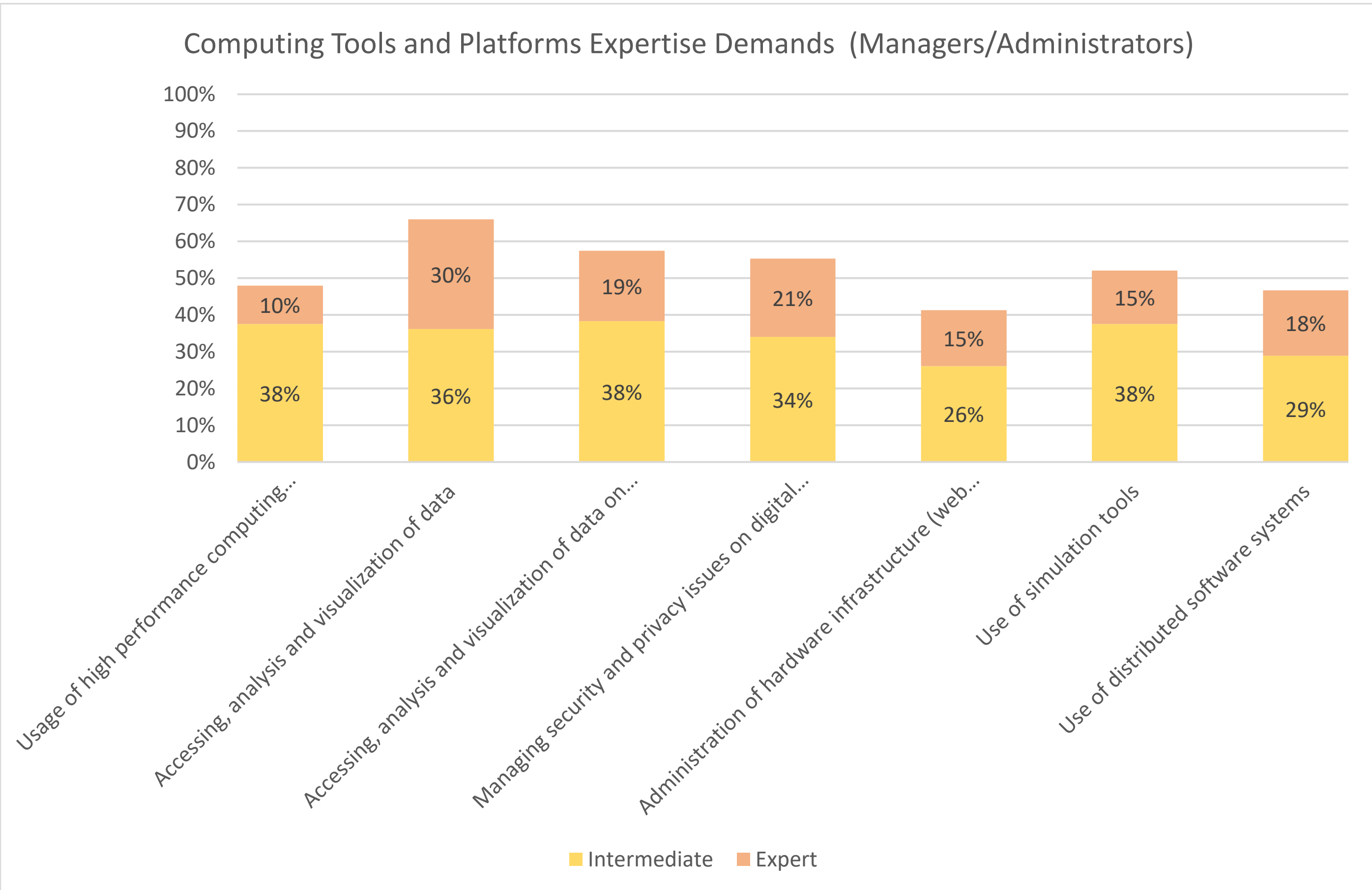


Figure 16 Computing Tools and Platforms Expertise Demands for Managers and Administrators

From Figure 17 it can be concluded that the **industry demands high level of expertise in almost every skill in this skillset (>75% Expert and Intermediate Level Combined) and >40% Expert**. In addition, the skills *"Accessing, analysis and visualization of data"* and *"Use of simulation tools"* showcase the highest demands of high-level expertise while the *"Administration of hardware infrastructure*" is the less demanded skill.

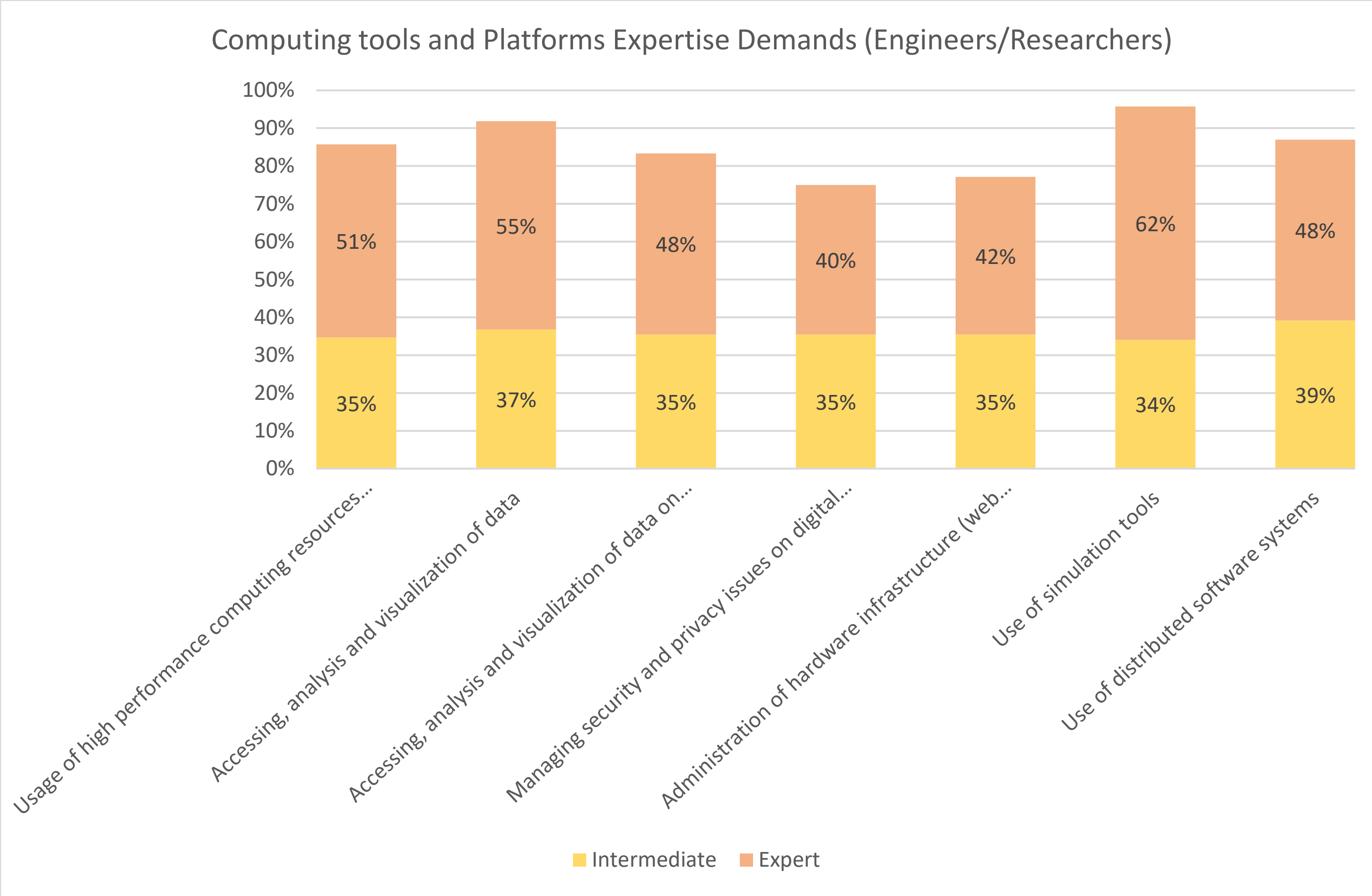


Figure 17 Computing Tools and Platforms Expertise Demands for Engineers/Researchers

The next figure shows that the **industry demands high level of expertise in almost every skill in this skillset (>70% Expert and Intermediate Level Combined) and >40% Expert** for technicians and specialists. In addition, the skills *"Accessing, analysis and visualization of data" and "Usage of high-performance computing resources and high availability systems"* showcase the highest demands of high-level expertise while the *"Accessing, analysis and visualization of data on cloud infrastructures*" is the less demanded skill.

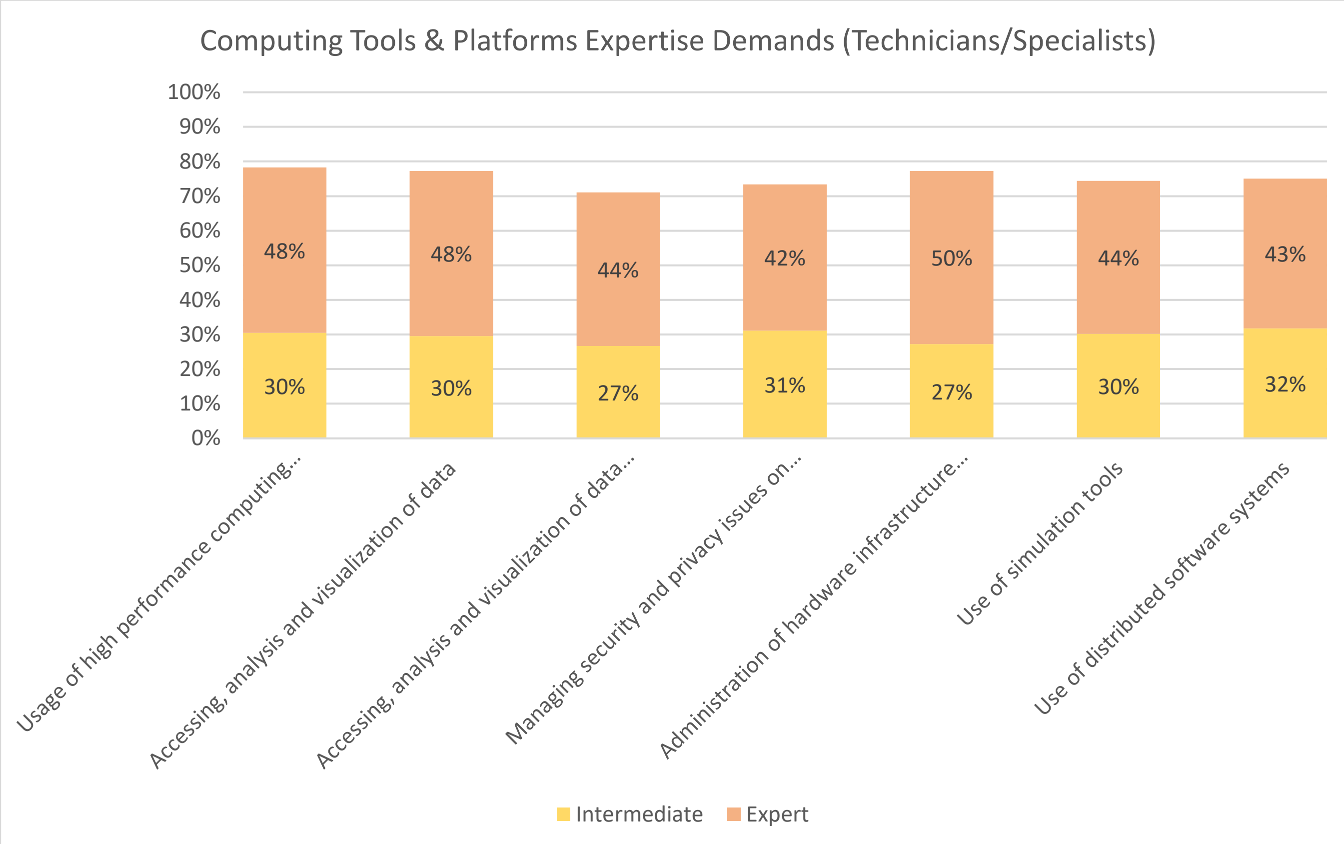


Figure 18 Computing tools and Platforms Expertise demand for Technicians/Specialists

To summarize, the expertise demand showcases the highest percentages in the categories "**Engineers / Researchers" and "Technicians/Specialists**". Furthermore, the ***"Accessing, analysis and visualization of data"*** skill showcases high expertise demands in all categories. It is also worth mentioning that the skill ***"Use of simulation tools***" showcases a higher expertise demand in comparison with the other skills in the "Engineers/Researchers" category which is not the case in the other two categories. Finally, the ***"Administration of hardware infrastructure"*** is the **less demanded** skill for "Engineers / Researchers" and "Managers/Administrators" but it **is highly demanded** for "Technicians/Specialists".

Programming, Development and Technology Related

The Programming, Development and Technology Related skillset involves the following skills:

- Creatively use digital technologies
- Development of prototypes and new analysis algorithms
- Use specific data analysis software
- Requirement Analysis
- Development of web applications (JavaScript, HMTL, CSS etc)
- Design and development of applications (Python, Java, C++ etc)
- Query data from database (via SQL etc)
- Integration of sensor data and IoT applications
- System design competence
- Blockchain skills
- Understanding of Cybersecurity
- Understanding and usage of communication technologies

Analyzing Figure 19 above we observe that the **industry demands moderate to low level of expertise in many of the skills in this skillset**. The skill **“Understanding of cybersecurity”** showcase the **highest demands** of high-level expertise while on the other hand skills like “Development of prototypes and new analysis algorithms”, “Development of web applications”, “Design and development of applications”, “Query data from database”, “Integration of sensor data and IoT applications” and “Blockchain skills” are not in high demand within the “Managers/Administrators” category.

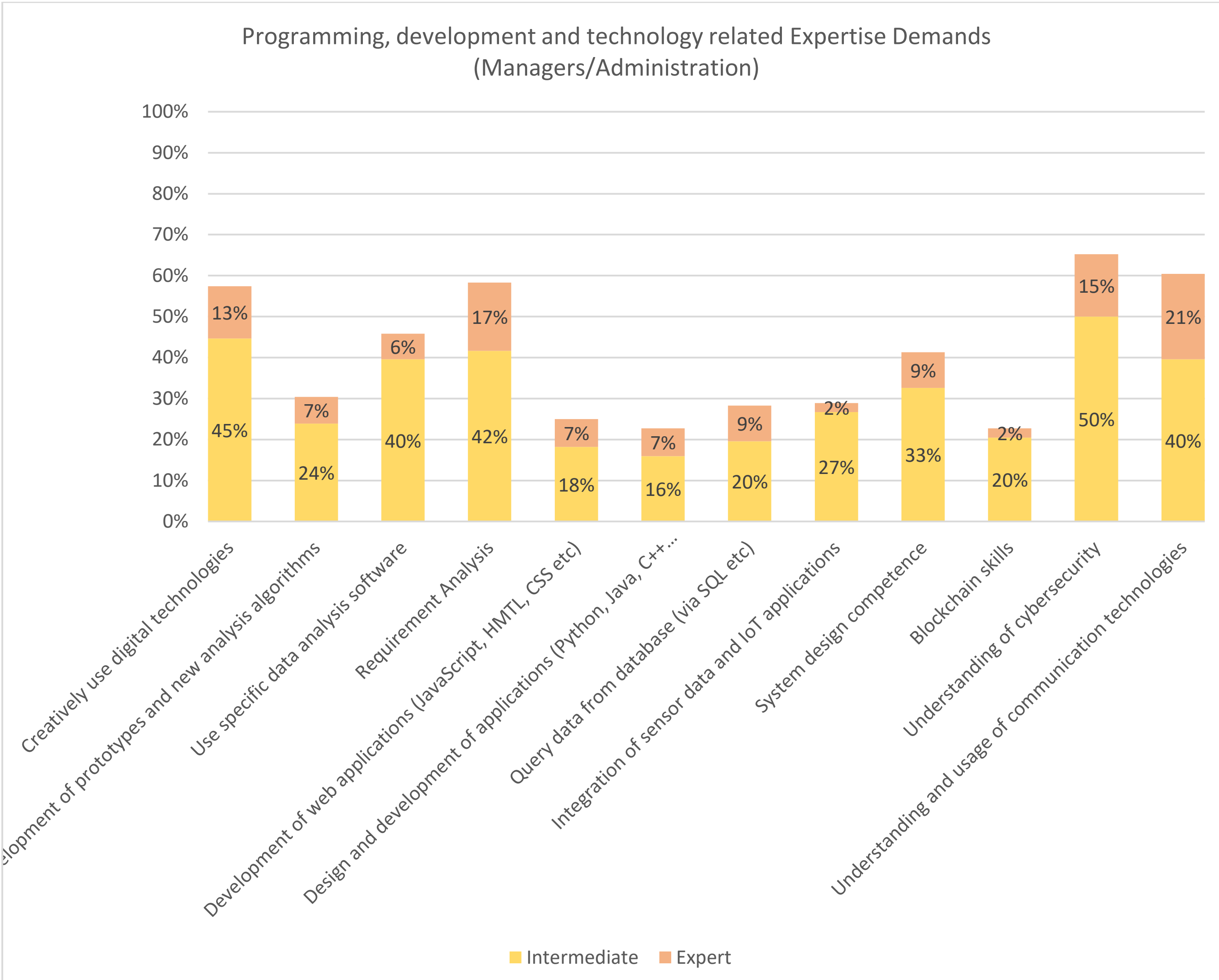


Figure 19 Programming, development and technology related for Managers/Administration

Figure 20 highlights the high level of expertise demand in almost every skill of this skillset (>75% Expert and Intermediate Level Combined) except for the “Blockchain Skills”. The skills “**Creatively use digital technologies” and “Use specific data analysis software**” showcase the **highest demand** of high level expertise while the “**Blockchain Skills**” showcases the **lowest demands**.

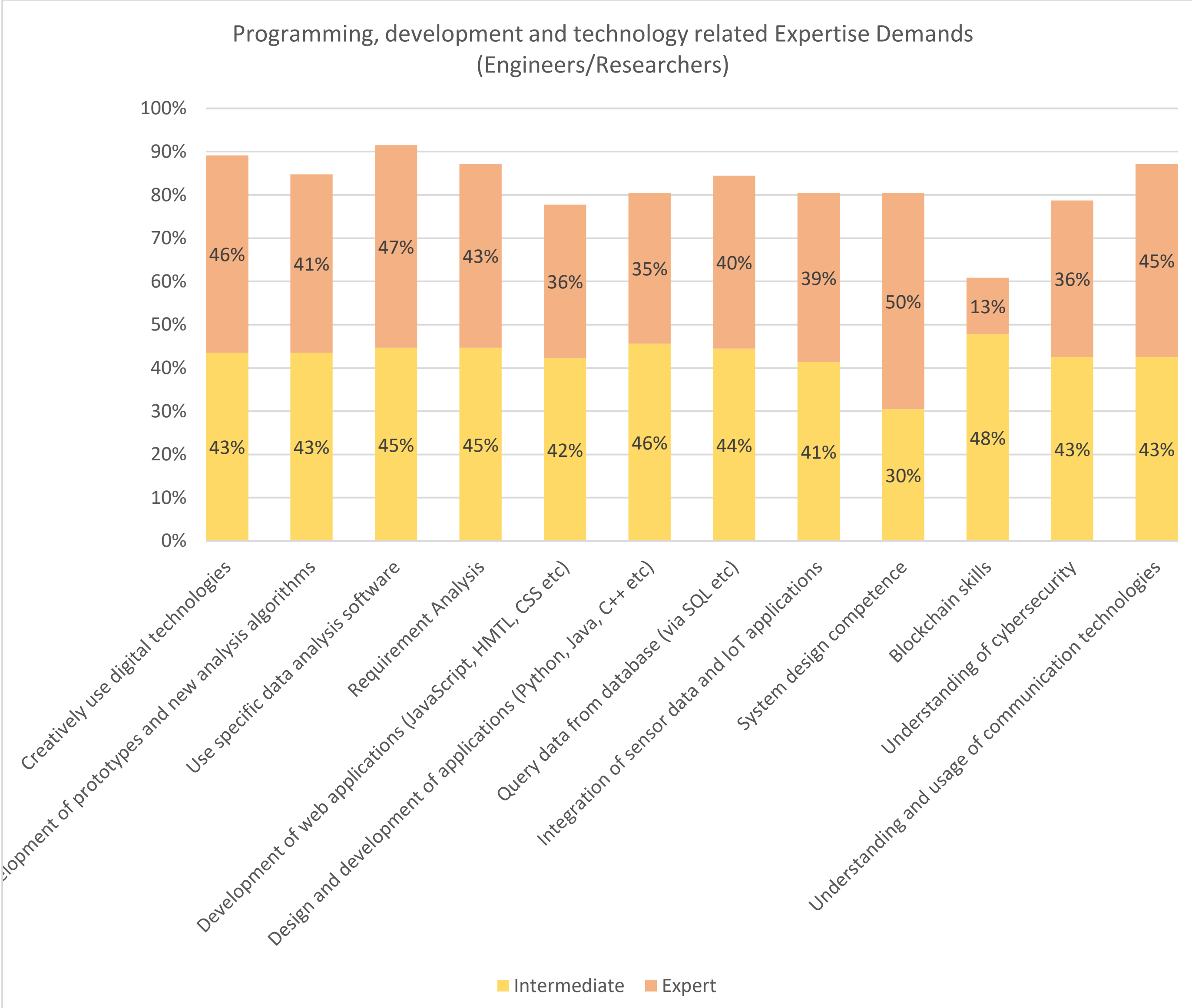


Figure 20 Programming, development and technology related for Engineers/Researchers

Figure 17 dictates that **there is a high level of expertise demand in almost every skill in this skillset (>65% Expert and Intermediate Level Combined) with the exception being the "Blockchain Skills"**. The skills "Creatively use digital technologies", "Understanding of cybersecurity" and "Understanding and usage of communication technologies" showcase the highest demands of high-level expertise although the percentages of "Intermediate" and "Expert" combined are similar.

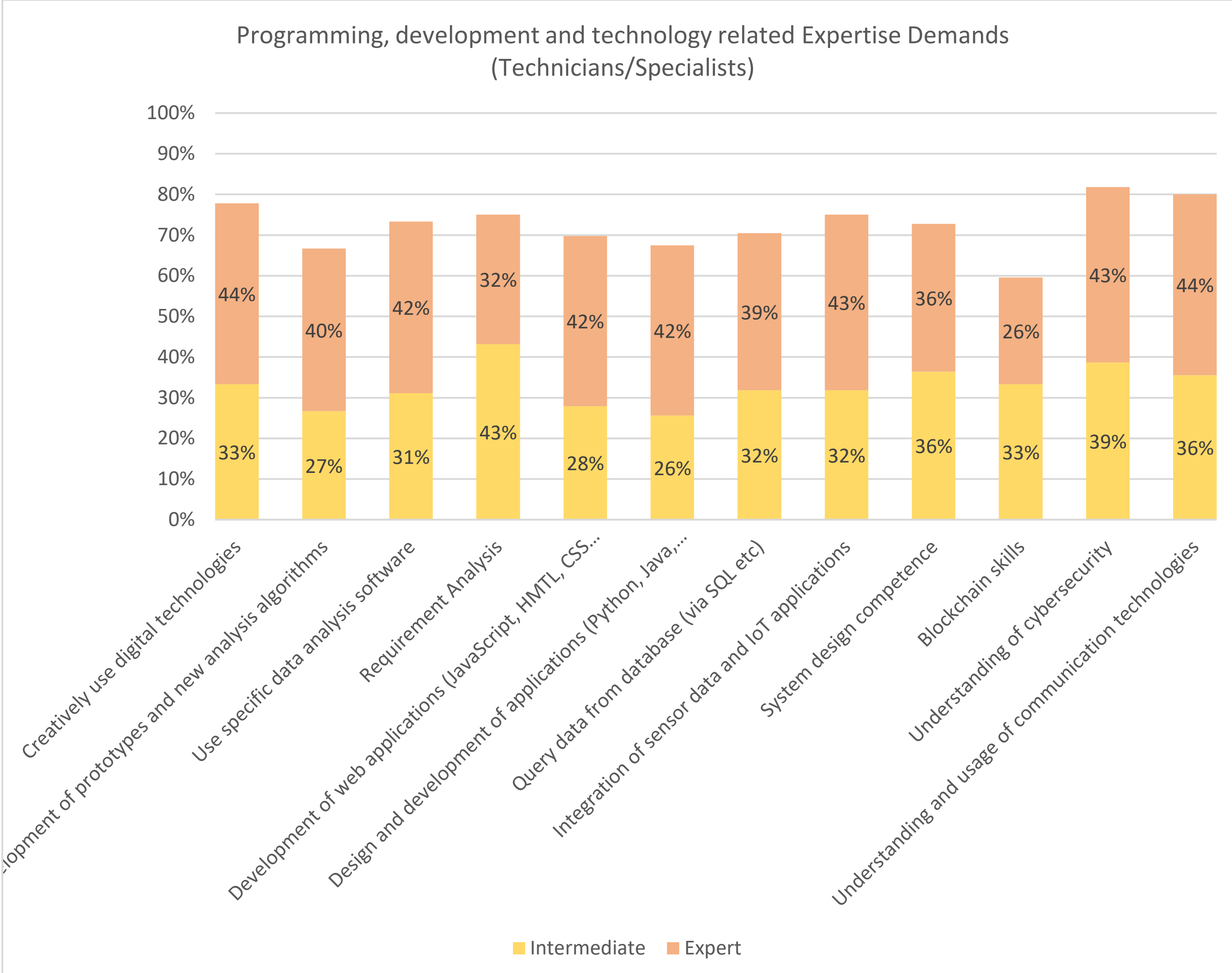


Figure 21 Programming, development and technology related for Technicians/Specialists

In conclusion, the expertise demand showcases the **highest percentages in the category "Engineers / Researchers" and "Technicians/Specialists" and they are significantly lower in "Managers/Administrators" category**. Furthermore, **the skills "Creatively use digital technologies", "Understanding of cybersecurity" and "Understanding and usage of communication technologies" showcase high demands of expertise** and seem to be the most important of the skillset. It is also worth mentioning that the skill "Use specific data analysis software" showcases the highest expertise demand in the "Engineers/Researchers" category which is not the case for the other two categories. The skill "Blockchain skills" is the least demanded skill regardless of the specialization.

Transversal skills

The Transversal skillset involves the following skills:

- Communication
- Team Working
- Ease of learning
- Planning and Organization
- Customer Handling
- Problem Solving

- Innovation and Creativity
- Leadership
- Systemic / Holistic Thinking
- Cross-disciplinary technical competences

Figures 18, 19, 20 present the transversal skills for the different staff categories. It can be observed that there is high demand on the Transversal skillset in general, but it is significantly higher for Managers/Administrators and Engineers/Researchers than Technicians/Specialists. In addition, there are differences between the staff categories on which skills are the most important. More specifically, “Leadership” and “Customer Handling” are not especially important for Engineers/Researchers and Technicians/Specialists while for Managers/Administrators they are two of the most important skills. On the other hand, “Ease of learning” is important for Engineers/Researchers and Technicians/Specialists while for Managers/Administrators is the least demanded skill. Furthermore, the skill “Innovation and creativity” seems to play an important role for “Engineers/Researchers” while for the other two categories it is less important. Finally, all the categories consider “Team Working” as a very important skill so it is safe to assume that this is one of the important skills of the skillset as a whole.

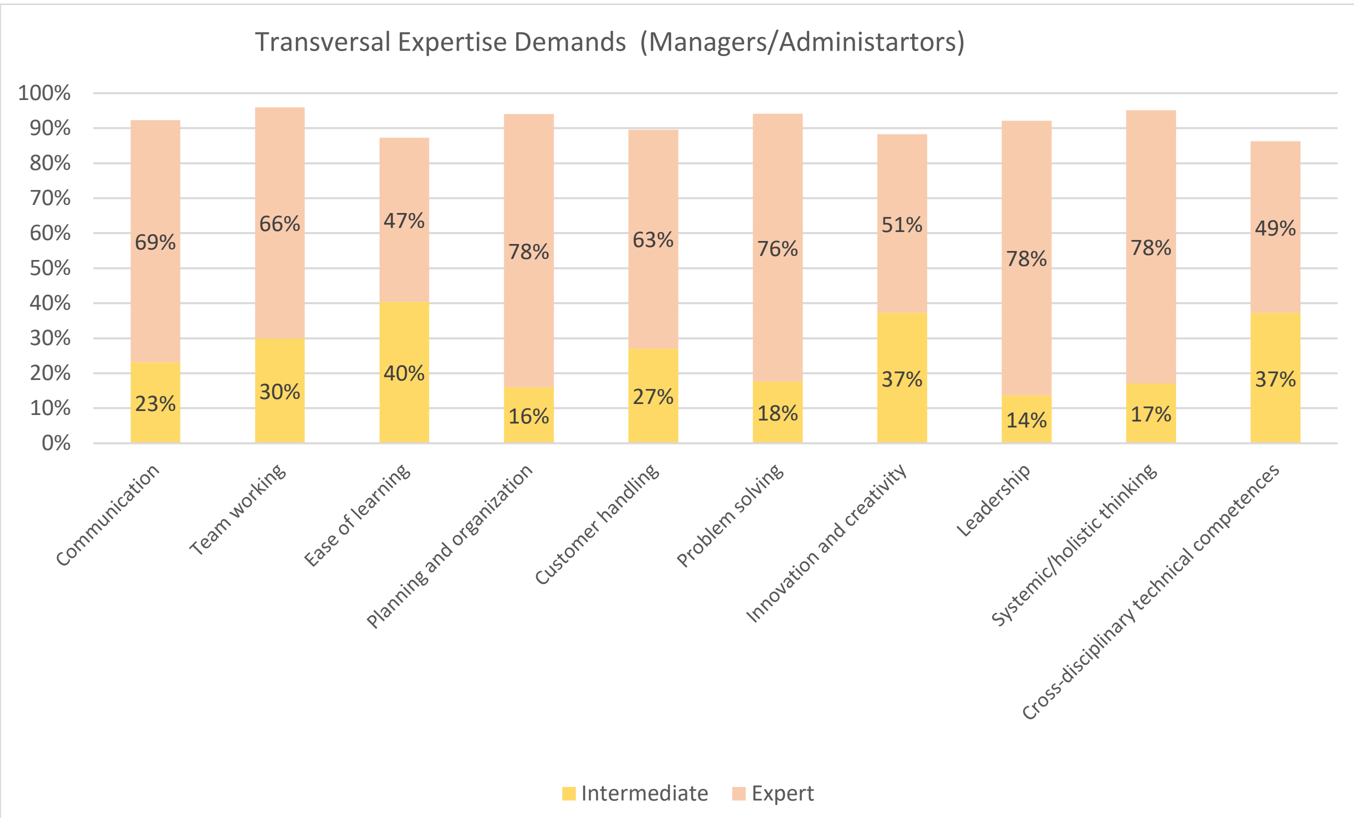


Figure 22 Transversal Skills for Managers/Administration

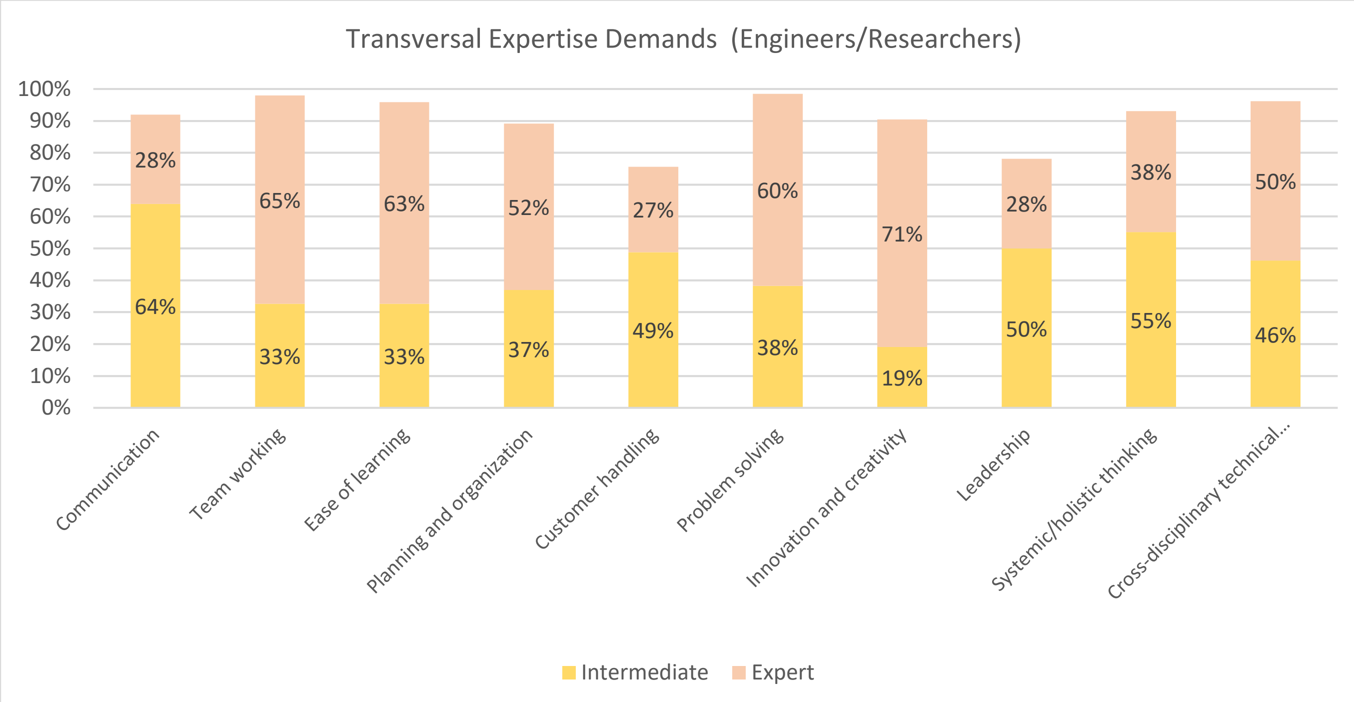


Figure 23 Transversal Skills for Engineers/Researchers

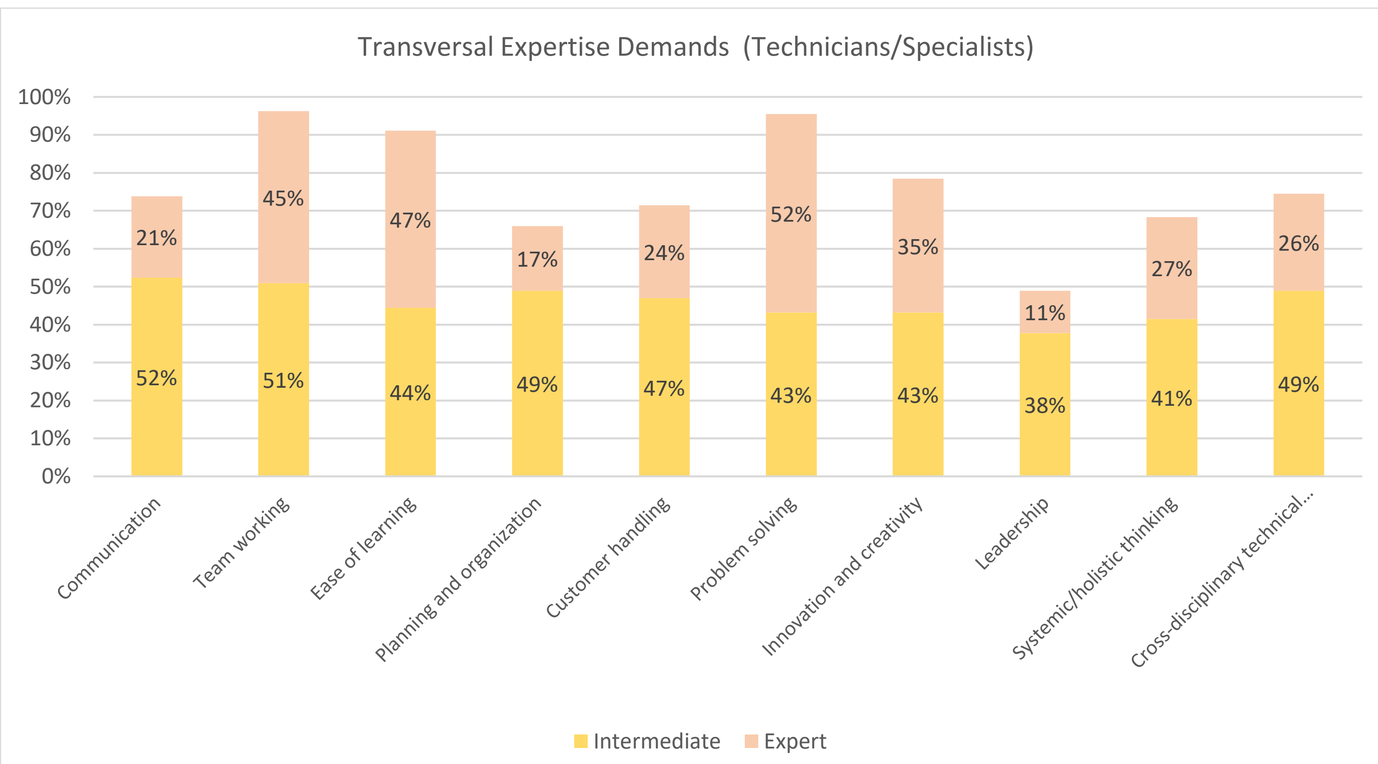


Figure 24 Transversal Skills for Technicians/Specialists

Green skills

"Green skills" or Skills for sustainability, are the technical skills, knowledge, values, and attitudes needed in the workforce to develop and support sustainable social, economic, and environmental outcomes in business, industry and the community.

Considering green skills most of the participants indicated that they are regarded necessary and increasingly trending in the industry. Developing green skills should be a continuous learning process considering that there is an evolving environment, to which skills should be adapted. Implementations of new environmental rules (e.g. on Pollutants, F-gases, biocides directives), implementation of energy efficiency measures (losses reduction), management of large scale Distributed Generation and carbon emissions tracking & reporting are some of the green skills the survey participants pointed out. Overall, green skills such as technical skills, knowledge, values, and attitudes are needed in the workforce to develop and support sustainable social, economic and environmental outcomes in the energy sector. The following figures point out the importance of green skill development reflected in the industry.

Does your organization face the challenge of adapting to climate-driven goals and policies?

		Answers	Ratio
Yes		44	73.33 %
No		7	11.67 %
Not sure		6	10.00 %
No Answer		3	5.00 %

Figure 25 Green skills adaptation

Does your organization engage in activities that require green skills as described above?

		Answers	Ratio
Yes		49	81.67 %
No		3	5.00 %
Not sure		4	6.67 %
No Answer		4	6.67 %

Figure 26 Green skills related activities

What are the main drivers towards green skills adaptation?

		Answers	Ratio
Economic cycle		23	38.33 %
Trends in policy		30	50.00 %
Trends in industry/technology		43	71.67 %
Environmental awareness		40	66.67 %
Other		0	0.00 %
No Answer		4	6.67 %

Figure 27 Drivers towards green skills adaptation

Skill demand by country

Observing Figure 28 it can be concluded that Germany showcases the lowest expertise demands on every skillset while on the other hand, Spain showcases the highest expertise demands.

Regarding the skillsets, we observe that:

- The skillset “Data Capture and Management” showcase the highest expertise demands in all countries.
- The skillset “Programming, Development and technology” related, showcases a big difference in the expertise demands by Spain in comparison to the other countries.

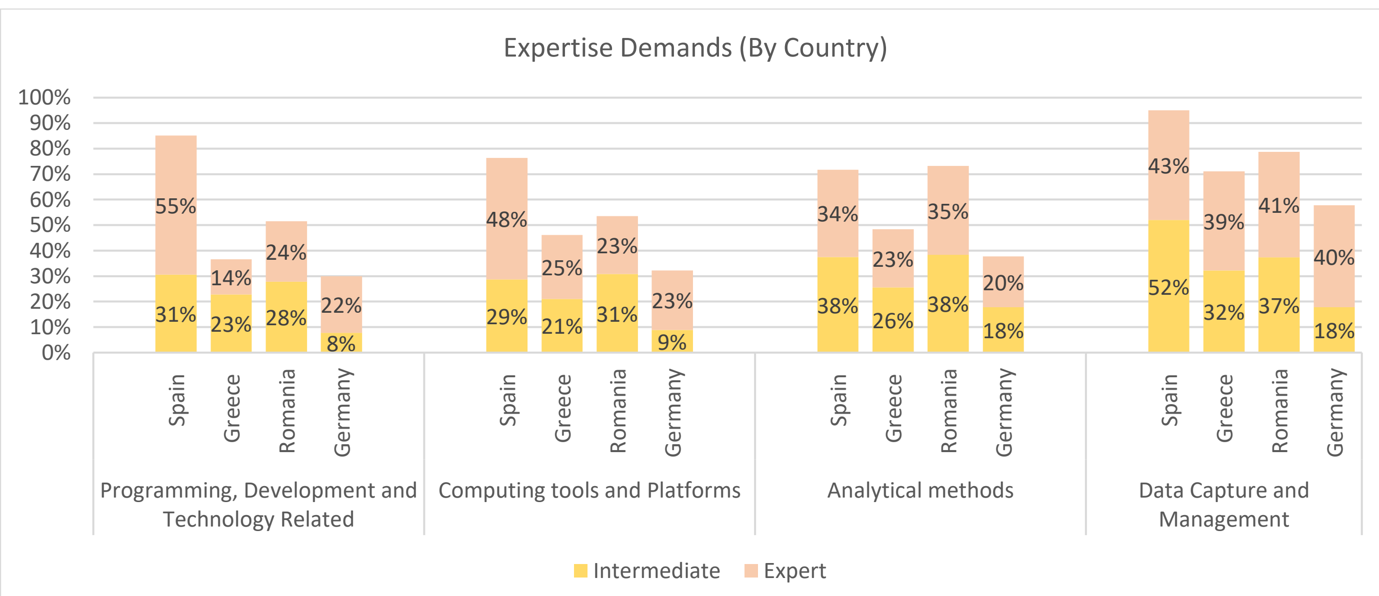


Figure 28 Expertise demand by country

Skill demand by sector

The analysis that is already presented in the sections above, was also performed per country, focusing on the 4 countries with the most participants in the survey, which happen to be 4 of the EDDIE demo countries. This analysis is graphically presented in Figure 29 and it can be pointed out the that the “**Power” sector showcases the highest expertise demand on average** while **the “Oil & Gas” sector showcases the lowest expertise demand** on average. Finally, regarding the skillset "Programming, Development and technology related", the "Heating and Cooling" sector stands out for having a different pattern in comparison with other skillsets, demanding the highest level of expertise of all sectors and more specifically 50% of the industry demanding expert level.

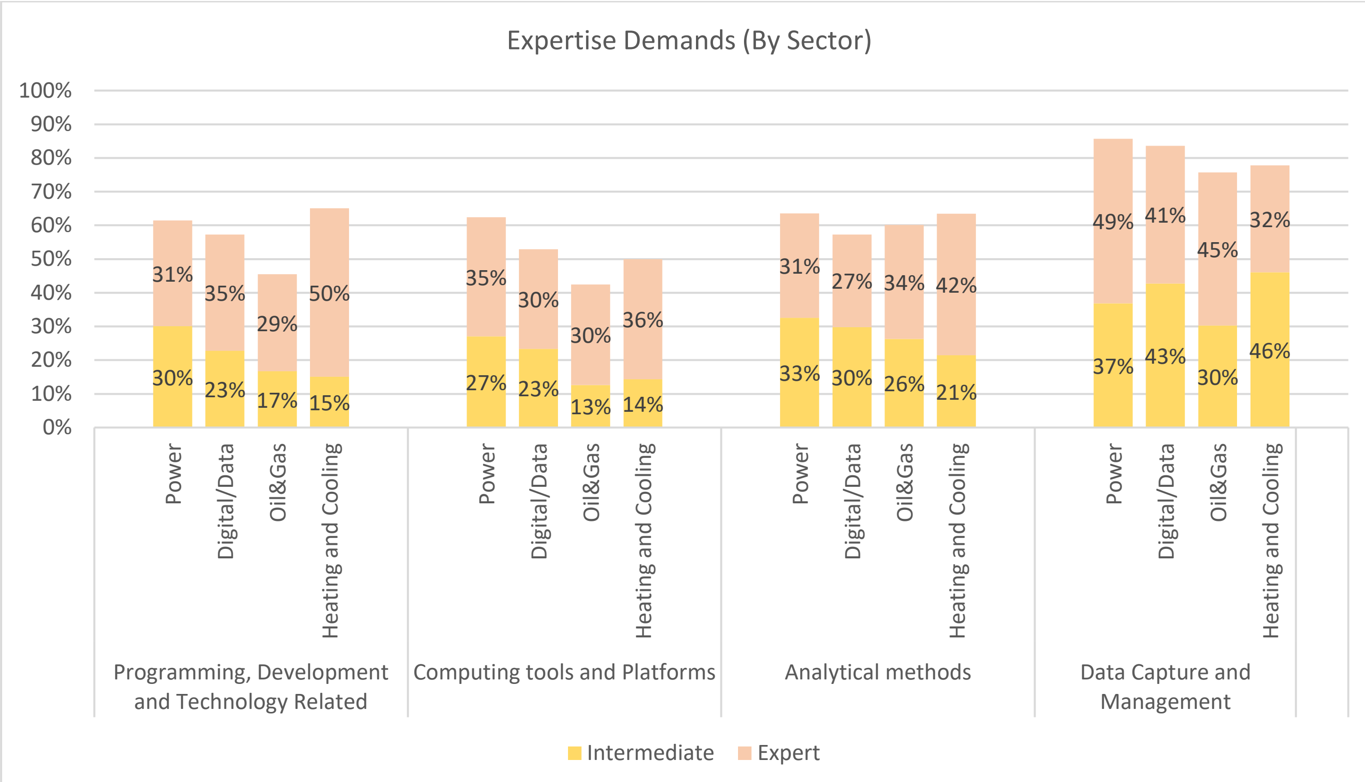


Figure 29 Expertise demand by sector

Skill demand by type of operation

Analyzing Figure 30 it can be observed that the types of operation "Network" and "Retailer" present the highest expertise demand in every skillset excluding the skillset "Data Capture and Management" while the type of organization "Other" showcases the lowest expertise demands on every skill.

Finally, regarding the skillsets, we observe that:

- The skillset "Data Capture and Management" showcase the highest expertise demands by all types of organization.
- The skillset "Data Capture and Management" showcases have an expertise demand percentage >80% by all types of Organization excluding "Other".

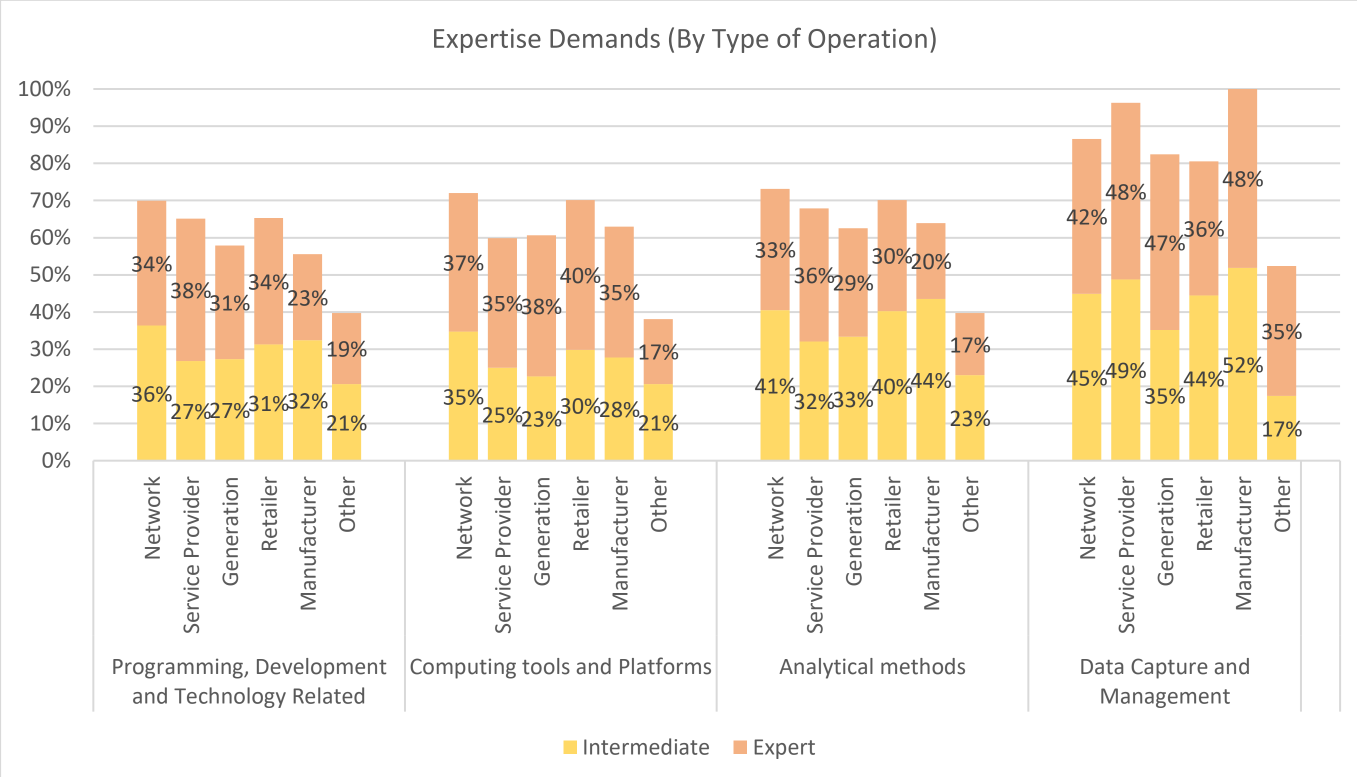


Figure 30 Expertise demand by type of operation

3.3.2. Interviews

To complement the survey analysis, several useful insights can be obtained from the interviews that were conducted with reference stakeholders within the industry.

A combination of hard and soft skills is important for the growth of the employees and company achievements. Academic credentials, complementary training and specific knowledge in the field, foreign languages and a based digital proficiency are some of the most common skills. Besides that, soft skills like the affinity on problem solving, customer focused approach, creativity and initiative, ability to learn, resilience, open minded, flexible and critical thinking, autonomy and cooperation attitude are the basic. Sometimes social competences are valued higher than hard skills, if they stand in between a good and healthy working environment.

Fast comprehension and the ability to adapt to spontaneous events is a crucial skill described by all representatives of the industry. The companies need personalities who are not specialised in one mere topic alone but can transform their knowledge and current experience on to new fields and adapt it to the task at hand.

If it comes to technical skills, the ability to manage flexibility in the grid through algorithms and big data is one of the highest required skill for system operators. The deployment of smart-meters and other tools, which provide a better observation status and the chance to plan ahead, are important features. The new ways to operate grids and flexibility services allow an efficient process, but need people who program tools on the go, tailored to the needs of distributing operations.

Energy management system related to big data and data analytics is needed in high amount by DSO currently to operate the grids. Even though this technology has been used the last 20 years, it still requires improvement due to the vast speed nowadays.

Forecast demand and supply of customer, resource efficiency, minimizing grid losses, minimizing economic impact and the right investment in new technologies, are overall challenges which need a wider understanding of the energy sector than isolated focus areas. This also relates to the skills which are needed from new staff for the company. The real challenge is not to find an expert in a single area, but to contract a combination of knowledge pools. What used to be a good engineer for a DSO, should be today a combination of an electrical engineer, a communications engineer, together with a mathematician, and someone who understands computation or at least common languages in programming, together with the capability to understand and know how to deal with data big data, and how to get insights of these data. Most probably it is impossible to find someone directly from university. Therefore, it is the task for HR to identify the candidate for each position.

Digitalisation should not just be viewed as the act of implementing new methods and IoT device, but also the applicability to deal with the data, find the most suitable and cost-efficient way of integrating it in current processes and the ability to benefit from this investment. The industry highlights that for them it is important to see a union between the product and the understanding. For example, automatization, robotics and digital assets automatization is a technology helpful due to the digitalized power generation, power transmission and distribution assets and giving the best usage for existing data from SCADA networks. Data science and the IoT, being highly covered and beneficial in Renewables & Retail & Energy Management. Otherwise, new technological innovations like digital twins, virtual product development and blockchain are empty tools, if they are not put into relation. The real benefit of the technology and facilitated progress should be the center. Understanding the potential of technologies, being up-to-date and have the ability to transpose the need into real business use cases is what makes a candidate to a valuable staff member.

IT and Cyber Security are the highest issues in the current and midterm plans of the industry. While IT Security is protecting data and information systems prevent the misuse, modification, or theft of sensitive information and from unauthorized access Cybersecurity concern leads to more investment into communication services to prevent hackers and other cybercriminals to gain access through the internet. One being a basic and common understanding of security of data and security of information, which should be deployed throughout the company. The other communicating the risks and educating the staff about the global concerns, external threats through cyberattacks. Hence, companies are investing and investigating how to launch efficiently awareness campaigns and simulations of external attacks at the company's IT system. These practical examples for the employees contribute to be sufficiently informed about the risks, but also educates them about the general points of this field. Companies also invest in training which work specifically on these areas, that they are accurately qualified for the job. Cloud services and digital platforms is a trend which can be seen everywhere and is the base. But security issues and national regularities forbid the use of cloud services in most MS, disabling actual benefit and deployment of this technology in the energy system. Sensitive Data which is saved outside the prelimits of the company's own IT System, is a security threat too high for a critical infrastructure like the energy providers.

Viewing the C-Suite challenges it is to mention that all these technical skills are needed to an extended, but not in detail for a managing position. For example, a manager needs to know how to create algorithm using ML or DL, but he has to know how to engage the team to cooperate together. Managers should be able to set new goals that are related to new technologies and, in a clear way, define them. Stakeholder management, strategic thinking, and ability to promote diversity with a high-level view on the current digital innovations is a basic portfolio. They are the ones who support their unit and create space for growth.

Green skills are sustainability in social, economic, and environmentally friendly way. (indicator down-jones sustainability index, best sustainable practices) work ethics, and integrate attitude.

Table 6 List of skills extracted from interviews

	DESCRIPTION
HARD SKILLS:	• Fundamental knowledge and technical processes • Comprehending energy economical nexuses • modern technologies in the energy sector • public procurement • operating the swpp2 purchasing system • SAP support • MS Office support.
SOFT SKILLS:	• motivating and assessing employee competencies • team management & shift management • customer service • increasingly important leadership, creativity, clarity in communication and teamwork skills, eliability and responsibility • cooperation and conflict management

	• initiative and independence, commitment and quality of work, goal orientation, decision-making ability • Information Management: ability to search, obtain, evaluate, organize and share information in digital contexts. • Networking: ability to work, collaborate and cooperate in digital environments. • Digital Communication: ability to communicate, relate and collaborate efficiently with tools and in digital environments. • Digital Identity: Ability to manage professional identity and corporate identity efficiently with tools and in digital environments • Technological habits and security: set of behaviors to take advantage of technology and digital tools in an optimal and safe way in both private and professional life. • Digital Culture: ability to understand the opportunities that the digital economy provides to professionals and organisations. • Strategic Vision: ability to understand the digital phenomenon and incorporate it into the strategic orientation of your organisation's projects.
GREEN SKILLS:	• ethical behaviour, with particular emphasis on preserving the natural environment, ecology (code of ethics) • economical use of entrusted resources • waste segregation • energy-efficient drivers • Ecological integrity • Ecological sustainability
DIGITAL SKILLS:	• Big Data/Data Analytics (data mining, statistical analysis, etc.) & Data science (Artificial Intelligence, machine learning, deep learning). In Renewable, it is used for predicting renewable power generation, optimizing performance and managing operations. Most of smart products used to optimized consumption are based on these technologies. It is also widely used in the Global Energy Management Area, responsible for purchasing electricity and to ensure customers' supply at the most competitive price and conditions, controlling the global operation of the generating system in real time and making make very long-term forecasts (20 years) regarding the price of electricity. • Internet of things (for example, in Renewable Business is used to monitor and operate renewable generation facilities (wind turbines). It is expected to be widely used in the future in several business such as Energy Management. • Knowledge in work methodologies (agile, scrum, Kanban, design thinking, etc.). • Cybersecurity: Workers supporting digital infrastructure will need specialised ICT skills, such as coding and cybersecurity. • In addition, it is requested generic ICT skills to operate digital technologies (digital platforms, communication technologies). • Low demand in blockchain within the energy industry, it is not widely applied within the sector. It has been used mainly for Renewable Energy Guarantees of Origin (REGO) scheme that provides transparency to consumers about the proportion of electricity that supply source from renewable generation. • Skills to Improve the user experience through chatbots, advanced assistants, applications, smart home hubs, voice assistants, etc. are particularly demanded in Retail.

3.4.Conclusions

The current and future skill needs in the energy sector can be considered a multi-sided public policy issue. Workers will always need updated and relevant skills to obtain a job in society, but also useful skills to move across labor market. At the same time, the employers need trained and efficient workforce. In this equation the role of the governments is to deliver coherent public policy, productive investment, and a framework for all participants: students, training providers and employers.

Although technical skills are especially important, are also unlikely to be sufficient. In this perspective digital skills; green skills; resilience and adaptability technics need to find a place in the curricula of the education institutions and on the agenda of the training providers.

A dedicated survey was conducted which addressed 60 reference companies in Europe, in order to receive feedback on skill needs and the current coverage levels of these needs. Vis-à-vis interviews were also utilized to validate and complement the output of the survey. The analysis was conducted for different categories of staff, namely Managers/Administration, Engineers/Researchers and Technicians/Specialists.

Concerning the Data Capture & Management skill-set, all **of the staff categories demand high level of expertise in every skill in this skillset**. **The highest expertise demand can be observed in "Engineers/Researchers** ".

The skill demand analysis showcases **the highest percentages** in the categories **"Engineer /Researchers" and "Technicians/Specialists"** for **computing tools and platforms** skill-set. Particularly, the *"**Accessing, analysis and visualization of data**"* skill showcases high expertise demands in all categories of staff. It is also worth mentioning that the skill "**Use of simulation tools**" showcases a higher expertise demand in comparison with the other skills in the "Engineers/Researchers" category which is not the case in the other two categories (Managers/Administration, Technicians/Specialists). Finally, the "**Administration of hardware infrastructure**" is the least demanded skill for "Engineers/Researchers" and "Managers/Administrators" but it is highly demanded for "Technicians/Specialists".

Considering **analytical skills** skill set, the analysis showed **a high skill expertise demand both in Engineers and Technicians**. In addition, the **"Report Analysis Results**" skill showcases high expertise demands in all categories while the skill "Application of Data Mining Approaches" is the least demanded. The skill **"Mathematical Optimizations"** showcases a high expertise demand in comparison with the other skills in the "Engineers/Researchers" category which is not the case in the other two categories.

The expertise demands for **Programming and development related skills present the highest percentages in the category** "**Engineers / Researchers" and "Technicians/Specialists**" and they are significantly lower in "Managers/Administrators". Furthermore, the skills "**Creatively use digital technologies", "Understanding of cybersecurity" and "Understanding and usage of communication technologies" showcase high demands of expertise and seem to the most important of the skillset**. It is also worth mentioning that the skill "Use specific data analysis software" showcases the highest expertise demand in the "Engineers/Researchers" category which is not the case for the other two categories.

The interviews provided a useful insight concerning the skill need in the industry. A combination of hard and soft skills is important for the growth of the employees and company achievements. Academic credentials, complementary training and specific knowledge in the field, foreign languages and a basic digital proficiency are some of the most common skills identified through the interviews. Besides that, soft skills like problem solving, customer service, creativity and initiative, ability to learn, resilience, open minded, flexible and critical thinking autonomy and cooperation attitude are some of the most requested transversal skill needs. Sometimes social competences are valued higher than hard skills, if they stand in between a good and healthy working environment. Moreover, regarding technical skills, it seems that IT and Cyber Security are the top priorities in the current and midterm plans of the industry

4. Analysis of the skills and knowledge provided by education and training providers

4.1. Review of the Action Agenda in Energy Transition for European universities

In an Action Agenda published in 2017, the European University Association (EUA) [8] called for the mobilization of universities that have developed, or are developing, energy-related education programmes. It also called on policy makers to harness the role and value of universities in addressing the energy challenge. Produced by the EUA European Platform of Universities in Energy (EUA-EPUE) [9] after the extensive three-year UNI-SET project, the Action Agenda promoted innovative education and research activities and aimed at supporting the ambitions of many universities across Europe to strengthen their existing initiatives.

The Agenda provides concrete examples and suggestions for education programmes in the fields of energy systems and smart grids, renewables integration, and energy efficiency. It also presents ideas for interdisciplinary education in energy, not only related to science and technology but also related to social sciences and humanities, since these are too crucial in addressing the multi-layered challenge of energy transition. The Agenda addresses specifically university master programmes, doctoral programmes and life-long learning programmes for employees, with the key objective to develop new scientific and technical expertise, and also include – in order to cover a broad range of social perspectives and techno-economic challenges - the necessary skills in the areas of sciences, anthropology, sociology, psychology, economy, and law and regulations. In this way, the Agenda represents a statement that all academic disciplines require to recognise that energy-related perspectives backed by knowledge from all disciplines bring value to energy solution development and help achieve real progress and change.

The Agenda identified 3 technologically important areas of energy research and innovation where its recommendations should be immediately implemented also at the level of Education, namely: i) *Energy Efficiency*; ii) *Smart Grids and Energy Systems*; iii) *Renewables Integration*. Detailed description can be found in [8] whereas the main outcomes of the Agenda evaluation is given in the following, at master and doctorate program level.

Master's Programmes

The Action Agenda advocated repurposing Electrical Engineering and other energy-related master's programmes on the global energy challenges of today and promoted the development of an education path aimed at developing robust, coherent, and holistic professional preparation that could provide detailed, comprehensive, state-of-the-art preparation in a specific area as well as significant training and skills for a career in the energy industry.

While master's programmes across Europe still vary in length, skills development is most effective over an extended period, giving students time to acquire skills, reflect and refine their approaches. Employers value projects focused on problem-based or challenge-based learning, particularly those that address economic and business issues and include social/human contexts (e.g., ethics and user interactions). Therefore, practical or applied experience is often seen as more important than a student's academic achievement. In this context, the Agenda highlighted the following points:

- new energy-related master's programmes should include contextual and background material that expose participants to the full breadth of the energy challenge in addition to their chosen field of study. Both aspects need to be carefully balanced so as not to compromise the core skills required.
- University programmes should be designed to give students insight into the complexities and interconnected nature of the energy system and the society. A key aim of providing such background information is to allow students to understand how their master's programme specialisation fits into the energy landscape.
- It is important to combine background information with more specific master's programme topics, and to set these in the context of locally available/possible energy systems. Care must also be taken to ensure that additional components are not too onerous.

The result of the abovementioned points should be a coherent programme that includes complementary topics to provide context, scope, and background knowledge for particular specialisations. The recommended generic/specialist split could range from 50/50 all the way to 20/80 to create a variety of different master's programmes that fulfil employer needs. To achieve this, it would not be strictly necessary that universities revolutionise their programmes or launch additional courses in the existing ones. They could instead include project work, industry cooperation, case studies or workshops to integrate interdisciplinary aspects into the existing curricula.

i) Energy efficiency

According to the Agenda, Energy efficiency issues should form an integral part of any master's programme for students wishing to plan and operate industrial sites and/or buildings. In addition to general energy-related components, the methodologies and technologies curriculum should be dedicated to energy efficiency modules. At least a genal understanding of some of the following topics should be covered (and integrated in other parts of the curriculum dealing with related issues):

- System Simulation/Modelling
- (Renewable) Technologies / Energy Sectors
- Energy System Control
- Technology Use
- Building Design.

Additionally, certain topics like Energy Efficiency, should be covered thoroughly.

ii) Smart Grids and Energy Systems

The Agenda recommends that master's programmes on smart grids and energy systems focus on any of these topics:

- Energy Infrastructure
- Smart Grids
- Distribution Networks
- (Renewable) Technologies / Energy Sectors
- Chemicals

and either combine these, or explore a specific field, such as solar, or wind in more detail to focus on a specific system.

Furthermore, cross-disciplinary subjects should be included in the redesigned programme, being taught from a technical angle that would allow students appreciate why these modules are added to their curriculum. Such subjects include, e.g.: social responsibility, (re)building communities, privacy versus efficient system control, local decision making versus central coordination. Similarly, relevant new technologies and markets (5G, e-mobility, prosumer aggregation, inertia-less systems) should be addressed and emerging concepts (e.g., cell-based approaches, energy communities, energy harvesting, distributed storage, etc.) investigated. Finally, the ethical implications of integrating technologies such as smart metering and its impact on user behaviour, especially when this results in pricing changes and could drive more people into fuel poverty, are important and should be also presented to the students as topics covered in their master curriculum.

iii) Renewables

The Agenda identifies 4 general categories of existing master's programmes in Renewables Integration, each focusing respectively on: a) a specific renewable technology (e.g., wind energy, solar power, etc.) – b) grid integrated with renewables - c) application in a specific sector (e.g., buildings with integrated PV) – d) a wider overview of a technology (e.g. thermo-technical conversion). These programmes do not include system and integration topics that should be included.

The Agenda recommends that master's curricula in renewables provide students with knowledge on how different renewable sources interact with the energy system, with society and the wider environment, and on where their specific focus fits in the energy system from both a technical and social perspective. In this view, such curricula should cover the following elements:

- Structural and operating principles of renewable energy sources, their intermittent and situational characteristics, as well as a comparison with non-renewables.
- Study of the interfacing and interaction of renewable energy sources with the energy grid and its components, considering techno-economic factors such as optimal operation and management, environmental sustainability and costs minimization.

- Study of the social value of different renewable technologies and their implementation.
- Basic analysis of how different energy systems influence energy flow.
- Energy systems interaction to balance production with demand, across time and geography.
- Economic, social and political factors influencing energy. It is therefore important to consider the role of society and citizens

An overview of energy economics, including energy markets, energy poverty, ownerships, system service and regulatory costs should also be covered. While all programmes have more specific elements, more generic elements will also be included. For example, those undertaking a master's programme in engineering or physical sciences will obviously examine a specific technical/scientific area in more depth, but more generic elements will also need to be covered, e.g. through practical case studies. This could be achieved using campus facilities as a living lab to collect and share data among students. Traditional labs and field trips should also be revised to ensure they serve all aspects of the challenges of renewables integration. The benefits of this new approach are wide ranging. For example, after taking this kind of master's programme in renewables integration, students will be able to discuss and answer the following questions in an informed and insightful manner:• Who are the key stakeholders in the integration of a certain renewable energy technology?• Which (combination of) transport is more sustainable for a particular user/scenario: land, air, water and vehicle fuel type: electricity, hydrogen, biofuel, etc• Which combination is most beneficial on a given surface (km2): solar panels, wind turbines, a bio-crop field, etc? Giving graduates a holistic perspective will ensure that they can make a broader contribution to soc

Doctoral and Research Programs

Doctoral programmes entail original research in a specific area to generate new knowledge, new understandings, new insights and new approaches. They also provide doctorate holders with a broad range of advanced scholarship, research, analytical, communication and other professional and transferable skills that are highly beneficial for different careers in the energy sector. Therefore, there is broad scope to set out guidelines for a strategic re-design of doctoral education that could ensure continuous strategic development in the direction of the transformation of the energy sector.

In this regard, the Agenda recommended a strong consideration - in all doctoral energy-related programmes – of the areas of ethics, digitalisation and globalisation. In fact,

- successful 'doctors' should learn and be prepared to make informed judgements on a range of complex issues in specialist fields of the energy sector, using innovative approaches and autonomous (sometimes creative) actions in complex and unpredictable environments such as the one of the energy, in which data and information may be incomplete or characterised by unpredictable dynamics.
- Doctoral programs should be shaped in such a way that provides additional scope of knowledge and skills (in economy, mechanical engineering and industry-related disciplines), so that the PhD holder will develop skills to develop applicable approaches that can lead to durable, sustainable and effective solutions to the energy transition.

i) Energy efficiency

According to the Agenda, at doctoral level Energy efficiency should be addressed systemically, giving priority to the investigations related to the interdisciplinary and transdisciplinary integration of different players involved. Studies must complement knowledge acquired at master's level, to ensure that all doctoral candidates in energy-relevant disciplines have a fundamental understanding of a) energy efficiency technologies and planning methods in industry and buildings; b) stakeholder interaction (consumers, prosumers, investors, etc.); and c) social and behavioural aspects.

Generally speaking, the following are considered important research subjects the Agenda:

- *Energy efficiency planning methods*: more thorough research is needed on a) the many different planning methods used in different disciplines and at different levels, b) comparative studies on the optimal application for each and their value to the parties involved; c) the potential benefits of combining planning methods.
- *Total energy requirements*: more thorough research is needed on major energy consumers (such as European industry, transport systems, etc.) in relation to energy efficiency requirements.
- *Model collaboration*: thorough research should be dedicated to the potential of combining the best model classes for a new and more integrated approach to modelling (model collaboration).

- *Socio-technical transitions*: research should address the transitions that are required and ongoing in order to meet EU energy efficiency goals. The transformation regards the entire energy system from production, distribution, consumption to how the various sectors use energy and interact. The research should address, here, how such transitions occur, the identity of the players and how they are connected in the larger value chain (e.g. property owners versus residents). It also requires study how innovation can create technological niches for energy efficiency, and how these then penetrate the larger socio-technical status quo and transform the energy system.
- *Rebound effect*: any energy efficiency initiative should also include mechanisms and strategies to understand and counteract a rebound effect. Behaviour analysis and incentive structures need to be identified to give a better understanding of how efficiency improvements relate to improvements in quality of life, and how to make the most of a utility using the lowest possible level of end user consumption.

ii) Smart Grids and Energy Systems

In this case, the Agenda differentiates the recommendations distinguishing between applied and basic research programmes. The topics are those mentioned also for the Master's programmes. Basic research should be inspired by real-life problems, whereas applied research should focus more on technical aspects. A good doctoral program should include both types of research. While there are obvious differences for each individual project, this would ensure that part of a PhD study leads the candidate to adopt a well-rounded approach that appreciates the social, economic, political, environmental, aspects of their work. In practice, every dissertation should include a section/chapter focusing on the context and impact of the research carried out. This section could be shorter but more focused on potential long-term impact. To applied research could be dedicated a longer section of the dissertation, also examine the context and impact of the research topic. If dissertations cover a wider perspective, it will be easier to share them with other fields of expertise, where readers can start from the more generic aspects and obtain an understanding of more detailed perspectives.

There are many key research topics that need investigation in the smart grid, for example (and just to name a few basic ones):

- decentralised locations,
- energy storage,
- creation of autonomous system-of-systems
- long-term reliability and security

Any research, in this respect, should investigate how systems will be integrated with other systems, analyse their life cycle and the materials used to construct them, the challenges for interactions between new and existing systems as well as their individual and overall sustainability.

iii) Renewables

Doctoral programmes addressing the integration of renewable energy sources must primarily focus on a specific issue. Existing programmes mainly focus on developing new technology, for example a new type of more efficient and sustainable thin-film solar cells, and that very few programmes include system-oriented activities. This should be overcome by including minimum system-level knowledge as part of the PhD curriculum.

The Agenda recalls that doctoral students should be able to understand the answers to key questions such as: Where does this technology fit? When does it come into play? How does it interact with the system and society? Who are the stakeholders and what is the best business model for deploying the technology researched?

The general or specialist nature of the answer to these questions will depend greatly on the research topic. However, there is value in all doctoral candidates being able to provide at least a general answer to these questions, particularly as the SET-Plan is a vehicle for achieving the aims of the Energy Union.

4.2. University Curricula analysis

1. Review of European university programs in Electrical Engineering and Energy

Unified European university framework

The higher education qualifications offered are mostly similar in all European and in general can be as follows:

Bachelor's Degree

- Most full-time Bachelor's study programmes in Europe last 3 or 4 years (longer if studied part-time).
- To be eligible to study a Bachelor's degree, some school qualifications first – this varies according to the entry requirements for the chosen study programme.
- Most study programmes involve lectures and classes, with assessment through essays, exams and coursework. Many also involve a period working in industry or working on industry-related projects as internships or placements.

Master's Degree

- Most full-time Master's study programmes in Europe last 1 or 2 years (longer if studied part-time).
- To be eligible to study a Master's degree, usually a Bachelor's degree or other undergraduate qualification is needed.
- Most study programmes involve lectures and classes, with assessment through essays, exams and coursework. Many also involve a period working in industry or working on industry-related projects as internships or placements.
- Depending on preference, one can opt for a Master's that focuses on coursework or one which focuses on independent research, where one subject is studied closely with the guidance of a supervisor, producing a thesis or dissertation.

Doctorate/PhD

- Most full-time doctorates in Europe last around 3 or 4 years (longer if studied part-time).
- To be eligible for a PhD program, usually a Bachelor's degree and a Master's degree fare needed.
- Doctorates usually involve a lot of independent study and research, specialised in one particular subject. One may need to attend some classes, but usually one carries out their own independent research, under the guidance of a supervisor
- The aim of a doctorate is to break new ground – to produce new information and ideas or to conduct original research to help advance your subject. One may be expected to produce papers throughout the programme, and to produce a thesis for evaluation.
- To apply, one usually submits a research proposal, outlining what the doctorate will aim to achieve.

The European Qualifications Framework (EQF)

The EQF [10] is an **8-level**, learning outcomes-based framework for all types of qualifications that serves as a translation tool between different national qualifications frameworks (NQF). This framework helps improve transparency, comparability and portability of people's qualifications and makes it possible to compare qualifications from different countries and institutions.

The EQF covers all types and all levels of qualifications and the use of learning outcomes makes it clear what a person knows, understands and is able to do. The level increases according to the level of proficiency, ***level 1 is the lowest and 8 the highest level.*** Most importantly the EQF is closely linked to national qualifications frameworks, this way it can provide a comprehensive map of all types and levels of qualifications in Europe, which are increasingly accessible through qualification databases.

The EQF was set up in 2008 and later revised in 2017. Its revision has kept the core objectives of creating transparency and mutual trust in the landscape of qualifications in Europe. Member States committed themselves to further develop the EQF and make it more effective in facilitating the understanding of national, international, and third-country qualifications by employers, workers and learners.

Table 7 Detailed description of European Qualifications Framework (EQF)

EQF Level	**Knowledge**	**Skills**	**Responsibility & Autonomy**
1	Basic general knowledge	Basic skills required to carry out simple tasks	Work or study under direct supervision in a structured context
2	Basic factual knowledge of a field of work or study	Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	Work or study under supervision with some autonomy
3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	Take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problem
4	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others
6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research. Critical awareness of knowledge issues in a field and at the interface between different fields	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams

8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

The European Qualifications Framework (EQF) levels 1-8 are described in Table 7 above, in the context of EQF definitions of the following:

1. ***"Knowledge"*** is described as theoretical and/or factual.
2. ***"Skills"*** are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).
3. ***"Responsibility & Autonomy"*** is described as the ability of the learner to apply knowledge and skills autonomously and with responsibility.

The focus of the task is on European Qualifications Framework levels 6-8 i.e. the ones which offer Bachelor's, Master's, and PhD degrees along with related degrees of the same level. Hence, the highlighting of the said levels.

The EQF in the focus countries

In order to analyse the possible dependency of the EQF framework on the territory, the following focus countries are taken into consideration:

1. Germany
2. Spain
3. Greece
4. Romania
5. Sweden

The detailed description of each country's EQF along with related National Qualifications Framework (NQF) has been shown in Table 8 below:

Table 8 European Qualifications Framework (EQF) levels 6-8 of the focus countries

Country	EQF Levels	NQF Levels	Degrees Awarded
Germany	Level 8	NQF 8	Doctorate and equivalent artistic degrees
	Level 7	NQF 7	Master's degrees and equivalent higher education qualifications (traditional German courses of higher education study such as the first degrees of "Diplom" or "Magister", State Examinations)
			Strategic Professional (IT) (certified) (Strategische/r Professional (IT)
			Other advanced vocational training pursuant to the Vocational Training Act or Crafts and Trades Regulation Code
	Level 6	NQF 6	Bachelor degrees and equivalent higher education qualifications
			Specialist commercial clerk (certified)
			Business management specialist (certified)
			Master craftsman
			Operative Professional (IT) (certified)

			Trade and technical school (advanced vocational training governed by federal state law)
			Advanced vocational training pursuant to § 54 of the Vocational Training Act
			Other advanced vocational training pursuant to the Vocational Training Act or Crafts and Trades Regulation Code
Greece	**EQF Levels**	**NQF Levels**	**Degrees Awarded**
	Level 8	NQF 8	Doctorate (Διδακτορικό Δίπλωμα) (Universities)
	Level 7	NQF 7	Master degree (Μεταπτυχιακό Δίπλωμα Ειδίκευσης-postgraduate specialized degree) (Universities/technological educational institutions (TEI)-higher education)
	Level 6	NQF 6	Bachelor degree (Πτυχίο Ανώτατης Εκπαίδευσης - Higher education undergraduate degree) (Universities/TEI-higher education)
	Level 6,7	NQF 6	Integrated bachelor and master diploma (Δίπλωμα Πολυτεχνικής Σχολής) (Polytechnic universities provide 5-year programmes leading to diploma equivalent of a bachelor + master)
Romania	**EQF Levels**	**NQF Levels**	**Degrees Awarded**
	Level 8	NQF 8	Doctoral degree (3rd cycle of higher education)
			Certificate for postdoctoral studies
	Level 7	NQF 7	Master degree and Diploma supplement (2nd cycle of higher education)
			Bachelor and master degree and Diploma Supplement
	Level 6	NQF 6	Professional conversion diploma
			Graduation certificate and Descriptive Supplement - accredited higher education institution/ postgraduate university studies - permanent education
			Graduation certificate and Descriptive Supplement - authorised training provider / training programme
			Bachelor degree / Engineering diploma / Urbanism diploma and Diploma supplement (1st cycle of higher education)
			Certificate of professional competence - higher education institution with bachelor and master programmes / postgraduate university studies continuous education and training
			Graduation certificate - higher education institution with bachelor and master programmes / postgraduate university studies
	EQF Levels	**NQF Levels**	**Degrees Awarded**

Sweden	Level 8	NQF 8	Degrees, third cycle, Annex 2 to Higher Education Ordinance 1993:100 (PhD)
			Degrees, third cycle, Annex to Regulation 1993: 221 (PhD)
	Level 7	NQF 7	Degrees, second cycle, Annex 2 to Higher Education Ordinance 1993:100 (Master of Arts, Master of Science, Master of Political Science)
			Degrees, second cycle, Annex to Regulation 1993: 221 (Swedish Agricultural Universities) (Master of Arts, Master of Science, Master of Political Science)
			Degrees, second cycle, in the Annex to Regulation 2007: 1164 (Swedish National Defence College) (Master of Arts, Master of Science, Master of Political Science)
	Level 6	NQF 6	Degrees, first cycle, Annex 2 to the Education Ordinance 1993:100 (Bachelor's)
			Degrees, second cycle, in the Annex to Regulation 2007: 1164 (Swedish National Defence College) (Bachelor's)
			Degrees, second cycle, Annex to Regulation 1993: 221 (Swedish Agricultural Universities) (Bachelor's)
			Advanced diploma in Higher Vocational Education
			Qualifications awarded outside formal education
	EQF Levels	**NQF Levels**	**Degrees Awarded**
Spain	**EQF Levels**	**NQF Levels**	**Degrees Awarded**
	Level 8	NQF 8	Doctorate
	Level 7	NQF 7	Official Master's Degree
			University Specific Master's Degree
	Level 6	NQF 6	Bachelor

2. European Curricula for Electrical Engineering and Energy-related university programs.

There is no general curriculum for Electrical Engineering all over Europe. Rather, the different countries and the individual universities have their own curriculum designed.

Bachelor's Curricula

The fundamental courses in mathematics, physics and chemistry are mostly the same in all universities. The curriculum of the top 3 universities in "Electrical & Electronic Engineering" per focus country are investigated, according to the QS World University Rankings 2021.

Germany

Generally, in Germany, the Bachelor's degree programs in Electrical Engineering are offered in **German** with some English taught subjects.

- **Credits** - 180 ECTS
- **Duration -** 6 semesters (3 years)

The programs are modular. The modules of the first semesters provide mathematical-scientific and methodical principles with their corresponding (software) laboratories necessary for further studies. *In subsequent semesters, specialisation courses are offered generally from the 4th and 5th semester onwards.*

The following table shows some Energy/Power related courses and their details offered by the top 3 German universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 9 Bachelor's Programs in Electrical Engineering of top 4 Universities of Germany

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
Technical University of Munich (TUM)	Electrical Engineering and Information Technology	Bachelor of Science (B.Sc.)	German	• Electromobility • Biomedical Engineering • Aerospace Engineering • Nanoelectronics • Robotics • Computer Engineering	A fundamentals and orientation exam after 2nd semester. Courses, Projects, Laboratories, Seminars and Bachelor Thesis
RWTH Aachen University	Electrical Engineering, Information Technology and Computer Engineering	Bachelor of Science (B.Sc.)	German	• Energy Engineering • Micro- and nanoelectronics • Information and Communications Technology • Computer Engineering • Biomedical Engineering	Courses, Projects, Laboratories, Seminars and Bachelor Thesis
Technische Universität Berlin *(TU Berlin)*	Electrical Engineering	Bachelor of Science (B.Sc.)	German	• Electrical Power • Electronics & Information Technology	Courses, Projects, Laboratories, Seminars and Bachelor Thesis
Technische Hochschule Köln *(TH Köln)*	Electrical Engineering	Bachelor of Science (B.Sc.)	German	• Power Engineering • Renewable Energy • Electromobility • Electrical Product Design • Smart Energy • Automation • Photonics • Internet of Things • Information and Communication Technology	210 ECTS course (with internship) Courses, Projects, Laboratories, Seminars and Bachelor Thesis
	Renewable Energy	Bachelor of Engineering	German		210 ECTS course (with internship)

		(B.Eng.)			Courses, Projects, Laboratories, Seminars and Bachelor Thesis

Spain

Generally, in Spain, the Bachelor's degree programs in Electrical Engineering are offered in **Spanish** with some English taught subjects.

- **Credits** - 240 ECTS
- **Duration -** 8 semesters (4 years)

The modules of the first and second semesters provide mathematical-scientific and methodical principles with their corresponding (software) laboratories necessary for further studies. *In some universities, in subsequent semesters, specialisation courses and electives are offered generally in the 7th and 8th semester.*

The following table shows some Energy/Power related courses and their details offered by the top 34 Spanish universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 10 Bachelor's Programs in Electrical Engineering of top 4 Universities of Spain

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
Universidad Politècnica de Madrid	Electrical Engineering	Bachelor of Science (B.Sc.)	Spanish		Courses, Laboratories and Bachelor Thesis
	Energy Engineering	Bachelor of Science (B.Sc.)	Spanish		Courses, Laboratories and Bachelor Thesis
Universitat Politècnica de Catalunya · Barcelona Tech (UPC)	Electrical Engineering	Bachelor of Science (B.Sc.)	Spanish	• Automation Engineering • Electronic Engineering	Courses, Laboratories and Bachelor Thesis
	Energy Engineering	Bachelor of Science (B.Sc.)	Spanish		Courses, Laboratories and Bachelor Thesis
Universidad Carlos III de Madrid (UC3M)	Electrical Power Engineering	Bachelor of Science (B.Sc.)	Spanish, English		Courses, Laboratories and Bachelor Thesis. Industrial Internships are optional
	Energy Engineering	Bachelor of Science (B.Sc.)	English		Courses, Laboratories and Bachelor Thesis. Industrial Internships are optional
Universidad Pontificia Comillas	Engineering for Industrial Technology	Bachelor of Science (B.Sc.)	Spanish		Courses, Laboratories, Internship and Bachelor Thesis.

Greece

Generally, the programs are offered widely in **Greek**. The modules of the first and second semesters provide mathematical-scientific and methodical principles with their corresponding (software) laboratories necessary for further studies. *In some universities, in subsequent semesters, specialisation courses and electives are offered generally in the 9th and 10th semester.*

- **Credits** – 240-300 ECTS
- **Duration –** 8 semesters (4 years) or 10 semesters (5 years)

The following table shows some Energy/Power related courses and their details offered by the top 3 Greek universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 11 Bachelor's Programs in Electrical Engineering of top 3 Universities of Greece

University	*Course*	*Degree*	*Language*	*Specialisations*	*Characteristics*
National Technical University of Athens	Electrical and Computer Engineering	Diploma	Greek	• Computer Systems • Computer Software • Electronics, circuits and Materials • Telecommunication Systems and Computer Networks • Electromagnetic Waves and Telecommunications • Signals, Automatic Control and Robotics • Energy Conversion, High Voltages and Industry Applications • Electric Power Systems • Management and Decision Support Systems • Bioengineering • Physics	Courses, Laboratories, optional Internship and Thesis
Aristotle University of Thessaloniki	Electrical and Computer Engineering	Diploma	Greek	• Electrical Energy • Electronic & Computer Engineering • Telecommunications	Courses, Laboratories, optional Internship and Thesis
University of Patras	Electrical and Computer Engineering	Diploma	Greek		Courses, Laboratories, and Thesis

Romania

Generally, in Romania, the Bachelor's degree programs in Electrical Engineering are offered in **Romanian.**

- **Credits** - 240 ECTS
- **Duration -** 8 semesters (4 years)

The modules of the first and second semesters provide mathematical-scientific and methodical principles with their corresponding (software) laboratories necessary for further studies. *In some universities, in subsequent semesters, specialisation courses and electives are offered generally in the 7th and 8th semester.*

The following table shows some Energy/Power related courses and their details offered by the top 3 Romanian universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 12 Bachelor's Programs in Electrical Engineering of top 3 Universities of Romania

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
University POLITEHNICA of Bucharest	Electrical Engineering	Bachelor of Science (B.Sc.)	Romanian	• Electrical systems • Power electronics and electrical drives • Instrumentation and data acquisition	Courses, Laboratories, and Thesis

				• Economic engineering in electrical, electronic and energy domains • Applied informatics in electrical engineering	
	Power Engineering	Bachelor of Science (B.Sc.)	Romanian	• Electrical Power System Engineering • Hydro Power Engineering • Thermal Power Engineering • Nuclear Power Engineering • Management of Energy • Applied Informatics in power Engineering • Environment Protection and Engineering within Industry • Economic Engineering in Electrical Power Systems and Electronic fields	Courses, Laboratories, and Thesis
Technical University of Cluj-Napoca	Electrical Engineering	Bachelor of Science (B.Sc.)	Romanian	• Electrotechnics • Instrumentation and Data Acquisition • Power Electronics and Electric Drives • Electromechanics	Courses, Laboratories, and Thesis
The Polytechnic University of Timisoara	Electrical Engineering	Bachelor of Science (B.Sc.)	Romanian		Courses, Laboratories, and Thesis
	Energy Engineering	Bachelor of Science (B.Sc.)	Romanian		Courses, Laboratories, and Thesis

Sweden

Generally, in Sweden, the Bachelor's degree programs in Electrical Engineering are offered in **Swedish** with some English taught subjects.

- **Credits** - 180 ECTS
- **Duration -** 6 semesters (3 years)

The modules of the first and second semesters provide mathematical-scientific and methodical principles with their corresponding (software) laboratories necessary for further studies. *In some universities, in subsequent semesters, specialisation courses and electives are offered generally in the 5th and 6th semester.*

The following table shows some Energy/Power related courses and their details offered by the top 3 Swedish universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 13 Bachelor's Programs in Electrical Engineering of top 3 Universities of Sweden

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
KTH Royal Institute of Technology	Electrical Engineering	Bachelor of Science (B.Sc.)	Swedish, English	• Built-in systems and Computer networks • Electrical Power	Courses, Laboratories and Bachelor Thesis
Chalmers University of Technology	Electrical Engineering	Bachelor of Science (B.Sc.)	Swedish		Courses, Laboratories and Bachelor Thesis
Lund University	Electrical Engineering	Bachelor of Science (B.Sc.)	Swedish	Automation engineering	Courses, Laboratories, Project work and Bachelor Thesis

Masters Curriculum

The domain and subject-specific skills and competences attained at master's level build upon the skills and competences at bachelor's level. The master phase of the programme provides a high level of specialisation, a research-related training and in-depth domain-specific knowledge at a professional level.

We look into the curriculum of the top 3 universities in "*Electrical & Electronic Engineering"* per focus country, according to the ***QS World University Rankings 2021***. Master's programs are much specialised and hence diverse concentrations are observed. The following information are specific for Electrical Engineering courses focusing mainly on Energy/Power related technologies.

Germany

Generally, the individual programs are offered mainly in **German** but with many full-fledged **English taught** programs coming up in the last couple of years.

- **Credits** - 120 ECTS
- **Duration -** 4 semesters (2 years)

The following table shows some Energy/Power related courses and their details offered by the top 3 German universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 14 Master's Programs in Electrical Engineering (focus on Energy/Power) of top 3 Universities of Germany

University	*Course*	*Degree*	*Language*	*Specialisations*	*Characteristics*
Technical University of Munich (TUM)	Electrical Engineering and Information Technology	Master of Science (M.Sc.)	German	• Automation and Robotics • Bioengineering and Life Science • Communications Engineering and Signal Processing • Electronic Circuits and Systems • Electromagnetics, Microwave Engineering, Measurements • Embedded and Computer Systems • Micro- and Nano-electronics • Power Engineering	Courses, Laboratories, Seminars, Research Internship and Master Thesis
	Power Engineering	Master of Science (M.Sc.)			Interdisciplinary mix of Electrical Engineering and Mechanical Engineering courses Courses, Laboratories, Seminars, Research Internship and Master Thesis
RWTH Aachen University	Electrical Engineering, Information Technology and	Master of Science (M.Sc.)	English, German	• Biomedical Systems Engineering • Communications Engineering • Computer Engineering	Different concentrations offered in each specialisation

	Computer Engineering			• Electrical Power Engineering • Micro- and Nanoelectronics • Systems and Automation	Courses, Laboratories, Seminars, Projects, Industrial Internship and Master Thesis
Technische Universität Berlin (TU Berlin)	Electrical Engineering	Master of Science (M.Sc.)	English, German	• Automation engineering • Electrical power engineering • Electrical engineering, photonics, and integrated systems • Communication systems	Courses, Laboratories, Seminars, Industrial Internship and Master Thesis

Spain

In Spain there are two types of Master's degrees - official and university-specific degrees.

- ✓ The official degrees (bachelor's, master's, PhD) have the endorsement of the university which grants them and the recognition of the State. These studies are subjected to a full evaluation process that guarantees their quality and their inclusion in the RUCT (Registry of Universities, Centres and Qualifications, RUCT for its Spanish acronym).
- ✓ University-specific degrees are backed and endorsed by the prestige of the university (or the training centre) granting them.
- ✓ In Spain, in general, private companies do not consider whether a qualification is an official or a university-specific degree when they hire a professional, but consider the prestige of the programme and whether it provides students with the knowledge and skills required for the profile they seek.

Generally, the programs are offered widely in **Spanish** with some additional English taught individual courses.

- ➢ **Credits** – 60 ECTS or 120 ECTS
- ➢ **Duration –** 2 semesters (1 year) or 4 semesters (2 years)

The following table shows some Energy/Power related courses and their details offered by the top 3 Spanish universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 15 Master's Programs in Electrical Engineering (focus on Energy/Power) of top 4 Universities of Spain

University	*Course*	*Degree*	*Language*	*Specialisations*	*Characteristics*
Universidad Politècnica de Madrid	Electrical Engineering	Master of Science (M.Sc.)	Spanish		60 ECTS course Courses and Masters project work
	Energy Engineering	Master of Science (M.Sc.)	Spanish		60 ECTS course Courses and Masters project work
Universitat Politècnica de Catalunya · BarcelonaTech (UPC)	Energy Engineering	Master of Science (M.Sc.)	English	• Renewable Energies • Electrical Energy • Thermal Energy • Energy Management	120 ECTS course Interuniversity program organised by InnoEnergy which is supported by the European Institute of Innovation and Technology (EIT), a body of the EU
	Decentralised Smart Energy Systems	Erasmus Mundus Masters	English	Thermal Energy Engineering	120 ECTS course

					Interdisciplinary program with 4 European Universities
Universidad Carlos III de Madrid (UC3M)	Renewable Energy in Electrical Systems	Master of Science (M.Sc.)	Spanish		60 ECTS course Courses and Master Thesis
Universidad Pontificia Comillas	Electric Power Industry	Master of Science (M.Sc.)	Spanish	renewable energy sources, management of active demand, development of smart grids	60 ECTS course
	Industrial Engineering and Smart Grids	Master of Science (M.Sc.)	Spanish/English	• Smart grids	187,5 ECTS course
	Environment and Smart Energy Management	Master of Science (M.Sc.)	Spanish/English	• Smart energy management	60 ECTS course

Greece

Generally, the programs are offered widely in **Greek** with some additional English taught individual courses.

- **Credits** – 240-300 ECTS
- **Duration –** 4 semesters (2 years) or 10 semsesters (5 years) integrated BSc and MSc

The following table shows some Energy/Power related courses and their details offered by the top 3 Greek universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 16 Master's Programs in Electrical Engineering (focus on Energy/Power) of top 3 Universities of Greece

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
National Technical University of Athens	Energy Production and Management	Diploma of Postgraduate Studies	Greek		300 ECTS Course Courses, Laboratories, and Master Thesis
Aristotle University of Thessaloniki	Electrical and Computer Engineering	Postgraduate Spezialisation Diploma	Greek		Courses, Laboratories, and Master Thesis
University of Patras	Distributed Green Electric Power and the Advanced Network Infrastructure for its Management and Economy	Postgraduate Program (P.M.S)	Greek		300 ECTS Course Courses, Laboratories, optional Internship and Master Thesis

Romania

Generally, the individual programs are offered in **Romanian** with some courses offered in English.

- **Credits** – 120 ECTS
- **Duration –** 4 semesters (2 years)

The following table shows some Energy/Power related courses and their details offered by the top 3 Romanian universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 17 Master's Programs in Electrical Engineering (focus on Energy/Power) of top 3 Universities of Romania

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
University POLITEHNICA of Bucharest	Electrical Engineering	Master of Science (M.Sc.)	Romanian	• Power Elctronics and Electric Drives • Applied Electrical and Computer Engineering • Engineering of Products and Services in Electrical Engineering • Engineering of Integrated Electrical Systems in Cars • Advanced Electrical Systems • Intelligent Instrumentation and Measurement Systems	Courses, Laboratories, and Master Thesis
	Energy Engineering	Master of Science (M.Sc.)	Romanian	• Applied Informatics in Energy • Electrical Energy Systems Engineering • Energetic efficiency • Nuclear Engineering • Renewable Energy Sources • Energy Services • Hydro-informatics and Water Engineering • Smart City Engineering	Courses, Laboratories, and Master Thesis
Technical University of Cluj-Napoca	Electrical Engineering	Master of Science (M.Sc.)	Romanian	• Modern Computer Aided Design Techniques in Electrical Engineering • Monitoring and Control Systems in Electrical Engineering • Advanced Electrical Systems and Structures	Courses, Laboratories, and Master Thesis
The Polytechnic University of Timisoara	Electrical Engineering	Master of Science (M.Sc.)	Romanian	Power Engineering	Courses, Laboratories, and Master Thesis
	Energy Engineering	Master of Science (M.Sc.)	Romanian	Management of Electrical Power Systems	Courses, Laboratories, and Master Thesis

Sweden

Generally, the individual programs are offered mainly in **English** with some programs offered completely in Swedish or Bilingual.

- **Credits** – 120 ECTS
- **Duration –** 4 semesters (2 years)

The following table shows some Energy/Power related courses and their details offered by the top 3 Swedish universities in "*Electrical & Electronic Engineering*" category, according to the ***QS World University Rankings 2021***:

Table 18 Master's Programs in Electrical Engineering (focus on Energy/Power) of top 3 Universities of Sweden

University	*Course*	*Degree*	*Language*	*Specializations*	*Characteristics*
KTH Royal Institute of Technology	Electrical Power Engineering	Master of Science (M.Sc.)	English		Courses, Laboratories, Projects, and Master Thesis
	Nuclear Energy	Master of Science (M.Sc.)	English		Interuniversity program organised by InnoEnergy which is supported by the European Institute of Innovation and Technology (EIT), a body of the EU
	Renewable Energy	Master of Science (M.Sc.)	English		Interuniversity program organised by InnoEnergy which is supported by the European Institute of Innovation and Technology (EIT), a body of the EU
	Environmental Pathways for Sustainable Energy Systems	Master of Science (M.Sc.)	English		Interuniversity program organised by InnoEnergy which is supported by the European Institute of Innovation and Technology (EIT), a body of the EU
	Smart Electrical Networks and Systems	Master of Science (M.Sc.)	English		
	Decentralised Smart Energy Systems	Erasmus Mundus Masters	English	Thermal Energy Engineering	Interdisciplinary program with 4 European Universities
Chalmers University of technology	Sustainable Electric Power Engineering and Electromobility	Master of Science (M.Sc.)	English		Courses, Laboratories, Projects, and Master Thesis
	Sustainable Energy Systems	Master of Science (M.Sc.)	English	• Energy systems • Process Industry • Heat and power • Buildings • Computational Fluid-Dynamics	Courses and Master Thesis
	Electrical Engineering	Master of Science (M.Sc.)	Swedish	• Biomedical Engineering • Communication Engineering • Complex Adaptive System • Computer Systems and Networks • Data Science and AI • Electric Power Engineering • Embedded Electronic System Design	300 ECTS course 5 years consolidated program Courses, Laboratories, Projects, and Master Thesis

				• High-Performance Computer Systems • Industrial Ecology • Nanotechnology • Sound and Vibration • Systems, Control and Mechatronics • Wireless, Photonics and Space Engineering •	
Lund University	Sustainable Energy Engineering	Master of Science (M.Sc.)	English	• Automotive Engineering • Computational Engineering • Electric Power Systems • Space Heating and Cooling	Courses, Laboratories, Projects, and Master Thesis
	Electrical Engineering	Master of Science (M.Sc.)	Swedish	• Images and Graphics • Integrated Systems • Energy and Environment • Photonics and High-Frequency Electronics • Communication Systems • Medical Technology • Production, Logistics and Business • Software • Control Technology and Automation • Signals and Sensors	300 ECTS course 5 years consolidated program Courses, Laboratories, Projects, and Master Thesis

3. Review of university curricula with links to Energy digitalisation for members of the European University Atlas

The European Atlas of Universities in Energy Research & Education is a result of the UNI-SET Universities Survey and contains information about several hundred energy research and master's programmes. The Atlas also shows information about related doctoral schemes, where available. It features key information on energy-related educational and research activities at universities throughout Europe.

Germany

Table 19 Curricula link to digitalisation for Germany

University	Domain	Focus Area	Programme Name	Degree	Language	Digitalisation Areas	Course Website
Bielefeld University of Applied Sciences	Electrical Engg.	Power	Electrical Engineering	Master of Engineering (M.Eng.)	German	Smart Grids, Intelligent Energy Systems	https://www.fh-bielefeld.de/studiengaenge/elektrotechnik-master
Carl von Ossietzky University of	Electrical Engg.	Power	Postgraduate Programme Renewable Energy (PPRE)	Master of Science (M.Sc.)	English		https://uol.de/f/5/inst/physik/stud/ppre/PPRE/B.2.1_CURRICULUM-PPRE_4_Semester_2020-16-10.pdf

Oldenburg	Electrical Engg.	Power	European Master in Renewable Energy (EMRE)	Master of Science (M.Sc.)	English		https://uol.de/en/eurec/
	Electrical Engg.	Power	European Wind Energy Master (EWEM)	Master of Science (M.Sc.)	English	Machine Learning, Big Data/Data Analytics	https://ewem.tudelft.nl/about-ewem/programme/
Deggendorf Institute of Technology	Electrical Engg.	Power	Electrical Engineering and Information Technology	Master of Science (M.Sc.)	English		https://www.th-deg.de/et-m-en
	Building Energy Engg.	Building	Healthy and Sustainable Buildings	Master of Engineering (M.Eng.)	English	Artificial Intelligence	https://www.th-deg.de/hsb-m-en
Hamburg University of Technology	Electrical Engg.	Power	Energy Systems	Master of Science (M.Sc.).	German		https://studienplaene.tuhh.de/index.php?stgart=M&stgM=ENTMS&Lang=en
	Interdisciplinary	Interdisciplinary	Energy and Environmental Engineering	Master of Science (M.Sc.).	German		https://studienplaene.tuhh.de/index.php?stgart=M&stgM=EUTMS&Lang=en
	Electrical Engg.	Power	Renewable Energy	Master of Science (M.Sc.)	German		https://studienplaene.tuhh.de/index.php?stgart=M&stgM=REMS&Lang=en
	Environmental Engg.	Environmental	Environmental Engineering	Master of Science (M.Sc.).	English		https://studienplaene.tuhh.de/index.php?stgart=M&stgM=MAMS&Lang=en
	Environmental Engg.	Environmental	Joint European Master in Environmental Studies - Cities & Sustainability	Master of Science (M.Sc.)	English		http://www.jemes-cisu.eu/joomla3/index.php/study-programme/curriculum
	Environmental Engg.	Environmental	Water and Environmental Engineering	Master of Science (M.Sc.)	German		https://studienplaene.tuhh.de/index.php?stgart=M&stgM=WUMS&Lang=en
	Electrical Engg.	Power	Electrical Engineering	Master of Science (M.Sc.)	German		https://studienplaene.tuhh.de/index.php?stgart=M&stgM=ETMS&Lang=en
Ingolstadt University of Applied Sciences	Interdisciplinary	Interdisciplinary	Renewable Energy Systems	Master of Science (M.Sc.)	English		https://www.thi.de/en/mechanical-engineering/degree-programmes/renewable-energy-systems-msc/
Karlsruhe Institute of Technology	Electrical Engg.	Power	Electrical Engineering and Information Technology	Master of Science (M.Sc.)	German	Deep Learning, Machine Learning	https://www.sle.kit.edu/vorstudium/master-elektrotechnik-informationstechnik.php
	Electrical Engg.	Interdisciplinary	Energy Technologies (ENTECH)	Master of Science (M.Sc.)	English		https://www.innoenergy.com/media/4630/masters-in-energy-technologies-

							handbook-updated-march-2020.pdf
	Computer Science	Others	Information Systems Engineering and Management	Master of Science (M.Sc.)	English	Artificial Intelligence, Cloud Services, Blockchain, Cybersecurity, Machine Learning	https://www.hectorschool.kit.edu/master-information-systems-engineering-and-management.php
	Electrical Engg.	E-Mobility	Mobility Systems Engineering and Management	Master of Science (M.Sc.)	English	Cyber Physical Systems, Internet of Things (IoT), Artificial Intelligence	https://www.hectorschool.kit.edu/master-mobility-systems-engineering-and-management.php
	Electrical Engg.	Power	Energy Engineering and Management	Master of Science (M.Sc.)	English	Smart Grids	https://www.hectorschool.kit.edu/master-energy-engineering-and-management.php
Mannheim University of Applied Sciences	Electrical Engg.	Power	Automation and Energy Systems (EM)	Master of Science (M.Sc.)	German		https://www.english.hs-mannheim.de/study-programmes/master-courses/automation-and-energy-systems.html
RWTH Aachen University	Electrical Engg.	Power	Electrical Engineering, Information Technology, and Computer Engineering	Master of Science (M.Sc.)	English	Artificial Intelligence, Artificial Neural Networks, Smart Grids	https://www.elektrotechnik.rwth-aachen.de/cms/Elektrotechnik-und-Informationstechnik/Studium/Master-Studiengaenge/Master-of-Science/~ghfq/ENGLISCHSPRACHIG-Studiengang-Elektrote/lidx/1/
	Mechanical Engg.	Power	Energy Engineering	Master of Science (M.Sc.)	German	High Performance Computing (HPC)	https://www.maschinenbau.rwth-aachen.de/global/show_document.asp?id=aaaaaaaaamzale
	Interdisciplinary	Power	Sustainable Energy Supply	Master of Science (M.Sc.)	German		https://www.rwth-aachen.de/cms/root/Studium/Vor-dem-Studium/Studiengaenge/Liste-Aktuelle-Studiengaenge/Studiengangbeschreibung/~bnof/Nachhaltige-Energieversorgung-M-Sc-/?lidx=1
	Interdisciplinary	Sustainability	Sustainable Management – Water and Energy	Master of Science (M.Sc.)	English		https://www.rwth-aachen.de/go/id/nmyt?lidx=1#aaaaaaaaaaanmyu

	Environmental Engg.	Environmental	Environmental Engineering	Master of Science (M.Sc.)	German		https://www.fb3.rwth-aachen.de/cms/Bauingenieurwesen/Studium/Studiengaenge/Masterstudiengaenge/Studienverlaufsplaene-M-Sc-UIW/~djcu/Studienverlauf/?lidx=1
	Interdisciplinary	Interdisciplinary	Business Administration and Engineering: Electrical Power Engineering	Master of Science (M.Sc.)	German	Artificial Neural Networks	https://www.elektrotechnik.rwth-aachen.de/cms/Elektrotechnik-und-Informationstechnik/Studium/Master-Studiengaenge/Master-of-Science/wirtschaftsingenieurwesen/~tpn/Studienverlauf/lidx/1/
TU Darmstadt	Interdisciplinary	Interdisciplinary	Energy Science and Engineering	Master of Science (M.Sc.)	English		https://www.ese.tu-darmstadt.de/master_ese/fuer_studierende_4/po_2020/po_2020.en.jsp
TU Dresden	Energy Economics & Policy	Policy	Business Management (Specialisation: Energy Economics & Management)	Master of Science (M.Sc.)	German		https://tu-dresden.de/studium/vor-dem-studium/studienangebot/sins/sins_studiengang?set_language=de&autoid=37
	Electrical Engineering	Power	Renewable Energy Systems	Diplom Ingenieur (Dipl. Ing.)	German		https://tu-dresden.de/ing/elektrotechnik/studium/studieren-an-der-fakultaet/studiengaenge/diplom-studiengang-regenerative-energiesysteme
	Electrical Engineering	Power	Electrical Engineering	Diplom Ingenieur (Dipl. Ing.)	German		https://tu-dresden.de/studium/vor-dem-studium/studienangebot/sins/sins_studiengang?set_language=de&autoid=275
	Building Energy	Building	Building-Energy-Management	Master of Science (M.Sc.)	German		http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_bauingenieurwesen/studium/ablauf_inhalt/vertiefung/vertiefer-gem
University of Applied Sciences Berlin	Electrical Engineering	Power	Renewable Energy	Master of Science (M.Sc.) Master of Science (M.Sc.)	German	Smart Grids	https://re-master.htw-berlin.de/studium/ordnungen-module/#c5267
	Building Energy	Building	Building Energy and Information Technology	Master of Engineering	German		https://geit-master.htw-berlin.de/studium/ordnungen-module/

				(M.Eng.)			
	Electrical Engineering	Power	Electrical Engineering	Master of Engineering (M.Eng.)	German	Energy Management Systems, Smart Grids	https://et-master.htw-berlin.de/studium/ordnungen-module/
University of Applied Sciences Offenburg	Electrical Engg.	Power	Electrical engineering / information engineering (EIM)	Master of Science (M.Sc.)	German		https://ei.hs-offenburg.de/nc/studium/master/elektrotechnik-informationstechnik-master-eim/modulhandbuch/
	Interdisciplinary	Interdisciplinary	Renewable Energy and Data Engineering (RED)	Master of Science (M.Sc.)	English	Big Data/Data Analytics, Machine Learning, Artificial Intelligence	https://incoming.hs-offenburg.de/en/international-masters-degree-programs/renewable-energy-and-data-engineering/study-program/
Kempten University of Applied Sciences	Mechanical Engg.	Power	Energy Engineering	Master of Engineering (M.Eng.)	German		www.hs-kempten.de/master-energietechnik

Spain

Table 20 Curricula links with digitalisation for Spain

University	Domain	Focus Area	Programme Name	Degree	Language	Digitalisation Areas	Curriculum
University of La Laguna	Electrical Engg.	Power	Master in Renewable Energies	Master	Spanish		https://www.ull.es/apps/guias/guias/view_degree/666/
Las Palmas University	Computer Science	Others	Energy Efficiency	Master	Spanish		https://www.siani.es/files/documentos/masteres/EE/ULPGC_Master_Universitario_en_Eficiencia_Energetica.pdf
	Computer Science	Interdisciplinary	Intelligent Systems and Numerical Applications in Engineering	Master	Spanish	Big Data/Data Analytics, Internet of Things (IoT)	https://www.siani.es/files/documentos/masteres/SIANI/Curso_2019-2020/GuiaAcademica.pdf
Rovira i Virgili University	Building Energy Engg.	Building	Energy Efficiency and Air Conditioning System In Buildings	Postgraduate Diploma	Spanish		https://www.fundacio.urv.cat/diploma_de_posgrado_en_eficiencia_energetica_y_sistemas_de_climatizacion_e3sc/of_es/es/E3SCEN-A1-2019-1/temari
	Electrical Engg.	E-Mobility	Electric Vehicle Technologies	M.Sc.	Spanish, Catalan		https://www.urv.cat/en/studies/master/courses/electric-vehicle/programme/

	Environmental Engg.	Environmental	Environmental Engineering and Sustainable Energy	M.Sc.	English		https://www.urv.cat/en/studies/master/courses/environmental-engineering/programme/
University of Barcelona	Others	Environmental	Renewable and Sustainable Energy	Master	Spanish		http://www.ub.edu/estudis/sites/default/files/pe_md703_energies_renovables_es_2.pdf
	Electrical Engg.	Power	Energy Efficiency 4.0 And Climate Emergency	Master	Spanish		https://www.il3.ub.edu/ca/master-eficiencia-energetica-sostenibilitat-online
University of the Basque Country	Electrical Engg.	Power	Integration of Renewable Energy Sources into The Electricity Grid	Master	Spanish		https://www.ehu.eus/documents/10089085/10240700/47_Energia_berriztagarrien_integrazioa.pdf/247f62c1-e981-b014-8f5b-fdcfc6e6ad14?download=true
	Interdisciplinary	Interdisciplinary	Research in Energy Efficiency and Sustainability in Industry, Transport, Building and Urban Planning	Master	Spanish		https://www.ehu.eus/documents/10089085/10264309/Investigaci%C3%B3n+en+Eficiencia+Energ%C3%A9tica+y+Sostenibilidad+en+Industria%2C+Transporte%2C+Edificaci%C3%B3n+y+Urba/574731fc-ff84-d698-09d5-c77fb9707303?download=true
	Environmental Engg.	Environmental	Erasmus Mundus Master in Renewable Energy in The Marine Environment (REM)	Master of Science (M.Sc.)	English		https://www.master-rem.eu/complete-programme/
	Electrical Engg.	Interdisciplinary	Erasmus Mundus Master in Smart Cities And Communities (SMACCs)	Master of Science (M.Sc.)	English		https://www.smaccs.eu/the-programme/courses/upv-ehu-courses/
	Interdisciplinary	Interdisciplinary	Erasmus Mundus Master Of Materials For Energy Storage And Conversion (MESC+)	Master of Science (M.Sc.)	English		https://mesc-plus.eu/the-master/curriculum
	Electrical Engg.	Power	Sustainable Energy Engineering	Master	Spanish		https://www.ehu.eus/documents/10089085/10210925/Folleto+Ingenier%C3%ADa+Energ%C3%A9tica+Sostenible/77ca7dff-ed7e-9ed1-1a81-634a6600e26d?download=true

Universitat Politècnica de Catalunya · Barcelona Tech (UPC)	Environmental Engg.	Environmental	Sustainability Science and Technology	Master	English		https://www.upc.edu/en/masters/sustainability-science-and-technology
	Electrical Engg.	Interdisciplinary	Enertronics	Master	Spanish		https://www.talent.upc.edu/ing/estudis/formacio/curs/205500/master-enertronica/
	Interdisciplinary	Interdisciplinary	Energy Engineering	Master	Spanish	Smart Grids	https://www.upc.edu/en/masters/energy-engineering
	Interdisciplinary	Interdisciplinary	Smart Energy	Master	Spanish	Big Data/Data Analytics, Smart Grids, Machine Learning, Internet of Things (IoT), Blockchain, ICT	https://www.talent.upc.edu/ing/estudis/formacio/curs/201800/master-degree-smart-energy/
	Interdisciplinary	E-Mobility	Electric Vehicles and Other Propulsion Technologies	Postgraduate Certificate	Spanish	Energy Management Systems	https://www.talent.upc.edu/ing/estudis/formacio/curs/323400/postgraduate-course-electric-vehicles-propulsion-technologies/
	Electrical Engg.	Power	Smart Grids	Postgraduate Certificate	Spanish	Smart Grids	https://www.talent.upc.edu/ing/estudis/formacio/curs/324500/postgraduate-course-smart-grids/
	Electrical Engg.	Power	Renewable Energies And Electrical Mobility	Postgraduate Certificate	Spanish		https://www.talent.upc.edu/ing/estudis/formacio/curs/324400/postgraduate-course-renewable-energies-electrical-mobility/
	Interdisciplinary	E-Mobility	Smart Mobility: Intelligent Transport Systems	Postgraduate Certificate	Spanish	ICT	https://www.talent.upc.edu/ing/estudis/formacio/curs/306300/postgraduate-course-smart-mobility-intelligent-transport-systems/
	Energy Economics & Policy	Policy	Energy Economics	Postgraduate Certificate	Spanish		https://www.talent.upc.edu/esp/estudis/formacio/curs/302300/posgrado-economia-energia/
	Electrical Engg.	Interdisciplinary	Digital Energy	Postgraduate Certificate	Spanish	Big Data/Data Analytics, Smart Grids, Machine Learning, Internet of Things (IoT), Blockchain, ICT	https://www.talent.upc.edu/esp/estudis/formacio/curs/300800/posgrado-digital-energy/
	Electrical Engg.	Power	Erasmus Mundus Master's Degree in Decentralised Smart Energy Systems (DENSYS)	Master of Science (M.Sc.)	English		https://www.upc.edu/en/masters/erasmus-mundus-decentralised-smart-energy-systems-densys

Greece

Table 21 Curricula links to digitalisation for Greece

University	Domain	Focus Area	Programme	Degree	Language	Digitalisation Areas	Course Website
Democritus University of Thrace	Electrical Engg.	Interdisciplinary	Advanced Technologies of Electrical and Computer Engineering (Specialisation: Energy Systems Technologies and Exploitation of Renewable Energy Sources)	Postgraduate Program (P.M.S)	Greek	Artificial Neural Networks, ICT	https://pms.ee.duth.gr/
University of Patras	Electrical Engg.	Interdisciplinary	Distributed Green Electric Power and The Advanced Network Infrastructure for its Management and Economy	Postgraduate Program (P.M.S)	Greek	Smart Grids, ICT	http://greenpower.upatras.gr/index.php/%CF%80%CE%BB%CE%B7%CF%81%CE%BF%CF%86%CE%BF%CF%81%CE%B9%CE%B5%CF%83/%CE%BC%CE%B1%CE%B8%CE%B7%CE%BC%CE%B1%CF%84%CE%B1_/%CF%83%CF%85%CE%BD%CE%BF%CF%80%CF%84%CE%B9%CE%BA%CE%B7-%CF%80%CE%B5%CF%81%CE%B9%CE%B3%CF%81%CE%B1%CF%86%CE%B7
University of Thessaly	Mechanical Engg.	Power	Analysis and Management of Energy Systems	Postgraduate Program (P.M.S)			http://www.mie.uth.gr/n_page.asp?ID=56&lang=en&lc=1
	Electrical Engg.	Power	Intelligent Electricity Networks (Smart Grid Energy Systems)	Master of Science (M.Sc.)	Greek	Artificial Intelligence, ICT	https://smartgrids-msc.e-ce.uth.gr/structure.php#students
University of Western Macedonia	Electrical Engg.	Building	Renewable Energy Sources & Energy Management in Buildings	Master of Science (M.Sc.)		Smart Grids, Energy Management Systems	https://ape.uowm.gr/index.php?lang=en
National Technical University of Athens	Electrical Engg	Power	Energy Production and Management	Diploma of Postgraduate Studies	Greek	smartgrids, renewable energy integration and digitalisation, Data Bases, Artificial Intelligence and	http://epm.ntua.gr/courses

						Data Analytics.	
Aristotle University of Thessaloniki	Computer Science	Interdisciplinary	Advanced Computer and Communication Systems	Postgraduate Speciailisation Diploma	Greek, English		http://ascc.web.auth.gr/wp-content/uploads/2020/06/%CE%A0%CE%A1%CE%9F%CE%93%CE%A1%CE%91%CE%9C%CE%9C%CE%91-%CE%A3%CE%A0%CE%9F%CE%A5%CE%94%CE%A9%CE%9D-2019-20.pdf

Romania

Table 22 Curricula links to digitalisation for Romania

University	Domain	Focus Area	Programme Name	Degree	Language	Digitalisation Areas	Course Website
University POLITEHNICA of Bucharest	Electrical Engg.	Power	Energy Efficiency	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Energy Services	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Smart City Energy	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Applied Informatics in Energy	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Engineering Power Systems	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Nuclear Engineering	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Heating System	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Power	Renewable Energy	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Electrical Engg.	Interdisciplinary	Energy Systems Management	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html
	Environmental Engg.	Environmental	Hydro-informatics and water engineering	Master of Science (M.Sc.)	Romanian		https://www.energ.pub.ro/invatamant_master.html

	Electrical Engg.	E-Mobility	Integrated Electrical Systems Engineering in Vehicles	Master of Science (M.Sc.)	English		http://www.electro.pub.ro/master/planuri-de-invatamant/
	Electrical Engg.	Power	Electrical Engineering	Master of Science (M.Sc.)	Romanian		http://www.electro.pub.ro/master/planuri-de-invatamant/
	Interdisciplinary	Interdisciplinary	Energy Engineering	Master of Science (M.Sc.)	English		https://www.energ.pub.ro/invatamant_master.html
Technical University of Cluj-Napoca	Electrical Engg.	Power	Electrical Engineering	Master of Science (M.Sc.)	Romanian		https://ie.utcluj.ro/planuri-de-invatamant.html
The Polytechnic University of Timisoara	Electrical Engg.	Power	Electrical Engineering	Master of Science (M.Sc.)	Romanian		http://www.upt.ro/img/files/2020-2021/master/pi/ee/2020-2021-ET_EEP_Anii%20I-II.pdf
	Interdisciplinary	Interdisciplinary	Energy Engineering	Master of Science (M.Sc.)	Romanian		http://www.upt.ro/img/files/2020-2021/master/pi/ee/2020-2021_ET_CSE_Anii_I-II.pdf

Sweden

Table 23 Curricula links to digitalisation for Sweden

University	Domain	Focus Area	Programme Name	Degree	Language	Digitalisation Areas	Course Website
Chalmers University of Technology	Electrical Engg.	Power	Sustainable Electric Power Engineering and Electromobility	Master of Science (M.Sc.)	English		https://student.portal.chalmers.se/en/chalmersstudies/programme-information/Pages/SearchProgram.aspx?program_id=1654&parsergrp=1
	Electrical Engg.	Others	Sustainable Energy Systems	Master of Science (M.Sc.)	English		https://www.chalmers.se/en/education/programmes/masters-info/Pages/Sustainable-Energy-Systems.aspx#second-page
	Electrical Engg.	Power	Electrical Engineering	Master of Science (M.Sc.)	Swedish		https://student.portal.chalmers.se/sv/chalmersstudier/programinformation/Sidor/SokProgramutbudet.aspx?program_id=1622&parsergrp=1
Linköping University	Interdisciplinary	Interdisciplinary	Sustainability engineering and management with a major in Energy and Environmental Engineering	Master of Science (M.Sc.)	English		https://liu.se/studieinfo/en/program/6msus/4943

Mälardalen University	Interdisciplinary	Interdisciplinary	Sustainable Energy Systems	Master of Science (M.Sc.)	English		https://www.mdh.se/international/programme/masters-programme-in-sustainable-energy-systems?
	Interdisciplinary	Interdisciplinary	Energy Systems	Master of Science (M.Sc.)	Swedish	Energy Management Systems	https://www.mdh.se/utbildning/program/civilingenjorsprogrammet-i-energisystem
Uppsala University	Electrical Engg.	Power	InnoEnergy Master's Programme in Energy Technologies (ENTECH)	Master of Science (M.Sc.)	English		https://www.innoenergy.com/media/3245/entech_handbook.pdf
	Electrical Engg.	Power	Renewable Electricity Production	Master of Science (M.Sc.)	English		https://www.uu.se/en/admissions/master/selma/studieplan/?pKod=TFE2M
	Electrical Engg.	Power	Wind Power Project Management	Master of Science (M.Sc.)	English		https://www.uu.se/en/admissions/master/selma/studieplan/?planId=1428&pKod=TVP2M
KTH Royal Institute of Technology	Electrical Engg.	Power	Electrical Power Engineering	Master of Science (M.Sc.)	English		https://www.kth.se/en/studies/master/electric-power/course-overview-1.268252
	Electrical Engg.	Power	Nuclear Energy	Master of Science (M.Sc.)	English		https://www.kth.se/en/studies/master/emine
	Electrical Engg.	Power	Renewable Energy	Master of Science (M.Sc.)	English		https://www.kth.se/en/studies/master/rene
	Electrical Engg.	Power	Energy for Smart Cities	Master of Science (M.Sc.)	English		https://www.kth.se/en/studies/master/smcs
	Electrical Engg.	Power	Smart Electrical Networks and Systems	Master of Science (M.Sc.)	English		https://www.kth.se/en/studies/master/sense
	Electrical Engg.	Power	Decentralised Smart Energy Systems	Erasmus Mundus Masters	English		https://densys.univ-lorraine.fr/files/2019/09/DENSYS_Courses_v1.0.pdf
Lund University	Electrical Engg.	Power	Sustainable Energy Engineering	Master of Science (M.Sc.)	English		https://www.lunduniversity.lu.se/sites/www.lunduniversity.lu.se/files/2020-10/Sustainable-Eenergy-Engineering-preliminary-course-list.pdf
	Electrical Engg.	Power	Electrical Engineering	Master of Science (M.Sc.)	Swedish		http://www.lth.se/utbildning/elektroteknik/kurser/

Other notable university programs on Energy transition and Digitalisation

Examples of notable university programs on energy transition and digitalisation are presented below. The list is not exhaustive.

Master's Degree in Smart Grids - Comillas Pontifical University (SP) with University of Strathclyde (UK)

The Master's Degree in Smart Grids (MSG) [11] is a Master of Science Degree with 90 ECTS credits, offered by the University of Strathclyde and the ICAI School of Engineering, in close collaboration with Iberdrola. The main objective of the program is to respond to the growing demand for engineers, needed to lead the ongoing process of the digitalisation of the electric grid. This program provides students with a detailed understanding of the operation and planning of grids under the new Smart Grid paradigm, along with new business opportunities and models that are arising from it. The alliance between university and industry guarantees both the practical component, thanks to the participation of industry, and the academic rigor of the courses.

One of the most interesting features of the MSG program is the intensive international experience offered. Students not only spend one semester in both Spain and Scotland, but also carry out internships at any of the international offices of Iberdrola in Spain, Scotland, the USA and Brazil.

Contents of the Program:

The program consists in 3 Terms:

- Term 1 (September – December): 30 ECT credits – ICAI School of Engineering, Comillas Pontifical University
- Term 2 (January – mid-May): 30 ECT credits – Department of Electronic & Electrical Engineering, University of Strathclyde
- Term 3 (mid-May – mid-Sept): 30 ECT credits – Individual Research Project: this will take the form of a practical, applied project with one of the University partners, or a paid internship with Iberdrola at one of their international branch offices; there are 10 internships available for the top-performing MSc students

Topics covered include:

- Term 1: Operation & planning of future distribution grids – Regulation & new business models – Fundamentals of TLC – TLC for Smart grids – Fundamentals of Power Systems – Leadership, Change management and Corporate responsibility
- Term 2: Control and Protection of Future Networks – Hardware IoT communication design - 5G comms networks – Offshore and Pan-European Supergrids – Data Analytics and AI for energy systems – Power Electronics for Transmission and Distribution
- Term 3 (mid-May – mid-Sept): MSG individual project

MSc Smart Electrical Networks and Systems – EIT InnoEnergy with KTH, KU Leuven, UPC and TU/e

This Master's programme [12] covers smart electric grids, a critical component in the creation of a sustainable power supply. Students develop the engineering and entrepreneurial skills needed to understand, design, implement and manage smart grids. Graduates have a unique understanding of the role played by new technologies and new businesses in a changing landscape. Seven universities offer the programme through EIT InnoEnergy

In the first year students study at KTH. In the second year, they can choose to study at one of the following:

- Grenoble INP: Institute of Technology in France
- KU Leuven in Belgium
- UPC:Universitat Politècnica de Catalunya BarcelonaTech in Spain
- TU/e: Eindhoven University of Technology in the Netherlands

Contents of the Program:

During the first year at KTH, student focus on the fundamentals of electric energy systems, including: power system analysis, power electronics, electrical machines, and high-voltage engineering. KTH also offers a mandatory course in innovation and entrepreneurship in electric-power engineering. Students also attend several one-week modules at a number of our partner universities, for example:

- The impact of ICT solutions on the smart grid, at Grenoble INP: Institute of Technology, France
- Power quality and energy efficiency, at AGH: University of Science and Technology, Poland
- Integration of renewable energy into the grid, at UPC: Universitat Politècnica de Catalunya · BarcelonaTech, Spain

For the second year, students choose an area of specialisation at one of the four universities:

- Energy Management in Buildings and Power Grids at Grenoble INP: Institute of Technology, France

- Power Distribution and Storage, at KU Leuven, Belgium
- Power Electronics as Enabling Technology for Renewable Integration, at UPC: Universitat Politècnica de Catalunya BarcelonaTech, Spain
- Sustainable Electrical Energy Systems, at TU/e: Eindhoven University of Technology, the Netherlands

Students complete the second and final year with a Master's degree project in the fieled of Smart Grids, which is undertaken at industrial or research partners. The degree project is worth 30 ECTS credits and corresponds to five months of full-time study.

MSc Energy production and management NTUA (GR)

The main goal of the programme is the deepening of knowledge for engineers and scientists in the methods and techniques of the interdisciplinary approach of Energy production and management, so as to form executives with specialized knowledge in the scientific areas of the Energy production and management, able to cover the growing needs of private and public enterprises, organizations and services of the country or other countries, in the multidimensional issues of energy production and management. Moreover, it aims in-depth training of engineers and other scientists and the development of their research skills, so that they become capable of producing knowledge.

Considering digital technologies and energy, all forms of energy are covered and also an overview course on ICT technologies with special application to power systems is provided. This course includes an introduction to Data Bases, Artificial Intelligence and Data Analytics.

Interdisciplinary curriculum in power systems and ICT of the Institute Automation of Complex Power Systems (ACS) at RWTH Aachen (DE)

The Institute for Automation of Complex Power Systems offers a variety of courses for students in bachelor's and master's degree programs. Thanks to a multidisciplinary team that works at the intersection of traditional power systems with advanced control and automation concepts and modern ICT solutions, the Education programmes and the research at ACS cover, in a unique way, different scientific areas of the Energy transition [14]

Relevant courses include among others: Automation of Complex Power Systems, Advanced Monitoring for Power Systems, Modern Control Systems, Foundations of Computer Science, Distributed Intelligence for Power Systems Future Energy Systems.

The Education curriculum program is constantly upgrading – also supported by Research in the most innovative fields, and also offers several PhD opportunities in the areas of Smart Grids, Renewables, Big Data, Cloud computing, Machine Learning and Artificial Intelligence.

Smart Grid program at the Politecnico of Milan (IT)

The Politecnico of Milan offers a Master of Science in Electrical Engineering aimed at forming highly-qualified professionals able to face complex design problems and foster technological innovation in the field of electrical power systems. It builds on basic disciplines (covering digital signal processing, electromagnetic compatibility and engineering electromagnetics, measurement and diagnosis techniques, power electronics and electrical drives, design of electrical machines and apparatus, etc.) and provides solid skills in the areas of electrical energy and renewable sources, electrical systems in transportation, design and automation of electrical systems. The programme includes a broad range track entitled "Renewable Sources, Transport, Design and Automation" and a special track devoted to "Smart Grids", organized and run in collaboration with Enel S.p.A.

Courses cover innovative subjects that are quite aligned with the recommendations if the Action Agenda previously discussed, such as [15] Project Management: Principles & Tools, Electricity Market, Communications Networks for Electricity Systems, Measurement and Smart Metering, Planning and Operation of Distribution Grids with High Penetration of RES, Renewable Energy Sources and Network Interface, Network Automation and Protection Systems, Tools for Network Simulation, Smart Grids: Components, Functionalities & Benefits.

Master's Degree Programme in Smart Grids at University of Tampere (FI)

The Master's Degree Programme in Smart Grids is a 2-year programme that combines technical knowledge and skills related to power electronics and electric power engineering with broader viewpoints of control, electricity markets and ICT/automation. The study module and courses explore existing practices and possible future ideas to design, implement and maintain smart grids, as the critical infrastructure of future electricity systems.

The study module includes two options, electric power engineering and power electronics, allowing students to deepen their practical knowledge and skills in one of the fields.

The programme is based on blended learning: courses combine theoretical understanding and analysis with the "learning by doing" approach of computer simulations and laboratory assignments [16].

4.3.VET Curricula analysis

Review of European VET programs in Electrical Engineering and Energy

The European Qualifications Framework (EQF)

The European qualifications framework (EQF), with its eight levels, serves as a translation grid between qualifications acquired in different European countries.

The analysis showed that VET education ranges from EQF level 2 to EQF 6. As it can be seen in the knowledge levels range from basic to advanced knowledge reaching on several occasions an equivalent level to a bachelor's degree.

Germany

The German VET system comprises initial and continuing education; alongside school-based activity, work-based learning (WBL) plays a major role in most of the programmes offered at secondary and tertiary levels. There are the following VET learning options, which all include WBL:

At upper secondary level:

- general vocational programmes with vocational orientation.
- school-based VET programmes.
- apprenticeship programmes (incl. WBL of ca. 75%).

At post-secondary level:

- specialised programmes;

At tertiary level:

- advanced vocational qualifications and exams at EQF level 5 (certified advisor in specific professional areas; technician), EQF 6 (master craftsperson, specialist) and EQF 7 (management expert; vocational pedagogue, IT-Professional).

As an example, Federal Agency for employment website [17] selected to find the information about the different opportunities and curricula reviews.

From all the proffesional modules, those more relevant to energy and digitalisation are selected.

Table 24 Professional fields and occupations related to energy and digitalisation

PROFESSIONAL FIELD	ELECTRICAL PROFESSION FIELD	SPECIFIC OCUPPATION
ELECTRICITY	**Professions in power engineering**	- Electrical system fitter Electronic technician Electronic technician - Building and infrastructure systems electronic technician - Machines and drive technology electronic assistant - Specialist practitioner for assembly - Industrial electrician Technical assistant - regenerative energy technology / energy - management technical system planner
	Professions in information and communication technology	- Assistant - IT (technical informatics) - Electronics technician (craft) - Electronics technician - Devices and systems

		- Electronic technician - Information and system technology - Electro-technical assistant - Practice specialist in electronic devices and systems - Specialist practitioner for assembly mechanics - specialist for electrical devices - specialist for information technology - production mechanic aircraft - electronics technician - hearing acoustics industrial electrician - Information electronics technician - IT system electronics technician - Microtechnologist - System electronics technician - Technical assistant - electronics and data technology - Technical assistant - medical device technology - Technical system planner
	Professions in mechatronics and automation technology	- Assistant - IT (technical informatics) - Machine specialist electronic technician (trade) - Automation technology (industry) Electronics technician - Devices and systems electronic technician - Information and system technology electronic technician - Machines and drive technology Assistant - Aircraft electronics technician - Mechatronics technician - Rolling shutter and sun protection mechatronics technician - System electronics technician - Technical assistant – mechatronics - Technical assistant - medical device technology
PROFESSIONAL FIELD OF TECHNOLOGY	**Professions related to renewable energies**	- Technical assistant - regenerative energy technology - energy management

DUAL VET

Dual vocational education and training systems (dual VET-systems) in Germany stand out due to the two learning venues, hands on practice and vocational school. That is why a dual VET program is selected to present a good example of how currilula in Germany is adapted to its environment.

Federal Institute for Vocational Education and Training (BIBB) offers degree-level entry as an academic researcher or administrator as well as a wide range of opportunities for those who have completed vocational education and training. Students or school pupils are able to further their training by completing an internship at BIBB. Permeability between various activities and training pathways is something which BIBB practises on a daily basis, not merely an object of research.

On its information can be found such as; profile of skills and competences, official basis of the certificate [18]

The following table shows the DUAL formation in electric systems technician was found on the website.

Table 25 DUAL formation in electric systems technician

ELECTRICITY AND ELECTRONICS	ELEKTROANLAGENMONTEUR/ELECTRIC SYSTEMS TECHNICIAN (PROFESSIONAL MODULES)	CURSE (YEAR)
TRAINING IN THE COMPANY AND, IF REQUIRED, IN INTER-COMPANY COURSES	technical communication	1º and 2º
	operational communication	1º and 2º
	Plan the order processing	1º and 2º
	Prepare to run the job	1º and 2º
	Setting up and clearing the assembly site	1º and 2º
	Machining and joining of mechanical parts	1º and 2º
	Assembling and wiring assemblies and control cabinets	1º and 2º
	Assembly of electrical machines, devices and other equipment	1º and 2º
	Assembly of cable routing systems and laying of cables	1º and 2º
	Installation of electrical systems	1º and 2º
	Testing, measuring, setting and commissioning	1º and 2º
	Eliminating faults in electrical systems	1º and 2º
	documentation	1º and 2º
TRAINING IN THE VOCATIONAL SCHOOL IN THE AREAS AND LEARNING FIELDS:	Introduction to electrical engineering	1º
	Introduction to control and digital technology	1º
	Introduction to Electronics	1º
	Introduction to protective measures	1º
	Introduction to measurement technology	1º
	Introduction to technical drawing	1º
	Introduction to materials, material processing and line types	1º
	Process orders	2º
	Generate and adapt electrical energy	2º
	Transmit and distribute electrical energy	2º
	Work on building services systems	2º
TRAINING IN THE COMPANY AND, IF REQUIRED, IN INTER-COMPANY COURSES	- Depending the knowledge from the 1st and 2nd year of training	3º
TRAINING IN THE VOCATIONAL SCHOOL IN THE AREAS AND LEARNING FIELDS:	- Working on systems with electric drives	3º
	- Working in systems with automation equipment	3º
	Final exam after the 3rd year of training	3º

Digitalisation related skills: the professional will be able to [19]:

1. Electrical system fitters will be able to install energy, control and regulation systems, signalling, safety and lighting systems, e.g. Generators or Transformers, lanterns, overhead lines, tram overhead lines or lightning rods.
2. They plan the order processing and provide measuring and tools, materials, auxiliary materials and materials ready.
3. Manufacture mechanical partly also offer electrical components and groups that you need for the planned assembly.
4. Assemble connection and distribution boards, wire assemblies and
5. Check system components
6. Carry out maintenance and repair work on behalf of customers through defective systems.

Spain

If close attention is paid to the Formal education general and vocational programmes in Spain, it can be observed that they are regulated by the Ministry of Education and Vocational Training (hereafter: education ministry). VET programmes are offered at three levels:

- lower secondary basic VET (ISCED 353) programmes target learners over 15;
- upper secondary intermediate VET (ISCED 354) programmes for learners aged 17-18;
- higher VET (ISCED 554) programmes for learners 18-19.

There are several possibilities of studying VET education in Spain:

- **Attendance studies:** Is characterized by attending daily classes at the educational center, either in the morning shift or in the afternoon shift.
- **DUAL:** Is applied to both upper secondary intermediate and higher VET training cycles. Except for some exceptions such as double degrees, the first year is done in the educational center where the minimum contents are learned, and the second year in the company, where it does not consist so much in an internship as the FCTs but is also an apprenticeship. There the contents are completed based on a training program agreed between the educational center and the company.
- **Distance VET:** It is especially suitable if due to your circumstances you cannot afford to attend face-to-face classes daily. This is special to those that are partially working and want to continue their studies to improve or develop the professional carrier

The following table shows an example of vocational programme in the Electricity and electronics family which have the specific equivalence with the European qualifications framework (EQF).

Table 26 Professional fields and occupations related to energy and digitalisation

PROFFESIONAL FAMILY	COURSE NAME	EQF
ELECTRICITY AND ELECTRONICS	Basic Professional Title in Electricity and Electronics	3
ELECTRICITY AND ELECTRONICS	Basic Professional Title in Electrotechnical and Mechanical Installations	3
ELECTRICITY AND ELECTRONICS	Technician in Electrical and Automatic Installations	4
ELECTRICITY AND ELECTRONICS	Telecommunications Installations Technician	4
ENERGY AND WATER	Technician in Networks and Water Treatment Stations	4

ELECTRICITY AND ELECTRONICS	Superior Technician in Electrotechnical and Automated Systems	5
ELECTRICITY AND ELECTRONICS	Superior Technician in Telecommunications and Computer	5
ELECTRICITY AND ELECTRONICS	Senior Technician in Electronic Maintenance	5
ELECTRICITY AND ELECTRONICS	Superior Technician in Automation and Industrial Robotics	5
ELECTRICITY AND ELECTRONICS	Clinical and Biomedical Laboratory	5
ENERGY AND WATER	Senior Technician in Energy Efficiency and Solar Thermal Energy	5
ENERGY AND WATER	Senior Technician in Water Management	5

As an example of module, "Technician in Electrical and Automatic Installations" is selected to see in details the curricular hours within the curse and how they are distributed.

The Community of Madrid is used as a guide. the All the specific curricula are published in the community portal and previously approved by the government. These modules curricular are available in Community of Madrid VET portal [20].

Table 27 Detailed description of technician in Electrical and Automatic Installations program

Electricity and electronics	Technician in Electrical and Automatic Installations (Professional Modules)	Curricular hours	Curse (year)
01	Industrial Automation and Control	300	1º
02	Electronics	100	1º
03	Electrical engineering	210	1º
04	Employee Orientation and Training	90	1º
05	Indoor Electrical Installations	300	1º
06	Business and Entrepreneurship	65	2º
07	Common Infrastructure of Telecommunications	105	2º
08	Technical English for intermediate grade	40	2º
09	Distribution facilities	105	2º
10	Domotic Installations	125	2º
11	Photovoltaic solar installations	65	2º
12	Formation in work centers	125	2º

Digitalisation related skills: the professional will be able to do:

1. Assemble and maintain telecommunication infrastructures in buildings,
2. electrical installations of low voltage,
3. electrical machines and automated systems,
4. applying standards and regulations
5. current, quality,
6. safety and occupational risk protocols,
7. ensuring their operation and respect to the environment.

8. carries out its activity in small and medium-sized companies, mainly private, dedicated to the assembly and maintenance of communication infrastructures in buildings,
9. electrical machines,
10. automated systems,
11. low voltage electrical installations and systems
12. domotic systems

Sweden

There are several VET learning options:

Initial VET at upper secondary level leading to EQF 4 is available in the formal education system as:

- school-based learning for the young and adults;
- work practice (practical training at school and in-company practice) is mandatory in VET for the young, and encouraged through state grants in municipal adult VET;
- distance learning, which is available in municipal adult VET-education.

The Swedish National Agency for Higher Vocational Education (HVE) [21] has been appointed by the Swedish Government as the national coordination point for the Swedish NQF, the SeQF. It encompasses and presents all types of learning by describing knowledge, skills and competence at eight different levels.
They have the key function to ensure that HVE programmes meet the labour market's needs for qualified workforce. They are also responsible for coordinating and supporting a national framework for recognition of prior learning, as well as serving as a national coordination point for the EQF - the European Qualifications Framework.

HVE is tailored to suit an evolving marketplace situation. The range of programmes and specialisations will therefore change over time. New programmes will start, and old ones will be discontinued as the labour market changes.

The following table shows the national vocational programmes in upper secondary school vocational programmes concerning anergy and digitalisation [22].

Table 28 National vocational programmes

PROGRAMME	ORIENTATIONS
THE ELECTRICITY AND ENERGY PROGRAMME	Automation Computers and ICT Electrical technology Energy technology
THE INDUSTRIAL TECHNOLOGY PROGRAMME	Operations and maintenance Process technology Product and machine technology Welding Technology
THE HVAC AND PROPERTY MAINTENANCE PROGRAMME	Property Refrigeration and heat pump technology Ventilation technology HVAC

As an example, the curricula on Authorized Electrician in Sweden is presented. The duration of the course is one year.

Table 29 Authorized Electrician program

Electricity and electronics	Authorized Electrician program	Curricular (%)
01	Installations for the production and transmission of electricity and industrial facilities	33
02	Electrical installations in buildings	33

03	Electric machines - drive system	10
04	High voltage installations	13
05	Rules and standards	10

Related skills: the professional will be able to know about:

1. electricity production
2. electricity transmission and electricity use
3. maintenance
4. safety
5. electricity quality.

Completion of a one-year minimum programme results in a Higher Vocational Education Diploma and therefore places demands on previous education and another prior knowledge. For this course, the admission requires a special prior knowledge / conditions:

The electricity and energy program

- Electrical installations,
- Electric power technology,
- Practical e-learning,
- Energy Technology 1,
- Mechatronics 1,

Professional experience

Scope and length: 3 years full time

Type of professional experience:

- Must have worked for at least 1 year in an electrical installation company with electrical installation work on high-voltage installations
- Must have worked for at least 1 year in an electrical installation company with electrical installation work on low-voltage installations

Other time may have been spent working on electrical installation, electrical power and electrical machines.

Greece

According to the current education system of Greece, Vocational Education and Training is provided both from public and private schools and belongs to the non – compulsory part of the system. VET Schools in general can be categorized in three different types that correspond to EQF Level 4 and 5. More specifically:

- Vocational Education Schools or Vocational Apprenticeship Schools (in Greek: Epaggelmatikes Scholes, EPAS), EQF Level
- Vocational Upper Secondary Schools (in Greek: Epaggelmatika Lykeia, EPAL), EQF Level 4
- Public and private Post – Secondary VET Schools (in Greek: Institouta Epaggelmatikis Katartisis IEK), EQF Level 5

In the broader fields of Energy, VET provides a variety of options in Greece, some of which are indeed very popular among young people, in vast majority male students. The relevant VET courses and specialties per educational level are summarized in the following table. All of them provide the opportunity for theoretical and practical training, while in the EPAS and IEK providers there is training that takes the form of on internship. The courses/specializations that have a focus on Electrical Engineering are highlighted in bold.

Table 30 Professional fields and occupations related to energy and digitalization (Greece)

VET PROVIDER	PROGRAMME NAME	EQF
EPAS	– Fuel and Natural Gas Technician – **Electrical Installer** – Heating and Plumbing Technician – Heating and Air – Conditioning Installer	4
EPAL	– Mechanical Installations and Constructions Technician – Heating and Plumbing Technician – Heating and Air – Conditioning Installer – **Electrical Installations and Networks Technician**	4
PUBLIC IEK	– Heating and Air – Conditioning Installer – Mechatronics Technician – **Internal Electrical Installations Technician** – Technician of Technological Applications and Installments in Landscape and Environmental Projects – Renewable Energy Sources Installation Technician – Technical Engineer of Thermal Installations	5
PRIVATE IEK	– **Electrician** – Plumber – Heating and Air – Conditioning Installer – Mechatronics Technician – Fuel and Natural Gas Technician – Technical Engineer of Heating Installations	5

When it comes to focusing in a more detailed way in one of the curricula offered, as an example of the educational programmes offered, the study programme of “Internal Electrical Installations Technician” has been chosen. More specifically, this VET educational programme is offered by Public VETs (IEK) and its curriculum is formulated under the guidelines of the General Secretariat for Lifelong Learning.

Table 31 Detailed description of Internal Electrical Installations Technician Educational Programme (Greece)

COURSE REF. NO.	INTERNAL ELECTRICAL INSTALLATIONS TECHNICIAN EDUCATIONAL MODULES ***(THEORETICAL AND PRACTICAL TRAINING)***	WEEKLY CURRICULAR HOURS	SEMESTER
01	Electrical Technology and Applications	5	1 & 2
02	Electrical Installations I	7 / 8 (for Semester 2)	1 &2
03	Mechanical and Electrical Design	3	1 & 2
04	Mechanical Applications	3	1 & 2
05	Environmental Protection	1	1
06	Work Safety, Hygiene and Fire Protection	1	1 & 2
07	Electrical Applications II	8 / 12 (for Semester 4)	3 & 4
08	Power Electronics	5	3
09	Automatics	4	3 & 4

10	Laboratory Organisation and Operation	1	4
11	Practical Training / Internship	3	3 & 4

Digitalization related skills: the qualified professional will be able to do:

1. Work in electrical technology and related systems/applications
2. Assemble basic electrical infrastructures in the interior of buildings
3. Design electrical related projects
4. Use mechanical applications
5. Apply environmental protection protocols
6. Work in compliance with safety, hygiene and fire protection risks
7. Create more advanced electrical infrastructures in the interior of buildings
8. Work with electronics related to energy power
9. Work with and use automated systems
10. Organise and operate the working space (laboratory)

Romania

The Romanian VET system is based on the following features regarding the practical and theoretical aspects of education:

- Dual VET programme

The Dual VET programme combines apprenticeship into one company, where the apprentice benefits from practical training (on-the-job learning), and training theory in a vocational school.

- Apprenticeship programmes as specialization concomitant with other VET training

Apprenticeship programs can also be organized in parallel with other forms of VET, in which case a mixed approach is followed where the apprenticeship coexist with in-school VET.

- Work-based education

Work-based education elements are integrated into school curricula. Here the main option is school-level training, where features of on-the-job learning are integrated.

- VET fully integrated in schools

VET fully integrated in schools occurs mostly at the school level, which leads to a weaker cooperation between schools and companies and, implicitly, to a poor relevance in workforce sector. [25]

The institutions and organisations that are entitled to deliver VET programmes are the following:

- Technological high schools or technical colleges
- Professional schools
- Vocational high schools
- Post-secondary schools
- Public or private learning organisations or authorized entities

For the scope of this study, a specific focus has been given to educational programmes related to the energy sector. Therefore, bellow there is a table of the programmes in the field of Construction that are related to the Electrician's occupation.

Table 32 Professional fields and occupations related to energy and digitalization (Romania)

FIELD	OCCUPATION/PROGRAMME NAME	EQF

CONSTRUCTION	Electrician for construction	3
CONSTRUCTION	Electrician for mining exploitations	3
CONSTRUCTION	Electrician for ships	3
CONSTRUCTION	Electrician for low-voltage operations	3
CONSTRUCTION	Electrician for electrical and energetic equipment	3
CONSTRUCTION	Electrician for protection by relays, automation and measurements in electrical installations	3
CONSTRUCTION	Electrician for generating plants, stations and networks	3
CONSTRUCTION	Electrician for drilling-extraction equipment	3
CONSTRUCTION	Manufacturer of electro- technical products	3
CONSTRUCTION	Electrician for maintenance and repairs of household appliances	3

The training for these occupations has a duration of three (3) years, which include a total of 2.328 hours for practical and theoretical training. The curriculum is designed and provided according the Professional Training Standards related to the 10 occupations. In the first year of professional training, the curriculum is the same, in terms of subjects and number of hours, for all 10 occupations. The total number of training hours is 456 hours. During the second year of professional training, the curriculum is also the same. The total number of training hours is 9420 hours. However, in the third year of the training, the curriculum varies for each occupation/programme. The total number of training hours is 930 hours in the final year.

In order to be ale and provide a more focused insight, a specific examination has been made to the basic modules of the Electrician in Construction Curriculum. The main modules are provided in the following table:

Table 33 Basic Modules of the Electrician for Construction Educational Programme (Romania)

MODULE REF. NO.	ELECTRICIAN FOR CONSTRUCTION EDUCATIONAL MODULES *(THEORETICAL AND PRACTICAL TRAINING)*
01	General technologies in electrotechnics
02	Components of electrical equipment
03	Electric measures for continuous current and in alternating current voltage/power
04	Electric devices
05	Electric machines

06	Electrical installations specific to buildings
07	Electrical installations for solar panels

Digitalization related skills: the qualified professional will be able to do:

11. Work in electrical technology and related systems/applications
12. Use and work with components of electrical equipment
13. Apply measure for voltage/power change
14. Work with electric devices
15. Work with electric machinery and equipment
16. Assemble electrical infrastructures in buildings
17. Work with and use solar energy systems

4.4. Industrial training programs (corporate universities)

As talent becomes the primary source of competitive advantage, companies must excel at attracting, developing, and retaining the talent they need. Most of them offer **industrial training** to their employees to improve skills or add to the existing level of knowledge so that the employee is better equipped to do his present job or to mold him to be fit for a higher job involving higher responsibilities.

Given the importance of an organization's human capital to business success, aligning training and competency development with business needs has become a key challenge. Thus, in the last 10 years, many companies created **corporate universities** (CU) to face this challenge. Corporate universities really come into place when companies see the education of their employees as a strategic instrument to create competitiveness and support overall corporate strategy and culture. they are generally dedicated units acting as partners with senior leadership to develop strategic skills and capabilities.

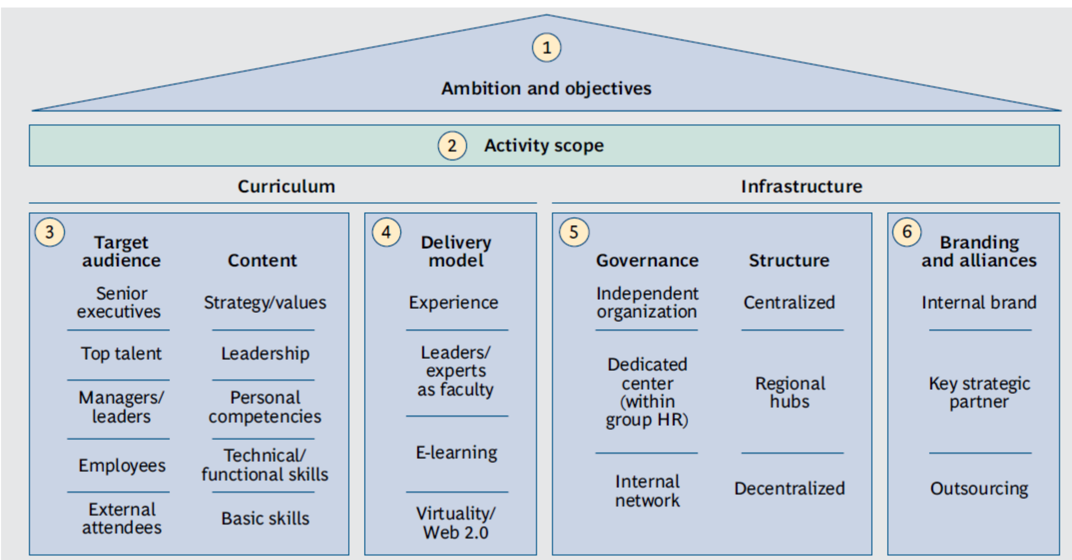


Figure 31 Strategic Building Blocks of a Corporate University (Source: Boston Consulting Group, BCG [23])

Many companies in the energy sector (EDF, EON, ENI, Iberdrola, REPSOL, NATURGY, EDP, MAPFRE, ENEL, GDF Suez, GE, etc.) have corporate universities for different purposes focus depending on the target audience and strategic objectives:

- *Training Center.* In this role, the corporate university provides training to regular employees and company leaders. The goal is to achieve operational excellence and drive alignment around key business processes and standards.
- *Leadership Accelerator.* Targeting middle and top management to foster a companywide leadership culture is the focus of this role. By bringing together diverse groups of company leaders, these programs create networks that connect participants long after formal training is completed.
- *Strategy Platform.* These programs target senior and top management with content directly relevant to the company's strategy.
- *Learning Network.* Creating a learning culture and ongoing learning opportunities beyond the classroom is the charge of these programs, which target a broad base of management and employees to fortify functional, technical, and management skills.

Those Universities are usually organized in schools of knowledge to provide all employees with technical, professional and managerial skill:

- Technical Schools of Knowledge
- Schools of Skills, Languages and Culture and Global Politics (Transversal Training).
- School of Leadership aimed exclusively at the first level of management.

Training programs are often conducted in partnerships with entities belonging to the CU's external organization of knowledge.

As Corporate universities operate in dynamic environments, they are continually adapting their models to meet the demands of new strategies and acquisitions and market volatility. In this sense, most of these programs include digital skills for managers and employees, which may include both short training sessions and longer, "level" programs for transition to the next level:

- Data & Information Management (Big Data, Data Bases, Data mining, etc.).
- Cultural Transformation (Change management, Digital Culture, Digital Identity, etc.).
- Work methodologies (Agile, Design Thinking, etc.).
- Digital Work Environment (Tools, Digital Workplace, etc.).
- New Businesses and Operating Models (smart solutions, smart networks, etc.).
- Customer (customer experience, customer journey, etc.).

Some of these programs also includes **specific training offer for stakeholders participating in their value chain** in order to improve their operational efficiency, incorporate innovative methods and develop skills for excellence in operations and services. Some of their courses are related to the products of the company. As an example, ABB, General Electric and Siemens offer, through their online platforms or training centers, professional training on their products related to the digitisation of the energy sector:

- Through its learning Center Grid Automation, ABB offers a wide range of professional training courses related to digitalisation focus on the needs of operator and maintenance staff, service and commissioning as well as application engineers. The catalogue of ABB includes a wide variety of courses such as all the SCADA RTUs, microgrid controllers, networks management systems, protection relays, substation automation devices, multiservice platform, etc.
- SIEMENS Power academy offers courses related to practice for the entire Siemens product and service portfolio which can be customized to meet your needs (digital substation, microgrids, solutions based on internet of things & machine learning, Grid control systems, cybersecurity, simulation software, substation automation, etc.). From oil and gas extraction and refining, to power generation from fossil and renewable sources, power transmission and distribution, and grid connections, SIEMENS training covers all areas of central and distributed energy conversion.
- GE's portfolio of Protection & Control and Substation Automation learning and development courses, feature a wide variety of integrated and flexible programs taught across multiple platforms. The courses

create the environment to learn about GE's Protection & Control and Substation Automation products, services and solutions offerings, and to build upon their knowledge to create integrated systems capability.

On the other hand, recently, **some companies are launching public-private partnerships with community colleges or school districts** to prepare young people with the academic, technical and professional skills required for 21st Century Jobs and ongoing education. For instance, IBM collaborates in a new model of public education, called P-TECH. P-TECH schools span grades 9-14 and enable students to earn both a high school diploma and a no-cost, two-year post-secondary degree in a STEM field. Students participate in a range of workplace experiences, including mentorship, worksite visits and paid internships. Upon graduation, students have the academic and professional skills required to either continue their education in a four-year postsecondary institution or enter into entry-level careers in IT, healthcare, advanced manufacturing and other competitive fields. While the P-TECH Model encompasses six years, students are able to move at their own pace, enabling some to accelerate through the model in as little as four years. P-TECH serves students from primarily underserved backgrounds, with no testing or grade requirements

Interviews

Considering corporate universities and industrial training programs, dedicated discussions were held during the interviews with industrial stakeholders. Some key messages are presented in the next paragraphs.

As for the technical part, at the moment the company's policy is aimed at training employees whenever a new technology requires it. It is difficult to find a new employee in the market who would meet all requirements needed at technical position. Courses inside company organisation link to ***cooperate universities*** are offered to tackle knowledge gaps. Trainings, workshops for managers, training materials, HR support in the evaluation process and in people management. The core value in the industry is to count on own available experts and rely on the group abilities and first re-skill before hiring. A ranking of courses taken at a cooperate university is listed below:

For all employees

1. Grid Quality of Service
2. Digital Transformation
3. Ethics
4. Cybersecurity
5. Safety General Principles

For Engineers (new hires)

- Energy Business
- Grid Management

For Electricians (new hires)

- Electrical isolation of Distribution Grid
- Fundamentals for Grid electronics

In order to ensure the highest quality and efficiency, all development activities carried out in the Company are regularly recorded, monitored and subject to formal evaluation and assessment using evaluation questionnaires, interviews with participants or training observations. To obtain feedback, HR conducts talk with training participants and managers about the completed training activities. As an interviewee indicated strategic monitoring of the employees' educational journey is to being achieved by the employee competency project, which has been launched in 2019 and suspended due to the pandemic. The result of the assessment will be the identification of employee strengths and areas for development in terms of knowledge and skills. As a result of the assessment interview and identification of areas for improvement, the supervisor, in consultation with the employee, will establish an individual employee development plan for the next year. The company assumes that the competency assessment process will also allow for identifying employees with special development potential, directing their development and planning individual career paths.

Following several specific internal training programs and company strategies, below will be presented a best practices example. With these example EDDIE has a view of current strategic approach of educational training and re-skilling of employees in the industry.

- **70/20/10 model** which bases the development and training system on 70% - development through experience (e.g. tasks in everyday work, participation in projects, teamwork), 20% - development through relationships with others (e.g. feedback, knowledge sharing, coaching, mentoring),10% - development through training. This program supports managers in developing subordinate employees, inter alia, by strengthening leadership and managerial skills and engages trainers and internal experts in the implementation of development activities. Further, it supports employees in improving competences and professional qualifications resulting from legal regulations, job requirements and health and safety rules. It increases employees' initiatives in the field of self-improvement and knowledge sharing,

- **Strategic learning** program on digitalisation with two lines (a) strategic capabilities; b) business capabilities, operational for the whole company. The training experiences are holistic (internships, lessons and online training, webinar, talks, etc.). It addresses key skills for the digitalisation of the energy sector: to manage information (big data, data mining, databases, etc.), cultural change (digital identity, digital culture, etc.), work methodologies (agile, design thinking, etc.), new business and operational models, digital work environment, etc.
- **Global Digital Mentoring program.** This initiative seeks to contribute to the digital transformation process, by creating opportunities for the transfer of knowledge.
- **Nanodegrees:** some departments have nanodegree programs in technologies as machine learning and data science, data engineering and blockchain. These nanodegrees have a duration of approximately 6 months and their content is defined internally. The trainers can be internal, external or a mix of both.
- **Online Platforms:** a set online courses/ education on digital platform, which are web-browser-based and contain a mix of text, slides and videos. Examples of these courses are "Basic Environmental Knowhow for DSOs", "Rights and responsibilities for working environment" (different levels depending on employee's role and department), "Electrical Safety certification" (different levels), "HLR – Heart Lung Rescue", "Construction Safety" (different focuses), "Safety Driving", "Unbundling for DSOs" (different levels depending on your role), "Code of Conduct & Integrity", "GDPR", "Security for DSOs", coursera, Udacity, edX, futurelearn and a few others. All are not mandatory for all employees but an asset. In addition to the above there are mentorship-type of introduction for many employees to get into the processes in an efficient way.

Another approach that has been described by an interviewee is the setup of a department or even new branch to tackle the digitalisation. The Digital Hub department is an example, setup to speed up the digitalisation throughout the organization and in the processes. On one hand it is managing innovation as a way to have an outside in perspective on what is possible in a way that may disrupt existing organization and processes. This is mainly done according to a plan that looks at the Digital Grid, Digital Customer, Digital Worker and Digital Business Model. On the other hand, it is a set of development teams that support the organization and projects in speeding up development through an agile approach. The number of development teams are scalable and allows competence and capability synergies.

The companies do not permanently cooperate with any consulting company in the field of employee development or education. Whenever necessary, individual trainings are carried out by external entities. When choosing a contractor, the decision is primarily guided by the quality of the training, the level of lecturers and taken into account whether the training program is individually tailored to the needs. If possible, previous experience with the training companies is also a significant factor. One of the evaluation criteria is also price. Even though large-scale retraining of employees is not expected, so the costs in this regard will not be a significant burden on the budget. Whenever possible, it is enabled the acquisition of knowledge and skills through gaining experience in everyday work, support of more experienced colleagues, or self-improvement. The company tries to organize trainings with the use of trainers and internal experts as much as needed.

4.5. Digital platforms for digitalisation education

The interest in online courses is rising in the last few years, and it has been further increased within the social context of the covid-19 pandemic. Consequently, it is possible to find several high-quality platforms that play the role of education marketplaces where providers and consumers meet, leveraging the powerful network effect of a learners' community in action.

However, specific investigation was needed to assess whether the digital skill needs of the Energy sector were properly covered by the current offering of Massive Open Online Courses (MOOCs): to this end, we have reviewed some of the main MOOC platforms along with other relevant MOOCs in English and in other European languages. We identified keywords covering areas at the intersection of energy and digitalisation topics, we used them in our search for learning opportunities and then we listed and analysed MOOCs to benchmark courses across training and education sectors, with a special focus on instruction for professionals. The point of benchmarking was to map the state of the art in this domain and to identify areas of improvement EDDIE might address.

Keywords used for the research:
Energy topics (energy systems - power systems - oil & gas - heating and cooling - smart grids – digitalisation - digital transformation - energy transition - sustainable energy)
digital topics (Big Data & Analytics - Cloud computing / storage – IoT - Mobile Applications - Social Networks - Autonomous robots - Artificial Intelligence - Augmented/Virtual/Mixed Reality - Digital Manufacturing - Digital Twin – Cybersecurity)

Platforms: the research included, but was not limited to:

- the main global providers - Coursera (https://www.coursera.org/), edX (https://www.edx.org/)
- the main European platforms such as FutureLearn (https://www.futurelearn.com/) and France Université Numérique (https://www.fun-mooc.fr/)
- other relevant platforms – e.g. Miriada X (www.miriadax.net)

After having listed all the interesting courses and the organisations offering them, we thoroughly explored their syllabi and main features. Finally, we labelled them as interesting, somehow interesting, or not interesting to the digital skill needs of the energy sector. The latter labels courses which were apparently aligned with digital energy, but then a deeper analysis found them not to be of direct interest, i.e., it is not a signal conveying any message about course quality, but about its relevance to the scope of EDDIE.

We show the list of courses selected in Annex 3: Massive Open Online Courses Table 62, where we also gather information about learning providers, course syllabi and other relevant remarks.

The list contains **37 courses** of which only 15 were found to be of direct relevance for the Energy sector, most of them due to tackling smart grids, and the rest indirectly covering them (e.g. courses with contents about the intertwining of the smart energy system and the smart city), or devoted to specific applications (e.g. blockchain for the energy sector).

Only 2 out of 15 courses are apparently targeting students from **EQF-4 level** (Internet of Energy Education and Qualifications; MARTEL MOOC), whereas the rest of one can be more naturally tagged as oriented to higher education levels, among other reasons because they present a broader scope of limited relevance for students that need to train very specific skills.

3 courses were identified (Electric Utilities Fundamentals and Future; Energy Systems Integration: An Introduction ; New Energy Technologies: Energy Transition and Sustainable Development) somewhat interesting for the sector, with only tangential covering of digital energy topics.

The other **19 courses** turned out not to be directly linked to the digital skill needs of the Energy sector, i.e. they cover energy topics but not digital energy ones. However, we have kept them in the list to complete a significant sample of MOOCs devoted to the energy sector, offering information about the approaches of the ones tackling digital topics and also some information about the proportion between them and the 'classic' ones.

Main takeaways from the benchmarking analysis:

- topics related to digitalisation of energy are not well established yet, especially in terms of classification / categorization of the respective knowledge and skills;
- there is a variety of target audiences not only in terms of training/education level, but also in terms of cross-sectoral domains.
- credentials / qualifications awarded as well as related reference standards such as EQF are seldom specified; Erasmus+ EnergyEducation and Internet of Energy Education and Qualification (IoE-EQ) projects provide some food for thought.
- there is no explicit reference to ESCO in MOOCs but describing learning outcomes and credentials with specific reference to ESCO will probably become increasingly important as Europass takes off.

Table 34 List of selected MOOCs

Keywords	MOOC	OFFERED BY	INFO ABOUT TOPICS	QUALIFICATION/TARGET
Digital skills / Energy efficiency measures	SMARTEL MOOC https://www.openlearning.com/courses/smartel-mooc/	SMARTEL Erasmus+ project (http://smartel-project.eu/en/home/) on openlearning The SMARTEL project aims to increase **the quality of VET** provision for electricians	The adoption of energy efficiency measures is shifting the building installation industry towards green technologies such as smart metering and home automation, bringing significant changes on workplace requirements and training. **Electricians, apart from technical proficiency, require a combination of digital and environmental skills** to perform the installation, maintenance, and programming of smart metering and energy efficiency home automation systems. Among topics • Resolve problems associated with energy controlling systems in buildings • Connect standardized energy controlling system • Design an operating energy controlling solution • Interpret energy farm schemes • Operate energy control and metering devices • Analyse energy control and metering specifications • EU and national legislation regarding sensors	VET (it complies with **EQF level 4** Start any time Flexible duration
Digital tools in energy management	Smart energy management (SEM) https://ilias.fh-muenster.de/ilias/goto_Bibliothek_crs_542294.html?lang=en	EnergyEducation Erasmus+ project (http://www.energyducation.eu) on FH Münster ILIAS	• Lighting • UX Design • Thermal Installations • Energy Mapping	**VET (EQF level 4/5)** Qualification definition https://skillstools.eu/wp-content/uploads/2019/11/Definition-SEM.pdf Course format: hands-on approach, challenges
Internet of Energy	Internet of Energy Education and Qualification https://www.ioe-edu.eu/en/ioe_profiles.aspx	IOE-EQ Erasmus+ project	**Course: IoE Manager/decision maker** · Module 1: Introduction to IoE technology · Module 2: IoE business analysis and strategy · Module 3: IoE data analysis · Module 4: Legal aspects · Module 5: Basics of networking and security **Course: IoE Expert for Smart Cities** · Module 1: Introduction to IoE	**VET Courses** The IoE-EQ project has adopted the e-CF 3.0 framework to design four professional qualifications

			· Module 2: Smart Grids · Module 3: Integration of electric mobility with the grid · Module 4: IoE data analysis · Module 5: Basics of networking and security **Course: IoE Expert for Smart metering systems** · Module 1: Introduction to IoE · Module 2: Smart energy metering · Module 3: Platforms for smart energy metering · Module 4: IoE data analysis · Module 5: Basics of networking and security **Course: IoE Expert for Renewable Energies** · Module 1: Introduction to IoE · Module 2: Smart uses and management of renewable energies · Module 3: Energy storage systems · Module 4: IoE data analysis · Module 5: Basics of networking and security	
Smart Grids / DIGITAL REVOLUTION	New Energy Technologies: Energy Transition and Sustainable Development https://www.futurelearn.com/courses/new-energy-technologies	Grenoble Ecole de Management on FutureLearn	Among topics • Energy Efficiency • Key energy efficiency markets and trends • Prosumers' concept • **Digital revolution** • Projects in energy efficiency in Europe • **Smart Grids** Definition of a smart grid Smart grid as key element of the future electricity system Smart grids connected with Smart buildings and Smart cities Links between Smart Grids and Storage Main actors in France and Europe Trends and innovation projects in the smart grids field	This course will be of particular interest to **students studying electrical networks**, electrical engineering or smart grids, and to **professionals, especially those working in energy industry.**
Smart Grids	Smart Grids: The Basics https://www.edx.org/course/smart-grids-the-basics	TU Delft	Understand the basics of smart grids. Learn about their heterogeneity, dynamics, control, and about security and assessment strategies. Syllabus Week 1. Modeling Smart Grids Week 2. Optimal Power Flow (OPF) Week 3. Power System Dynamics (PSD) Week 4. Automation networks	Intermediate level (Engineer)

			Week 5. Wide Area Monitoring Protection and Control (WAMPAC) Week 6. Smart Grid Cyber Security (+ week 0 and week 7 conclusion)	
Smart Grids	Smart Grids: Modeling https://www.edx.org/course/smart-grids-modeling	TU Delft	Learn to build a model of a smart power grid, and to diagnose the effects of disturbances from variable renewable energy resources and intelligent demand on the grid. Syllabus Week 1 Introduction to OpenModelica Week 2 Modeling and Simulating a Power System Week 3 Assessing Power Systems Week 4 Adding a Renewable Energy Source Week 5 Smart Grid Cyber Security Week 6 Conclusion (+ week 0)	Intermediate level (Engineer)
Smart Grids	Smart Grids for Smart Cities: Towards Zero Emissions https://www.futurelearn.com/courses/smart-grids	EIT InnoEnergy (with Homuork and Smartgrid.cat)	Find out how smart grids and big data can help citizens, companies and cities understand energy use and reduce carbon footprint. Topics • The power and energy transition impact in the world economy • How smart grids will enhance the era of information • What is a smart city and how can we make cities smarter • Smarts citizens: new forms of mobility and energy consumption and production • New business models for smart cities	Not currently running, no future dates
Smart Grids	Smart Grids : les réseaux électriques au cœur de la transition énergétique https://www.fun-mooc.fr/courses/course-v1:grenoblealpes+92005+session03/about	Université Grenoble Alpes on France Université Numérique	Semaine 1 : Introduction à l'électrotechnique et aux réseaux électriques Semaine 2 : Les principaux acteurs du réseau Semaine 3 : Les évolutions actuelles des usages, et leurs conséquences Semaine 4 : Les smart grids	For professionals, communities and citizens

Smart Grids / Sustainable cities	Co-Creating Sustainable Cities https://www.edx.org/course/co-creating-sustainable-cities	TUDelft Wageningen Universiteit	This MOOC address the topic of involving citizens in co-creating Sustainable Cities. It addresses topics such as participative democracy and legitimacy**, ICTs and big data,** infrastructure and technology, and SMART technologies in daily life. Syllabus Module 6 covers Smart Energy & Mobility: 6.1 Introduction to Energy&Mobility **6.2 Smart Grids and Citizens** 6.3 Sharing Energy: The Case of VPPs 6.4 Practical Assignment 6.5 Urban Mobility 6.6 Slow Mobility	Advances level (Social Science)
Smart Grids Microgrids	Solar Energy: Integration of Photovoltaic Systems in Microgrids https://www.edx.org/course/solar-energy-integration-of-photovoltaic-systems-i	TUDelft	Learn how to integrate a photovoltaic system into a microgrid of your design. You will master various concepts related to microgrid technology and implementation, such as **smart grid** and virtual power plant, types of distribution network, markets, control strategies and components. Topics Difference between a microgrid, a passive distribution grid and a virtual power plant Ancillary services provided by microgrids and PV Operation of centralized and decentralized control, forecasting, and evaluation of different market policies through a case study Operation of active power control and voltage regulation Different layouts and topologies of microgrids and power electronic components, and the role of power electronics converters in microgrids Microgrid protection, adaptive protection, and the consequences of using a fault current source and fault current limitation Main motivations and challenges for the implementation of DC microgrids	Advanced level (Engineer)
Smart urban Energy Systems	Smart Cities – Management of Smart Urban Infrastructures https://www.co	École Polytechnique Fédérale de Lausanne - EPFL on Cursera	Among topics **Week 2 - Smart Urban Energy Systems** Conceptualization of Smart Urban Energy Systems Interview with an Utility company	Beginner Level

	ursera.org/learn/smart-cities		The infrastructure layer of smart urban energy systems The services layer of smart urban energy systems The data/digital layer of smart urban energy systems Managerial and Policy takeaways Interview with an Energy company	
AI (some cases)	AI in Business https://www.agoria.be/ai-in-business/en/	Agoria (Belgium), Belgian association for supporting technology-inspired companies in Belgium, has developed a MOOC on AI, dedicated to the upskilling of workers and the uptake of AI in companies	Chapter 5: Let's get practical. Be inspired by more than 30 Belgian AI use cases in different industries, such as **energy**, healthcare, manufacturing, smart cities, and so on.	Target group: production managers, CxO's, HR managers, data scientists, business analysts, business architects, functional analysts, IT or business consultants, IT or business consultants with an interest in data analytics Level: Introductory
Blockchain	Blockchain in the Energy Sector https://www.futurelearn.com/courses/blockchain-energy-sector	EIT InnoEnergy with EIT digital	Learn how **blockchain works, how the technology has evolved, and why it will empower energy customers** like never before. Topics • What is blockchain? • Digital currencies • The evolution and future of blockchain • Smart contracts and decentralized applications • Blockchain in the energy sector: the new paradigm • P2P energy trading • Blockchain applied to EV charging	Not currently running, no future dates
Infrastructure	The Next Generation of Infrastructure https://www.edx.org/course/the-next-generation-of-infrastructure	TUDelft	Explore the challenges and complexity of both global and local infrastructure (IT/Telecom, **Energy**, Water and Transportation) and how to make the best decisions to improve it. Syllabus • Module 0: Setting the scene: the infrastructural challenge for the future • Module 1: The socio-technical complexity of infrastructures/key concepts • Module 2: Fuzzy borders: interconnectedness,	Intermediate level (Computer Science)

			interdependencies, bottom-up developments and need for standards • Module 3: Complexity theory and why infrastructures are complex systems • Module 4: Governance and regulation of complex infrastructures • Module 5: Modeling, gaming and simulation as tools for designing and understanding infrastructures • **Module 6: ICT-architecture and cybersecurity: challenges** • Module 7: Wrap-up: design of infrastructures of urban areas	

4.6. Survey to Education & Training providers

Overview

In continuation of EDDIE project's aim to identify the gaps between the digital skills that are supplied by education and training (ET) providers and the ones needed from the energy sector, the project's consortium developed a second dedicated survey. The first survey, that is presented in "Deliverable D2.1: Current challenges in the energy sector and state of the art in education/training"[ref] and can be found in the project's site: http://www.eddie-erasmus.eu/, is addressed to a variety of actors across the energy sector such as generators, DSOs, TSOs, service providers and others. It aims to gain feedback about the main challenges the industry faces in relation to the digitalisation of the energy sector and the new skills that are needed for the digitalisation to happen.

The second survey, that is presented in the current document, is addressing education and training providers regarding the inclusion of the digital tools and technologies on energy related studies. In order to have a realistic reflection from the actual situation the survey was sent to several stakeholders located mostly in Europe, that cover all levels of education from secondary education up (Universities, Colleges, Secondary education institutes, VETs and others), covering mainly EQF levels from 4 to 8. The results that are presented here are based on the aggregate responses.

The main goal of the survey is to understand in what extend skills and knowledge on digital tools and technologies are being currently covered within educational institutes. The secondary goal is to address the level of cultivation of transversal and business skills like communication, leadership and others. Finally, the tertiary goal is to understand how the COVID-19 crisis affected the education process. The complete survey is available at Annex 4.

The platform of choice to host the survey is the EU Survey. EUSurvey is an online survey management system for creating and publishing forms available to the public. Launched in 2013, EUSurvey is the European Commission's official survey management tool. Its main purpose is to create official surveys of public opinion and forms for internal communication and staff management. EUSurvey provides a wide variety of elements used in forms, ranging from the simple (e.g., text questions and multiple-choice questions) to the advanced (e.g. editable spreadsheets and multimedia elements). The application, hosted at the European Commission's Department for digital services (DG DIGIT), is available free of charge to all EU citizens. EUSurvey can be accessed from the dedicated website: https://ec.europa.eu/eusurvey.

Structure

The survey is divided in 3 sections (excluding introduction and communication).

Section 1. Demographics

The first section gathers information about the interviewee's institution such as country of origin, the levels of educational programs that are provided (according to EQF), the size of the organisation and the subsectors of Energy that are covered. These data make possible to correlate the use of the digitalisation tools and technologies with all these metrics and draw corresponding conclusions. Also, in this section the questions about the changes that were inevitable for the educational process due to COVID-19 are included.

Section 2. Tools, technologies, and skills in a study programme

The second section navigates the interviewee in describing up to three study programmes from their institution regarding the use of the digitalisation tools and technologies that are shown in the following tables. Additionally, the interviewee is asked to describe the skill level that the students are expected to reach in the skills that are shown in the following tables and are grouped in more general categories like "Analytical methods", "Data capture & Management" and others.

Technologies

Table 35 List of technologies addressed via the survey

1	Artificial Intelligence
2	Big Data/Data analytics
3	Cybersecurity
4	Digital Platforms
5	Internet of Things (IoT)
6	Cloud Services
7	Virtual product development and testing
8	Blockchain
9	Digital asset management
10	Energy management systems
11	Communication technologies (e.g. 5G)

Tools

Table 36 List of tools addressed via the survey

1	Cloud servers
2	SCADA/HMI Systems
3	Distribution Management Systems (DMS)
4	Peer to peer exchange tools
5	Smart sensors
6	Intelligent maintenance systems
7	Smart meters
8	Geographic Information Systems (GIS)
9	Customer services
10	Drones

11	Robotics/advanced manufacturing
12	Online collaboration platforms

Data capture & Management

Table 37 List of Data Capture & Management skills addressed at the survey

1	Browse, search and filter data, information and digital content
2	Evaluate data, information and digital content
3	Manage data, information and digital content

Analytical methods

Table 38 List of Analytical methods addressed at the survey

1	Application of statistical methods
2	Mathematical optimization
3	Application of data mining approaches
4	Perform big data analysis
5	Report analysis results
6	Predictive modelling/analysis

Computing tools and platforms

Table 39 List of Computing tools and platforms addressed at the survey

1	Usage of high-performance computing resources and high availability systems
2	Accessing, analysis and visualization of data
3	Accessing, analysis and visualization of data on cloud infrastructures
4	Managing security and privacy issues on digital platforms
5	Administration of hardware infrastructure (web servers, workstations, etc.)
6	Use of simulation tools
7	Use of distributed software systems

Programming, development and technology related

Table 40 List of Programming, development and technology related skills addressed at the survey

1	Creatively use digital technologies
2	Development of prototypes and new analysis algorithms
3	Use specific data analysis software
4	Requirements analysis
5	Development of web applications (JavaScript, HMTL, CSS etc)
6	Design and development of applications (Python, Java, C++ etc)
7	Query data from database (via SQL etc)

8	Integration of sensor data and IoT applications
9	System design competence
10	Blockchain skills
11	Understanding of cybersecurity
12	Understanding and usage of communication technologies

Section 3. Transversal, Business and Green Skills

In the last section the questions are about interdisciplinary skills like communication, team working and others. These skills are increasingly prevalent in online job listings and traditionally they were not considered as part of the formal education rather they were regarded as personality traits. Also, in this section the tendency to cover green skills is explored. Green skills are the skills that became necessary after the turn of the Energy sector towards more environmentally friendly practices. The above-mentioned skill groups are presented in the following tables

Transversal skills

Table 41 List of Transversal skills addressed at the survey

1	Communication
2	Team working
3	Ease of learning
4	Planning and organization
5	Problem solving
6	Innovation and creativity
7	Leadership
8	Systemic/holistic thinking
9	Cross-disciplinary technical competences

Business skills

Table 42 List of Business skills addressed at the survey

1	Changing business landscapes within the European energy sector
2	Regulatory and policy landscape within the European energy sector
3	Changing customer preferences and user experience expectations
4	Digital transformation (radical business development)
5	New business models
6	Platforms and eco systems
7	Governance systems
8	Enabling sustainability through digitalisation
9	Strategic cybersecurity
10	Change management

Analysis methodology

In order to draw useful conclusions, the analysis of the gathered data has to take into account the demographics of each respondent. This includes not only the country of the institute and the size of it but also the level of education that is provided by it and the position that the survey participant holds.

The level at which the digital tools, technologies and skills that were identified by the previous survey are being taught by the higher education institutes will be measured. For the tools and technologies (that are mentioned on the above tables) the questions are binary (whether it is used or not) but for the skills the questions are qualitative, so the interviewee is asked to provide the skill level that a student is expected to reach after taking the programme at question. The impact of digitalisation can be traced not only to the technical aspects of the profession (which was until now the primary target of education institutes) but to other areas that are shared among most of the professions nowadays hence they are called transversal. Since increasingly more companies are international or the collaboration with companies from other countries is required, communication, teamwork, multicultural experience and similar characteristics are frequently included in the current job listings. By measuring the degree in which a tool, technology or skill is already incorporated in the education we will then be able to identify the skill gaps between the industry and the education and provide insights as to where the education should aim

Survey results

The survey received **33 answers** from reference education and training providers, mostly from Europe. The majority of the answers come from the EDDIE focus countries (Spain, Germany, Sweden, Greece, Romania) while there is fair distribution within Europe. Also, participation from USA was also included in the results.

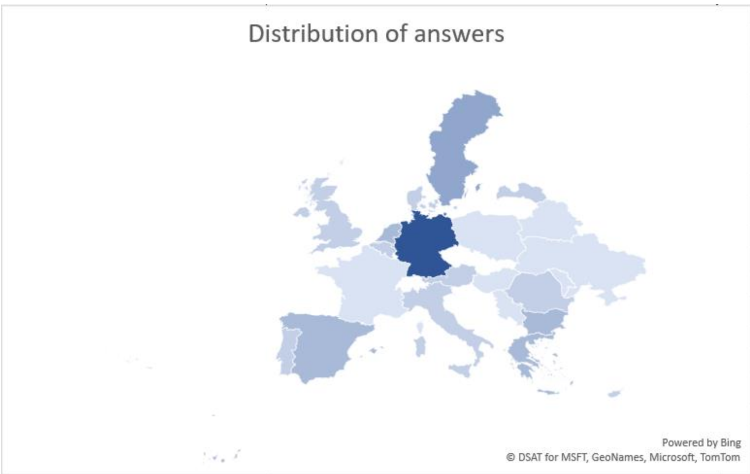


Figure 32 Distribution of answers

As shown in Figure 33 and Figure **34** almost all the responses come from Universities and there is one response coming from a VET institute and two from Research institutes. The majority of the responses are from large institutes with a student population between 10.000 and 50.000 From the above it is safe to state that our sample is not as diverse as it was intended to be regarding the size and type of institute and the results are more representative of a big university. **As it was pointed out by several participants, the survey was considered time-consuming to answer since it required a broad overview of the institution's overall positioning in the addressed topics. Throughout the life of EDDIE, it is the partners' ambition to update the survey and distribute it again to obtain more representative results. Through the Blueprint it is intended to find an updating mechanism to keep the questions relevant and use the survey to feed the blueprint regularly**

How can your organization be best described?

	Answers	Ratio
University	26	89.66 %
Other	2	6.90 %
Vocational Education & Training (VET) Provider	1	3.45 %
College	0	0.00 %
Secondary education institute	0	0.00 %
No Answer	0	0.00 %

Figure 33 Answers distribution per institute type

How many students study at your organisation (estimation)?

	Answers	Ratio
Less than 500	3	10.34 %
500-1000	0	0.00 %
1001-10.000	8	27.59 %
10.001-50.000	14	48.28 %
More than 50.000	4	13.79 %
No Answer	0	0.00 %

Figure 34 Answers distribution per institute size

The following figures contain the information of the types of degrees that the institutes award and the levels of the educational programs that the institutes provide according to the European Qualifications Framework (EQF). Figure 36 provides the EQF categorisation for easy reference. Both figures strengthen the idea that the responses come mainly from universities hence they award the three main degree types that correlate to EQF levels 6, 7 and 8.

What are the types of degrees attributed by your institution?

	Answers	Ratio
Associate Degree	0	0.00 %
Bachelor's Degree	24	82.76 %
Master's Degree	26	89.66 %
Doctorate Degree	26	89.66 %
Other	6	20.69 %
No Answer	0	0.00 %

Figure 35 Answers distribution per degree type

What are the European Qualifications Framework (EQF) level(s) of the educational programs at your institution?

	Answers	Ratio
Level 1	0	0.00 %
Level 2	0	0.00 %
Level 3	0	0.00 %
Level 4	2	6.90 %
Level 5	5	17.24 %
Level 6	20	68.97 %
Level 7	22	75.86 %
Level 8	28	96.55 %
No Answer	0	0.00 %

Figure 36 Answers distribution per EQF level

The two questions that follow are about the educational/training means that are available in each institute with multiple answers allowed and the role(s) the interviewee holds in their institute and the subsector they belong to. It is evident that the majority of the institutes have multiple educational/means which can accommodate all the different situations of the students. The only exception to that are the MOOCs which typically are not part of large universities but rather they are standalone platforms and can be used both by students and employees. Almost all of the respondents hold a position of professor (full, associate. assistant, adjunct, or teacher) and roughly 1 in 6 at the same time hold a position of either a researcher or a director. Their area of expertise which was described freely by them suits better either in the subsector of power or in the subsector of Digital/Data or both. Some of the answers were very general and could not be categorised.

Please indicate which of the following means are available for educational/training activities at your organisation (You can choose more than one if applicable)

	Answers	Ratio
Courses with physical attendance	28	96.55 %
Online courses	23	79.31 %
Seminars	24	82.76 %
Webinars	17	58.62 %
MOOCs (Massive Open Online Courses)	9	31.03 %
Summer Schools	20	68.97 %
Other	2	6.90 %
No Answer	0	0.00 %

Figure 37 Answer allocation per Educational/training mean

This section of questions is concluded with the ones about the effect of COVID-19 crisis on education. The next figures show in which way the institutes responded to the pandemic, whether they were ready for the transition to the online courses and how they evaluate the transition. Most of the institutes chose to switch to online courses except for the situations that this was not feasible like in lab activities. The readiness for this switch is divided between "Yes" and "No" with the sum of "Yes" and "Some departments" adding up to 86% of the answers and

“No” and “Some departments” adding up to 69% of the answers. So overall there is a slight leaning towards the fact that the departments were ready for the transition. This slight leaning towards being ready to handle the online transition is reflected to the self-evaluation of this transition which is above average.

How were/are the educational activities carried out during the pandemic?

	Answers	Ratio
Physical attendance	3	10.34 %
Online courses	24	82.76 %
Blended learning (e.g. physical attendance combined with digital tools)	15	51.72 %
Hybrid (e.g. online courses and physical attendance at laboratories)	26	89.66 %
Educational activities were stopped	0	0.00 %
No Answer	0	0.00 %

Figure 38 Answer allocation per way of handling the pandemic

Was your institution ready for the transition to online courses? (equipment, trained staff, software)

	Answers	Ratio
Yes	9	31.03 %
No	4	13.79 %
Partly (Some departments)	16	55.17 %
No Answer	0	0.00 %

Figure 39 Answer allocation of readiness for transition to online courses

On a scale 1-5, to your best knowledge, how good was the transition managed? (1- very good, 5-very bad)

	Answers	Ratio
1	7	24.14 %
2	11	37.93 %
3	3	10.34 %
4	4	13.79 %
5	0	0.00 %
No Answer	4	13.79 %

Figure 40 Evaluation of the transition to online courses

The next question is about the challenges that the institute had to face at the beginning of the COVID-19 crisis. The question was open-ended but there were common themes among the responses. Half of the institutes report some kind of problem with the examination without physical attendance and many institutes had problem with Laboratories (especially the ones about Power Systems) that cannot be done digitally. Almost all of the problems require effort from the teachers for their solution and this leads to exhaustion and psychological stress.

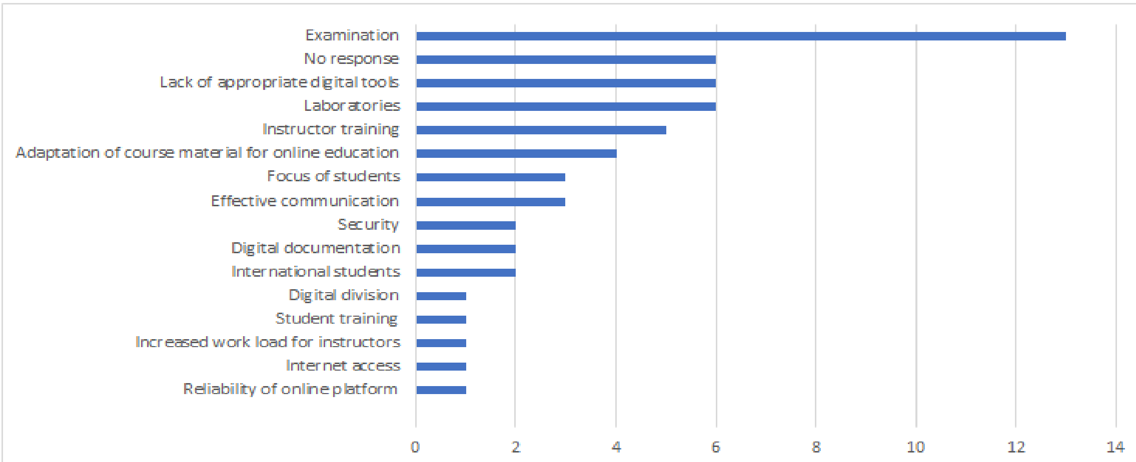


Figure 41 Most common obstacles that the institutes report

Finally, this section concludes with an open-ended question about the impact of the crisis and the lessons learned from it. Those responses can be summarized in the following remarks: The teachers had many problems to solve regarding the safe conduct of the lessons and the exams, making sure that all students can participate, and this not only stressed them psychologically but led to other important tasks like research work to fall behind. There is consensus that the traditional lessons cannot be fully replaced but rather substituted by the online courses. The main component missing is the communication channels individually with each student and the feedback from them which makes it harder to understand if the material is being understood.

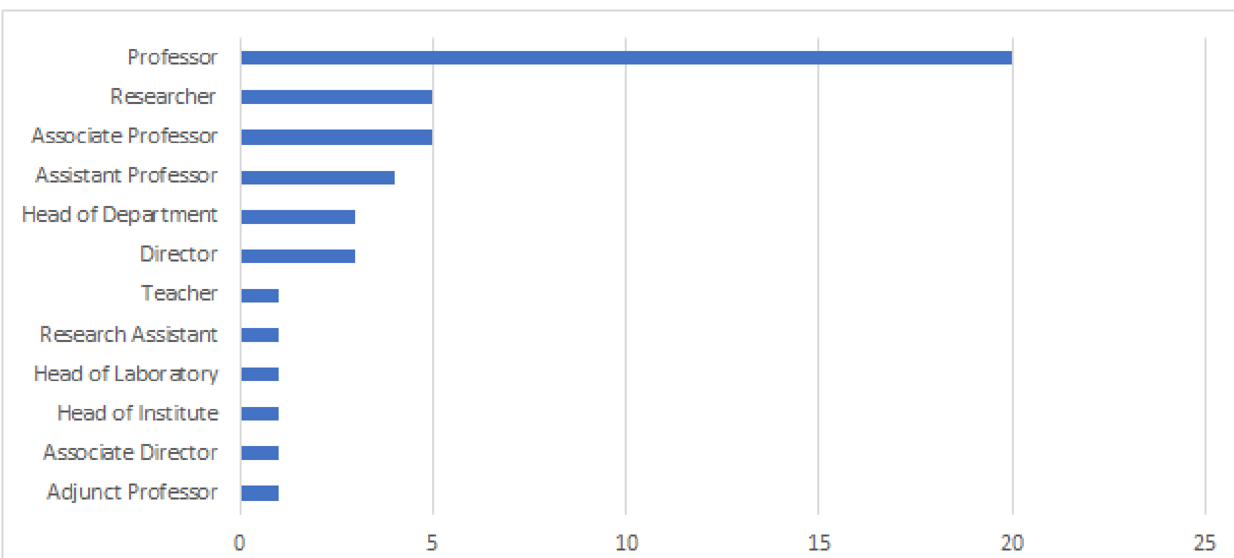


Figure 42 Answer allocation per Educational role

The next part of the survey focused at addressing the knowledge and skills provided by the ET providers considering digitalisation. The skill sets and specific skills used in the questionnaire are drawn from the survey that was targeted to industrial stakeholders, to have aligned and comparable results. In accordance with the survey to the industry, the skills were assessed in 3 different expertise level. So, each participant was asked to indicate if the skills are addressed within a specific study program and the level of expertise that students are expected to reach at the end of the studies. In the analysis only the intermediate and the expert levels are presented to make the figures clearer. The percentage "missing" from the figures refer to basic level and also some missing answers. For example for a skill that has 60% combined expert and intermediate level, the rest may be 30% basic level and 10% lack of answer.

Considering the skill set "Data capture & management" it is eminent that most of the participants provide all the skills at a high expertise level, since the intermediate and expert combined were answered by more than 60% of the participants.

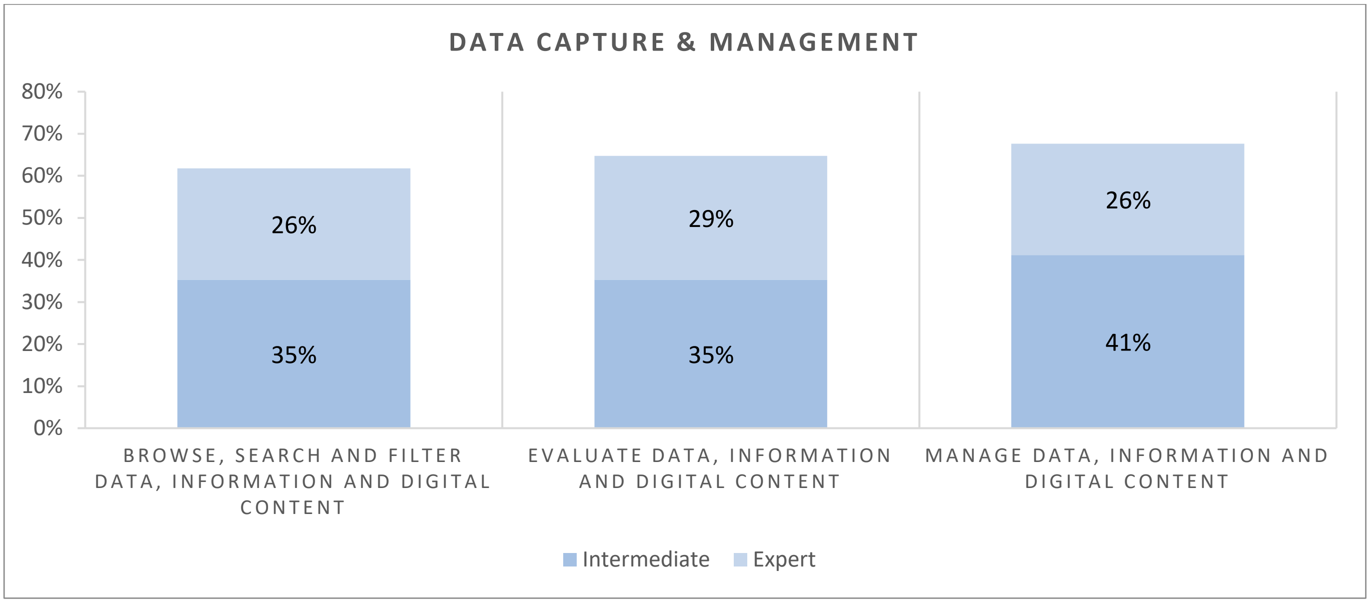


Figure 43 Data capture & management for students

Looking at Figure 44 it can be observed that the **"Application of statistical methods**", "**Report analysis results**" and "**Predictive modelling/analysis**" have similar percentages and they are taught mostly at **intermediate and expert level**. "**Mathematical optimization**" is the analytical method with the **highest percentage of expert level** teaching which means that it is perceived by ET providers as very crucial for the future of the students. Finally, "Application of data mining approaches" and "Perform data analysis" are mostly taught in basic level in the programmes of this survey.

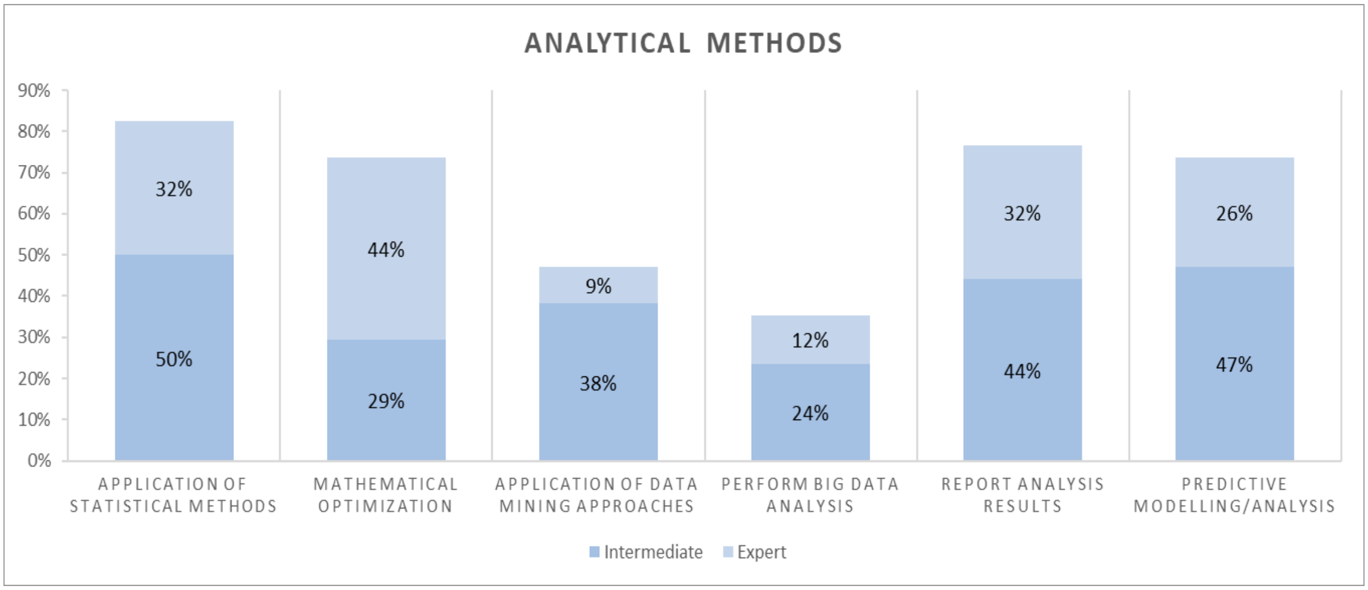


Figure 44 Analytical methods for students

Figure 45 presents the answers considering the “Computing tools and platforms” skill set, where relevant skills are assessed. The skill “**Use of simulation” tools** is the one that most of the participants indicated to be taught at **expert level**, while the skills “**Usage of high-performance computing resources and high availability systems**” and “**Accessing, analysis and visualization of data” are generally covered at a high expertise level**. On the other hand, “Managing security and privacy issues on digital platforms”, “Administration of hardware infrastructure (web servers, workstations, etc.) and “Accessing, analysis and visualization of data on cloud infrastructures” are relatively less covered at high expertise levels.

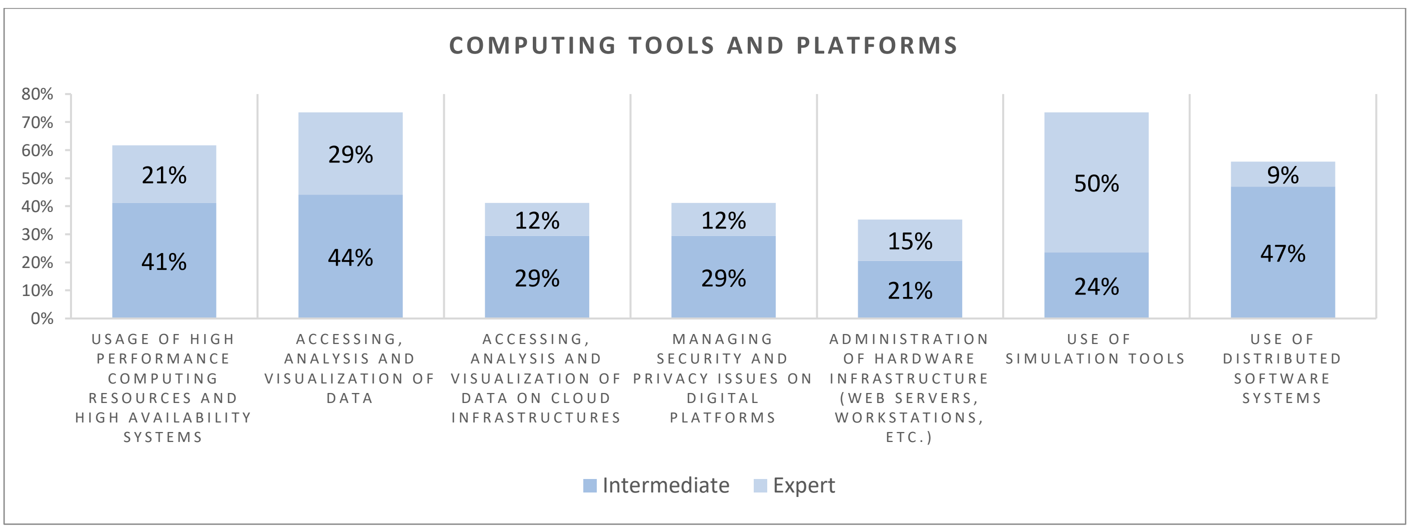


Figure 45 Computing tools and platforms for students

The last skill set is “Programming, development and technology related”. Most of these skills show similar distribution of answers between the different expertise levels taught. Different profile can be observed in the skill “**Blockchain skills” which is mostly taught at Basic level**. “**Design and development of applications (Python, Java, C++ etc.)” and “Understanding and usage of communication technologies” are taught mostly in intermediate** level which suggests that they are perceived as very useful from ET providers. Participants indicated also the skill “Quantum computing and computer technologies” as a relevant to this category skill.

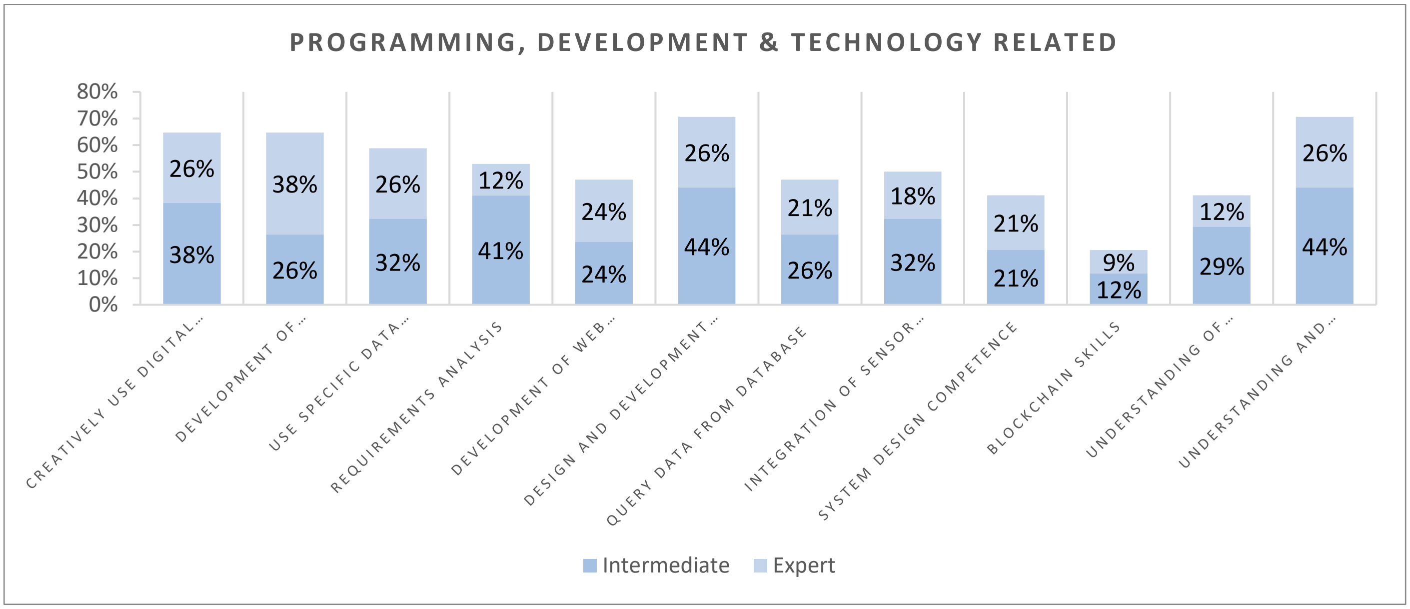


Figure 46 Programming, development and technology related

Transversal, Business and Green Skills

The last section contains questions about skills that are more general and are required to increasingly more job listings from various sectors. **Communication, Team working and Problem solving** are cultivated in more than two thirds of the institutes. What stands out is that Leadership is cultivated in only 20% of the institutes perhaps because it is considered as a personality trait rather than a skill that can be cultivated.

Transversal

		Answers	Ratio
Communication		21	70.00 %
Team working		23	76.67 %
Ease of learning		11	36.67 %
Planning and organization		19	63.33 %
Problem solving		24	80.00 %
Innovation and creativity		17	56.67 %
Leadership		6	20.00 %
Systemic/holistic thinking		12	40.00 %
Cross-disciplinary technical competences		19	63.33 %
No Answer		3	10.00 %

Figure 47 Transversal skills cultivated in educational institutes

As indicated in Figure 48 the Business perspectives that are covered by the institutes and are considered crucial for the digital transformation are mainly three: "**Changing business landscapes", "Regulatory and policy landscape" and "Enabling sustainability through digitalisation".**

Please indicate the business perspectives covered by your study programs that may be crucial for the digital transformation.

	Answers	Ratio
Changing business landscapes within the European energy sector	16	53.33 %
Regulatory and policy landscape within the European energy sector	17	56.67 %
Changing customer preferences and user experience expectations	8	26.67 %
Digital transformation (radical business development)	11	36.67 %
New business models	14	46.67 %
Platforms and eco systems	9	30.00 %
Governance systems	7	23.33 %
Enabling sustainability through digitalization	16	53.33 %
Strategic cybersecurity	8	26.67 %
Change management	6	20.00 %
Other	2	6.67 %
No Answer	4	13.33 %

Figure 48 Business perspectives that may be crucial for the digital transformation

The survey is concluded with the questions about Green skills. By Green skills we mean the skills, knowledge, values, and attitudes needed in the workforce to develop and support sustainable social, economic, and environmental outcomes in business, industry and the community. The need for sustainability in Energy production and use of environmentally friendly techniques is relatively recent and it is not yet adequately included in education. In Figure 49 it is shown that most of the institutes does face the challenge of adapting its study program but in Figure 50 and 39 it is shown that it is rather about adding green components to existing skills than adding skills that were not needed before. The main drivers for this skill adaptation are the three that were suggested in the question equivalently (Figure 52).

Does your institution face the challenge of adapting its study program to climate-driven goals and policies?

	Answers	Ratio
Yes	21	70.00 %
No	5	16.67 %
Not sure	4	13.33 %
No Answer	0	0.00 %

Figure 49 Need for study program adaptation due to climate-driven goals and policies

Does your organization need the adaptation of new green skills that were not needed before?

		Answers	Ratio
Yes		9	30.00 %
No		12	40.00 %
Not sure		10	33.33 %
No Answer		1	3.33 %

Figure 50 Need for adaptation of new green skills that were not needed before

Do you face the need to add green components to existing skills?

		Answers	Ratio
Yes		12	40.00 %
No		6	20.00 %
Not sure		10	33.33 %
No Answer		2	6.67 %

Figure 51 Need for adding green components to existing skills

What are the main drivers towards green skills adaptation?

		Answers	Ratio
Trends in policy		22	73.33 %
Trends in industry/technology		23	76.67 %
Environmental awareness		22	73.33 %
Other		1	3.33 %
No Answer		0	0.00 %

Figure 52 Main drivers towards green skills adaptation

4.7. Interviews with education and training providers

Similar to the approach used to gather feedback from industry stakeholders regarding skill gaps, reported in section 3.3 interviews were made with educational providers in order to complement the survey analysis. Similarly, from these interviews several useful insights can be obtained. Interviews were conducted with educational providers from the four focus countries of the project, Germany, Greece, Spain and Sweden. representing both university level as well as VET level organisations. The interviews consisted of open-ended questions covering the following topics:

- Demands and trends in educational offering
- Trends in skills with regards to digitalisation
- Content presently covered in offerings
- Formats of education provided
- Goals of the educational offering
- Evaluation of results
- Impact of the Pandemic on educational offering

At a general level, all respondents indicated a changing educational landscape with regards to the energy sector. There is an agreement that digitalisation has a double impact on education in the energy sector, both in terms of changing the energy sector as such, but also because of the impact on changing formats of education and the increasing pace of change regarding demands from stakeholders. Specifically, with regards to the areas covered by the interviews, the below observations were made.

The ***demands and trends in the educational*** offering can be summarized as a strong increase in need of well-trained engineers with a transversal, specifically energy and digitalisation technologies, skillset. The multi-disciplinarity extends also into fields such as cyber-security and business aspects such as management skills and market models for energy systems. In addition, the trends are towards shorter more flexible offerings including self-paced offerings, which can cater also to needs from industry stakeholders. With regards to the ***trends in skills with regards to digitalisation***, there is a clear need to provide more education in data analytics and artificial intelligence, with automation coming up as a close second. Additionally, needs related to digitalisation tools to enable modeling and simulation of energy consumers and markets is an emerging trend. The ***content presently covered in offerings*** map, at a high level, relates well to the identified trends. However, the bulk of education is still provided within traditional electrotechnical or energy related topics and the digitalisation topics are offered as add-ons, or electives in later years of studies. There are a few examples of educational offers in terms of new formats for continuing education, and most are adapted to a university context addressing mainly students in universities. Admittedly, this is biased due to the group of respondents representing mainly industry. The responses from the VET sector indicate a larger focus on use of digital tools rather than basic technologies. To some extent this maps well with requirements of allowing a self-paced format.

It is clear that the ***impact of the pandemic on the educational offering*** to a large degree has impacted the responses regarding ***formats of education provided***. All respondents have heavily strengthened their digital and online offering including interactive content. One respondent interestingly reported better learning results when a course was changed into a self-paced online learning format as opposed to previous classroom-based format. All respondents have tried to retain a physical component in the teaching with regards to lab-work, but this has in some cases not proven possible. The importance of practical work is emphasized by all, including both university and VET level. Regarding the “return to normal”, the view is split among the respondents, all see new opportunities in the online formats including the ability to offer more professional education, but the lack of physical interaction – not limited to lab-work – is an important criterion not the least in evaluation of student achievements.

Regarding ***objectives of the educational offering***, the respondents are all stressing the importance of providing employable trained professionals to society in order to impact the development of the energy system. Again, depending on the type of organization represented by the respondent, different emphasis is placed on fundamental theory as opposed to tool-based teaching to reach this goal. Also, those that find the impact on the energy system to be of high importance stress the importance of educating individuals to be awareness and provide a critical mindset, not the least important in a rapidly changing environment as the energy sector. Finally, with regards to ***evaluation of results*** the respondents offer largely traditional responses focused on the examination of students' skillsets using exams, questionnaires but also to a lesser degree by assessing employment levels after degree. This comes naturally when viewed from the perspective of an education provider but could possibly be nuanced by alternate methods such as interacting with alumni in design of programs.

4.8. Conclusions

Alignment of academia with the labour market is needed to teach the students both theoretical and practical, hands-on skills directly applicable in the work environment. To this end, incredibly significant effort in this direction is already being made by some universities and European initiatives, as presented in Sections 4.1, 4.2, 4.3. Areas such as Smart Grids, Information & Communication Technology, Innovative methods of simulation & analysis (machine learning, artificial intelligence, big data analytics) appear to be more and more present in several academic programmes throughout Europe.

Given the importance of an organization’s human capital to business success, aligning training and competency development with business needs has become a key challenge. Thus, in the last 10 years, many companies created **corporate universities** (CU) to face this challenge. Corporate universities really come into place when companies see the education of their employees as a strategic instrument to create competitiveness and support overall corporate strategy and culture. they are generally dedicated units acting as partners with senior leadership to develop strategic skills and capabilities.

Another useful source of education and training is indicated by the interest in online courses and Massive Open Online Courses (MOOCs) which is rising in the last few years, and it has been further increased within the social context of the covid-19 pandemic. Consequently, it is possible to find several high-quality platforms that play the role of education marketplaces where providers and consumers meet, leveraging the powerful network effect of a learners' community in action. One of the main takeaways from the benchmarking analysis is that topics related to digitalisation of energy are not well established yet, especially in terms of classification / categorization of the respective knowledge and skills. Nevertheless, there is a variety of target audiences not only in terms of training/education level, but also in terms of cross-sectoral domains. Moreover, the credentials / qualifications awarded as well as related reference standards such as EQF are seldom specified.

Diving deeper into the knowledge and skills offer by ET providers through the dedicated survey, one can identify if specific skills and skillsets are covered through different study programmes and the level of expertise the knowledge is provided. **Most ET providers (mainly Universities) indicate that they provide an adequate coverage of data related skills** which are crucial for the digital transformation since data is the key element in digital technologies. Nevertheless, **analytical methods** and way of thinking for example when conducting statistical analysis or mathematical optimization **are not provided at an expert level by a significant number of institutes**. **The least covered skills or the skills that are not provided at the highest expertise levels, refer to computing tools, such as simulation tools, and more ICT specific knowledge related to programming and development**. The importance of **transversal skills**, that are interdisciplinary and needed regardless the specialization, as well as **green skills** that are becoming crucial for a sustainable future is validated and stressed by the industry who is aware of their importance.

The comparison of the skill offer and the skill demand as it was expressed in Section 3.3 produces useful insights considering skills gaps and is presented in the next section .

5. Identification of skill gaps

5.1. Overview

Identifying skill gaps is a challenging task considering the whole energy sector and the spectrum of skills that are needed to perform the necessary tasks. Moreover, the skills that are needed towards the new digital era, go beyond pure digital skills, but include the addition of digitalisation related aspects to existing skills. To be able to identify skill gaps, the EDDIE project developed a methodology based on “Skills Intelligence” as it is defined by CEDEFOP. Skills intelligence is the outcome of an expert driven process of identifying, analyzing, synthesizing, and presenting quantitative and/or qualitative skills and labour market information. These may be drawn from multiple sources and adjusted to the needs of different users.

To identify the gaps towards digitalisation, the first step was to address the challenges the industry faces, already done and published in D2.1 “Current challenges in the energy sector and state of the art in education”, and then to extract information regarding the skills, knowledge and competences that the industry demands at the moment, to cover the existing needs. This process included reviewing the existing relevant work, focused primarily at the ESCO framework and CEDEFOP reviews. Moreover, since the EDDIE project proposes an industry-driven methodology, a dedicated survey was distributed to industrial stakeholders (as described in Section 3.2), and dedicated interviews with important stakeholders were carried out.

The next step is to determine whether the skill demand is covered by the skills provided by education and training institutions. To perform this task the identification of skill offer is necessary, as well as the status of professionals and graduates. By revising the curricula of prestigious institutions within Europe, going through the study programs and syllabi, the relevant skills are extracted. Also, a dedicated survey and interviews gathered more insights on the skill offer by education and training institutions. The current status of professionals is addressed via the interviews to industrial stakeholders and the survey used for the skill demand identification, where the participants were called to provide information both for the skills needed and the current coverage level of those skills as described in Section 3.3.1.

Combining the skill demand and skill offer leads to the identification of skill gaps. The gaps are identified per sector, country, type of operation as well as type of professionals (managers/administration, engineers/researchers, technicians/specialists). This approach enables the identification of the level of expertise required to mitigate each skill gap, an insight quite useful for the overall blueprint strategy proposed by the EDDIE project.

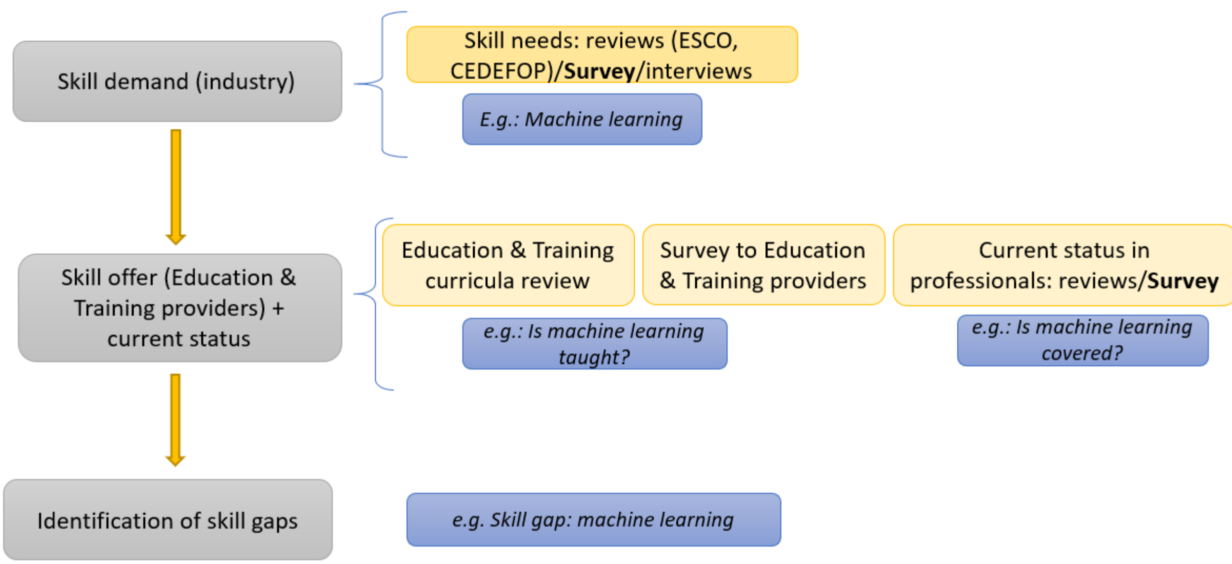


Figure 53 Simplified skill gaps identification methodology

Moreover, it is crucial to identify the “source” of the skill gaps when the goal is to design a strategy to mitigate them. In that, the results when comparing the skill demand and the current coverage level, as it was indicated by the industrial stakeholders and described in section 4.1, are not identical with the skill demand if compared to the skill offer by education and training providers. To the authors of this work best understanding, the difference might be a result of the professionals employed by the energy sector currently. For example, a lack of a specific IT skill in the energy sector might not be linked with lack of this particular skill provision, rather than that there are not qualified professionals occupied currently in the organisation. Although the education and training providers might offer the necessary skills, the industry employs people of all ages and different educational backgrounds. A mismatch in current study programmes and people educated or trained in the past may be a reason for this deviation. The confirmation of the last statement will indicate that the energy sector needs to attract qualified personnel but also reskill and upskill the current personnel. To this end, the work in the following section focuses on skill mapping, covering both the current coverage levels as well as the skill offer by education and training providers, which was presented in Section 4.2.

5.2. Skill gaps

5.2.1. Skill demand vs current status of professionals

In this section the skill gaps addressed refer to the required level of expertise, as expressed by industrial stakeholders, in comparison with the current level of coverage for each skill. Both the demand and the coverage were indicated by the industrial survey's participants. The gaps identified here do not necessarily indicate that the skill and knowledge providers fail to anticipate and cover the industry's demand, but they provide insights on the gaps of people already employed in the energy sector. As it was mentioned earlier, mitigating these gaps would require re-skilling employees, and thus they are linked with Section 4.2.4 "Industrial training programs/corporate universities", while also exploring methods to attract more qualified professionals in the sector. This is a useful insight for EDDIE project and the future development of the Blueprint.

Combining the results presented in Sections 3.2 and 4.2.2 it is possible to identify potential skill gaps. A skill mapping is considered a skill gap when there is high level of expertise needed and low level of coverage. The analysis is performed in accordance with the previous sections, addressing different categories of staff while also addressing different energy sectors, countries and types of operation. The analysis for the different skill sets follows.

Data capture and management

Figure 4 shows the intermediate and expert demand of the data capture and management skill set for people working in the management or administration position in the energy sector. The analysis indicated that the industry demands high level of expertise in every skill in this skill set which is depicted as more than 80% of the participants answered they need expert and intermediate level combined. The lowest coverage level is observed in the skill *"Evaluate Data, Information and Digital Content*" (below 50% coverage). The coverage levels on this skill set for Managers/Administration is adequately high, indicating that **there is not a definite skill gap for this staff category**.

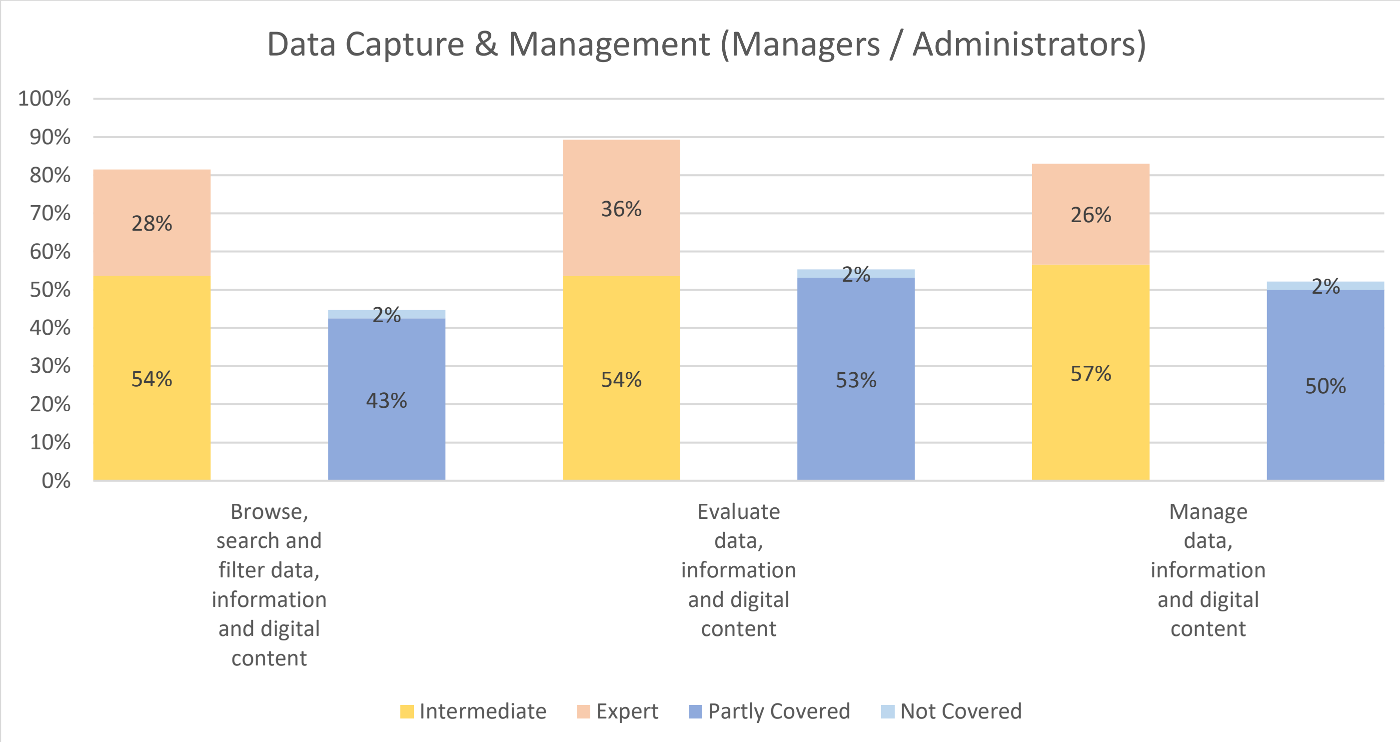


Figure 54 Data capture and management for managers/administration

In the case of *Engineers/Researchers* the expertise demand is quite high in all the skills in this skill-sets, as the Expert level is required by more than 60%of the participants. Regarding the coverage level the skill *"Evaluate Data, Information and Digital Content"* has the lowest coverage which in combination with the high expertise demand is a possible "partial" skill gap. Overall, the skill set is adequately covered compared to other skill sets thus it is not fair to state that it presents significant gap.

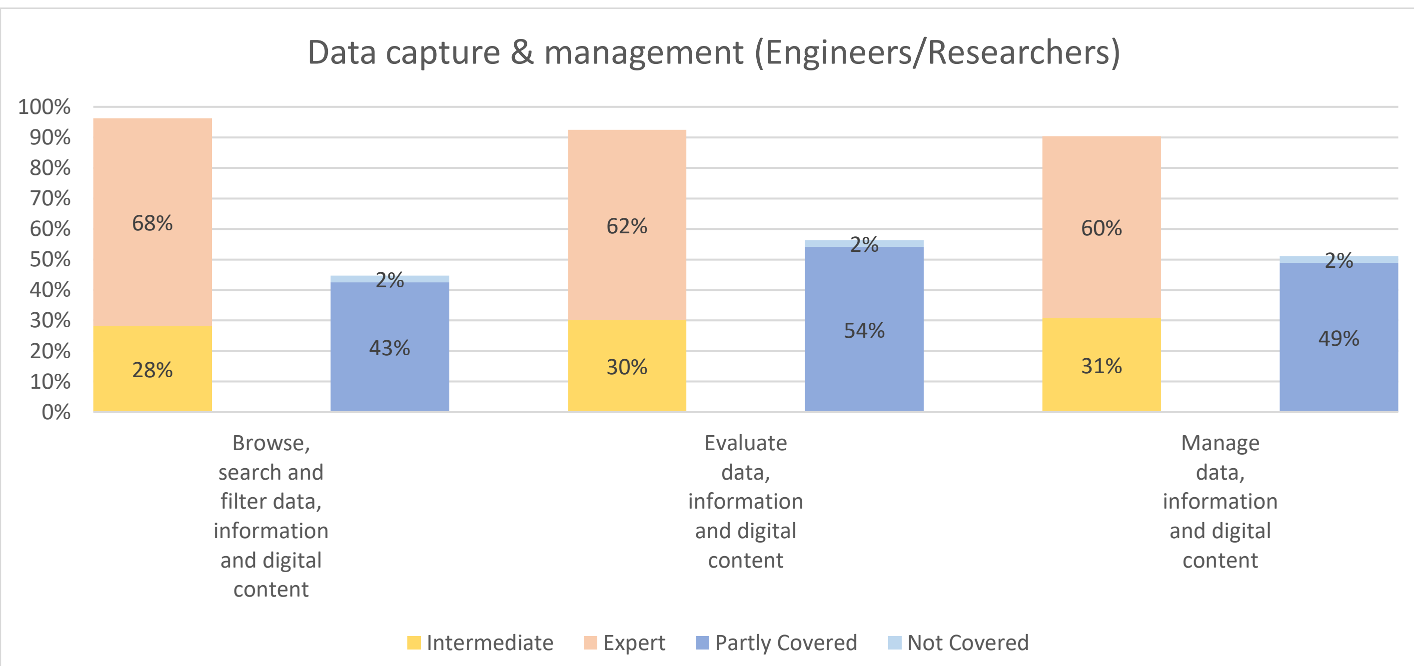


Figure 55 Data capture and management for Engineers/Researchers

The last staff category is the *"Technicians/Specialists".* Similar to the *"Managers/Administration"* the expertise demand is quite high in all the skills (>80% expert and intermediate) while the lowest coverage is observed in the *"Evaluate data, Information and digital content"* skill. Overall, it can't be definitely indicated in there is a significant skill gap overall in this skill set.

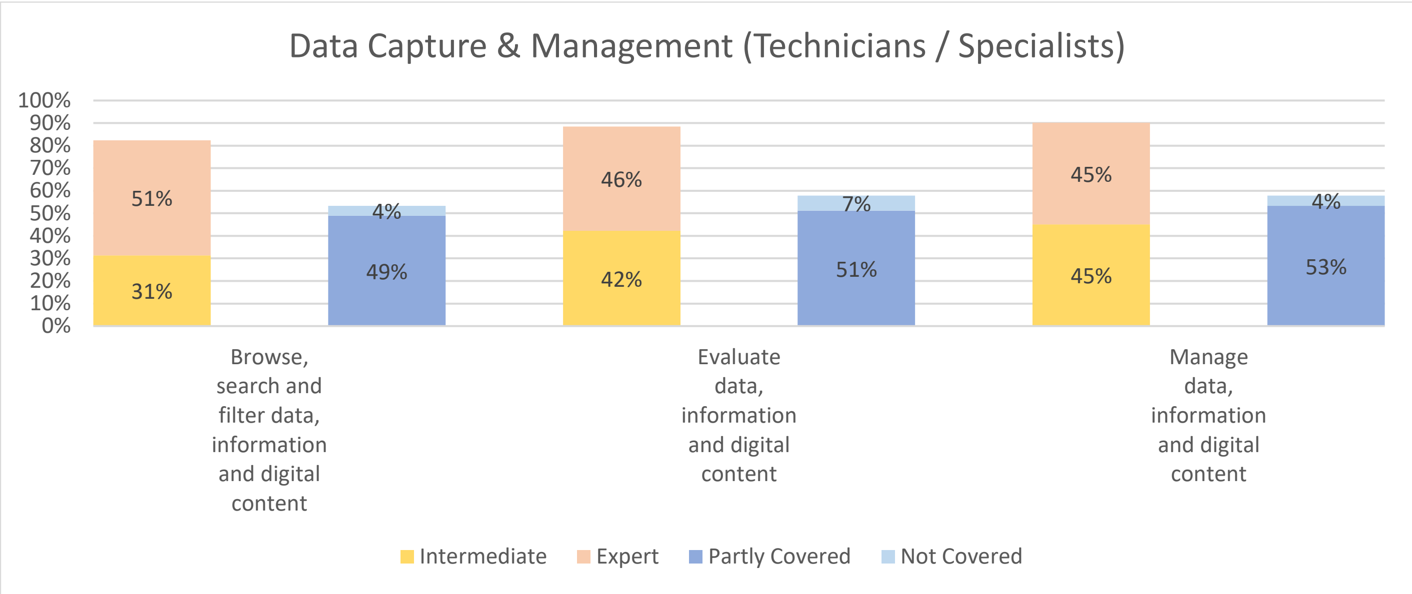


Figure 56 Data capture and management for Technicians/Specialists

Analytical methods

Figure 7 presents the comparison of skill demand and coverage level for the *"Analytical methods"* skill set for the staff category of managers. Comparing the relatively high demand levels with the coverage levels it cannot be concluded there are significant skill gaps. The lowest coverage level can be observed in the *"Application of data mining approaches"* skill but at the same time the expertise demand is quite low. To mitigate this gap, basic knowledge on data mining approaches should be adequate.

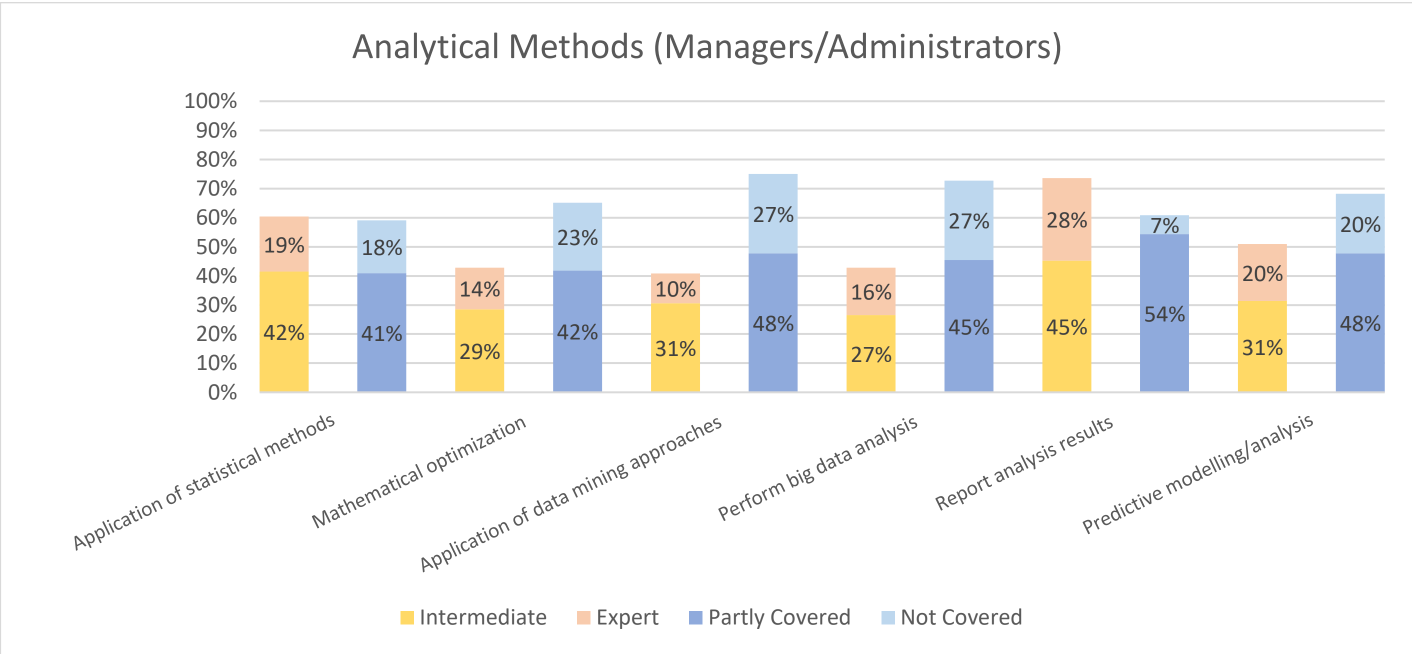


Figure 57 Analytical methods for Managers/Administration

Considering Engineers & Researchers the survey indicated that there is high demand in expertise for the "Analytical methods" skill set in every skill, as more than 80% of the participants responded that they require at least intermediate expertise. Particularly, the skills "*Mathematical optimization*" and "*Report Analysis Results*" need the highest expertise. On the other hand, the coverage level is relatively low for all the skills as more than 50% of the participants indicate that the skills are not fully covered (Partly and not covered combined >50%). The high expertise demand and low coverage indicate **that there is a skill gap in the whole Analytical methods skillset for engineers and researchers.**

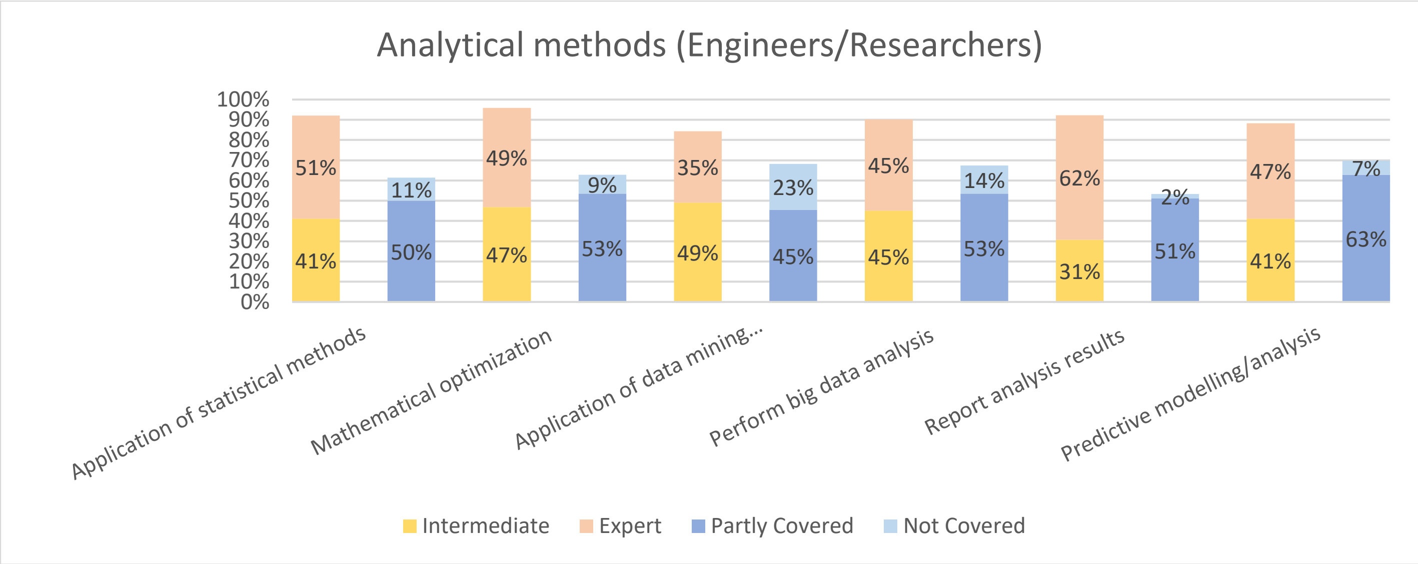


Figure 58 Analytical methods for Engineers/Researchers

Similarly, the same skill set is presented for Technicians & Specialists in Figure 9. The results show a similar distribution of answers for the expertise demand and coverage level as in Figure 8 referring to engineers. Accordingly, it can be noted that the whole analytical methods skill set is currently not adequately covered in the energy sector.

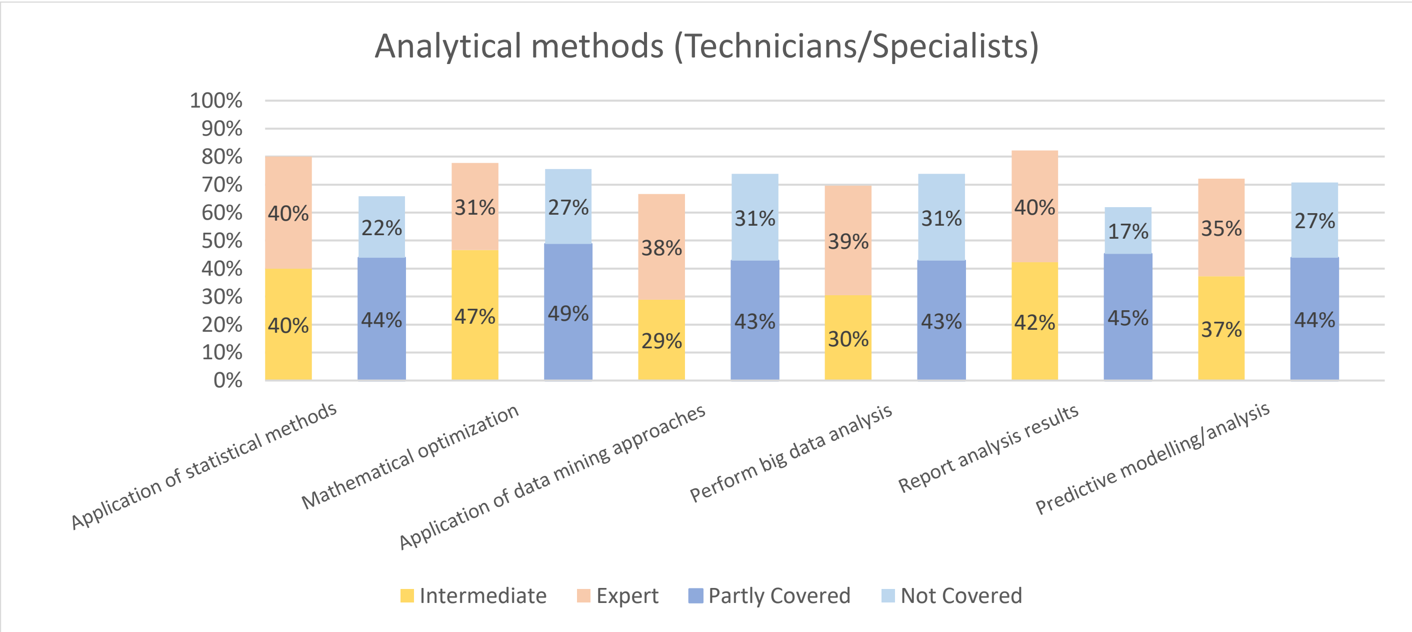


Figure 59 Analytical methods for Technicians/Specialists

Computing Tools and Platforms

The skills related to computing tools, the expertise levels needed, and their corresponding coverage levels are presented in the following figures.

Considering *"Managers/Administration"* the expertise level needs do not showcase high percentages in the participants' answers. Moreover, the skills "*Use of high-performance computing resources and high availability systems*", "*Accessing, analysis and visualization of data"* and "*Accessing, analysis and visualization of data on cloud infrastructures*" present low level of coverage and are the only candidate skill gaps. Comparing the coverage with the demand indicates potential skill gaps in these skills for the staff category of managers & administration.

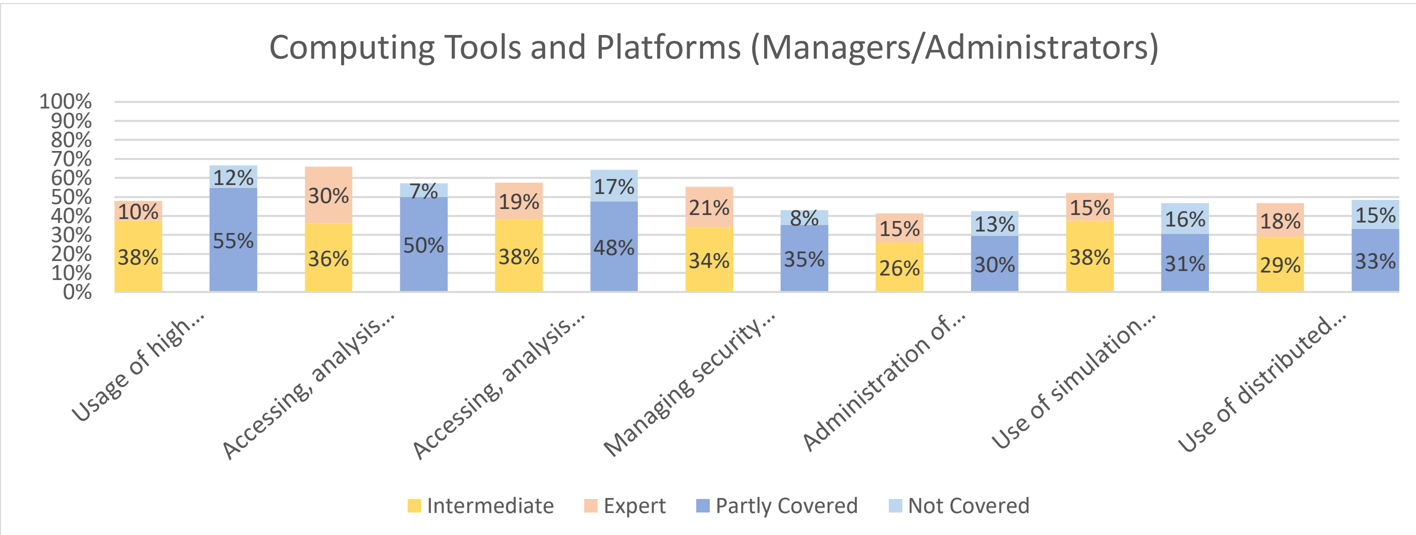


Figure 60 Computing tools and platforms for Managers/Administration

In the *"Engineers/Researchers"* staff category there is a high demand in expertise needed in all the skills, while the coverage levels are not particularly low as it can be observed in Figure 11. The outcome of this comparison cannot indicate significant skill gaps for this particular staff category.

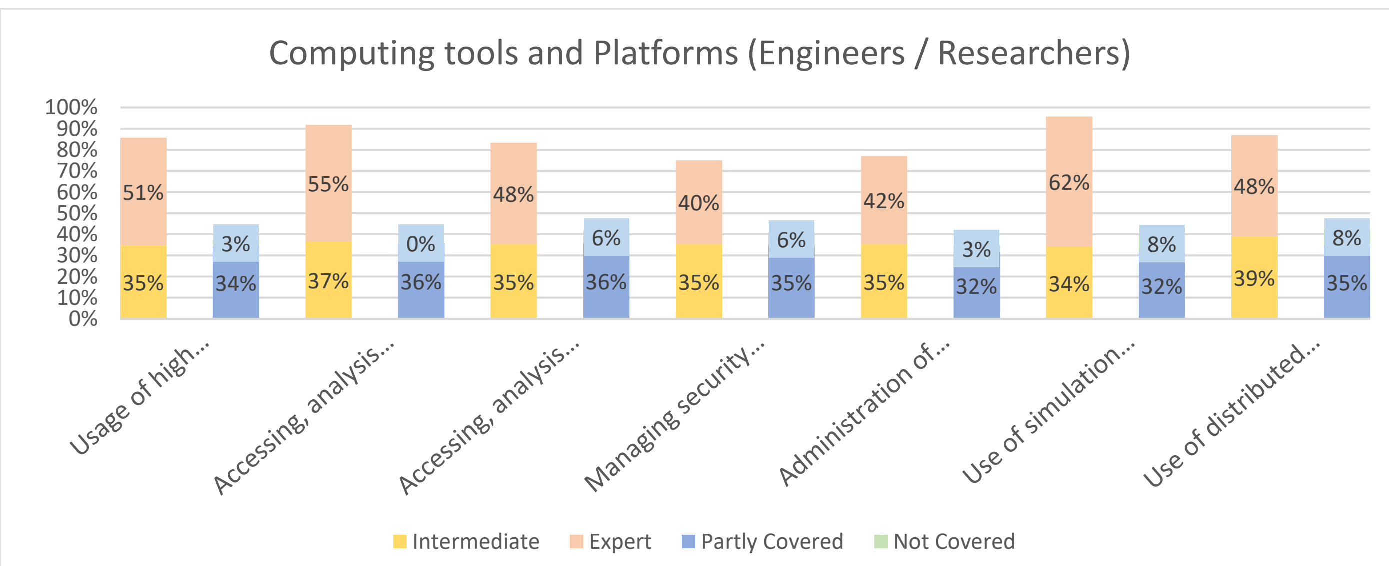


Figure 61 Computing tools and platforms for Engineers/Researchers

Figure 12 presents the same analysis for Technicians & Specialists where high levels of expertise needs can be observed while the coverage level relatively high. The overall skill is covered well except for the *"Accessing, analysis and visualization of data*" skill which has the lowest coverage level.

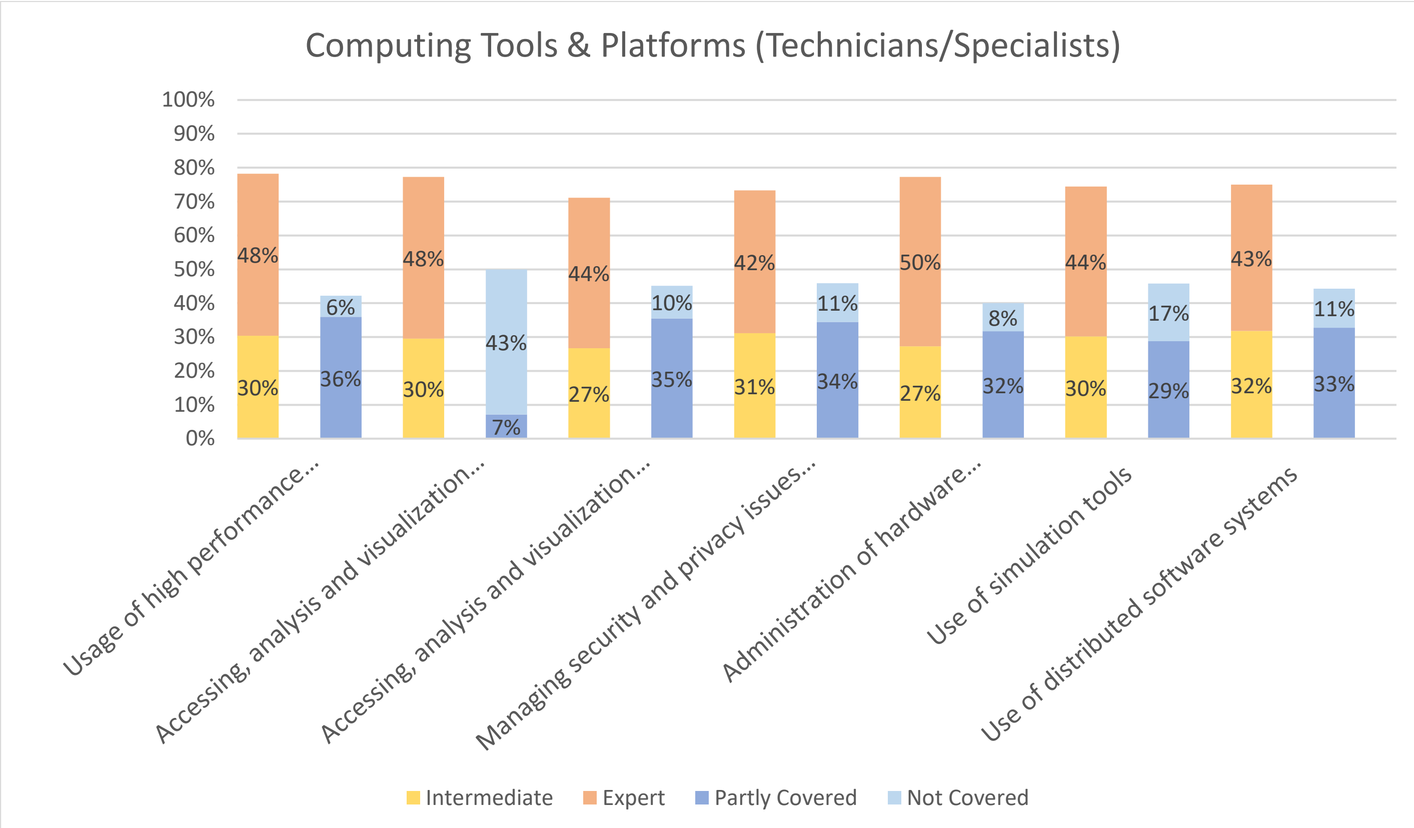


Figure 62 Computing tools and platforms for Technicians/Specialists

Programming, Development and Technology related

The next skillset comprises of the more IT related skills that are linked to digital technologies. Figure 63 presents the analysis for this skillset for managers/administration where we observe a low level of expertise needed for all the skills in this skillset, while the coverage level is also very low. From this analysis it can be stated that there is a skill gap in these skills, yet the knowledge and skill level needed to address the demand is at a lower level. For example, covering basic knowledge could be sufficient to cover the need of the industry in the energy sector for the staff category of managers and administration.

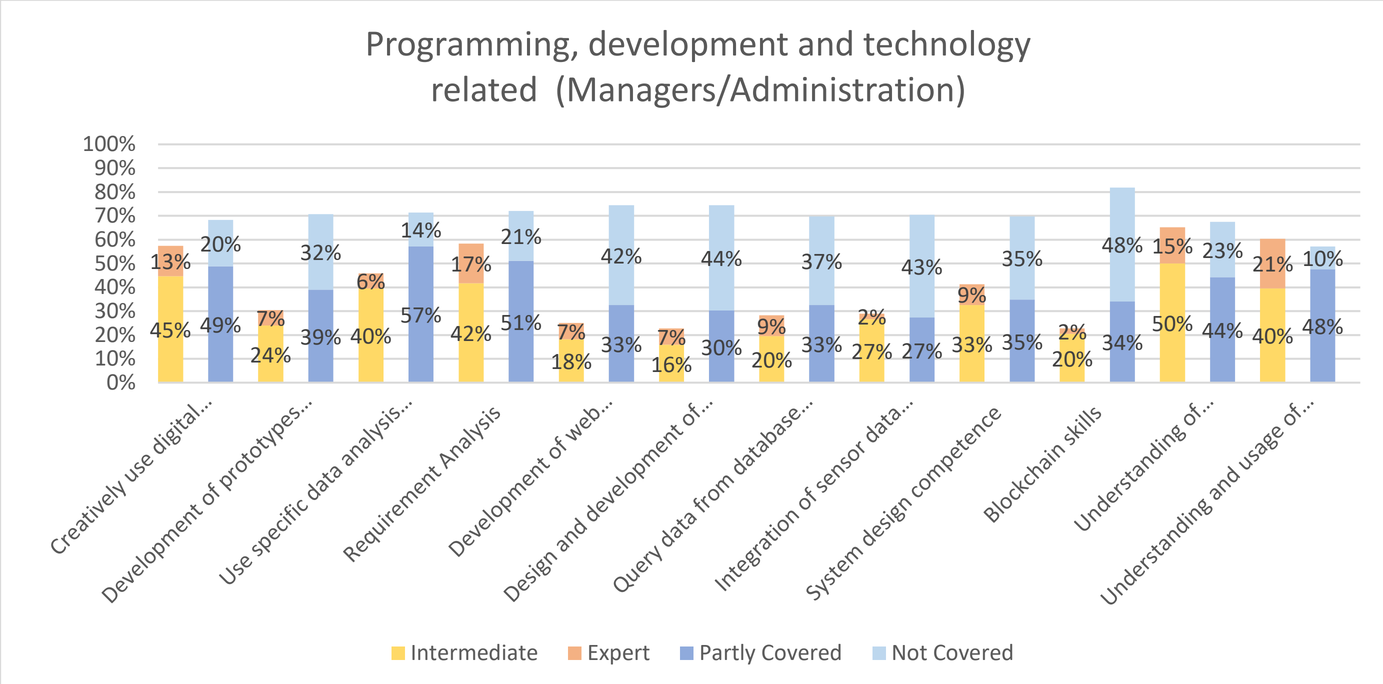


Figure 63 Programming, development and technology related for managers/administration

For “Engineers/Researcher” the coverage level is also very low while the expertise demand is a lot higher than the previous staff category. Every skill in this skill set can be regarded as a gap between the current status of professionals and the industry’s demand.

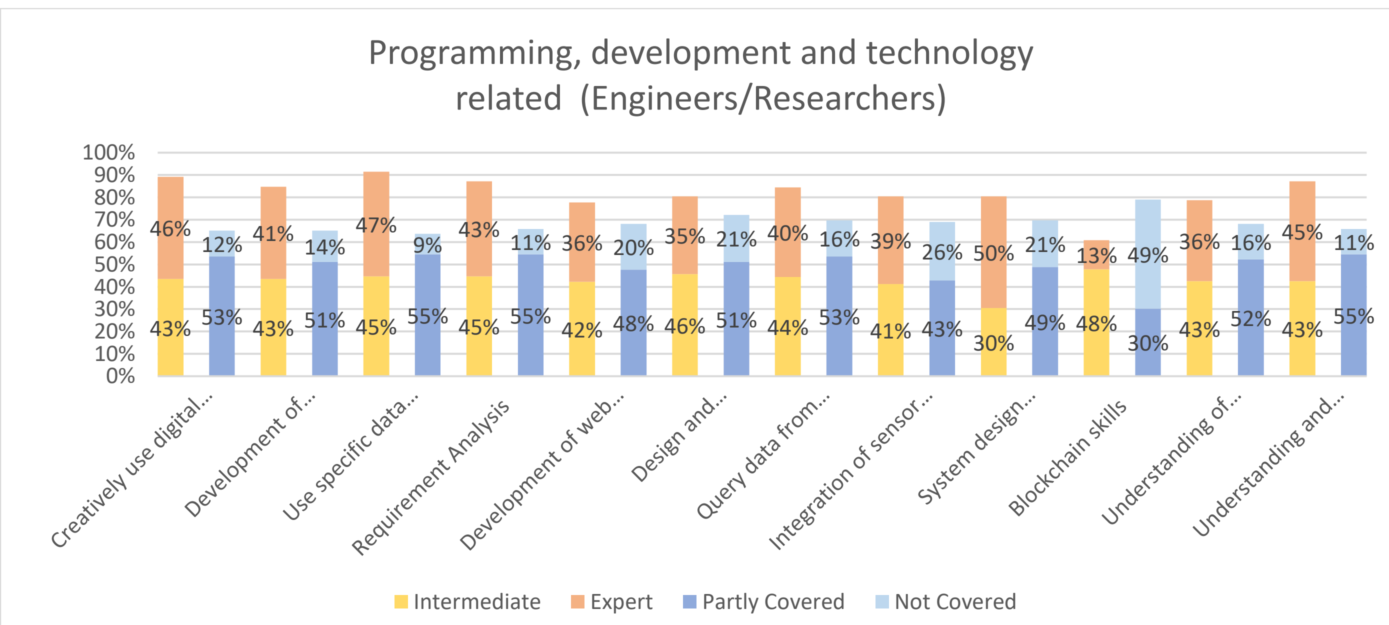


Figure 64 Programming, development and technology related for Engineers/Researchers

Technicians and specialists are also not covered adequately while having high expertise demand. The demand, while high, is relatively lower than the one for “Engineers/researchers” which can indicate that the expertise needed to cover the gaps for technicians is lower than for engineers. Nevertheless, a skill gap is observed in this skillset for technicians as well.

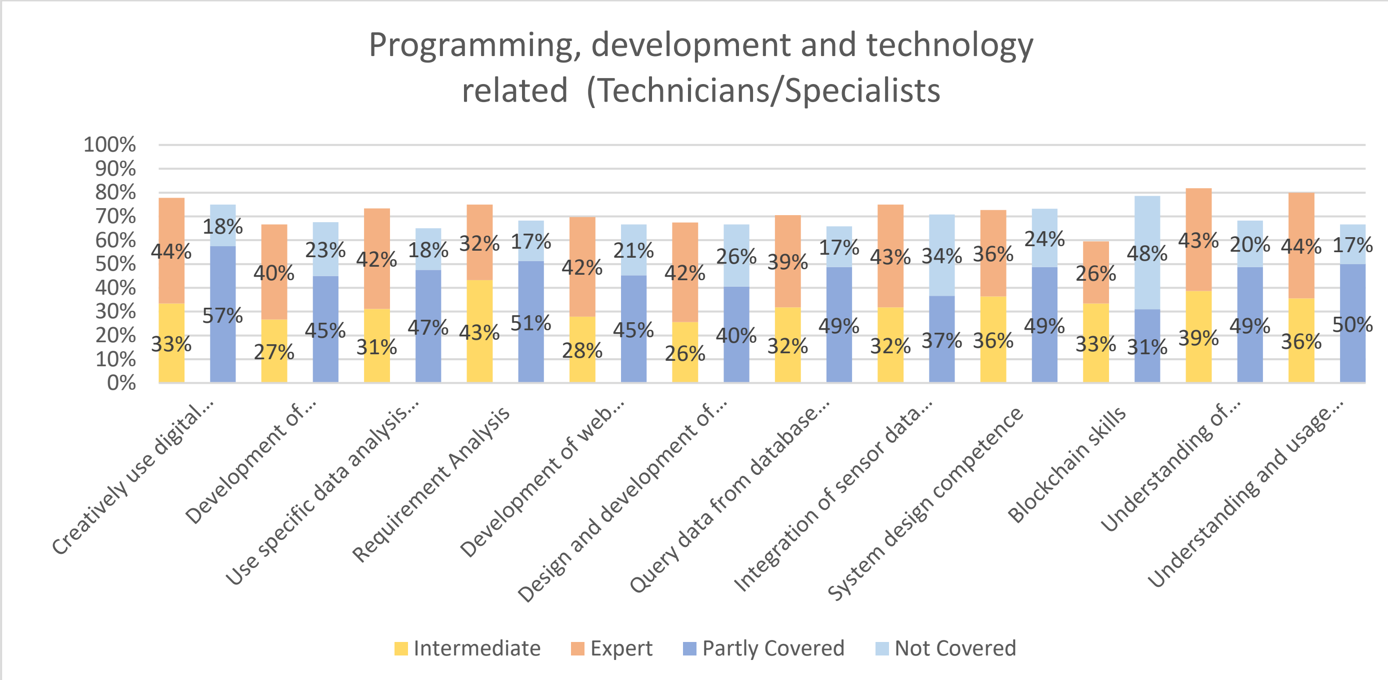


Figure 65 Programming, development and technology related for Technicians/Specialists

Comparing the results for the skill neds and the level of expertise which is presented in Figure 28 and the demand coverage in Figure 66 interesting insights can be generated, considering skill mismatches. Analysing the skill gaps by country it can be stated that Germany does not showcase big skill gaps on any of the skillsets examined. O**n the other hand, Romania and Spain showcase significant skill gaps in genera**l. As for Greece, the biggest skill gap is identified in the skillset "Programming, Development and Technology Related". Finally, the skillset "Data Capture and Management" is the most covered skillset in every country excluding Germany

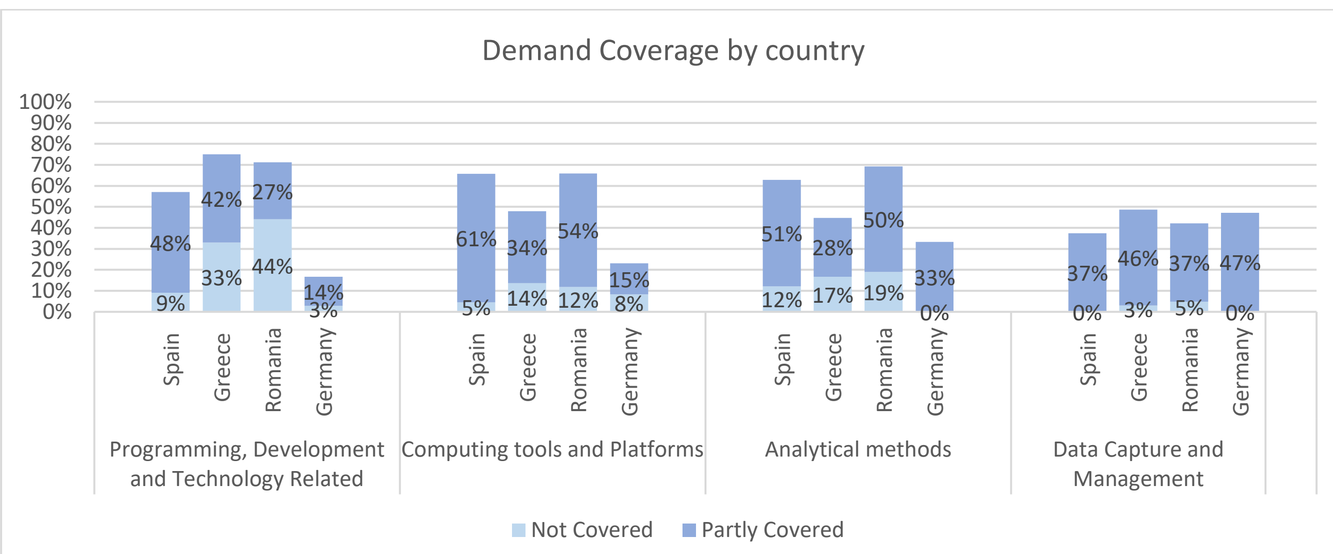


Figure 66 Demand coverage per country

Accordingly, the matching of skill demand in Figure 29 and the coverage in Figure 67 shows **that the "Power" sector showcases the biggest skill gaps**, because of having high expertise demands paired with high percentages of "Not Covered" and "Partly Covered" combined. On the other hand, the "Heating and Cooling" sector does not indicate significant skill gaps. Finally, the skillset "Data Capture and Management" is the most covered skillset in general despite having the highest expertise demands which comes to accordance with our previous observations by country.

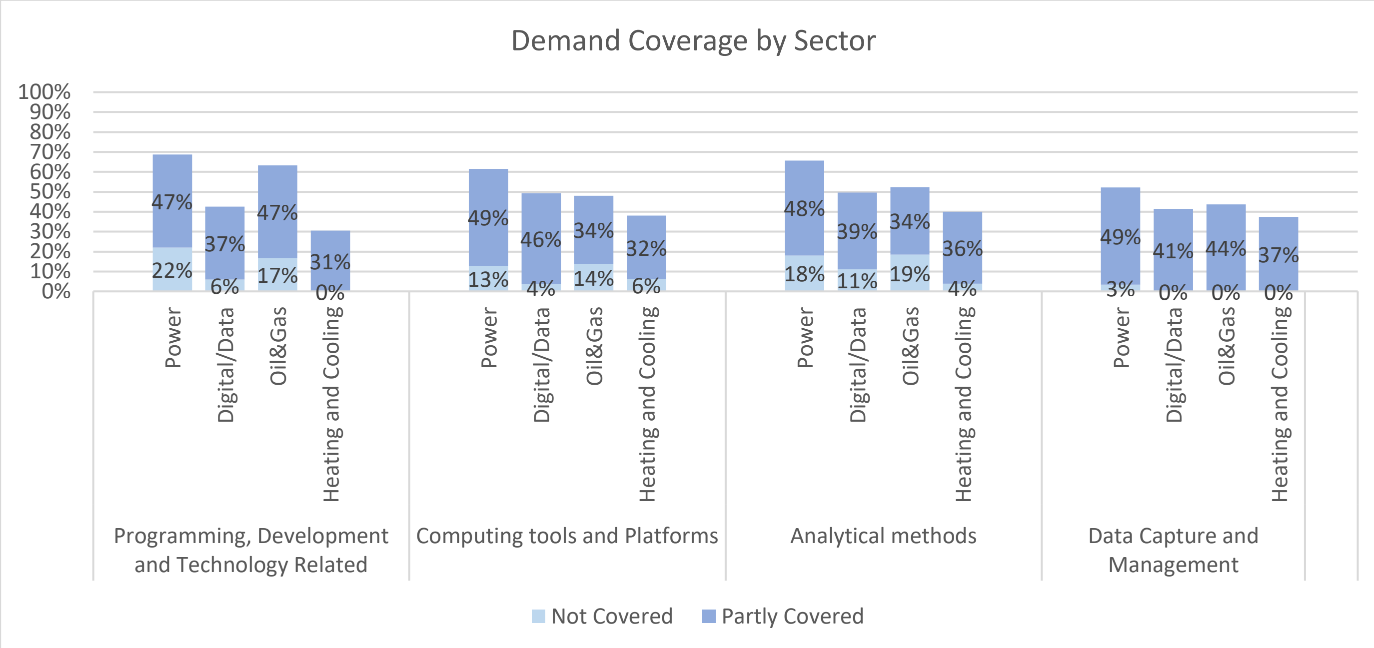


Figure 67 Demand coverage per sector

The comparison of Figure 30 and Figure 68 showcase that the activities "**Generation" and "Retailer" showcase the biggest skill gaps** while on the other hand, the activity "Service Provider" showcases the smallest skill gaps. In addition, a similar pattern of percentage distribution between sectors is observed in every skillset in both diagrams. Furthermore, **the activity "Manufacturer" showcases a particularly big skill gap in the "Analytical Methods**" skillset as we observe a high expertise demand paired with a 49% percentage of "Not Covered". Finally, in accordance to the previous two categorizations, the "Data Capture and Management" skillset is the most covered skillset despite having the highest expertise demands.

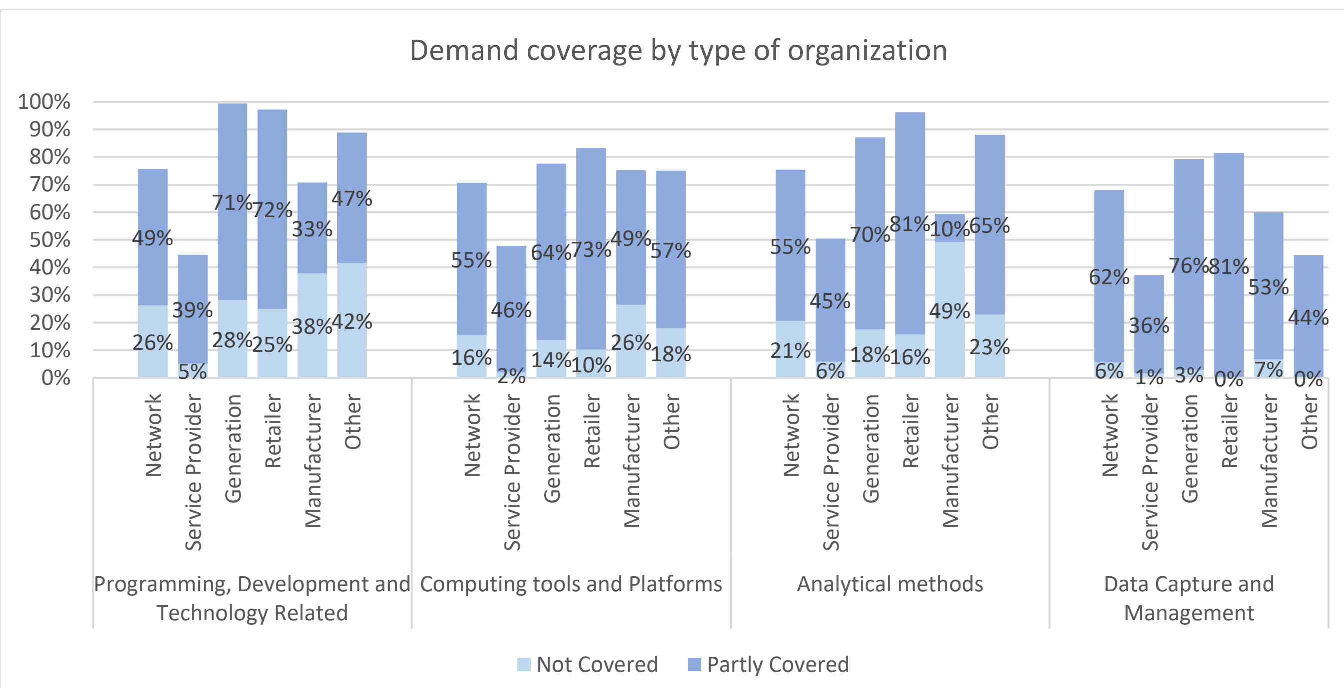


Figure 68 Demand coverage per type of organisation

5.2.2. Skill demand vs skill offer by education and training providers

Gap in technologies and tools used

Through the survey conducted to address the challenges faced and skill demands of the energy industry several technologies and tools were addressed in terms of frequency of use. The results were presented in detail in the report D2.1 “Current challenges in the energy sector and state of the art in education and training” [6]. Similarly, the survey to education and training providers aimed to address the training provided in the same set of technologies and tools and determine if graduates are equipped with the necessary skills and knowledge to use the technologies and operate the tools. The comparison showcases significant gaps between the importance for the industry and the training offered by ET providers.

Figure 69 shows on one hand the percentage of industrial stakeholders that are using each technology on a daily basis whereas on the other hand it presents the percentage of ET providers that offer training in these technologies. The differences between the demand and the offer indicates gaps when the demand in significantly greater that the offer. In the cases the offer is greater than the demand, it is assumed that the technology is adequately covered. In the following sections specific skills are addressed along with the level of coverage (basic, intermediate, expert) which can indicate the skill gaps level and the educational level that could mitigate them.

Considering technologies, the most significant gaps can be observed in ***Cloud services***, ***digital platforms*** and ***cybersecurity*** and ***communication technologies*** as it can be observed in Figure 69.

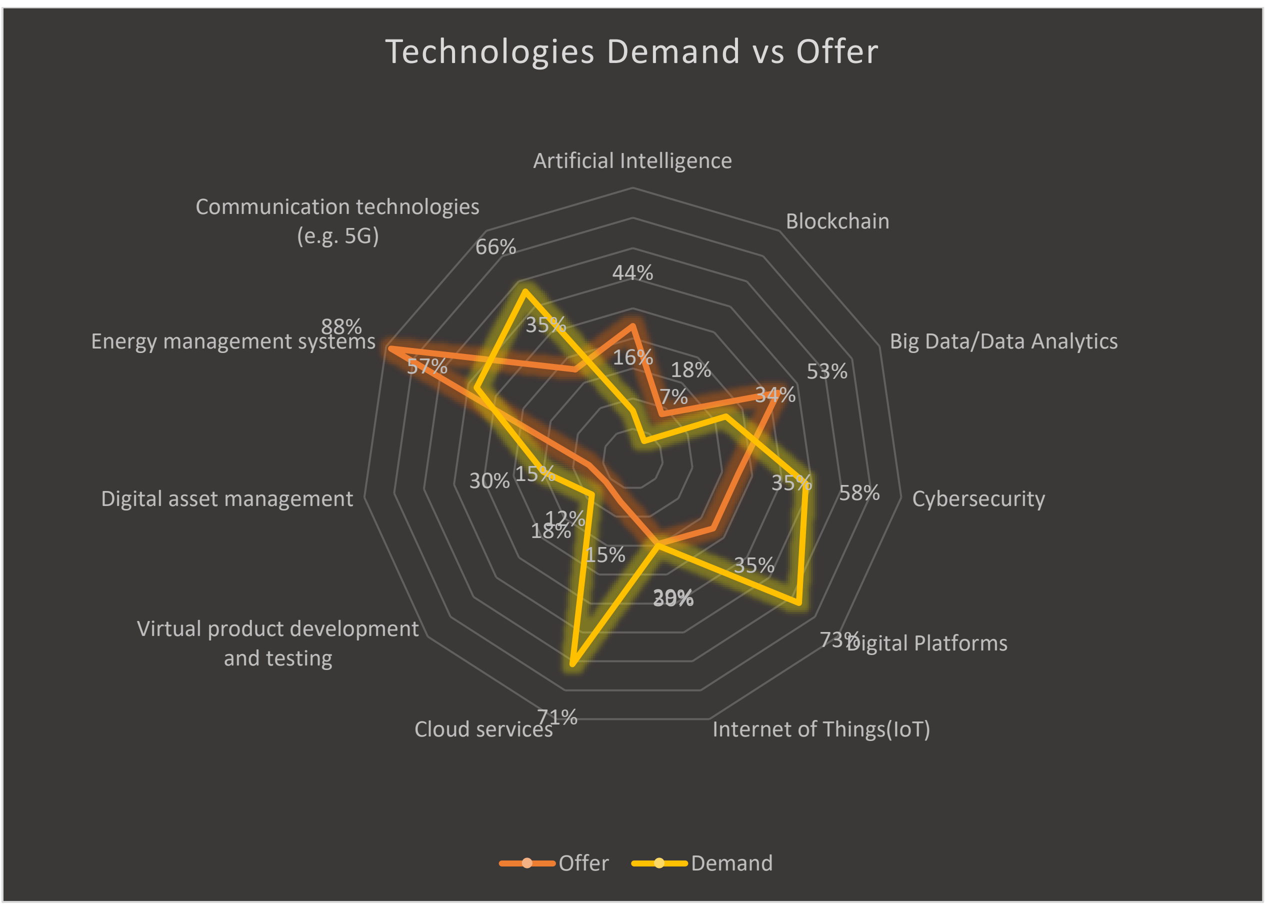


Figure 69 Technologies demand compared to offer

Accordingly, the demand and offer of specific tools is addressed in Figure 70. The analysis shows that the most significant gaps in tools usage are in ***cloud servers*** and ***online collaboration platforms.***

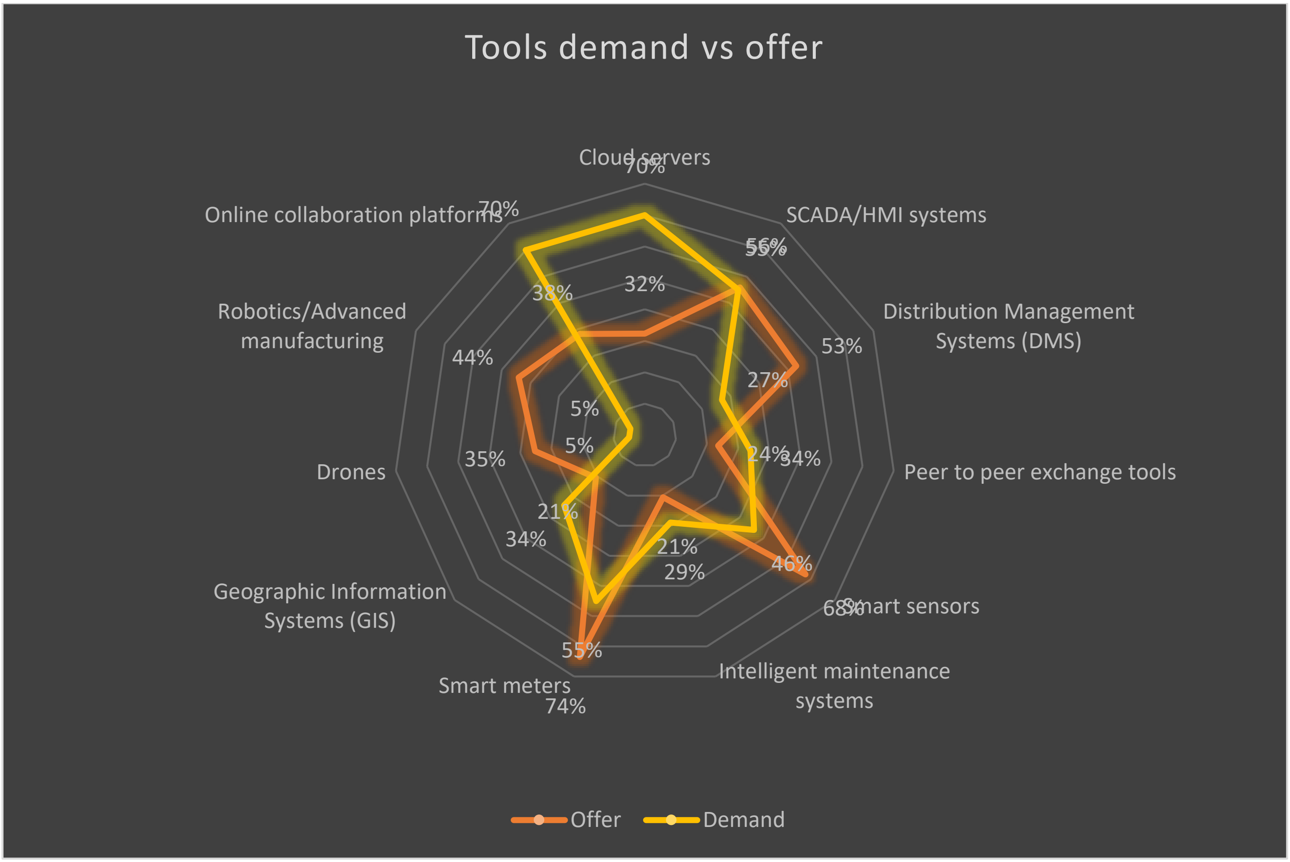


Figure 70 Tools demand compared to offer

Demand vs offer in different skill sets

Due to the lack of adequate number of answers from institutes of all educational levels the analysis of skill demand and skill offer would not present significant insights if it was conducted similar to the previous section referring to the skill demand and coverage level. To this end, a different approach was taken to address the gaps in education.

Comparing the results obtained from the survey to the industry and the one targeting education and training providers presented useful insights. To provide an overview of the comparison between skill demand and skill offer, an analysis was performed to calculate the skill demand level per skill set and the corresponding offer. In that, the average percentages for each skill sets were calculated, and the most requested expertise level was identified (basic, intermediate, expert) and it was compared to the percentage of ET providers that indicate the cover at least the required level. For example, if for a specific skill set the most requested expertise was the "Basic level", the skill offer was calculated by summing the answers indicating the provide at least Basic level, meaning the intermediate and expert levels were also included. The analysis was performed for 3 different staff categories.

Figure 71 shows the analysis for the managerial and administrative staff category. It is easily observed that the offer is significantly greater than the demand, indicating an overall coverage for this staff category by education and training providers. A deeper dive into the analysis, addressing specific skills can indicate gaps that are cannot be observed through this figure, yet this presentation is considered by the authors as a representative presentation of the overall situation.

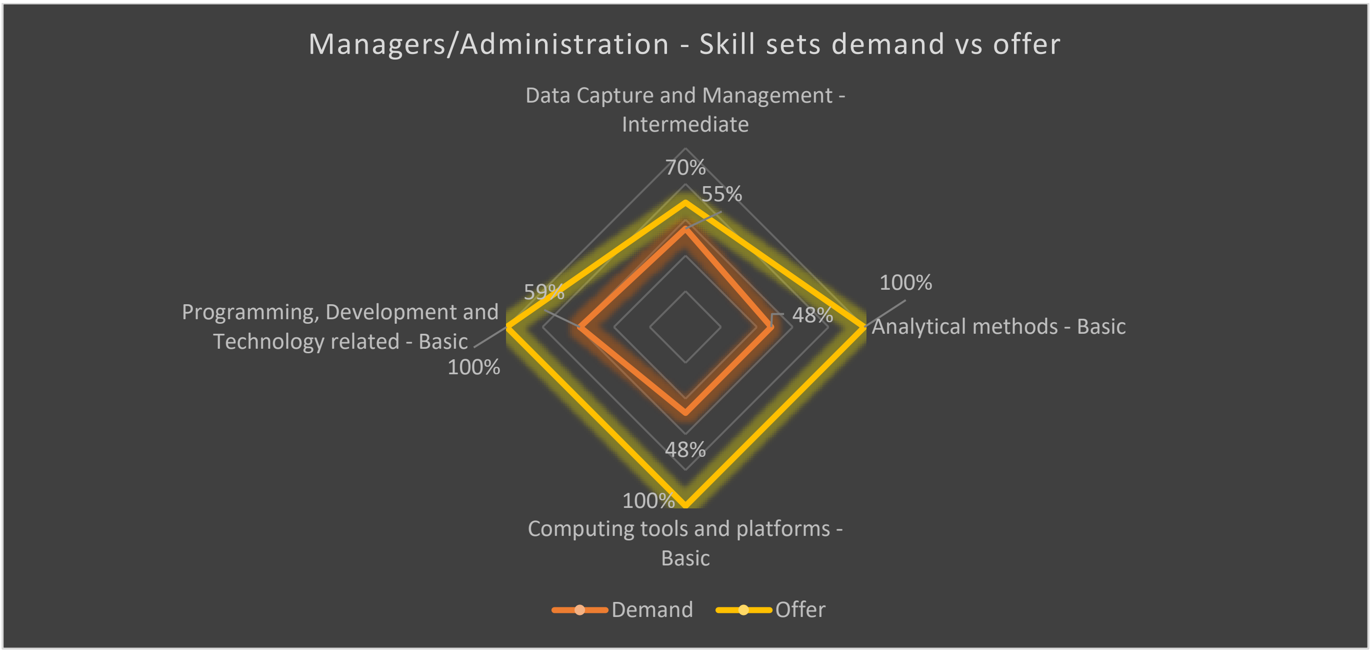


Figure 71 Skill demand compared to skill offer for Managers/Administration

Different results are observed in Figure 72 for engineers and researchers. The expertise demand is high for all the skill sets while in most of them **the demand is greater than the offer**. The only exception is the “Programming, Development and technology related” skill sets seems to be adequately covered by ET providers.

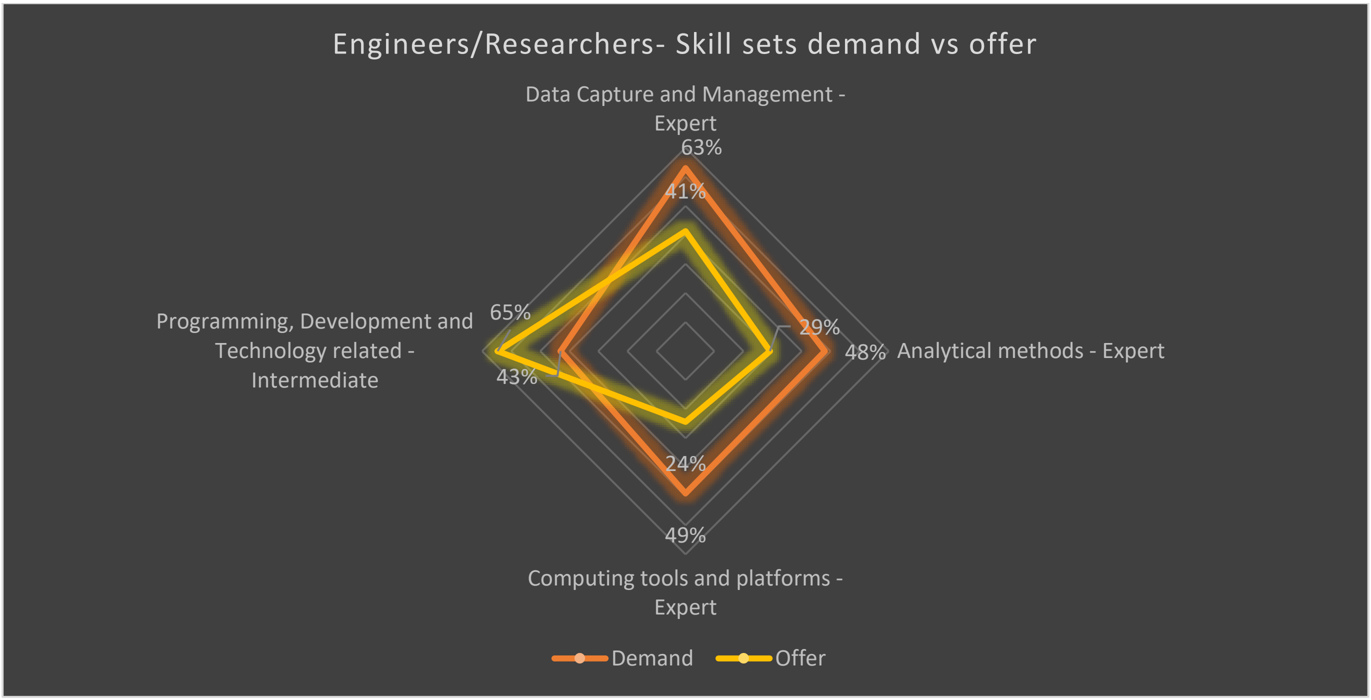


Figure 72 Skill demand compared to skill offer for Engineers/Researchers

Looking at Figure 73 the skill demand compared to offer can be observed for technicians and specialists. The demand of the most requested expertise is significantly greater than the offer by ET providers except for the “Analytical methods” skill set which showcases adequate coverage.

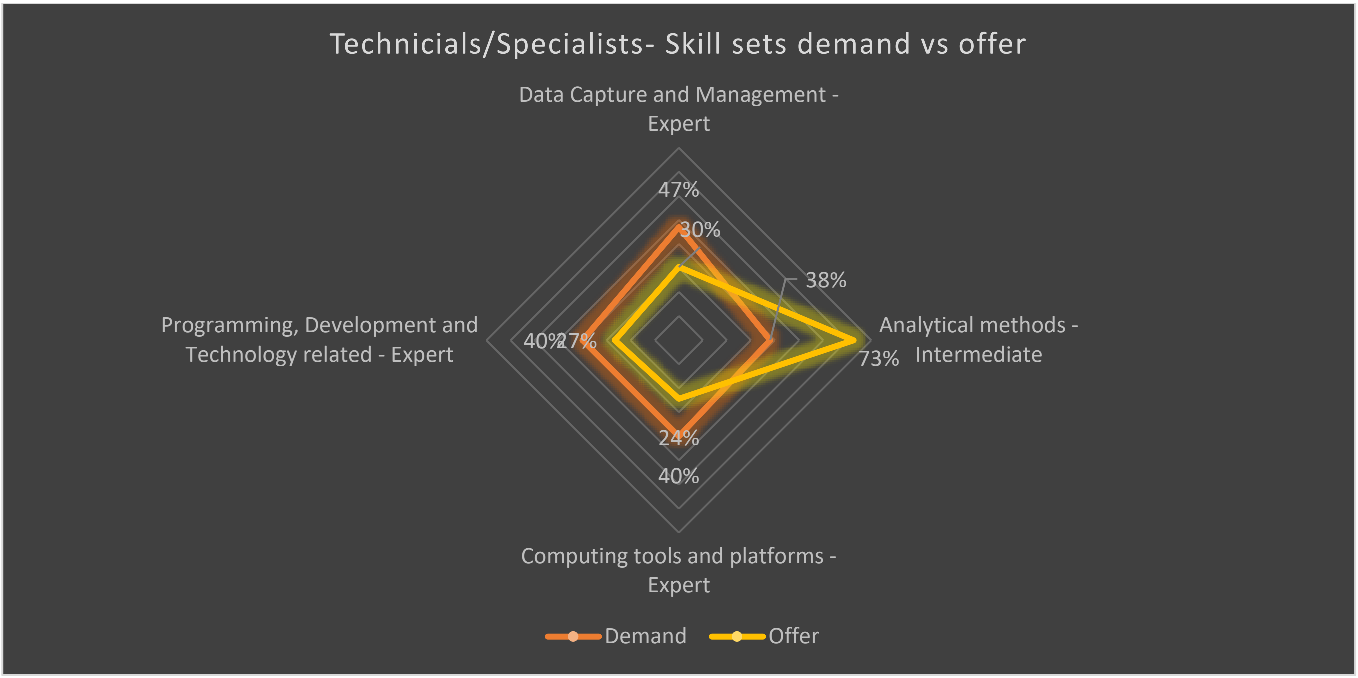


Figure 73 Skill demand compared to skill offer for Technicians/Specialists

Skill demand compared to skill offer for specific skills

Diving deeper into the analysis, a close comparison was conducted between the skill demand as it was expressed by the industrial stakeholders that participated in the first survey and the dedicated interviews and the skill offer as it was indicated by ET providers in the second survey, as well as the curricula review and interviews. Combining the results presented in sections 3.3 and 4.6 the comparison was conducted.

Considering the skill offer from ET providers the least covered skills are presented in the following table:

Table 43 Least offered skills from ET providers

Analytical methods
Application of data mining approaches
Perform big data analysis
Computing tools & platforms
Accessing, analysis and visualization of data
Managing security and privacy issues on digital platforms
Administration of hardware infrastructure (web servers, workstations, etc.)
Programming development and technology related
Development of web applications
Query data from database
System design competence
Blockchain skills
Understanding of cybersecurity

Most of the contributions from ET providers refer to bachelor's and master's programmes so it is adequate to indicate that the skills should be compared mostly with the expertise demand for the category of "Engineers/Researchers". **Comparing the demand as expressed in section 3.3.1 with the least offer skills for engineers it can be stated that all the skills presented in Table 43 present a skill gap.**

5.3. Conclusions

The survey analysis considering skill demand and coverage indicated several skill gaps for the different staff categories. The most significant belong to the "Analytical methods" and "Programming development and technology related" skill-sets and they are observed mainly in the Engineers & Researchers and Technicians & Specialists staff categories. The mapping of skill demand with skill offer from the ET providers also pointed out the mismatches in Analytical methods, Computing tools & platforms and Programming & development related skills, focusing on Engineers/Researchers since most of the contributions referred to master's degree in engineering level.

Table 44 summarizes the key findings from the analysis indicating the most important skill gaps. In the "Source" column the source of the gap as analysed in this section is presented. "Coverage" indicates a gap produced by the mapping of skill demand and current skill coverage in the industry while "offer" is produced by the analysis of skill demand of the industry and skill offer by ET providers. In the Engineers/Researchers category the skills gaps observed in both analyses have the indication "Both". Moreover, the skill level that is required to mitigate these gaps is presented in the column "Skill level". This level is extracted by assessing from the industrial survey the most requested expertise level needed by the industry in each of these skills.

Table 44 Identified skill gaps for the different staff categories

Staff category	Skill set/Skill	Source	Skill level
Managers/ Administration			
	Application of data mining approaches	Coverage	Basic level
Engineers/ Researchers			
	Data capture & management		
	Evaluate Data, Information and Digital Content	Coverage	
	Analytical methods		Expert
	Application of statistical methods	Coverage	Expert
	Mathematical optimization	Coverage	Expert
	Application of data mining approaches	Both	Expert
	Perform big data analysis	Both	Expert
	Report analysis results	Coverage	Expert
	Predictive modelling/analysis	Coverage	Expert
	Computing tools & platforms	Coverage	Expert
	Computing tools & platforms		
	Accessing, analysis and visualization of data	Offer	
	Managing security and privacy issues on digital platforms	Offer	
	Administration of hardware infrastructure (web servers, workstations, etc.)	Offer	
	Programming development and technology related		Expert
	Creative use of digital technologies	Coverage	Expert
	Development of prototypes and new analysis algorithms	Coverage	Expert
	Use specific data analysis software	Coverage	Expert
	Requirements analysis	Coverage	Expert
	Development of web applications	Both	Expert
	Design and development of applications	Coverage	Expert
	Query data from database	Both	Expert
	Integration of sensor data and IoT applications	Coverage	Expert

	System design competence	Both	Expert
	Blockchain skills	Both	Expert
	Understanding of cybersecurity	Both	Expert
	Understanding and usage of comm. technologies	Coverage	Expert
Technicians/ Specialists			
	Analytical methods	Coverage	Intermediate
	Application of statistical methods	Coverage	Expert
	Mathematical optimization	Coverage	Intermediate
	Application of data mining approaches	Coverage	Intermediate
	Perform big data analysis	Coverage	Intermediate
	Report analysis results	Coverage	Expert
	Predictive modelling/analysis	Coverage	Intermediate
	Computing tools & platforms	Coverage	Intermediate
	Computing tools & platforms		
	Accessing, analysis and visualization of data	Coverage	Expert
	Programming development and technology related		Intermediate
	Creative use of digital technologies	Coverage	Intermediate
	Development of prototypes and new analysis algorithms	Coverage	Intermediate
	Use specific data analysis software	Coverage	Intermediate
	Requirements analysis	Coverage	Intermediate
	Development of web applications	Coverage	Intermediate
	Design and development of applications	Coverage	Intermediate
	Query data from database	Coverage	Intermediate
	Integration of sensor data and IoT applications	Coverage	Intermediate
	System design competence	Coverage	Intermediate
	Blockchain skills	Coverage	Intermediate
	Understanding of cybersecurity	Coverage	Intermediate
	Understanding and usage of comm. technologies	Coverage	Intermediate

6. Validation of the results

To improve the quality of the produced results and expand them in terms of geographical and sectoral representation, a new survey was designed, targeting both industrial and educational stakeholders. The recipients of the new questionnaire were both stakeholders that were contacted and had contributed before and also new ones. The analysis of their responses aims at validating the outcomes of the work presented in this document.

To form the questions, the outputs of the analysis presented in the previous sections were utilized, extracting the major findings, and placing them against the judgement of experts in the energy sector. A Likert scale type of questions was used, requiring the participants to rate on a 5-scale basis, how significant they consider each skill gap presented.

Demographics

A first set of demographical questions aimed to acquire information regarding the background of the respondent. The whole spectrum of the energy sector is covered, with the Heating and Cooling sector being the less represented. A total of 49 answers were collected for this analysis.

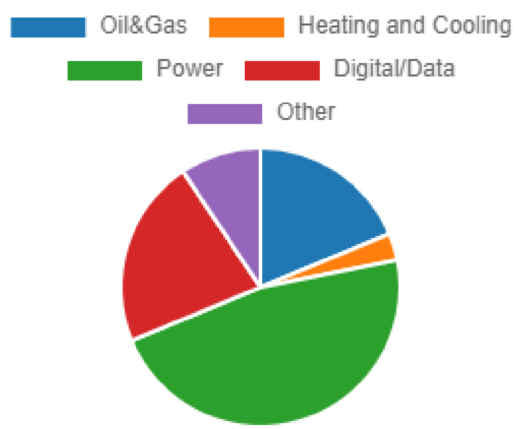


Figure 74 Validation survey sectoral representation

There was also an adequate representation from both Industry and Education/training. Moreover, several participants were from research industry, public authorities, advisory companies, and regulatory authorities. Thus, there is a broad representation from the whole energy value chain. Similarly, as depicted in Figure 76 there were contributions from stakeholders active in several European countries.

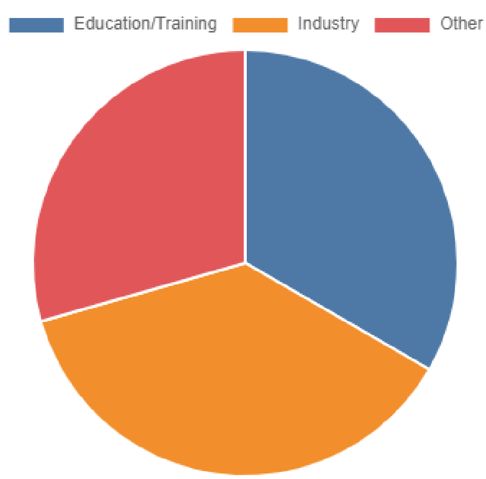


Figure 75 Validation survey demographics

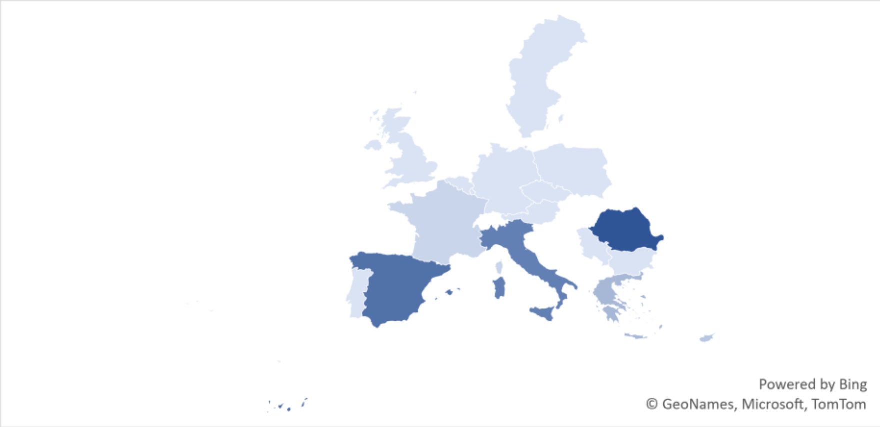


Figure 76 Validation survey geographical representation

Results

The 5-point Likert scale used in the questionnaire rendered possible to assess the level of significance the participants considered each skill gap. Scores above 3 indicate that the respondent considers significant enough the skill gap under question. As depicted in Figure 77 and Figure 78 more than 50% of all participants have rated the skill gaps with at least a score of 3, indicating that the majority of the stakeholders have identified these gaps in their area of operation, yet, some of them do not have significant impact at this point. Nevertheless, in most of the skill gaps presented, there are several participants that have attributed scores of 4 and 5, highlighting the importance of these gaps for a few stakeholders in the energy value chain. **Data related skill gaps and cybersecurity are amongst the ones that seem to be the most impactful.**

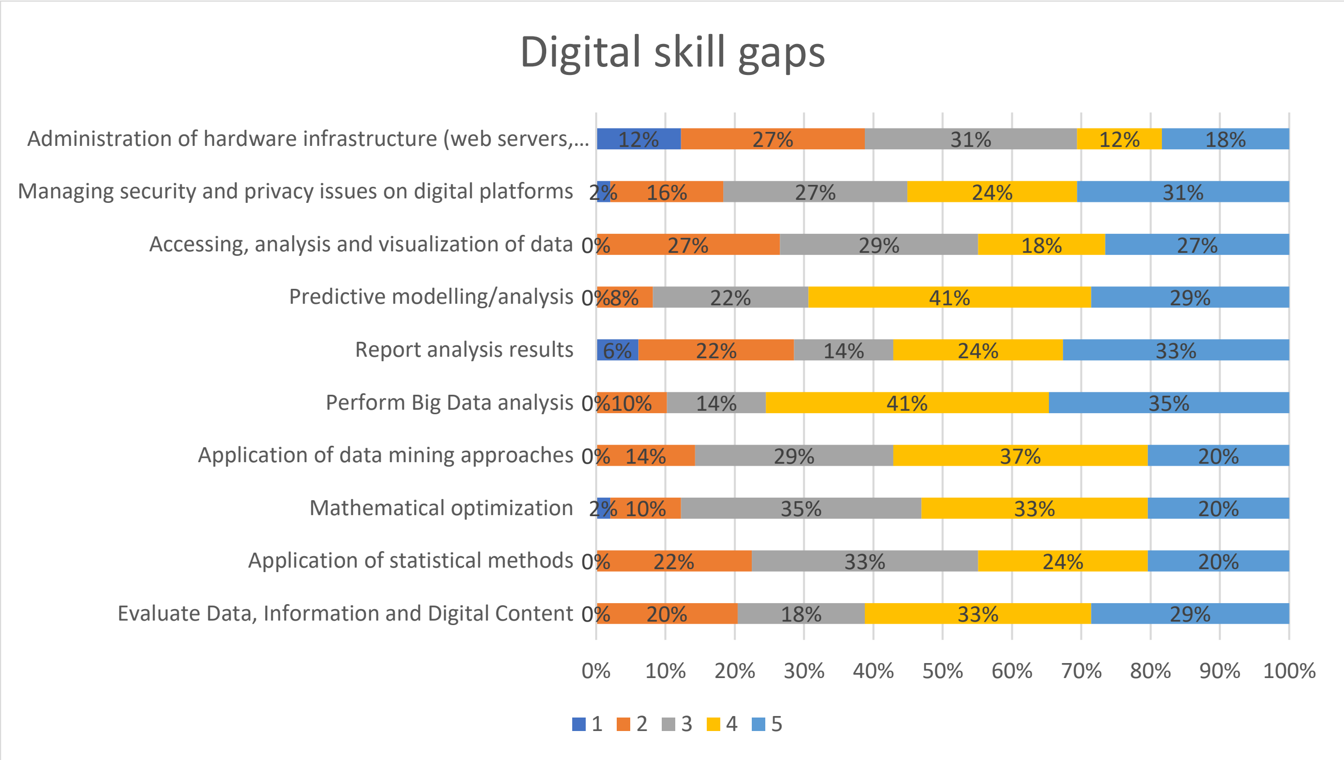


Figure 77 Skills gaps 1 - validation survey

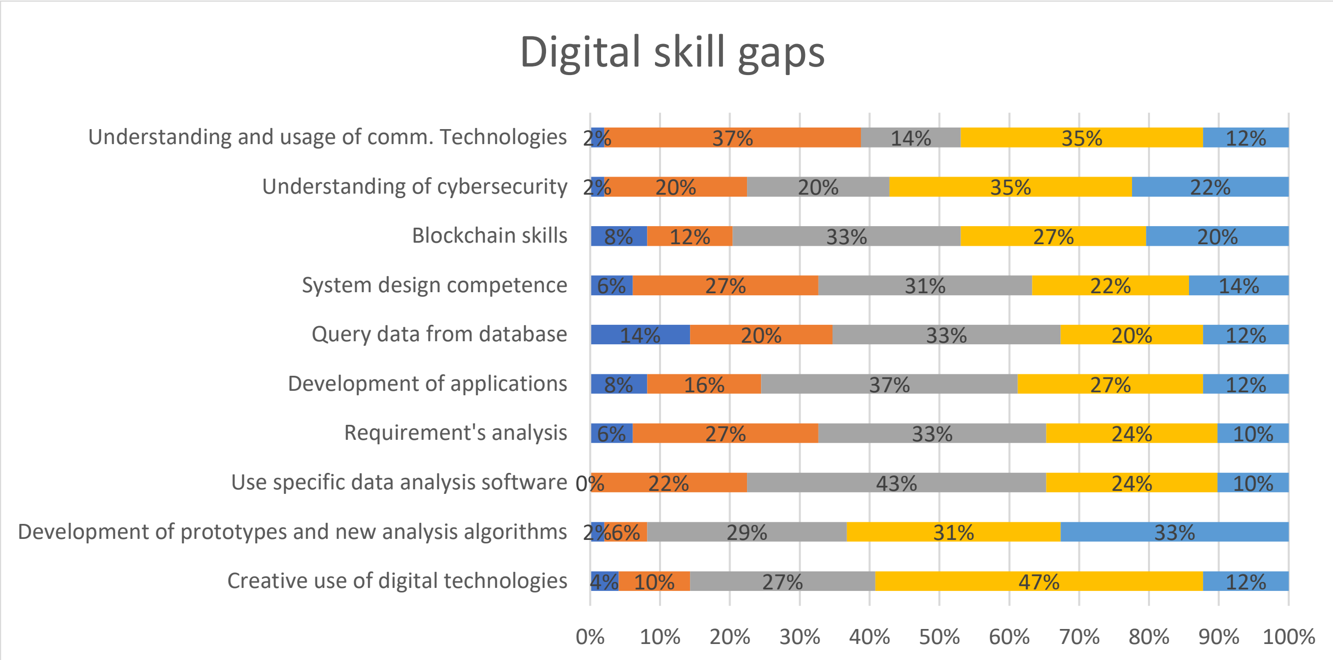


Figure 78 Skill gaps 2 - validation survey

The following table presents the descriptive statistics analysis, with the main indicators for the skill gaps identified and used in this questionnaire. They are sorted by the mean value from the **"most significant" to the least**.

Table 45 Digital skill gaps - validation survey

Skill Gap	Mean	Std. Error	Median	Mode	Std. Deviation
Perform Big Data analysis	4,00	0,14	4	4	0,96
Predictive modelling/analysis	3,90	0,13	4	4	0,92
Development of prototypes and new analysis algorithms	3,86	0,15	4	5	1,02
Evaluate Data, Information and Digital Content	3,69	0,16	4	4	1,10
Managing security and privacy issues on digital platforms	3,65	0,16	4	5	1,15
Application of data mining approaches	3,63	0,14	4	4	0,97
Mathematical optimization	3,59	0,14	4	3	1,00
Report analysis results	3,55	0,19	4	5	1,32
Understanding of cybersecurity	3,55	0,16	4	4	1,12
Creative use of digital technologies	3,53	0,14	4	4	0,98
Accessing, analysis and visualization of data	3,45	0,17	3	3	1,16
Application of statistical methods	3,43	0,15	3	3	1,06
Blockchain skills	3,39	0,17	3	3	1,19
Use specific data analysis software	3,22	0,13	3	3	0,92
Development of applications	3,18	0,16	3	3	1,11
Understanding and usage of comm. Technologies	3,18	0,16	3	2	1,13
System design competence	3,12	0,16	3	3	1,15
Requirement's analysis	3,06	0,16	3	3	1,09
Administration of hardware infrastructure	2,98	0,18	3	3	1,28
Query data from database	2,96	0,17	3	3	1,22

Similarly, as with the skill gaps, the participants were asked to rate the gaps of knowledge in a list of digital technologies, where each technology represents a set of skills and they easier for the respondents to assess. The results are presented in the figure below, and it is evident that the outcomes from the previous skills become more concrete. **Big Data/Data Analytics, Cybersecurity and Artificial Intelligence** are the rated as the most significant gaps by the participants. Blockchain and IoT are also among the top-rated gaps in the list.

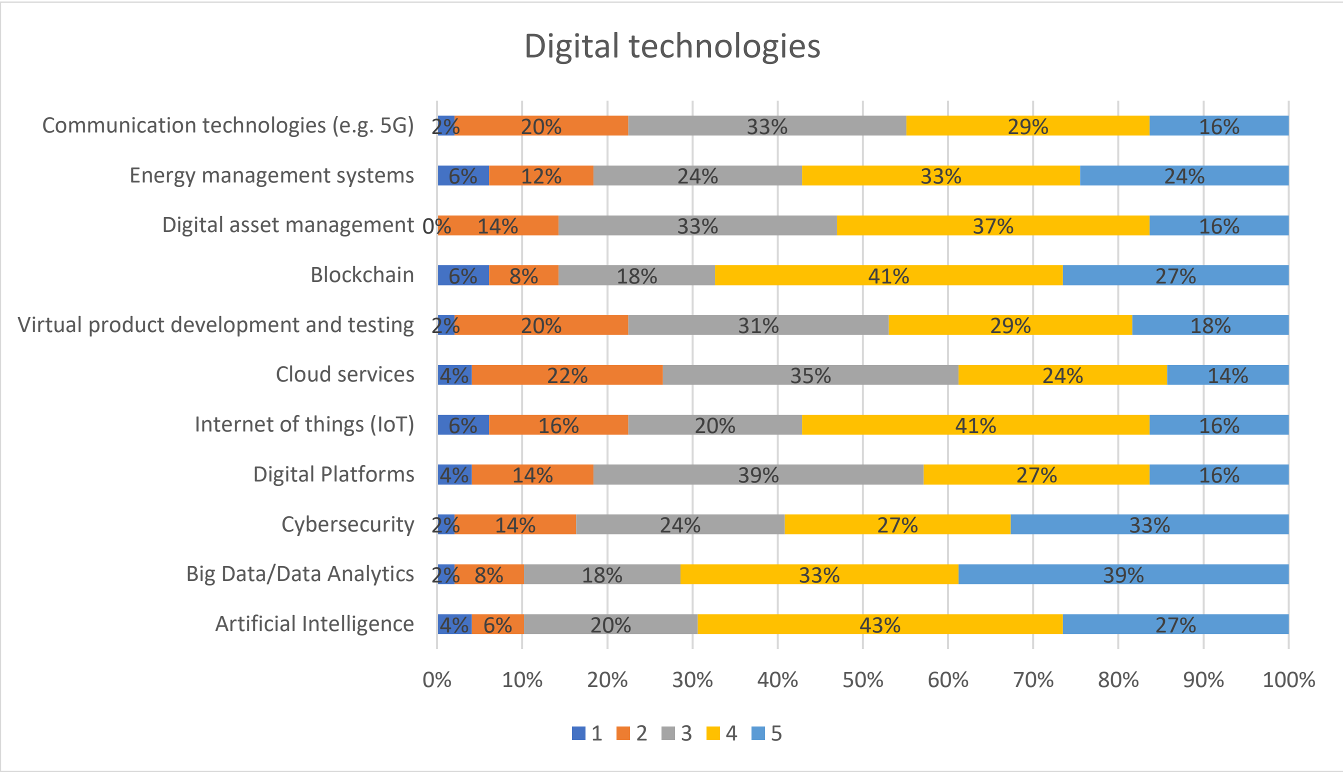


Figure 79 Gaps in digital technologies

As it was done with the previous list of skill gaps, the main descriptive statistics indicators are calculated and presented in the following table, presenting in a sorted way **the most significant gaps** as they were rated by the participants.

Table 46 Digital Technologies - statistics

Skill Gaps - Digital technologies	Mean	Std.Error	Median	Mode	Std. Deviation
Big Data/Data Analytics	3,98	0,15	4	5	1,05
Artificial Intelligence	3,82	0,15	4	4	1,03
Cybersecurity	3,73	0,16	4	5	1,13
Blockchain	3,73	0,16	4	4	1,13
Energy management systems	3,57	0,17	4	4	1,17
Digital asset management	3,55	0,13	4	4	0,94
Internet of things (IoT)	3,45	0,16	4	4	1,14
Virtual product development and testing	3,41	0,15	3	3	1,08
Digital Platforms	3,37	0,15	3	3	1,05
Communication technologies (e.g. 5G)	3,37	0,15	3	3	1,05
Cloud services	3,22	0,16	3	3	1,09

7. Conclusions

Nowadays, we are witnessing a discrepancy between current and future demand of abilities for multiple working domains, while digitalisation and technological changes are transforming the way of living and working. The digitalisation of the energy sector requests rapid transitions from the present level of knowledge to a more contemporary, and from one occupation to another, forcing people to continuously upskill and reskill. To keep up with the changing environment a multidimensional methodology was developed to address skill mismatches between the industry and the education and training providers, while also identifying relevant occupations and their respective requirements. The outcomes will serve as input for EDDIE's blueprint development.

Considering occupations, data handling abilities in job advertisements are emerging as the amount of information collected is increasing. A mandatory word associated with data is 'cybersecurity' as for creating a sustainable energy sector as well as a common ground based on trust between the industrial companies and consumers. Therefore, more occupations targeting all facets of cybersecurity must be considered on the labor market. Regarding the necessary qualifications to adapt to this changing framework, the industry itself indicated that usually, a most favored candidate brings experience and the ability to easy learn new technical innovations, combined with logical thinking and the ability to quickly analyze data. Although technical skills are especially important, they are also unlikely to be sufficient. In this perspective digital skills; green skills; resilience and adaptability techniques need to find a place in the curricula of the education institutions and on the agenda of the training providers.

The current education system in Europe still needs to improve in providing good employability to graduate students in relation to the knowledge and skills demanded by the ongoing transformation of the Energy sector. Alignment of academia with the labour market is needed to teach students both theoretical and practical, hands-on skills directly applicable in the work environment. To this end, significant effort in this direction is already being made by some universities and European initiatives. Areas such as Smart Grids, Information & Communication Technology, Innovative methods of simulation & analysis (machine learning, artificial intelligence, big data analytics) appear to be more and more present in several academic programmes throughout Europe.

Given the importance of an organization's human capital to business success, aligning training and competence development with business needs has become a key challenge. Thus, in the last 10 years, many companies created corporate universities (CU) to face this challenge. Corporate universities really come into place when companies see the education of their employees as a strategic instrument to create competitiveness and support overall corporate strategy and culture. They are generally dedicated units acting as partners with senior leadership to develop strategic skills and capabilities.

Online training platforms are another useful source of education and training as it is indicated by the interest in online courses which is rising in the last few years, and it has been further increased within the social context of the covid-19 pandemic.

The energy sector demands high level of expertise in many of the digitalisation related skill sets addressed through EDDIE's survey to industry. The highest expertise needs are observed in engineers & researchers' occupations, with technicians and specialists following in the expertise demand. Data capture, management and analysis skills are highly requested in the industry for all staff categories, while skills related to computing tools and programming & development are mostly requested for engineers and technicians in expert and intermediate levels accordingly. Moreover, it is evident that a combination of hard and soft skills is important for the growth of the employees and company achievements, since many of the addressed stakeholders pointed out the importance of transversal and green skills. At the analysis of the survey results, significant skill gaps are considered when there is high level of expertise needed and low level of current coverage in the industry, or the skill is not adequately offered by ET providers. The analysis is performed, addressing different staff categories (Managers, Engineers, Technicians) while also addressing different energy sectors, countries, and types of operation. The analysis includes the following skill sets, each of whom consists of specific skills:

- Data capture and management
- Analytical methods
- Computing tools and platforms
- Programming, development, and technology related
- Transversal skills
- Green skills

Through addressing ET providers, either by reviewing curricula or via immediate feedback from the surveys, and while considering the demands for knowledge and skills from the industry, several skill gaps were identified. The results of the analysis show several gaps that can be assessed individually or aggregated under contextual categorization in skill sets, while trying to identify the source of the gaps. The source can be either a mismatch of demand by the industry and offer of the ET providers, or lack of coverage by already employed personnel. This is a significant insight since the mitigation of these mismatches can only be performed via targeted actions of either inserting new aspects in the education and training sector, or by re-skilling employees through several channels such as corporate universities and industrial training programmes. Apart from the technical skills that will play important role in the digital transformation of the energy sector, the interdisciplinary transversal, green and business skills will also be crucial during the transformation. Overall, the work performed by EDDIE partners to identify skill gaps, point out that the key areas towards digitalisation, as reflected by different analyses performed in this work, converge towards **data management and analysis, big data, cybersecurity, and programming & development competences.** This is also validated by a dedicated survey aiming to cement the results and expand them in terms of geographical and sectoral representativeness. The outcomes of this work converge also towards knowledge gaps in the aforementioned digital skills and technologies.

Both surveys are still accepting contributions and the intention is to get more feedback and publish the updated results in EDDIE's website, particularly if there are significant insights.

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Annex 1: ESCO knowledge, skills, and occupations

Knowledge

a. Engineering, manufacturing and construction. For this wide domain, we will only select knowledge relevant to energy and digitalisation of energy.

Table 47 Engineering, manufacturing and construction knowledge

General Classification		Narrow Classification	Description	Related occupations
Engineering and engineering trades	Electricity and energy	1. battery components	The physical components, such as wiring, electronics and voltaic cells that can be found in batteries. The components vary according to size and type of battery.	Battery test technician, automotive battery technician, battery assembler
		2. battery testers	Battery testers test the charge level of battery cells, the battery's capacity for accumulating charge and detect flaws that may influence the battery's performance.	Battery test technician
		3. electric generators	The principles and operations of devices that can convert mechanical energy into electrical energy, such as dynamos and alternators, rotors, stators, armatures, and fields.	Power production plant operator, geothermal power plant operator, electromechanical engineer, solar power plant operator
		4. electrical engineering	Understand electrical engineering, a field of engineering that deals with the study and application of electricity, electronics, and electromagnetism.	Avionics technician, solar energy engineer, engineering lecturer, electromagnetic engineer, renewable energy engineer
		5. electrical equipment components	The essential components of a certain electrical product, such as electrical wires, circuit breakers, and switches.	Electrical equipment inspector, electrical drafter, electrical engineering technician
		6. electrical instrumentation engineering	How electrical and instrumentation engineering modernizes the production infrastructure from design, preparation of execution phase, the execution phase itself and the after-sales services.	Electrolytic cell maker
		7. electrical power safety regulations	Compliance with safety measures for working in installation, operation, and maintenance of constructions/equipment from the generation, transmission, and distribution of electrical power.	Wind turbine technician, power lines supervisor, energy systems engineer, electrical power distributor, power distribution engineer, energy manager
		8. electricity	Understand the principles of electricity and electrical power circuits, as well as the associated risks.	Sensor engineer, industrial machinery mechanic, power production plant operator, solar energy technician

		9. electricity consumption	The different factors which are involved in the calculation and estimation of electricity consumption in a residence or facility, and methods in which electricity consumption can be lowered or made more efficient.	Energy manager, power distribution engineer, substation engineer, energy systems engineer, energy assessor
		10. energy	Power capacity in the form of mechanical, electrical, heat, potential, or other energy from chemical or physical resources, which can be used to drive a physical system.	Solar energy engineer, energy analyst, hydropower technician, gas distribution engineer, energy engineer
		11. energy efficiency	Reduction of the use of energy. It encompasses calculating the consumption of energy, providing certificates, saving energy by reducing the demand and by efficient use of fossil fuels, promoting the use of renewable energy.	Solar energy sales consultant, energy analyst, energy assessor, energy conservation officer, renewable energy consultant, hydropower technician, energy manager
		12. energy market	The trends and major driving factors in the energy trading market, energy trades methodologies and practice, and the identification of the major stakeholders in the energy sector.	Waste treatment engineer, energy engineer, power plant manager, energy systems engineer, energy trader, solar energy engineer, energy analyst
		13. energy sector policies	The public administration and regulatory aspects of the energy sector, and requirements necessary to create policies.	Energy analyst
		14. energy transformation	The processes undergone by energy when changing its form from one state into the other.	Energy analyst, hydropower technician, hydropower engineer
		15. geothermal power plant operations	The different steps in the production of electricity from geothermal energy and the function of all the components of the required equipment - pumps, compressors, heat exchangers and turbines.	Geothermal power plant operator
		16. hydroelectricity	Generation of electrical power through the usage of hydropower, which uses gravitational force of moving water, and the benefits and disadvantages of hydropower as renewable source of energy.	Hydroelectric plant operator, power production plant operator, electricity and energy vocational teacher
		17. power engineering	Subdiscipline of energy and electrical engineering; it specializes in the generation, transmission, distribution, and usage of electrical power through the connection of electrical devices to motors, generators, and transformers.	Solar energy engineer, control panel assembler, power distribution engineer, control panel tester, renewable energy engineer, energy systems engineer

		18. renewable energy technologies	The different types of energy sources which cannot be depleted, such as wind, solar, water, biomass, and biofuel energy.	Renewable energy engineer, energy analyst, wind energy engineer, renewable energy consultant
		19. solar panel mounting systems	Setting up solar panels, such as pole mounting, ballasted mounting, and solar tracking.	Building electrician, electrician, solar energy technician, industrial electrician
		20. transmission towers	Tall structures used in the transmission and distribution of electrical energy, and which support overhead power lines, such as high voltage AC and high voltage DC transmission towers.	Electrical transmission system, operator street lighting electrician, electricity distribution worker, power lines supervisor, overhead line worker
		21. types of photovoltaic panels	Photovoltaic cells and panels, with different efficiencies in different types of weather, costs, durability and lifespan ratings, and mounting possibilities.	Solar energy engineer, solar energy technician
		22. types of steam engines	Heat engines which use steam as working fluid used to produce motion, as steam turbines and stationary steam engines.	Steam plant operator, steam turbine operator
		23. types of wind turbines	Wind turbines, namely those which rotate along a horizontal or those which rotate along a vertical axis, and their subtypes.	Wind energy engineer, wind turbine technician, electricity and energy vocational teacher
	Electronics and automation	1. automation technology	Set of technologies that make a process, system, or apparatus operate automatically using control systems.	Electronics and automation vocational teacher, automation engineer, power production plant operator
		2. electronics	The functioning of electronic circuit boards, processors, chips, and computer hardware and software, including programming and applications.	Electronics engineer, electronics and automation vocational teacher, automation engineer
		3. hardware architectures	The designs laying out the physical hardware components and their interconnections.	computer hardware engineer computer hardware test technician
		4. ICT infrastructure	The system, network, hardware and software applications and components, as well as devices and processes that are used to develop, test, deliver, monitor, control or support ICT services.	system configurator ICT product manager ICT capacity planner ICT system analyst ICT system administrator ICT networking hardware
		5. instrumentation equipment	The equipment and instruments used for the monitoring and controlling of processes, such as valves, regulators, circuit breakers, and relays.	instrumentation engineering technician instrumentation engineer precision instrument assembler

				electrical engineer
		6. power electronics	The functioning, design, and usage of electronics that control and convert electric power. Power conversion systems are usually categorized as AC-DC or rectifiers, DC-AC or inverters, DC-DC converters, and AC-AC converters.	Control panel tester, control panel assembler, electrical engineering technician, renewable energy engineer
		7. telecommunications engineering	Discipline that combines computer science with electrical engineering to improve telecommunications systems.	Mechatronics engineering technician, electronics production supervisor
		8. vehicle electrical systems	Know vehicle electrical systems, including components such as the battery, starter, and alternator. Understand the interplay of these components to resolve malfunctions.	Vehicle technician, engine designer, automotive electrician

b. Information and communication technologies (icts). For this wide domain, we will only select knowledge relevant to energy and digitalisation of energy.

Table 48 Information and communication technologies (icts). knowledge

General Classification		Narrow Classification	Description	Related occupations
Information and communication technologies (icts)	Computer use	1. decision support systems	The ICT systems that can be used to support business or organizational decision making.	ICT business analysis manager, chief ICT security officer, chief data officer, ICT system analyst
		2. human-computer interaction	The study of the behavior and interaction between digital devices and human beings.	User interface designer, ICT accessibility tester, ICT usability tester, user experience analyst
		3. Internet of Things	Principles, categories, requirements, limitations, and vulnerabilities of smart connected devices.	Embedded systems software developer, ICT security manager, mobile application developer
		4. web application security threats	The attacks, vectors, emergent threats on websites, web applications and web services.	ICT security technician, ethical hacker
	Database and network design and administration	1. automatic meter reading	Mobile, network and handheld technologies for automatically acquire data on energy & water consumption, and forward them to the central database for sending invoices or performing analysis.	Electricity and energy vocational teacher, meter reader
		2. cloud technologies	The technologies which enable access to hardware, software, data and services through remote servers and software networks.	ICT network administrator, ICT network engineer
		3. database management systems	The tools for creating, updating, and managing databases, such as Oracle, MySQL and Microsoft SQL Server.	Database administrator, data warehouse designer, database integrator, database developer

c. Natural sciences, mathematics, and statistics. For this wide domain, we will only select knowledge relevant to energy and digitalisation of energy.

Table 49 Natural sciences, mathematics, and statistics knowledge

General Classification		Narrow Classification	Description	Related occupations
Natural sciences, mathematics, and statistics	**Environment**	1. environmental policy	Local, national, and international policies dealing with the promotion of environmental sustainability.	Environmental policy officer, environmental protection manager, environmental expert
	Mathematics and statistics	1. 3D modelling	The process of developing a mathematical representation of any three-dimensional surface of an object via specialized software. The product is called a 3D model.	Engine designer, industrial engineer, product development engineering drafter, rotating equipment engineer
	Physical science	1. battery chemistry	Battery types according to the representative chemical components used in the anode or the cathode (zinc-carbon, lead-acid, or lithium-ion).	Automotive battery technician, battery test technician, battery assembler
		2. electromagnetism	The study of electromagnetic forces and the interaction between electric and magnetic fields.	Electromagnetic engineer, electrical engineer, electronics engineer
		3. physics	The natural science involving the study of matter, motion, energy, force, and related notions.	Electromechanical engineer, physics technician, instrumentation engineer
		4. thermodynamics	The branch of physics that deals with the relationships between heat and other forms of energy.	Solar energy engineer, steam engineer, geothermal power plant operator

Skills

a. Information skills. For this wide domain, we will only select skills relevant to energy and digitalisation of energy. The main domains listed here are *information skills, measuring physical properties & monitoring developments in* area of expertise.

Table 50 Information skills

General Classification	Narrow Classification	Description	Related occupations	Associated/Related knowledge

Information skills	Conducting studies, investigations and examinations	1. Examine engineering principles	Analyse the principles that need to be considered for engineering designs and projects such as functionality, replicability, costs and other principles.	Solar energy engineer, aerodynamics engineer, military engineer & energy systems engineer	Engineering principles
	Interpreting technical documentation and diagrams	1. Interpret electrical diagrams	Read and comprehend blueprints and electrical diagrams; understand technical instructions and engineering manuals for assembling electrical equipment; understand electricity theory and electronic components	Electrical equipment inspector, electrical drafter & control panel tester	Electrical wiring diagrams, electrical wiring plans & electricity
	Managing Information	1. Manage data	Administer all types of data resources through their lifecycle by performing data profiling, parsing, standardization, identity resolution	Software manager, database integrator and data quality specialist	Audit techniques
		2. Maintain logistics databases	Maintain databases accessible to users in the logistics and storage sub-sector	Logistics analyst	Logistics
		3. Manage digital archives	Create and maintain computer archives and databases, incorporating latest developments in electronic information storage technology	Archivist, medical transcriptionist and big data archive librarian	Digitalisation, Use database
Measuring physical properties	Measuring dimensions and related properties	1. Measure electrical characteristics	Measure voltage, current, resistance or other electrical characteristics by using electrical measuring equipment	Control panel tester, battery test technician & engineering technician	Electrical testing methods
		2. Measure pollution	Conduct pollution measurements to determine whether the prescribed pollutant limits are respected.	Chimney sweep & environmental expert	Pollution
Calculating and estimating	Estimating resource needs	1. Identify energy needs	Identify the type and amount of energy supply necessary in a building or facility.	Renewable energy sales representative, energy analyst, energy systems engineer & energy conservation officer	Energy

Monitoring developments in area of expertise	Monitoring developments in area of expertise	1. Monitor educational developments	Monitor the changes in educational policies, methodologies, and research by reviewing relevant literature and liaising with education officials and institutions.	Educational researcher, academic advisor, education program coordinator & education inspector	Education field
		2. Monitor technology trends	Survey and investigate recent trends and developments in technology. Observe and anticipate their evolution, according to current or future market and business conditions.	ICT system integration consultant, chief information officer, mobile devices technician & software manager	Emergent technologies
		3. Keep up with digital transformation of industrial processes	Keep up to date with digital innovations applicable to industrial processes. Integrate these transformations in the company's processes aiming for competitive and profitable business models.	Chemical production manager, mechanical engineer & industrial engineer	Digitalisation of industrial market

b. Management skills. For this wide domain, we will only select skills relevant to energy and digitalisation of energy. The main domains listed here are *management skills, developing objectives and strategies, leading and motivating & supervising people.*

Table 51 Management skills

General Classification		Narrow Classification	Description	Related occupations	Associated/Related knowledge
Management skills	Management skills	1. Serve on academic committee	Contribute to university or college managerial decisions, such as budgetary issues, school policy reviews and recommendations.	Computer science lecturer, higher education lecturer, engineering lecturer	Education field

c. Working with computers. For this wide domain, we will only select skills relevant to energy and digitalisation of energy. The main domains listed here are working with computers, setting up and protecting computer systems & accessing and analysing digital data.

Table 52 Working with computers skills

General Classification		Narrow Classification	Description	Related occupations	Associated/Related knowledge
Setting up and protecting computer systems	Setting up computer systems	1. Integrate system components	Select and use integration techniques and tools to plan and implement integration of hardware and software modules and components in a system.	Telecommunications engineering technician	ICT system integration, Hardware components
Accessing and analyzing digital data	Managing and analysing digital data	1. Perform online data analysis	Analyse online experiences and online data for purposes of understanding user behavior and triggers of online attention.	Search engine optimisation expert & Online community manager	Online analytical processing, Web analytics

d. Working with machinery and specialized equipment. For this wide domain, we will only select skills relevant to energy and digitalisation of energy. The main domains listed here are *working with machinery and specialised equipment, operating mobile plant, driving vehicles, operating machinery for the extraction and processing of raw materials, etc.*

Table 53 Working with machinery and specialized equipment skills

General Classification		Narrow Classification	Description	Related occupations	Associated/Related knowledge
Operating machinery for the extraction and processing of raw materials	Operating pumping systems or equipment	1. Check water pressure	Check the water pressure in a water circulation system, using a built-in gauge or by attaching a water pressure gauge onto a pipe.	Irrigation system installer, sprinkler fitter & kitchen unit installer	Pumping systems
		2. Operate pumping equipment	Operate pumps and piping systems, including control systems. Operate the bilge, ballast and cargo pumping systems.	Water plant technician	Types of pumping equipment
		3. Synchronise pumphouse activities	Ensure synchronicity between pump houses; pursue continuous product flow and minimal product contamination.	Petroleum pump system operator	Pumphouse activities

	Operating energy production or distribution equipment	1. Adapt energy distribution schedules	Monitor the procedures involved in the distribution of energy	Power plant manager, electrical power distributor, energy systems engineer & renewable energy engineer	Energy
		2. Close circuit breaker	Synchronize incoming generating units with units already in operation. Close the circuit breaker at the exact instant of coincidence between both unit types.	Power plant control room	Power
		3. Control steam flows	Admit steam through lines or fuel to furnace to heat drier.	Dryer attendant, boiler operator & Fossil-fuel power plant operator	Manufacturing of steam generators
		4. Ensure equipment cooling	Make sure the machines and installations are properly supplied with air and coolants in order to prevent overheating and other malfunctions.	Nuclear technician	Cooling equipment
		5. Manage electricity transmission system	Manage the systems which ensure the transmission of electrical energy from electricity production facilities to electricity distribution facilities.	Power distribution engineer & Electrical transmission system operator	Electricity
		6. Provide power distribution	Provide power distribution for light, stage, sound, video and recording purposes.	Lighting technician, Stage technician	Power distribution
		7. Respond to electrical power contingencies	Set in motion the strategies created for responding to emergency situations, in the distribution of electrical power.	Power production plant operator, electrical transmission system operator & Electrical power distributor	Electricity

	Operating petroleum, chemical or water processing systems or equipment	1. Chemical operate water purifying equipment	Operate and adjust equipment controls to purify and clarify water, process.	Wastewater treatment operator	Chemical process
		2. Manage recirculation systems	Manage pumping, aerating, heating and lighting equipment as needed in recirculation systems	Aquaculture recirculation manager	Recirculation systems
Installing, maintaining, and repairing electrical, electronic, and precision equipment	installing and repairing electrical, electronic, and precision equipment	1. install automotive electrical equipment	Place electrical circuits and wiring in vehicles to distribute and regulate electrical power and supply it to meters in the car.	vehicle electronics installer, coachbuilder, automotive electrician, electrical mechanic.	install electrical and electronic equipment
		2. install lightning protection system	Fix the electrodes deep in the ground, fasten the metal conductors such as copper cables to the walls, and install the lightning conductor on the roof.	Electrician, domestic, industrial and building electrician	sector specific skills and competences
		3. install low voltage wiring	Plan, deploy, troubleshoot, and test low voltage wiring.	broadcast technician, telecommunications technician, telecommunications equipment maintainer, battery assembler, communication infrastructure maintainer	cross-sector skills and competences
		4. repair overhead power lines	Identify damage and perform the required repairs, as well as perform routine maintenance, to overhead power lines and transmission towers used in the transmission and distribution of electrical energy.	Electricity distribution worker, overhead line worker, cable jointer	cross-sector skills and competences

Occupations

- Managers

Table 54 Occupations - Managers

General Classification	Narrow Classification	Description	Related skills	Associated/Related knowledge

Production and specialized services managers	Manufacturing, mining, construction, and distribution managers	Manufacturing Managers	industrial production manager	Industrial production managers oversee the operations and the resources needed in industrial plants and manufacturing sites for a smooth running of the operations.	Assess impact of industrial activities, manage budgets, manage resources, manage staff, meet deadlines,	1. industrial engineering 2. manufacturing processes
			operations manager	Operations managers plan, oversee and coordinate the daily operations of production of goods and provision of services.	Ensure equipment availability, establish daily priorities, manage budgets, plan safety procedures	1. corporate social responsibility
	Information and communications technology service managers	Information and communications technology service managers	chief technology officer	Chief technology officers contribute to a company's technical vision and lead all aspects of technology development, according to its strategic and growth direction.	Administer ICT system, coordinate technological activities, define technology strategy, establish an ICT customer support process	3. ICT project management 4. decision support systems
	Professional services managers	Professional services managers not elsewhere classified	energy manager	Energy managers coordinate the energy use in an organization, and aim to implement policies for increased sustainability, and minimization of cost and environmental impact.	Advise on heating systems energy efficiency, analyse energy consumption, compose energy performance contracts, develop energy policy	4. electrical power safety regulations 5. electricity consumption 6. energy efficiency

- Professionals
-

Table 55 Occupations for professionals

General Classification			Narrow Classification	Description	Related skills	Associated/Related knowledge
Science and engineering professionals	Engineering professionals (excluding electrotechnology)	Engineering professionals not elsewhere classified	energy engineer	Energy engineers design new, efficient and clean ways to produce, transform, and distribute energy to improve environmental	Adjust engineering designs, approve engineering design, perform scientific research, use technical drawing software	1. energy 2. energy market 3. technical drawings

				sustainability and energy efficiency.		
			test engineer	They plan and perform detailed quality tests during various phases of the design process to make sure that the systems are professionally installed and function correctly.	Adjust engineering designs, analyse scientific data, test hardware, use technical drawing software data	1. industrial engineering 2. manufacturing processes 3. production processes 4. test procedures
	Electrotechnology engineers	Electrical engineers	electric power generation engineer	Electric power generation engineers design and develop systems which generate electrical power, and develop strategies for the improvement of existing electricity generation systems.	Design electric power systems, develop strategies for electricity contingencies, ensure compliance with electricity distribution schedule	1. electric current 2. electric generators 3. electrical engineering 4. electrical power safety regulations 5. electricity
			power distribution engineer	Power distribution engineers design and operate facilities which distribute power from the distribution facility to the consumers.	Change power distribution systems, develop electricity distribution schedule, inspect overhead power lines & underground power cables	1. electrical engineering 2. electrical power safety regulations 3. electricity consumption 4. energy
			substation engineer	Substation engineers design medium and high voltage substations used for the transmission, distribution, and generation of electrical energy.	Create AutoCAD drawings, design electric power, systems, ensure compliance with safety legislation	1. electrical engineering 2. electricity consumption 3. electricity principles 4. engineering processes
		Electronics engineers	instrumentation engineer	Instrumentation engineers envision and design equipment used in manufacturing processes for controlling and	Adjust engineering designs, approve engineering design, design control systems,	1. control systems 2. design drawings 3. electricity 4. electricity principles 5. electronics

				monitoring various engineering processes remotely.	develop instrumentation systems	
	Architects, planners, surveyors and designers	Graphic and multimedia designers	digital media designer	Digital media designers create and edit graphics, animations, sound, text, and video to assist in the creation of integrated multimedia products.	Create website wireframe, integrate content into output media, manage online content, provide multimedia content	1. authoring software 2. copyright legislation 3. graphics editor software 4. publishing strategy
Teaching professionals	University and higher education teachers	Higher education lecturer	engineering lecturer	Professors, teachers, or lecturers who instruct students that have obtained an upper secondary education diploma in their own specialised field of study, engineering, which is predominantly academic in nature.	Apply teaching strategies, compile course material, demonstrate when teaching, develop course outline, guarantee students' safety	1. electrical engineering 2. engineering principles 3. engineering processes 4. technical drawings
	Vocational education teachers	Vocational education teachers	electricity and energy vocational teacher	Electricity and energy vocational teachers instruct students in their specialised field of study, electricity and energy, which is predominantly practical in nature.	Adapt instruction to labour market, adapt teaching to student's capabilities, assess students, assign homework develop course outline	1. assessment processes 2. curriculum objectives 3. electricity 4. energy 5. learning difficulties
	Software and applications developers and analysts	Systems analysts	data scientist	Data scientists find and interpret rich data sources, manage large amounts of data, merge data sources, ensure consistency of datasets.	Collect ICT data, deliver visual presentation of data, design database scheme, develop data processing applications, interpret data	4. data mining 5. data models 6. information categorisation 7. information extraction
	Database and network professionals	Database designers and administrators	data warehouse designer	Data warehouse designers are responsible for planning, connecting,	Assess ICT knowledge, create database diagrams, create software design,	1. ICT security legislation

				designing, scheduling, and deploying data warehouse systems.	define technical requirements manage standards for data exchange	2. business process modelling 3. data warehouse 4. database
		Systems administrators	ICT network administrator	ICT network administrators maintain operation of a reliable, secure, and efficient data communications network.	Define firewall rules, design computer network, implement ICT network diagnostic tools.	1. ICT network routing 2. ICT performance analysis methods

- Technicians and associate professionals

Table 56 Occupations - Technicians and associate professionals

General Classification			Narrow Classification	Description	Related skills	Associated/Related knowledge
Science and engineering associate professionals	Physical and engineering science technicians	Civil engineering technicians	1. Energy analyst	Energy analysts evaluate the consumption of energy in buidings owned by consumers and businesses. Energy analysts suggest efficiency improvements.	Analyse energy consumption, carry out energy management of facilities & Promote sustainable energy	1. Energy 2. Energy market 3. Renewable energy technologies
			2. Energy conservation officer	Energy conservation officers promote the conservation of energy in both residential	• Advise on heating systems energy efficiency, develop energy policy and Identify energy needs	Energy

				homes as in businesses. They advise people on ways to reduce their power consumption.		
			3. Energy consultant	Energy consultants advise clients on the advantages and disadvantages of different energy sources. They help clients to understand energy tariffs and try to reduce their energy consumption.	Answer requests for quotation, assess customers	Energy efficiency
Technicians and associate professionals	Electrical engineering technicians	Electrical engineering technicians	1. Electrical engineering technicians	Electrical engineering technicians work in electrical engineering research. They perform technical tasks and aid in testing, of electrical devices and facilities.	Assemble electrical components	1. Electrical discharge 2. Electrical engineering **3.** Electrical equipment components

			2. Electromechanical engineering technician	Electromechanical engineering technicians are responsible for building, installing, testing and maintaining the electromechanical equipment, circuits and systems.	Assemble electromechanical systems, fasten components & Inspect quality of products	4. Electric drives 5. Electrical machines 6. Electricity
			3. Hydropower technician	Hydropower technicians install and maintain systems in hydropower plants. They perform inspections, analyse problems and carry out repairs..	http://data.europa.eu/esco/skill/42b23922-1c40-4dbe-9e0c-7a568dfdf06bApply health and safety standards, maintain electrical equipment and monitor electric generators	1. http://data.europa.eu/esco/skill/c8c18b8d-a813-49f8-a702-689564dcf8b2Electrical power safety regulations 2. Energy efficiency 3. Renewable energy technologies
Science and engineering associate professionals	Process control technicians	Power production plant operators	1. Electrical power distributor	Electrical power distributors operate and maintain equipment which deliver the energy from the transmission	Ensure safety in electrical power operations	http://data.europa.eu/esco/skill/57869946-cec2-4121-981c-84c9846c58d0 Electrical power safety regulations

				system to the consumer.		
			2. Electrical transmission system operator	Electrical transmission system operators transport energy in the form of electrical power. They transmit electrical power from generation plants to electricity distribution stations.	Ensure compliance with electricity distribution schedule, manage electricity transmission system	Electricity

- Plant and machine operators and assemblers

Table 57 Occupations - Plant and machine operators and assemblers

General Classification			Narrow Classification	Description	Related skills	Associated/Related knowledge
Plant and machine	Stationary plant and	Mining and mineral processing plant operatos	1. Dewatering technician	Dewatering technicians install and operate pumps, spares, pipe ranges, and vacuum dewatering systems to collect and remove liquids and chemicals.	Collect samples, manage storage tanks	Chemistry

operators and assemblers	machine operators					
			2. Driller	Drillers set up and operate drilling rigs and related equipment for mineral exploration, in shotfiring operations, and for construction purposes.	Check borehole depth, operate drilling equipment	Health and safety hazards underground
			3. Surface miner	Surface miners perform a wide range of ancillary surface mining operations, such as pumping and transport of materials.	Operate hydraulic pumps, operate mining tools	1. Electricity 2. Geology 3. Mechanics
	Stationary plant and machine operators	Mineral and stone processing plant operators	1. Mineral crushing operator	Mineral crushing operators monitor machines to crush materials and minerals. They fill the machines with minerals and ensure that the end products meet requirements.	Inspect quality of products, maneuver stone blocks & operate crusher	1. Quality standards 2. Types of stone for working

			2. Mineral processing operator	Mineral processing operators operate a variety of plants and equipment to convert raw materials into marketable products.	Conduct inter-shift communication, deal with pressure from unexpected circumstances http://data.europa.eu/esco/skill/2416dc09-6384-409e-8b1d-80bb7a2e7369	1. Electricity. 2. Bioleaching 3. Chemistry
Assemblers	Electrical and electronic equipment assemblers	Electrical equipment assemblers	1. Electrical equipment assembler	Are responsible for the assembly of electrical equipment. They assemble product components and wiring according to the blueprints.	• Align components, apply soldering techniques, assemble electrical components	1. Electrical discharge 2. Electricity
			2. Electrical cable assembler	Manipulate cables and wires made of steel, copper, or aluminium so they can be used to conduct electricity in a variety of appliances.	Carry out measurements of parts, crimp wire, ensure conformity to specifications	1. Electrical wire accessories 2. Electrical wiring diagrams
			3. Wire cable assembler	Bind wires or cables to form wire harnesses used in electronic and electrical	Assemble wire harnesses, crimp wire & Use electrical wire tools	1. Electricity 2. Manufacture of electrical wire products 3. Quality standards 4. Wire harnesses

				systems and equipment.		
Drivers and mobile plant operators	Mobile plant operators	Mobile farm and forestry plant operators	1. Forestry equipment operator	Use specialised equipment in the forest to maintain, harvest, extract the wood for the manufacturing of consumer goods and industrial products.	Assess felled timber quality, carry out routine maintenance of wood cutting machinery	1. Agronomy 2. Forest conservation
			2. Land-based machinery operator	Land-based machinery operators operate specialised equipment and machinery for agricultural production and maintenance of landscape.	Handle chemical products for soil and plants, harvest cover crops, operate agricultural machinery	1. Mechanical tools 2. Pesticides 3. Road traffic laws

Annex 2: LinkedIn occupations

Table 58 LinkedIn occupations in Greece

Job Position	Business	Degree	Digital Skills
Associate PV Developer	Renewables & Environment	Engineering Degree from a reputable university	-Strong computer skills and proficiency with Microsoft Office products including Auto Cad
Calibration Technician	Information technology and services Network interconnection - Communications	Very Good technical education with qualifications in mechanical or electronic engineering (not expecified)	-Experience in precision measurement techniques (eg dimensions, mass, temperature, etc.) -Experience in quality control systems such as ISO/IEC 17025, ISO 9001 etc. -IT knowledge (Microsoft Word, Microsoft Excel, Windows 10) -Basic knowledge of statistical control analysis
Control Room Operator	Oil & Energy	Degree in Electrical or Mechanical Engineering (Technological Institute is preferred)	-Proficient in operating computers and all other plant SCADA systems used in monitoring and controlling plant operations -Good analytical skills to process information in a timely and accurate manner
Data Engineer	Oil & Energy	Bachelor's degree in Software Engineering, Computer	-4+ years experience with Talend Open Studio and/ or MS SSIS -3+ years of database modeling, implementation and tuning using MySQL (Maria DB, MySQL 5.7+), MSSQL (2016+) and MongoDB -Experience with database design & development, data modeling, ETL/ ELT tools, data profiling and data quality -Scripting database queries against RBMSs (MySQL and MSSQL) and/or document/ graph/message DBs -Experience on statistical and data analysis packages/ tools (Excel, SSRS, SSAS, raw files, etc.) -Coding (Java, Python) to tackle hard/ complex data manipulation, pre-processing, post-processing, and transformation problems

Data Scientist - Gas & Power Trading	Oil & Energy	not stated	- Development of forecasting models - Machine Learning & Deep Learning methods - Multivariate statistics - Strong Python and SQL coding skills with good understanding of software engineering best practices
Energy Engineer (design of energy software, energy engineering)	Information technology	University degree in Engineering / Energy engineering, preferably with postgraduate qualification at PhD level;	-At least 2 years' experience specifically in National and European research programmes in ICT -Experience in software design and development
Field Support Technician Wind & Solar – Tools management (M/F)	Renewables & Environment	Bachelor from a Technological Education Institute (TEI) in Electrical/Mechanical Engineering (or equivalent) with 2 to 5 years of experience in a technical position delivering Renewable Energy services	-Experience required in the fields of Rotating mechanism, Hydraulics, LV/MV Electrical systems, Electronics and SCADA -Extended PC knowledge (MS Office)
Golang Software Engineer	Renewables & Environment	not stated	-Experience in software systems development using Go -Git use experience -2-5 years of software development experience -Experience in iterative development environment using Scrum -Linux Systems Programming -Solid understanding of databases and message brokers (will work with Cassandra, Kafka, PostgreSQL) -Knowledge of Web and API development
Health & Safety and Environmental Specialist	Renewables & Environment	Environmental Engineering or Environmental sciences. Occupational Health and Safety Officer or equivalent.	-User-level command of Word, Excel and Access -Use of ArcGIS software -Good communication skills -Analysis and team work skills -Understanding of Microsoft Products and/or complementing products (preferred) -Competency in Analytical Problem Solving, Strong

			Communication -Customer/Partner Relationships and Technology expertise (preferred)
Junior Project Developer	Renewables & Environment	Bachelor's degree (preferably M.Sc. degree) in Mechanical or Electrical Engineering	-Experience in Renewables software's, AutoCAD and Microsoft Office Suite
Long Term Energy Analyst	Oil & Energy	Bachelor's degree in Mathematics or Engineering	-Minimum 2 years' experience as Data Scientist/Analyst or in a similar role -Experience with programming in R and/or Python, scripting and/or statistical software strongly preferred -Understanding of machine-learning and operations research -Strong quantitative, analytic, modelling, pricing and risk management skills -Interest in applying technology and/or quantitative skills to solve complex trading problems -Strong analytical and numeracy skills -Advanced presentation skills -Open minded & Agile
Maintenance Planner	Petrol and energy	Preferably BSc degree in Engineering or equivalent	-Structured and planned way of working -Focused and can-do attitude -Knowledge about Operations & Maintenance -Good co-operation and communication skills -Maintenance Management knowhow -Contract business understanding -Fluent in written and spoken English, Greek language seen as an advantage -IT skills
Manufacturing Technician	Machine industry	High School Diploma or General Educational Development (GED)	-Successful completion with a passing score of the Manufacturing Tech course -Previous manufacturing experience preferred -General computer skills -Experience with Microsoft Applications (e.g. word, excel, outlook, etc)

Network Planner & Real Estate Specialist	Petrol and energy	University degree preferably in Engineering, Finance or a related discipline	-Knowledge on legal matters such as petroleum laws and regulations, commercial agreements and lease contracts will be considered will be preferred -Experience working with software packages e.g. SAP
Outsourcing Manager	Retail	AEI/TEI Graduate (University)	-At least three (3) years of working experience in similar position -Excellent knowledge of the English language (both written and verbal communication) -Excellent PC skills (Windows, MS Office suite, Internet) -Excellent interpersonal, communication and organization skills -Excellent negotiation skills
PHP Developer	Oil & Energy	Bachelor's degree in Engineering, Computer Science, or other related discipline.	-Strong background with LAMP Stack development environment -4+ years of PHP development experience -3+ years of object oriented programming -3+ years working with the following: HTML, JavaScript, CSS, UI Frameworks -2+ years of SQL and relational database experience like MySQL/ MariaDB -Handling server-side DevOps as needed and be familiar with containerized applications in Docker, Kubernetes -Familiarity with Could/ SaaS services like AWS and Azure will be a plus -Working as a member of distributed teams, leveraging collaboration, code sharing (GitLab) and task management tools
Project Engineer in Wind Energy	Renewables & Environment	Bachelor's degree (preferably M.Sc degree) in Mechanical or Electrical Engineering	-Experience in Wind Pro / Wasp, AutoCad and Microsoft Office Suite -Familiarity with legislation, rules, regulations, best practices and ISO standards
Project Engineer in Wind Energy	Renewables & Environment	Bachelor's degree (preferably M.Sc degree) in Mechanical or Electrical Engineering	-Assisting the Technical Director and project team with wind data processing and evaluation, wind energy feasibility studies, -Project documentation and permit supervision and following up, -Renewables legislation follow up

Project Manager	Oil & Energy	BSc Degree in Engineering.	-Strong working knowledge of Microsoft Office
PV O&M Manager	Renewables & Environment	Diploma in Electrical Engineering field by a Technical University (AEI)	-Ability to configure and repair communication hardware and software -Good communication skills, use of standard work related PC programs -Communication system knowledge
R&D Electronic Engineer	Oil & Energy	Bachelor Degree in Electrical Engineering or relevant field	-Experience with Electronic Design Automation (EDA) tools (e.g. OrCAD) -Experience with Product Lifetime Management (PLM) tools -Experience with SPICE-based circuit simulators (e.g. LTSpice, PSpice etc)
Regional Operations Manager Greece	Renewables & Environment	Bachelor's degree in a related field	-Proficient knowledge of Microsoft Office software and database applications -Experience with LAN, WAN, and enterprise SCADA systems preferred
Renewables Operations & Maintenance Engineer	Petrol and energy	Bachelor's degree in Electrical or Mechanical Engineering	-Accountability and results orientation -Analytical thinking -Problem solving skills -Strong communication skills -Teamwork spirit and collaboration -Adaptability and flexibility
SCADA Network Engineer	Renewables & Environment	Engineering or Technical degree in Automation, IT, Electronics or similar	-2 years of experience in network installation and communications -Cisco devices experience is mandatory, installing and configuring mainly routers and switches -Previous experience in commissioning and maintenance Windows Server systems -SQL server knowledge -HP Server platform knowledge

Senior .NET Developer	Oil & Energy	Bachelor's degree in Software Engineering, Computer Science, or other related discipline.	-5+ years of experience in programming software including requirement analysis, design, development, implementation, testing, maintenance, quality assurance, documentation, troubleshooting and/or upgrading of software systems -4+ years' experience with C#, .Net Framework Core (2.1 & 3.1) and the .NET Framework (WinForms & Web) running either on Linux and Windows -Familiar with task management and tracking systems among project basic technical management skills -Experience on high availability 24/7 systems architecture, related hosting and security aspects, performance tuning & monitoring and incident management -Excellent technical skills, ability to work independently meanwhile acting as part of a wider remote team. Should be comfortable on using various tracking/ task systems (Teamwork, MS Teams, Asana, etc.) and have the ability to act as a technical expert on new projects -Agile minded working experience is a must, while maintaining high level of responsibility on the technical decisions
Senior R&D Embedded Software Engineer	Oil & Energy	Bachelor Degree in Electrical Engineering or Information Sciences and Technology.	-At least 4 years programming experience in C language -Minimum 3 years' experience on microcontroller firmware development (preferably Microchip) -Proven experience at least on 2 communication protocols (i2C, SPI, USB, UART) -Experience on CAN bus networks will be considered as a major asset -Ability to read and understand electrical schematics, datasheets, and wiring diagrams -Familiar with revision control systems (e.g. Git, Svn, Perforce, PTC Integrity)

			-Familiar with configuration and requirement management tools (eg: JIRA, Confluence) -Familiar with integrated development toolchains (Eclipse, KDbg, MS Visual Studio, MPLAB, VS code etc)
Service Technician	Machine industry	Apprentice-trained or equivalent and fully conversant with electrical and/or engineering disciplines	-Experience with overhead cranes and hoists is desirable, but not essential as full product training will be given -Good grasp of the Greek language (verbal and written) -Strong interpersonal skills as there is extensive customer contact -It is expected that you will be safety conscious -You must be physically fit and able to work at heights -Willingness to work extra hours during the week and at weekends -Hold a current driving licence
Surveying Engineer	Oil & Energy	University degree of Surveying Engineering	-Excellent computer skills (MS Office) -Necessary knowledge of design programs (Autocad etc.)

Table 59 LinkedIn occupations in Germany

Job Position	Business	Degree	Digital Skills
AI and Simulation Expert (f/m/d) in Process Industries	Renewables and Environment	Master's degree in computer science, mathematics, physics, engineering or a comparable field	-Professional experience with technologies, algorithms and methods in the areas of data analysis, machine learning, optimization, simulation and corresponding libraries (Tensorflow, Keras, Scikit-learn etc.) -Relevant experience in the deployment of data analytics models and in the corresponding technology (e.g. flask, Docker) as well as in using cloud services specifically for data analytics. Furthermore, you have knowledge in agile software development (scrum and lean) -Excellent analytical skills and physical understanding in order to create simulation and optimization models. You demonstrate excellent programming skills in Python and R as well as good skills in related analytical libraries. Additional programming skills (e.g. in Java/C++, C#, etc.) are an advantage

Battery Data Scientist	Electrical and electronic manufacturing	M.Sc. Physics, Computer Science, Mathematics, Electrical Engineer or similar	-3 or more years of data analysis with background on lithium-ion battery or related technologies -Experience with mathematical modeling of physical systems, preferably including battery designs -Experience in data evaluation and statistical methods in technical / electrical environment -Experience in evaluation complex data sets
BMS Engineer	Renewables and Environment	M.Sc. Physics, Computer Science, Electrical Engineering	-Experience in data processing within BMS, data evaluation and communication
Cleantech Services Specialist (f/m/d), Renewable Energy Solutions	Electrical and electronic manufacturing	Bachelor's Degree in Energy, Business, Finance, Engineering	-Proficiency in Microsoft Office environment
Creative electric engineer for renewable energy company	Renewables and Environment	Electrical engineer	-Ability to draw diagrams in platforms such as SolidWorks, AutoCad or equivalent -Understanding of Firmware across any relevant platform, ie, reading manuals and making parameter settings -Ability to set up modbus, canbus, RTU, MQT or other comms platforms where components exchange data in real time -Understanding of modern platforms such as Raspberry, Arduino and other edge-computing systems
Data Architect (f/m/d)	Renewables and Environment	Bachelor's degree in Computer Science, Computer Engineering	-Strong knowledge of database structure systems and data mining as well as a strong knowledge and experience in data modelling
Development Engineer (f/m/d) - CAD Design Electrolysis Cells	Renewables and Environment	Completed studies in mechanical engineering, power engineering, process engineering or a comparable field.	-Practical design experience, ideally with NX and Teamcenter -Profound knowledge in the fields of flow simulation, system simulation and modelling as well as an in-depth knowledge in the fields of fluid mechanics and heat transfer
Digitalisation Enterprise Architect (f/m/d)	Renewables and Environment	Master's degree in computer science or a similar field with long time experience	-8-10 years of experience in designing and implementing complex architectures with focus on digitalisation (analytics, cloud, RPA, Low Code, Data Warehousing, Data Lake etc.) -Deep technical cloud knowledge (AWS certified) with understanding of demands regarding reusability and high

			security demands as well as deep knowledge of current technologies (e.g. AWS tool portfolio, analytics and reporting tools), and current technology trends like low code with hands on experience
Electrical Power Engineer for sustainable energy systems – (m/f/d)	Oil & Energy	M.Sc. or B.Sc. in Electrical Engineering with focus on power systems	-Experience in using electrical grid simulation software tools such as NEPLAN, ETAP, PowerFactory or others (during university studies or first professional experience) -Proficiency in MS Office
Embedded Hardware Engineer	Renewables and Environment	Degree or MSc in Electrical/Electronic Engineering or similar background	-Proficiency in PCB design software like Altium Designer, Mentor Graphics or Eagle. -Programming skills would be a plus
Embedded Software Engineer (m/w/d)	Electrical and electronic manufacturing	Completed studies in electrical engineering, communications engineering or similar	-Experience in commissioning modern microcontrollers (e.g. ARM, Aspeed, Infineon, TI, ST) -Professional experience in hardware-related software programming and signal conditioning -Solid knowledge of various DSP / µC platforms and real-time systems -Good knowledge of Embedded Linux (Devicetree, Yocto bitbake layer, recipes, Docker and U-boot) -Good knowledge of Ethernet Protocol: IPMI 2.0, DCMI 1.5, RESTful API, SSH, Ethernet TCPI-IP -Knowledge in the development of web-interface / GUI -Knowledge of Open Compute / OpenRMC / OpenBMC / DMTF's Redfish -Good knowledge of communication protocols (CAN-Bus, I2C/PMbus, RS485/Modbus) -Knowledge in the development of graphical user interfaces in C# -Experience in model-based software development (e.g. with Matlab / Simulink / TargetLink) desirable
Energy Storage Sales Engineer	Renewables and Environment	Bachelor's or Master's degree in engineering or similar technical discipline	-Experience developing technical and financial models using Excel and/or Matlab -Experience working with CRM and engineering tools (e.g. Salesforce, CAD)

Engineer Operational Excellence	Public safety	Bachelor or Master's degree in electrical engineering, information technology, computer science, business engineering, telecommunication or business IT	-Knowledge and experience related to power utility processes like system operation, smart metering, smart grid protocols, substation automation (IEC 61850) or utility communication technology -The Common Information Model (IEC 61970), a standardized data model for power utilities -Knowledge of SCADA, DMS, Power System Operation -Knowledge of Data Management processes or requirements -Hands on expertise with data analytics
IT architect (f/m/d)	Renewables and Environment	Computer Sciences, IT, Elec. Eng. (not required if they have enough practical experience)	-Significant experience (min. 3-5y) in enterprise IT system and solution architectures, data center operations, cloud infrastructure, container solutions, security, Linux operating system and storage solutions. -Communicate fluently in English
Nordic Hydro Optimizer (m/f/d)	Oil & Energy	Degree in engineering, economics, mathematics	-Strong analytical and problem-solving skills that emphasize a logical approach to tackle new ideas, sorting information and discovering creative solutions -Deep understanding of IT applications for optimization & trading as well as experience in structuring and developing own tools -Programming and database skills would be beneficial and viewed positively upon, in particular hands-on experience in e.g. Python, R, SQL
Principal Battery Systems Design Engineer	Renewables and Environment	M.Sc. Physics, Electrical Engineering, or similar	-Experience with mathematical modeling of batteries or experimental work in the field of batteries -Experience in design, developing and testing of battery systems
Risk Analyst for Renewable Energy Markets (m/f/d)	Renewables and Environment	University degree in a quantitative discipline like Finance, Mathematics, Physics, Economics, Engineering or Statistics	-Programming experience (e.g. Python, Matlab or R)
Senior Enterprise Architect (f/m/d) Cybersecurity	Renewables and Environment	Computer science or natural science	-Long-term professional experience in developing und running IT/Cybersecurity applications, infrastructure and solutions (especially Cloud Computing based & IoT). You possess proven knowledge of system architectures -Familiar with different enterprise architecture frameworks and

			their application, e.g. NIST framework & CMMi -Very good knowledge of national and international security standard as well as an understanding of risk-based assessment methods
Senior Finance Automation Architect (f/m/d) for Digital Processes	Renewables and Environment	Technology or business management background	-Professional experience in a process optimization expert role and with shaping and optimizing business processes that are connected to digital data flows -Affiliation to data tools and an interest in digital technologies. You are also familiar with SAP ERP, experience in creating software robots and/or using UIPath is beneficial -Business-fluent English language skills, both verbal and written
Senior Principal Project Lead Engineer	Electrical and electronic manufacturing	Master (or Bachelor) degree in Electrical Engineering	-Good understanding of electrical power grids, network control systems (SCADA EMS, SCADA ADMS), power applications, telecommunication, substation automation, related data acquisition infrastructures, etc. -Proven experiences in the design, engineering, installation and commissioning of such control system infrastructure projects
Senior Risk Analyst for Renewable Energy Markets (m/f/d)	Renewables and Environment	University degree in a quantitative discipline like Finance, Mathematics, Physics, Economics, Engineering or Statistics	-Programming experience (e.g. Python, Matlab or R)
Senior System Engineer (m/f/d)	Renewables and Environment	Master's degree in engineering, electrical engineering or equivalent	-Familiar with methods and process models of system engineering -Proficient in requirement management IT tools such as Polarion and very good
Senior Wind Turbine Blade Engineer (m/f/d)	Renewables and Environment	PhD in mechanical engineering	-Working experience in wind turbine blade design, modelling, controls or relevant field -Strong computer skills, preferably in Python, MATLAB or Simulink, with experience using databases
Teamlead Manufacturing Engineering (m/f/d)	Oil & Energy	Studies in the field of mechatronics, mechanical or electrical engineering or a comparable subject	-Have good knowledge of a variety of standard software tools and ERP-system (preferably SAP)

Wind Developer (m/f/d)	Renewables and Environment	not stated	-Wind resource assessment software and GIS competences (WindPro, ArcGIS, CAD,…)

Table 60 LinkedIn Occupations in Sweden

Job Position	Business	Degree	Digital Skills
Electrical Engineer	Oil & Energy	University degree in electrical engineering	-Qualifying will be your knowledge of E3 CAD, ETAP, Auto CAD, Excel and related programs
Senior Technical Analyst/Specialist (m/w/d) for Research and Applications	Oil & Energy	University Degree in Physics, Meteorology, Mathematics, Data Science	-Object oriented programming (Python, Matlab, C# or C++) -Advanced script skills either in Python, R, Matlab, C# or C++ coupled with advanced skills in wind data processing -Database skills (database design and SQL) and Data science knowledge (supervised learning, neural networks, and time series forecasting) -Statistical knowledge in resampling methods, probability distributions, confirmatory data analysis, and data modelling fitting coupled with understand of wind data analysis
R&D Engineer Wind Power	Utilities	Master's degree in Electrical Engineering, Physics, Power Technology	-Three years of experience in the design and analysis of power systems for either distribution grids, energy industries, or wind power systems -Strong command in simulation tools such as PSS/E, PSCAD, DigSilent Power Factory, and/or Matlab
Engineering Support Hero	Renewables & Environment	Developer	-You have some knowledge or understanding of Github, HTML, CSS, JavaScript, React, .NET, .NET Core, NodeJs, GraphQL and AWS, if you're fluent in any, that's a plus!
Cell Design Engineer	Electrical & Electronic manufacturing	BSc, MSc or PhD degree within mechanical engineering	-+3 years of mechanical design experience where part of the experience is in product development is a plus -Experience from one or several of Catia, Ansys, Siemens NX or similar CAE simulation software is a must

R&D Project Manager	Industrial automation	Bachelor's degree in Engineering 5 years of experience of Product Development	-Experience from or good understanding of several of the following areas: electronics development, mechanical design, product validation testing, type testing, electronics production, production testing, embedded software development, HW/SW interaction
Electrical Engineer	Electrical & Electronic manufacturing	Bachelor's or Master's Degree in Electrical Engineering	-Experience in schematics drawing and wire/cable routing in E3/NX -Experienced in electrical design to meet safety and EMI requirements -Knowledge of Prototype integration and testing
Senior Applications Engineer	Utilities	Academic degree in IT, engineering, science or mathematics	-Building and operating of server virtualization environments -Thorough knowledge of operating systems (Linux/Windows 2012 and up) -Working with Agile methodology and/or DevOps way -Automation experience with at least one configuration/deployment management system (Salt, Ansible, Jenkins pipelines, Azure DevOps…) -Experience with at least one of the following scripting languages (Powershell, Shell, Python…) -Experience working with GIT -Experience developing CI/CD
Service Technician	Oil & Energy	Electrical and/or Mechanical education on vocational or higher level	-Ability to work using computers (experience with Windows OS, Microsoft Office and SAP is considered beneficial)
Project Manager (m/f/d) Renewable Energy Projects	Renewables & Environment	University degree in finance, business administration, economics, engineering	-Analytical, well-structured, open to digital transformation as well as communicative, proactive and enthusiastic
E-MOBILITY - SYSTEM ENGINEER - POWER ELECTRONICS	Electrical & Electronic manufacturing	M.Sc Electric & Electronics Engineering, Systems, Signals & Control engineering or equivalent.	-5 years of experience from SW Development or Test & Verification within power electronics systems. -Experience of system integration -Vector tools chain CANoe, CANalyzer…

ERP Analyst	Electrical & Electronic manufacturing	Masters of Science or similar in computer science o IT, Business with IT or related field	-Knowledge of Process Modelling and/or ERP implementation -Work within the team implementing Microsoft Dynamics 365
Electronic Hardware (HW) Design Engineer	Electrical & Electronic manufacturing	Master's Degree in Electrical Engineering, Mechatronics, Applied Physics	-Experience of software development, C & Python
System Study Engineer and Senior System Study Engineer	Electrical & Electronic manufacturing	M.Sc. or Ph.D. in Electrical Engineering or similar.	-Knowledge in several of the programs and tools we are using: RTDS, PSCAD, PSS/E, DIgSILENT PowerFactory, Matlab, EMTP-RV, etc.
Systems & Research Engineer	Renewables & Environment	Sc. or Ph.D. degree in Engineering	-Proficiency in using mathematical and numerical modelling as a main work tool, both commercially available and in-house tools -Experience from experimental and validation work -Strong in one or more computer languages with Python and Modelica considered extra assets
Business Intelligence Manager	Renewables & Environment	B.Sc. or M.Sc. in Data Science or similar, or you can prove you have the skills for the role without a degree.	-Experience with Tableau -Experience with SQL
Technical Operations Engineer (m/f/d)	Renewables & Environment	Degree in Electrical or Mechanical engineering (or similar technical educational background)	-Excellent Microsoft Office knowledge, particularly Excel, Word, and Power Point -Experience in working with different software, especially SCADA systems as interface to the assets is a benefit
Integration DevOps Engineer (f/m/d)	Utilities	Academic degree, preferably in IT, Computer Science, Information Management or other relevant field	-You are analytical, structured and a problem solver -You are familiar with the Microsoft Ecosystem (Windows Server, .Net Framework, IIS) -You know integration standards (ESB / EAI preferred BizTalk, queueing solutions (preferred IBM MQ series), (s)FTP) and have been working with Cloud Technologies like Azure before
Software Engineer - Integrations	Renewables & Environment	not stated	-Fluent in C#, preferably .Net Core -Experience and knowledge of handle and transfer big data sets -Practical experience building, monitoring and maintaining API's

Technical Integration Specialist	Renewables & Environment	Relevant technical education or proven professional experience	-Experience in networking, routing, and common network protocols -Experience with Linux and Windows network stack and protocols -Experience with SQL databases -Experience with scripting (Python, Bash, etc.) -Knowledge of REGEX, working with different file types, e.g. JSON, XML, Excel, CSV -Analytical skills with the ability to assess problems and learn new domains.
HSE Advisor Wind	Utilities	University studies (M.Sc./Diploma) in a relevant subject area (engineering-related/safety/risk engineering or similar studies)	-You have good analytical and conceptual skills as well as a high degree of self-directed initiative and personal responsibility
Software Engineer .Net	Renewables & Environment	not stated	-Fluent in C#, preferably .Net Core -Knowledgeable in Microsoft Azure -Git (we use bitbucket) -Agile methodology -DevOps -Experience working with Microservice Architectures. -Practical experience building, monitoring and maintaining API's
Junior Lab Engineer	Renewables & Environment	Relevant bachelor or master's degree	-Data analysis -Some programming skills
SCADA Engineer	Renewables & Environment	not stated (Background within IT and remote troubleshooting)	-Good experience in troubleshooting Windows servers -Experience with SQL databases -VM Ware -OPC/OPC UA -Working with wind turbines -Strong analytical and problem-solving skills -Highly structured with good coordination skills
(Lead) Electrical Engineer	Renewables & Environment	University degree in Electrical Engineering/Power Systems	-Power system analyses and studies -Power system simulation software, such as DIgSILENT/PSCAD/PSSE -HV and MV equipment and power systems -Knowledge of industrial automation and networks, PLC hardware, SCADA systems and communication interface

Table 61 LinkedIn occupations in Spain

Job Position	Business	Degree	Digital Skills
Electrical & Control Engineer (Wind Energy Electrical Grid Code Model	Power	B.E/B.Tech/BS-Electrical Engineering	-Software: advanced user of MATLAB, PSCAD & Power factory
Solar Design Engineer	Electrical & Electronic Manufacturing	University degree (engineering / technical preferred)	-Competence in AUTOCAD is mandatory. Fully capable of producing drawings for PV projects. -Well versed in Microsoft office and other MS Project tools
ELECTRICAL DESIGN ENGINEER (HARMONIC)	Mechanical Or Industrial Engineering	University degree - Electrical engineering	-'Disilient power factory for harmonic study -Harmonic filter design experience -Experience with test specification for harmonic study and harmonic test validation, -Characterization of power loads driving harmonic emission, -Experienced designing and specifying harmonic filter. -Experienced in Thevenin Harmonic Model -Experienced in high frequency representation of power transformerin regards to harmonic filtering strategy
Blade System Engineer- HAL-X – Wind turbine	Renewables & Environment	Engineering degree with a master's in mechanical or aeronautics design or equivalent, from an accredited university.	-Strong experience in wind turbines development including participation in creation of specifications, design, calculation and validation. -Experience in wind turbine loads simulation (i.e. Flex, Bladed) -Experience in Mechanical/ Structural engineering including design based in finite elements assessment and development (i.e. Ansys, Abacus -Experience with systems simulation tools (i.e. Matlab, Simulink -Experience with CAD and mechanical tools (i.e .NX)
Systems and Instrumentation Field Engineer (m/f/d)	Oil & Energy	Bachelors degree in a related subject or demonstrate, good, equivalent, similar work experience	-Show good knowledge of Networking, Hardware and Protocols -Demonstrate good knowledge of Modbus, OPC, NetDDE and serial communications protocols (RS232, 422, 485)
Drives Field Service Engineer	Electrical & Electronic Manufacturing	Electrical/Electronic engineering degree or Professional Module (FP2)	-Knowledge of AC/DC drives technology, industrial communications (Profibus, Ethernet, Modbus, industrial routers, cloud-based services, etc.) and remote monitoring and remote support systems

Power Systems Engineer	Public safety	Bachelor degree in Industrial/Electrical/Energy Engineering (or other relevant disciplines)	-Python, Fortran programming-scripting experience -Simulation skills with PSCAD / PSS®E / DigSilent Power Factory / EMPT-RV -Previous renewable energy, consulting, project management, electronics experience or credentials -Proficiency in MS Outlook, Word, Excel, PowerPoint
SE Supplier Quality and Development Engineer (f/m/x)	Renewables & Environment	Bachelor or Master's degree in Engineering	-IT skills, including SAP and Microsoft Office applications
Electronics Quality Engineer	Renewables & Environment	Electronics Engineering degree	-Microsoft Office tools knowledge (Word, Excel, PowerPoint) -Altium Designer software knowledge (preferable) -Electronics circuit simulation software knowledge (LTSPICE)
HAL-X – Pitch System Electrical Engineer	Renewables & Environment	Engineering degree with a master in electrical or mechatronics	-Experience with systems simulation tools (i.e. Matlab, Simulink) -Experience with electrical CAD and mechanical tools (i.e. ePLAN, Solidworks, NX)
Industrial Communications Application Engineer	Renewables & Environment	Electronics/Electrical Engineering degree or equivalent	-Engineering and Business knowledge, with relevant experience with RF communications systems, IP networking, system-level design, and troubleshooting concepts -Experience in telecommunication or IT sectors
Software Applications Engineer	Renewables & Environment	Master's Degree in Computer Engineering or Science from an accredited college or university	-Strong experience in software developments -Software developer experience in more of one discipline .NET and Python -Experience in web development framework -Experience using big data technologies, AWS redshift is an asset
HAL-X –Rotor Structural Engineer	Renewables & Environment	Engineering degree with a master in structural or mechanical design, from an accredited university	-Experience with mechanical CAD design tools (NX, Catia or similar) -Consolidated experience with FEM design and calculation tools (Ansys, Abacus or similar) -Experience with fatigue design and calculation tools (nCode or similar) -Significant experience in structural components development including participation in creation of specifications, design, calculation and validation
Project Execution Tendering Manager (ITO coordinator)	Renewables & Environment	Master's in engineering (electrical, mechanical, civil)	-Computer Science: Knowledge of Microsoft Applications and Industrial and Management Software

Senior Wind Turbine Loads Engineer	Renewables & Environment	Master degree from an accredited university in Mechanical Engineering, Aerospace Engineering or Renewable Energy Engineering	-Expert knowledge of Wind turbine aero elastic simulations (Flex5, Bladed, Simpack, etc.) -Significant aeroelastic simulation experience for Wind Turbines
Engineer	Renewables	Educated to Degree level in relevant engineering discipline	-Building services such as BMS, Security and Fire Systems. -IT literate with the ability to operate MS Office systems and other IT based project management software.
Senior Offshore Wind & Operating Windfarm Analyst	Renewables	BSc/MSc in a relevant scientific discipline (meteorology, engineering or similar)	-Microsoft office applications. -Very strong skills on coding with Python, Matlab or similar, for the preparation of ad-hoc data analysis tools for the Performance Assessment of Operating Wind Farms. Ability to work with huge SCADA datasets from the Operational Iberdrola Offshore Wind Farm Projects
Database + Analysis Manager	Retail		-Experience in data query languages, particularly, Oracle SQL -Experience in statistical analysis tools (e.g. SAS, SPSS) -Ability to use various software solutions to carry out data analysis and create reports including but not limited to Oracle SQL, SAS and Excel
Solution Architect (Digital)	Corporate		-Experience from a Software development and implementation background on related project delivery of digital solutions, with a strong understanding of IT Architecture and support -Experience of developing solutions on Azure cloud via SaaS, PaaS and IaaS -Understanding of the challenge in IoT such as Edge computing, API and communication frameworks. Understanding of large scale middleware and data management technologies -Wider experience of digital products:Digital platforms hosting services such as ML/AI, IoT, chatbots, event hubs both on-premise and cloud hosted -Cloud IaaS and PaaS experience preferably on MS Azure -Data Platforms (On-Premise & Cloud Hosted such as relational, NoSQL and Hadoop) -Experience of emerging solution technologies such as RPA, VR, MR, VA, Data science a bonus -Knowledge and experience in a breadth of Infrastructure and

			Application platforms and technologies. This will include experience of one or more of:Operating Systems (Windows OS & Linux OS) -Application Servers including JBOSS, Tomcat, .Net -IT network and security architectures -BI Platforms and packages -Knowledge of CICD DevOps lifecycle and deployment pipelines, using associated tools such as Jenkins, maven, selenium, sonar -Strong understanding of application containerisation, management and deployment in AKS, OS, Docker
Project Manager Distribution	Networks	Bachelors' degree or 7 years relevant experience required. Degree in Engineering or experience in energy industry preferred. Project Management Certification (PMP, etc.) preferred	-Expert in integrating Scheduling IT tools and software (Primavera with costs and resource requirements preferred) -Expert in risk management and mitigation plans -Expert in utilizing MS Excel for data analysis, budgeting and planning and optimizing schedules -Ability to use and query SAP preferred
Agile Scrum Master	Corporate-Marketing, Products & Digital department	Scrum Certification with a prior experience of delivery using agile methods across multiple SCRUM teams and technology areas	-Expert knowledge of agile methodology and frameworks including Scrum and Kanban, including theory, rules and practices -Expert knowledge of Atlassian Jira and Confluence -Knowledge and experience of tasks, backlog tracking, burndown metrics, velocity, user stories and value metrics -Evangelist for Agile Continuous integration and Continuous Delivery methodologies -Prior experience of Scrum Master/Product Owner/Agile Lead/Delivery Lead role in an Agile product development team, be it software or infrastructure - diligently applying Scrum principles, practices, and theory -Experience of delivering Agile based projects in both an Agile and Waterfall context ensuring seamless integration of Agile delivery methods with more traditional models -Experience of managing complex and cross-platform system integration vendors to ensure compliance and stability for our business deliverables
Lead Engineer - Software Application	Corporate-Integrated System Planning	BS Degree in Software Engineering, Computer Science or equivalent 5-7 years of relevant experience	-Analysis and design of object-oriented solutions -Server-side: Proficiency with C# using Visual Studio -Client-side: Proficiency with HTML, JSON, javascript (jQuery framework a plus) -Experience with Python

			-Experience with Sql Server (including spatial data): Data modeling, data management and data manipulation -Performance tuning -Cyme -Graph theory knowledge -Oracle and PostgreSQL databases -Version control tools such as Git, SVN
Lead Java Developer	Retail	Bachelor's degree in software engineering, computer science or other relevant field of study At least 5 years' experience in Software Architecture and Development	-Strong understanding in infrastructure and architectural design -Experience in working with Kubernetes and docker -Experience in working with Technical IT teams with understanding of networks and architecture -Strong understanding in integrations with 3rd parties via SOAP, REST -Good understanding of microservice architecture and Java Applications -Good understanding of Single Page Applications -Experience in leading development teams, including multi-channel teams (e.g. mobile, web and services)
Analyst	Retail	Vacante interna	-Excellent knowledge of SAP CRM and IS-U front end systems -Good working knowledge and experience of Microsoft office
Reporting Development Analyst	Retail	Vacante interna	-Knowledge of the following software applications and programming tools/languages -MS Excel -MS Access -MS Powerpoint -MS Word -SQL/PSQL -Visual Basic -Ability to maintain database infrastructure ensuring queries are refreshed and storage capacity is monitored and kept within storage parameters -Ability to review datasets with an analytical and structured approach

Annex 3: Massive Open Online Courses

Table *62*. List of MOOCs with digital contents. Courses of relevance for the Energy sector are identified

Relevant	Keywords	MOOC	OFFERED BY	INFO ABOUT TOPICS	REMARKS
YESSSSS	**Digital skills / Energy efficiency measures**	SMARTEL MOOC https://www.openlearning.com/courses/smartel-mooc/	SMARTEL Erasmus+ project (http://smartel-project.eu/en/home/) on openlearning	The adoption of energy efficiency measures is shifting the building installation industry towards green technologies such as smart metering and home automation, bringing significant changes on workplace requirements and training. **Electricians, apart from technical proficiency, require a combination of digital and environmental skills** to perform the installation, maintenance, and programming of smart metering and energy efficiency home automation systems. Among topics · Resolve problems associated with energy controlling systems in buildings · Connect standardized energy controlling system · Design an operating energy controlling solution · Interpret energy farm schemes · Operate energy control and metering devices · Analyse energy control and metering specifications · EU and national legislation regarding sensors	· Does it comply with EQF level 4? · Start any time · Flexible duration
YESSSSS	**Smart Grids / DIGITAL REVOLUTION**	New Energy Technologies: Energy Transition and Sustainable Development https://www.futurelearn.com/courses/new-energy-technologies	Grenoble Ecole de Management on FutureLearn	Among topics · Energy Efficiency o Key energy efficiency markets and trends o Prosumers' concept **o Digital revolution** o Projects in energy efficiency in Europe · Smart Grids o Definition of a smart grid o Smart grid as key element of the future electricity system o Smart grids connected with Smart buildings and Smart cities o Links between Smart Grids and Storage o Main actors in France and Europe o Trends and innovation projects in the smart grids field	Duration 6 weeks Weekly workload 2 hours This course will be of particular interest to students studying electrical networks, electrical engineering or smart grids, and to professionals, especially those working in energy industry.
YES (Project not MOOC)	digital tools in energy management	Smart energy management https://ilias.fh-muenster.de/ilias/goto_Bibliothek_crs_542294.html	EnergyEducation Erasmus+ project (http://www.energyducation.eu) on FH Münster ILIAS	· Lighting · UX Design · Thermal Installations · Energy Mapping	· Qualification definition https://skillstools.eu/wp-content/uploads/2019/11/Definition-SEM.pdf · Course format: hands-on approach, challenges

YES	**AI (some cases)**	AI in Business https://www.agoria.be/ai-in-business/en/	Agoria (Belgium), Belgian association for supporting technology-inspired companies in Belgium, has developed a MOOC on AI, dedicated to the upskilling of workers and the uptake of AI in companies	· Chapter 5: Let's get practical. Be inspired by more than 30 Belgian AI use cases in different industries, such as **energy**, healthcare, manufacturing, smart cities, and so on. · Certificate. Upon completion of chapter 4 'AI in business', you will receive a certificate demonstrating your ability to set up your own AI project.	· Length: 3.5 hours + 30 use cases · Target group: production managers, CxO's, HR managers, data scientists, business analysts, business architects, functional analysts, IT or business consultants, IT or business consultants with an interest in data analytics · Level: Introductory · Language: English
YES	**Blockchain**	[Blockchain in the Energy Sector](https://www.futurelearn.com/courses/blockchain-energy-sector) https://www.futurelearn.com/courses/blockchain-energy-sector	EIT InnoEnergy with EIT digital	Short Description Learn how **blockchain works, how the technology has evolved, and why it will empower energy customers** like never before. Topics · What is blockchain? · Digital currencies · The evolution and future of blockchain · Smart contracts and decentralized applications · Blockchain in the energy sector: the new paradigm · P2P energy trading · Blockchain applied to EV charging	Basic features · Language: English · Platform: FutureLearn · Course Structure: 4 weeks · Weekly workload: 3 hours Not currently running, no future dates
YES	infrastructure	The Next Generation of Infrastructure https://www.edx.org/course/the-next-generation-of-infrastructure	TUDelft	Short Description Explore the challenges and complexity of both global and local infrastructure (IT/Telecom, Energy, Water and Transportation) and how to make the best decisions to improve it. Syllabus · Module 0: Setting the scene: the infrastructural challenge for the future · Module 1: The socio-technical complexity of infrastructures/key concepts · Module 2: Fuzzy borders: interconnectedness, interdependencies, bottom-up developments and need for standards · Module 3: Complexity theory and why infrastructures are complex systems · Module 4: Governance and regulation of complex infrastructures · Module 5: Modeling, gaming and simulation as tools for designing and understanding infrastructures **· Module 6: ICT-architecture and cybersecurity: challenges** · Module 7: Wrap-up: design of infrastructures of urban areas	Basic features · Language: English · Platform: edX · Course Structure: 7 weeks · Weekly workload: 6-8 hours · Self-paced Course not available (starts September 16, 2020)
YES	**Internet of Energy**	Internet of Energy Education and Qualification https://www.ioe-	IOE-EQ Erasmus+ project	**Course: IoE Manager/decision maker** · Module 1: Introduction to IoE technology · Module 2: IoE business analysis and strategy · Module 3: IoE data analysis	

		edu.eu/en/ioe_profiles.aspx EU FUNDED PROJECT The IoE-EQ project has adopted the e-CF 3.0 framework to design four professional qualifications · Language: English		· Module 4: Legal aspects · Module 5: Basics of networking and security **Course: IoE Expert for Smart Cities** · Module 1: Introduction to IoE · Module 2: Smart Grids · Module 3: Integration of electric mobility with the grid · Module 4: IoE data analysis · Module 5: Basics of networking and security **Course: IoE Expert for Smart metering systems** · Module 1: Introduction to IoE · Module 2: Smart energy metering · Module 3: Platforms for smart energy metering · Module 4: IoE data analysis · Module 5: Basics of networking and security **Course: IoE Expert for Renewable Energies** · Module 1: Introduction to IoE · Module 2: Smart uses and management of renewable energies · Module 3: Energy storage systems · Module 4: IoE data analysis · Module 5: Basics of networking and security	
YES	Smart Grids	Smart Grids: The Basics https://www.edx.org/course/smart-grids-the-basics	TU Delft	Short Description Understand the basics of smart grids. Learn about their heterogeneity, dynamics, control, and about security and assessment strategies. Syllabus · Week 1. Modeling Smart Grids · Week 2. Optimal Power Flow (OPF) · Week 3. Power System Dynamics (PSD) · Week 4. Automation networks · Week 5. Wide Area Monitoring Protection and Control (WAMPAC) · Week 6. Smart Grid Cyber Security (+ week 0 and week 7 conclusion)	Basic features · Language: English · Platform: edX · Course Structure: 7 weeks · Weekly workload: 4-6 hours · Instructor-led on a course schedule Course not available (starts October 27, 2020)
YES	Smart Grids	Smart Grids: Modeling https://www.edx.org/course/smart-grids-modeling	TU Delft	Short Description Learn to build a model of a smart power grid, and to diagnose the effects of disturbances from variable renewable energy resources and intelligent demand on the grid. Syllabus · Week 1 Introduction to OpenModelica · Week 2 Modeling and Simulating a Power System · Week 3 Assessing Power Systems · Week 4 Adding a Renewable Energy Source · Week 5 Smart Grid Cyber Security · Week 6 Conclusion (+ week 0)	Basic features · Language: English · Platform: edX · Course Structure: 6 weeks · Weekly workload: 4-6 hours · Instructor-led on a course schedule Course not available (starts January 12, 2021)

YES	Smart Grids	[Smart Grids for Smart Cities: Towards Zero Emissions](https://www.futurelearn.com/courses/smart-grids) https://www.futurelearn.com/courses/smart-grids	EIT InnoEnergy (with Homuork and Smartgrid.cat)	Short Description Find out how smart grids and big data can help citizens, companies and cities understand energy use and reduce carbon footprint. Topics · The power and energy transition impact in the world economy · How smart grids will enhance the era of information · What is a smart city and how can we make cities smarter · Smarts citizens: new forms of mobility and energy consumption and production · New business models for smart cities	Basic features · Language: English · Platform: FutureLearn · Course Structure: 5 weeks · Weekly workload: 2 hours Not currently running, no future dates
YES	Smart Grids	Smart Grids : les réseaux électriques au cœur de la transition énergétique https://www.fun-mooc.fr/courses/course-v1:grenoblealpes+92005+session03/about	Université Grenoble Alpes on France Université Numérique	· Semaine 1 : Introduction à l'électrotechnique et aux réseaux électriques · Semaine 2 : Les principaux acteurs du réseau · Semaine 3 : Les évolutions actuelles des usages, et leurs conséquences · Semaine 4 : Les smart grids	· Duration 5 weeks · Weekly workload 2-4 hours · Language: French · For professionals, communities and citizens
YES	Smart Grids	Smart grid: las redes eléctricas del future http://prod022azws12.southcentralus.cloudapp.azure.com/en/node/210	Binational Laboratory for the Smart Management of Energetic Sustainability and the Technologic Formation (Mexican Energy Ministry, the Science and Technology National Council and Tecnologico de Monterrey) on MéxicoX (link not available)	· Tema 1. Introducción a las redes inteligentes · Tema 2. Elementos que conforman una smart grid · Tema 3. Retos y beneficios de las redes inteligentes	https://www.oeconsortium.org/wp-content/uploads/gravity_forms/16-c1480780880d51a4fc44ed750d41335f/2019/05/2019_Energy-Sustainability-MOOC-Tecnologico-de-Monterrey.pdf
YES	Smart Grids / Sustainable cities	Co-Creating Sustainable Cities https://www.edx.org/course/co-creating-sustainable-cities	TUDelft Wageningen Universiteit	This MOOC address the topic of involving citizens in co-creating Sustainable Cities. It addresses topics such as participative democracy and legitimacy, ICTs and big data, infrastructure and technology, and SMART technologies in daily life. Syllabus Module 6 covers Smart Energy & Mobility: · 6.1 Introduction to Energy&Mobility **· 6.2 Smart Grids and Citizens** · 6.3 Sharing Energy: The Case of VPPs · 6.4 Practical Assignment · 6.5 Urban Mobility · 6.6 Slow Mobility	Basic features · Language: English · Platform: edX · Course Structure: 8 weeks · Weekly workload: 6-8 hours · Self-paced Format Video-based format (often lectures with contextual quizzes)

YES	Smart Grids Microgrids	Solar Energy: Integration of Photovoltaic Systems in Microgrids https://www.edx.org/course/solar-energy-integration-of-photovoltaic-systems-i	TUDelft	Short Description Learn how to integrate a photovoltaic system into a microgrid of your design. You will master various concepts related to microgrid technology and implementation, such as **smart grid** and virtual power plant, types of distribution network, markets, control strategies and components. Topics · Difference between a microgrid, a passive distribution grid and a virtual power plant · Ancillary services provided by microgrids and PV · Operation of centralized and decentralized control, forecasting, and evaluation of different market policies through a case study · Operation of active power control and voltage regulation · Different layouts and topologies of microgrids and power electronic components, and the role of power electronics converters in microgrids · Microgrid protection, adaptive protection, and the consequences of using a fault current source and fault current limitation · Main motivations and challenges for the implementation of DC microgrids	Basic features · Language: English · Platform: edX · Course Structure: 9 weeks · Weekly workload: 10-11 hours · Instructor-led on a course schedule Course not available (starts August 24, 2020)
YES	Smart urban Energy Systems	Smart Cities – Management of Smart Urban Infrastructures https://www.coursera.org/learn/smart-cities	École Polytechnique Fédérale de Lausanne - EPFL on Cursera	Among topics **Week 2 - Smart Urban Energy Systems** · Conceptualization of Smart Urban Energy Systems · Interview with an Utility company · The infrastructure layer of smart urban energy systems · The services layer of smart urban energy systems · The data/digital layer of smart urban energy systems · Managerial and Policy takeaways · Interview with an Energy company	· Flexible deadlines · Beginner Level · Approx. 13 hours to complete · Language: English; subtitles: English, French, Persian
NO	Buildings	Energy Supply Systems for Buildings https://www.edx.org/course/energy-conversion-systems-for-buildings	TU Delft	ILOs · What the different heating, cooling and electricity generation systems are and what their working principles are. · How to combine the concept of efficiency with the building's energy demand to estimate primary energy usage and carbon emissions. · How cogeneration of heat/cold and heat/power works and how to cope with mismatches between supply and demand. · What rational use of energy entails in practice. · How to use load curves from energy demand profiles to decide on the right combinations of energy conversion systems.	Basic features · Language: English · Platform: edX · Course Structure: 4 weeks · Weekly workload: 4-6 hours · Instructor-led on a course schedule Course not available (starts August 25, 2020)[DC1]
NO	Buildings	Energy Demand in Buildings https://www.edx.org/course/energy-needs-in-buildings-2	TU Delft	ILOs · All about the energy chain approach, which is a powerful tool to achieve low energy and low carbon buildings. · To estimate the most important heat losses and gains in a building. · How to achieve thermal balance of the building and determine its space heating and cooling needs. · How to estimate the heating energy demand for hot tap water and	Basic features · Language: English · Platform: edX · Course Structure: 4 weeks · Weekly workload: 4-6 hours · Instructor-led on a course schedule

				the electricity needs for appliances and lighting. · How to achieve a low energy demand by optimizing window size, insulation, orientation and ventilation while taking into account building occupancy.	Part of the professional Certificate Buildings as Sustainable Energy Systems Course not available (starts August 25, 2020)
NO	Energy and environments	Energy Within Environmental Constraints https://www.edx.org/course/energy-within-environmental-constraints	Harvard university	Short description A quantitative introduction to the energy system and its environmental impacts. Syllabus · Week 2: Energy Overview. Forms of energy and common units of measurement. How energy flows through modern and historical economies, including the composition of energy supply, common energy transformations, and which sources are used for which purposes. Prices for energy around the world. · Week 6: The Electric Grid. A brief overview of modern electric grids including major technologies they use, how remarkably reliable and efficient they are, how they're planned and regulated, and how they're starting to change. · Week 9: Demand Reduction and Efficiency. Reducing energy demand, by changing behavior or making devices more efficient, can reduce environmental harms – sometimes while saving money! But are there limits to this strategy? Can humanity reduce demand and aim towards a lower-energy future?	Basic features · Language: English · Platform: edX · Course Structure: 10 weeks · Weekly workload 3-5 hours · Self-paced Future dates to be announced
NO	Energy systems	Energy Systems Integration: A Trend or a Revolution? https://www.edx.org/course/energy-systems-integration-a-trend-or-a-revolution	KU Leuven	Short Description Build upon your energy expertise, combining your existing knowledge with global and multidisciplinary strategies, and learn to create smart and sustainable integrated energy systems. Syllabus · Module 1 the concept of energy system integration as the coordination of coupling between different dimensions of the energy system · Module 2 the effects of policy and regulation on other aspects of the energy system · Module 3 the evolution of electromobility · Module 4 future electric power systems all over the world · Module 5 the individual consumer is brought into the picture and his/her potential roles in energy system integration are analyzed in detail	Basic features · Language: English · Platform: edX · Course Structure: 5 weeks · Weekly workload: 7-8 hours · Instructor-led on a course schedule Format Video-based format with lectures and case studies integrated with self-evaluation quizzes
NO	Energy Systems	Energy Systems Integration: A Trend or a Revolution? https://www.edx.org/course/energy-	KU Leuven with the support of EIT InnoEnergy and ESIG	· Module 1 will define the concept of energy system · Module 2 explores the effects of policy and regulation on other aspects of the energy system · Module 3 focusses on the evolution of electromobility, raising some questions about public acceptability and how it impacts the electric	· Duration: 5 Weeks · Weekly workload: 7–8 hours per week · Language: English

		systems-integration-a-trend-or-a-revolution		grid. · Module 4 challenges you to think about future electric power systems all over the world · Module 5 Finally, the individual consumer is brought into the picture	
NO	energy technologies	Batteries, Fuel Cells, and their Role in Modern Society https://www.edx.org/course/batteries-fuel-cells-and-their-role-in-modern-so-2	Ural Federal University, Russia	Short Description Explore the development of new energy technologies and discover key energy challenges with this online course. Syllabus · Week 1. History of electric vehicles · Week 2. EV revival or why governments care so much about EVs and clean energy · Week 3. Engineering. Electric Vehicles and batteries · Week 4. Science. Chemical power sources · Week 5. Science. Different types of batteries · Week 6. Electrode materials for lithium-ion batteries	Basic features · Language: English · Platform: edX · Course Structure: 6 weeks · Instructor-led on a course schedule Format Video lectures and computer animations with contextual forum threads and pdf slides
NO	environmental technologies/sustainable buildings	DEFMA (Digital and Environmental skills for Facilities MAnagement) MOOC https://www.openlearning.com/courses/defma-mooc/HomePage/	Erasmus+ DEFMA project	Short Description The DEFMA MOOC is designed to train Facility managers. It focuses on environmental technologies and sustainable building services that allows learners to follow flexible learning pathways as regards the acquisition of digital and environmental skills relevant to modern facilities management. Syllabus · Unit 1. Sustainability and Environmental Issues and their Impact on FM · Unit 2. Energy Efficiency and Energy Management in Buildings · Unit 3. Sustainable Buildings · Unit 4. Building Management and Intelligent Building Solutions · Unit 5. Maintenance and Repairs to Prevent Energy Losses · Unit 6. Occupant & Operator Health and Wellbeing	Basic features · Language: English · Platform: OpenLearning (Australian platform) · Course Structure: 6 units Format Very collaborative, hands on approach, well-detailed assessment activities
NO	Governance, Climate Change	Exploring Possible Futures: Modeling in Environmental and Energy Economics https://www.futurelearn.com/courses/exploring-possible-futures	University of Basel	Topics · Climate change and energy policies. · Evidence-based recommendations on current problems of energy policy. · Models in environmental economics and energy economics. · Building blocks of models and possible applications. · Informed decisions by the results of different modeling approaches.	Basic features · Language: English · Platform: FutureLearn · Course Structure: 5 weeks · Weekly workload: 4 hours Course not available (starts October 5, 2020)
NO	Governance, Climate Change	Transforming Energy Systems: Why Governance Matters https://www.futurelearn.com/courses/transforming-energy-systems	University of Exeter	Short Description Tackling climate change demands profound and rapid energy system transformation. Discover how effective governance enables this. Syllabus · Week 1 Energy system transformation: changes, challenges and governance	Basic features · Language: English · Platform: FutureLearn · Course Structure: 4 weeks · Weekly workload: 4 hours Format

				· Week 2 Emerging energy systems · Week 3 People, scale and society · Week 4 Energy governance change for rapid decarbonisation	Integrates videos, articles and online discussion
NO	natural gas	Expérience gaz https://mooc-experiencegaz.fr/	GRDF (Gaz Réseau Distribution France, company) in collaboration with Mines ParisTech, GRTgaz, Storengy, Elengy	Syllabus · Week 1 - Le gaz naturel, de l'énergie fossile à l'énergie verte · Week 2 - Le gaz naturel, des infrastructures aux marchés – partie 1 · Week 3 - Le gaz naturel, des infrastructures aux marchés – partie 2 · Week 4 - Le gaz naturel, une énergie au cœur des territoires · Week 5 - Le gaz naturel, une énergie au cœur des transitions	Basic features · Language: French · Platform: based on open edX Course not available (new edition starting in August 2020)
NO	OIL and Gas	Oil & Gas Industry Operations and Markets https://www.coursera.org/learn/oilandgas/home/welcome	Duke university	In the operations module, the course provides an overview of the production of oil and gas, from initial exploration to final transport. The second module focuses on the forces that drive the industry's operations, the oil and gas markets, including the cost of wells, seasonal impacts on prices, and the role of oil reserves. Syllabus · Week 1 Oil and gas operations and technology · Week 2 Oil and gas industry markets	Basic features · Language: English · Platform: Coursera · Course Structure: 2 weeks · Weekly workload 3 - 5 hours · Course with scheduled deadines Format Video-based format, 30% of evaluation is based on assignment + review 4 peers' assignments. With the Coursera "Save Note" button (available also for the other courses) learners can capture a screen, highlight and save lines from the transcript and add notes to anything they captured.
NO	Optimization softwares	Optimization Strategies and Energy Management Systems https://platform.europeanmoocs.eu/course_optimization_strategies_and_en	ASSET project	Participants attending this course will learn how to recognise and formulate different optimization problems in operation management, and control of energy systems, and how to solve them using existing software and solvers. Different principal algorithms for the linear, network, discrete, and dynamic optimization are introduced and related methodologies together with underlying mathematical structures are described accordingly. ILOs · Relate process system engineering with the modelling and optimization techniques used in power systems. · Apply different optimization tools for continuous, semi continuous and discrete optimization problems in energy systems and implement them using Excel, MATLAB or GAMS. · Design and implement the schemes of Supply side and	Basic features · Language: English · Platform: EMMA · Course Structure: 4 weeks ·Course not accessible Other online courses of the ASSET project on EMMA platform https://www.energytransition.academy/courses A holistic approach for Energy Transition: territory, networks and sustainability https://platform.europeanmoocs.eu/course_a_holistic_approach_for_energy An Introduction to AC Microgrids for Energy Control and

				demand/load side management including peak shaving and load control/ load shifting programmes.	Management https://platform.europeanmoocs.eu/course_an_introduction_to_ac_microgri Challenges and solutions in Future Power Networks https://platform.europeanmoocs.eu/course_challenges_and_solutions_in_fu Optimization Strategies and Energy Management Systems https://platform.europeanmoocs.eu/course_optimization_strategies_and_en
NO	Renewable energy	Energy: The Enterprise https://www.coursera.org/learn/energy-industry-overview/home/welcome	University at Buffalo & The State University of New York	Short Description This is the fourth course in the Energy Production, Distribution & Safety specialization that explores various facets of the power sector, and features a culminating project involving creation of a roadmap to achieve a self-established, energy-related professional goal. To learn more about the specialization, check out a video overview at https://www.youtube.com/watch?v=2Yh9qIYiUDk Syllabus · Week 1 energy touches everything · Week 2 energy sources · Week 3 energy and utility solutions · Week 4 adaptation	Basic features · Language: English · Platform: Coursera · Course Structure: 4 weeks Course 4 of 4 in the Energy Production, Distribution & Safety Specialization Format Videos (videos of lectures and conversations), readings and practice quizzes
NO	Renewable energy/energy transition	Solving the Energy Puzzle: A Multidisciplinary Approach to Energy Transition https://www.futurelearn.com/courses/energy-transition	Groningen Universiteit	Short Description Learn how to analyse energy transition cases from technological, legal, economics, spatial, and social perspectives. Topics · Energy transition and sustainability · Technical aspects of energy transition · Spatial Planning · Integrated Energy System · Psychological aspect of energy transition · Law aspect of energy transition · Energy Systems · Economic aspect of energy transition	Basic features · Language: English · Platform: FutureLearn · Course Structure: 7 weeks · Weekly workload 4 hours Not currently running, no future dates
NO	simulation models	Simulation models for the design of transition paths towards a sustainable society (2020) https://iedra.uned.es/courses/course-v1:UNED+SMD_X002+2020/about	MEDEAS H2020 project (https://www.medeas.eu) on UNED MOOC platform	Among topics Topic 3. Energy · Session 1: Energy resources · Session 2: Energy module implementation Topic 4. Energy infrastructures and Land-use · Session 1: Materials, Transport and EROI in MEDEAS · Session 2: Land use in MEDEAS	

NO	sustainable energy	Sustainable Energy: Design a Renewable Future https://www.edx.org/course/sustainable-energy-design-a-renewable-future	TUDelft	Short Description Learn how to make the transition to 100% renewable energy from wind, solar and biomass for electricity, heat and fuels for a sustainable future. Syllabus · Week 1: Definition of Energy Use · Week 2: Generation of Renewable Energy · Week 3: Energy Balances · Week 4: Policies for Sustainable Energy · Week 5: Wind Energy · Week 6: Solar Energy · Week 7: Biomass · Week 8: Electrical Power System · Week 9: Storage	Basic features · Language: English · Platform: edX · Course Structure: 9 weeks · Weekly workload: 6-8 hours · Instructor-led on a course schedule Format Lectures and hands-on examples in video-based format with weekly exercises
NO	urban development/energy infrastructure	Management of Urban Infrastructures – part 1 https://www.coursera.org/learn/managing-urban-infrastructures-1	École Polytechnique Fédérale de Lausanne	Syllabus Block 3 - Introduction to Urban Energy Management Short description of Block 3 First we will be introduced to urban energy infrastructures (3-1), we will then move on to understanding urban electricity systems (3-2). We will then learn how to manage urban electricity systems (3-3) and discover what challenges and opportunities must be confronted (3-4). Finally, an interview with Mr. Thierry Clement, from Veolia, will provide us with the perspective of a leading utility firm (3-5).	Basic features · Language: English · Platform: Coursera · Approx. 12 hours to complete, flexible deadlines Format Format based on videos, readings, contextual discussion prompts, self-assessment quizzes
NO	urban development/Sustainable cities	Sustainable Cities https://www.edx.org/course/sustainable-cities-2	SDG Academy (online education platform of the Sustainable Development Solutions Network of the United Nations)	Short Description Learn how government, the private sector, and other actors can support sustainable urban development Syllabus · Module 1: The urban opportunity · Module 2: What makes a city function? · Module 3: How can we reduce urban poverty and make cities inclusive and safe? · Module 4: Making cities productive and reduce inequality · Module 5: Improving human development in cities · Module 6: Providing universal urban services and infrastructure · Module 7: How can cities be resilient? · Module 8: Governing sustainable cities · Module 9: Implementing change	Basic features · Language: English · Platform: edX · Course Structure: 9 weeks · Weekly workload: 4-6 hours Format Videos with integrated quizzes for knowledge check, forum-based discussion activities, readings
NO	Urban Energy system	Energía y Ciudad: Hacia la Transición Energética https://miriadax.net/web/energia-y-ciudad-hacia-la-transicion-energetica-curso-2-edicion/inicio	Universidad Politécnica de Madrid on Miríada X	El curso aborda los aspectos fundamentales del sistema energético de las ciudades y sus implicaciones en términos medioambientales. Describe las medidas que se están promoviendo para reducir la huella de carbono de las ciudades, así como las profundas transformaciones técnicas y socioeconómicas del proceso de descarbonización del actual modelo energético. Expone los retos que supone transformas el modelo actual y las iniciativas de carácter mundial a nivel público y privado, que permiten reconocer el	Duration: 8 weeks Workload: 40 hours Para obtener la Acreditación Universitaria de este curso debes realizar todos los módulos, pagar el derecho a examen biométrico y superarlo en alguna de sus dos

				potencial de integración de energías renovables en el contexto urbano.	convocatorias. Esta compra te incluye el Certificado de Formación Continua con Aprovechamiento expedido por la UPM . También tendrás la opción de optar al Certificado Digital de Superación Miríadax, sin opción a acreditación universitaria
MAYBE	Electric utilities	Electric Utilities Fundamentals and Future https://www.coursera.org/learn/electric-utilities	University of Colorado on Coursera	It looks at the electric utility industry from the eyes of numerous industry experts through on-location interviews, compelling visuals, and animation giving behind-the-scenes information Among topics · Week 1 - Taking Shape and Grid Fundamentals · **Week 4 - Pace of Change, Technology and Regulation** · **Week 5 - Toward a Bright Future**	· Flexible deadlines · Beginner Level · Approx. 11 hours to complete · Language: English; subtitles: French, Portuguese (Brazilian), Russian, English, Spanish
MAYBE	innovative sustainable energy systems	Energy Systems Integration: An Introduction https://www.futurelearn.com/courses/introduction-to-energy-systems-integration	EIT InnoEnergy	Short Description Focused on innovative sustainable energy systems solutions and explores an integrated perspective on the energy market. Syllabus · Week 3 and week 4 talk about integrated energy systems (eg.: Energy vectors - electricity, heat, fuels - interact bidirectionally with water systems, transportation, and **data and communication networks**)	Basic features · Language: English · Platform: FutureLearn · Course Structure: 4 weeks · Weekly workload: 2 hours Currently not available (date to be announced)
MAYBE	main actors Innovative trends	New Energy Technologies: Energy Transition and Sustainable Development https://www.futurelearn.com/courses/new-energy-technologies	Grenoble Ecole de Management	Each week list the main actors in France and Europe and trends/innovative projects (also addressing digital?). Syllabus · Week 1 Energy Efficiency · Week 2 Solar Energy · Week 3 Hydropower · Week 4 Biogas · Week 5 Hydrogen · **Week 6 Smart Grids**	Basic features · Language: English · Platform: FutureLearn · Course Structure: 6 weeks · Weekly workload: 2 hours Format Integrates articles, videos and online discussion

Annex 4: Survey to education and training providers

EDDIE Project - Current and Future Skill Needs

Fields marked with * are mandatory.

1 Introduction

The EDDIE project aims at creating a Sector Skills Alliance (SSA) by bringing together all the relevant stakeholders in the Energy value chain such as industry, education and training providers, European organisations, recruiters, social partners and public authorities. The main objective of this SSA is to develop a long-driven Blueprint for the digitalisation of the European Energy sector to enable the matching between the current and future demand of skills necessary for the digitalisation of the Energy sector and the supply of improved Vocational Education and Training (VET) systems and beyond.

The EDDIE project proposes an innovative strategic approach for Education in the European Energy sector as an industry-driven movement, where the skills emerge as a need of the real application instead of the classic approach that starts from fundamentals to reach application. This will be materialised in the Blueprint Strategy for the Digitalisation of the Energy value chain (BSDE) and will be demonstrated and validated in a pilot environment. An interdisciplinary approach is also sought, including green and soft skills, social science, economics and gender dimension, looking for synergies and collaboration with other blueprints and initiatives in Europe. The involvement of workers will be key for the success of the Blueprint, improving the attractiveness of the Energy sector by using participatory approaches and Information and Communication Technologies (ICT) methodologies.

The cooperation between the EDDIE partners (coming from 10 EU countries) and other relevant stakeholders will be the key for developing a Blueprint that encompasses global, societal, and technological current and future trends and needs. This strategic approach will reinforce the competitiveness of the European Energy Sector in an efficient and innovative way by creating a highly skilled workforce, fostering smart, inclusive and sustainable growth in line with the EU objectives and values.

For more information please visit our website

This questionnaire aims at assessing the knowledge and skills offered by education providers and map them with industry's needs, addressing the emerging skill gaps.

The procedure involves filling an online survey that will take approximately 20-30 minutes.
All responses will be kept strictly confidential. Analysis and reporting will be based on the aggregate responses only.
If you decide to be informed about the follow up of this survey and about our project in general, your personal data will be processed in compliance with the General Data Protection Regulation (GDPR).

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

With the support of the
Erasmus+ Programme of the
European Union

2 Your organization

* 1 How can your organization be best described?

- University
- College
- Vocational Education & Training (VET) Provider
- Secondary education institute
- Other

2 Please specify

3 What are the European Qualifications Framework (EQF) level(s) of the educational programs at your institution?

You can choose more than one if applicable. More information on EQF levels can be found here: https://ec.europa.eu/ploteus/en/content/descriptors-page

- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8

EQF level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	Lower secondary school
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	Vocational school
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	Higher education
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Bachelor's degree
Level 7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research	Master's degree
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	PhD

4 What are the types of degrees attributed by your institution?

You can choose more than one if applicable.

- ☐ Associate Degree
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctorate Degree
- ☐ Other

* 5 How many students study at your organisation (estimation)?

- ○ Less than 500
- ○ 500-1000
- ○ 1001-10.000
- ○ 10.001-50.000
- ○ More than 50.000

6 In which country is your organisation based?

* 7 Which of the following sectors are covered within your institution's study programmes? (You can choose more than one if applicable)

- ☐ Oil&Gas
- ☐ Heating and Cooling
- ☐ Power
- ☐ Digital/Data
- ☐ Other

8 Please specify

9 Please indicate which of the following means are available for educational/training activities at your organisation (You can choose more than one if applicable)

- ☐ Courses with physical attendance
- ☐ Online courses

- [ ] Seminars
- [ ] Webinars
- [ ] MOOCs (Massive Open Online Courses)
- [ ] Summer Schools
- [ ] Other

10 Please indicate your area of expertise and position in your institution

500 character(s) maximum

Due to the recent COVID19-Crisis, flexible and ad-hoc reactions to immediate challenges are needed, which can influence the way we work and communicate.

11 How were/are the educational activities carried out during the pandemic?

You can choose more than one

- [ ] Physical attendance
- [ ] Online courses
- [ ] Blended learning (e.g. physical attendance combined with digital tools)
- [ ] Hybrid (e.g. online courses and physical attendance at laboratories)
- [ ] Educational activities were stopped

12 Was your institution ready for the transition to online courses? (equipment, trained staff, software)

- ◯ Yes
- ◯ No
- ◯ Partly (Some departments)

13 On a scale 1-5, to your best knowledge, how good was the transition managed? (1- very good, 5-very bad)

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5

14 What are the main challenges besides the transition to online teaching that your organisation had to face in the beginning of the crisis and how well did it respond?

1000 character(s) maximum

15 What is the impact and lessons learned at the beginning and during the crisis?

1000 character(s) maximum

3 Study programme 1

In the following section you are asked to provide information regarding technologies, tools and skills covered at your institution based on specific study programmes

Please answer for **specific energy related study programmes** available at your institutions. You may provide your feedback for **up to 3** different study programmes.

16 Please enter the title of the study programme

17 What is the EQF level of the programme?

- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8

18 What is the type of degree attributed by this programme?

- Associate Degree
- Bachelor's Degree
- Master's Degree
- Doctorate Degree

19 Which of the following technologies are covered by your study program?

(You can choose more than one if applicable)

- Artificial Intelligence
- Big Data/Data Analytics
- Cybersecurity
- Digital Platforms
- Internet of things (IoT)
- Cloud services
- Virtual product development and testing
- Blockchain
- Digital asset management
- Energy management systems
- Communication technologies (e.g. 5G)

20 Please list technologies, related to Energy system digitalization, that are not mentioned above

800 character(s) maximum

21 Which of the following tools are addressed (provide training or use) at your institution?

(You can choose more than one if applicable)

- [ ] Cloud servers
- [ ] SCADA/HMI systems
- [ ] Distribution Management Systems (DMS)
- [ ] Peer to peer exchange tools
- [ ] Smart sensors
- [ ] Intelligent maintenance systems
- [ ] Smart meters
- [ ] Geographic Information Systems (GIS)
- [ ] Drones
- [ ] Robotics/advanced manufacturing
- [ ] Online collaboration platforms

22 Please list tools, related to Energy system digitalization that are not mentioned above

800 character(s) maximum

In the following lists we provide **digitalization of energy related skill** sets. Please specify which of the following skills are covered through your study programme and what is the expected level of skill students reach.

23 **Data capture & management**

	Basic	Intermediate	Expert
Browse, search and filter data, information and digital content	○	○	○
Evaluate data, information and digital content	○	○	○
Manage data, information and digital content	○	○	○

24 Please list relevant skills that are not mentioned above

800 character(s) maximum

25 **Analytical methods**

	Basic	Intermediate	Expert

Application of statistical methods	○	○	○
Mathematical optimization	○	○	○
Application of data mining approaches	○	○	○
Perform big data analysis	○	○	○
Report analysis results	○	○	○
Predictive modelling/analysis	○	○	○

26 Please list relevant skills that are not mentioned above

800 character(s) maximum

27 **Computing tools and platforms**

	Basic	Intermediate	Expert
Usage of high performance computing resources and high availability systems	○	○	○
Accessing, analysis and visualization of data	○	○	○
Accessing, analysis and visualization of data on cloud infrastructures	○	○	○
Managing security and privacy issues on digital platforms	○	○	○
Administration of hardware infrastructure (web servers, workstations, etc.)	○	○	○
Use of simulation tools	○	○	○
Use of distributed software systems	○	○	○

28 Please list relevant skills that are not mentioned above

800 character(s) maximum

29 **Programming, development and technology related**

	Basic	Intermediate	Expert
Creatively use digital technologies	○	○	○
Development of prototypes and new analysis algorithms	○	○	○
Use specific data analysis software	○	○	○
Requirements analysis	○	○	○
Development of web applications (JavaScript, HMTL, CSS etc)	○	○	○

Design and development of applications (Python, Java, C++ etc)	◯	◯	◯
Query data from database (via SQL etc)	◯	◯	◯
Integration of sensor data and IoT applications	◯	◯	◯
System design competence	◯	◯	◯
Blockchain skills	◯	◯	◯
Understanding of cybersecurity	◯	◯	◯
Understanding and usage of communication technologies	◯	◯	◯

30 Please list relevant skills that are not mentioned above

800 character(s) maximum

3.1 Indicative courses

Please list 3 courses that are offered at this programme that, in your best knowledge, are more related to the digitalization of the energy system. Please indicate the **number of credits (e.g. ECTS)** attributed for each course, if applicable.

31 Course 1

800 character(s) maximum

32 Course 2

800 character(s) maximum

33 Course 3

800 character(s) maximum

34 Would you like to include another study programme?

- ◯ Yes
- ◯ No

4 Study programme 2

35 Please enter the title of the study programme

36 What is the EQF level of the programme?

- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8

37 What is the type of degree attributed by this programme?

- Associate Degree
- Bachelor's Degree
- Master's Degree
- Doctorate Degree

38 Which of the following technologies are covered by your study program?

(You can choose more than one if applicable)

- Artificial Intelligence
- Big Data/Data Analytics
- Cybersecurity
- Digital Platforms
- Internet of things (IoT)
- Cloud services
- Virtual product development and testing
- Blockchain
- Digital asset management
- Energy management systems
- Communication technologies (e.g. 5G)

39 Please list technologies, related to Energy system digitalization, that are not mentioned above

800 character(s) maximum

40 Which of the following tools are addressed (provide training or use) at your institution?

(You can choose more than one if applicable)

- Cloud servers
- SCADA/HMI systems
- Distribution Management Systems (DMS)
- Peer to peer exchange tools
- Smart sensors

- [ ] Intelligent maintenance systems
- [ ] Smart meters
- [ ] Geographic Information Systems (GIS)
- [ ] Drones
- [ ] Robotics/advanced manufacturing
- [ ] Online collaboration platforms

41 Please list tools, related to Energy system digitalization that are not mentioned above

800 character(s) maximum

In the following lists we provide **digitalization of energy related skill** sets. Please specify which of the following skills are covered through your study programme and what is the expected level of skill students reach.

42 **Data capture & management**

	Basic	Intermediate	Expert
Browse, search and filter data, information and digital content	○	○	○
Evaluate data, information and digital content	○	○	○
Manage data, information and digital content	○	○	○

43 Please list relevant skills that are not mentioned above

800 character(s) maximum

44 **Analytical methods**

	Basic	Intermediate	Expert
Application of statistical methods	○	○	○
Mathematical optimization	○	○	○
Application of data mining approaches	○	○	○
Perform big data analysis	○	○	○
Report analysis results	○	○	○
Predictive modelling/analysis	○	○	○

45 Please list relevant skills that are not mentioned above

800 character(s) maximum

46 **Computing tools and platforms**

	Basic	Intermediate	Expert
Usage of high performance computing resources and high availability systems			
Accessing, analysis and visualization of data			
Accessing, analysis and visualization of data on cloud infrastructures			
Managing security and privacy issues on digital platforms			
Administration of hardware infrastructure (web servers, workstations, etc.)			
Use of simulation tools			
Use of distributed software systems			

47 Please list relevant skills that are not mentioned above

800 character(s) maximum

48 **Programming, development and technology related**

	Basic	Intermediate	Expert
Creatively use digital technologies			
Development of prototypes and new analysis algorithms			
Use specific data analysis software			
Requirements analysis			
Development of web applications (JavaScript, HMTL, CSS etc)			
Design and development of applications (Python, Java, C++ etc)			
Query data from database (via SQL etc)			
Integration of sensor data and IoT applications			
System design competence			
Blockchain skills			
Understanding of cybersecurity			
Understanding and usage of communication technologies			

49 Please list relevant skills that are not mentioned above

800 character(s) maximum

4.1 Indicative courses

Please list 3 courses that are offered at this programme that, in your best knowledge, are more related to the digitalization of the energy system. Please indicate the **number of credits (e.g. ECTS**) attributed for each course, if applicable.

50 Course 1

800 character(s) maximum

51 Course 2

800 character(s) maximum

52 Course 3

800 character(s) maximum

53 Would you like to include another study programme?

- Yes
- No

5 Study programme 3

54 Please enter the title of the study programme

55 What is the EQF level of the programme?

- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8

56 What is the type of degree attributed by this programme?

- Associate Degree
- Bachelor's Degree
- Master's Degree
- Doctorate Degree

57 Which of the following technologies are covered by your study program?

(You can choose more than one if applicable)

- Artificial Intelligence
- Big Data/Data Analytics
- Cybersecurity
- Digital Platforms
- Internet of things (IoT)
- Cloud services
- Virtual product development and testing
- Blockchain
- Digital asset management
- Energy management systems
- Communication technologies (e.g. 5G)

58 Please list technologies, related to Energy system digitalization, that are not mentioned above

800 character(s) maximum

59 Which of the following tools are addressed (provide training or use) at your institution?

(You can choose more than one if applicable)

- Cloud servers
- SCADA/HMI systems
- Distribution Management Systems (DMS)
- Peer to peer exchange tools
- Smart sensors
- Intelligent maintenance systems
- Smart meters
- Geographic Information Systems (GIS)
- Drones
- Robotics/advanced manufacturing
- Online collaboration platforms

60 Please list tools, related to Energy system digitalization that are not mentioned above

800 character(s) maximum

In the following lists we provide **digitalization of energy related skill** sets. Please specify which of the following skills are covered through your study programme and what is the expected level of skill students reach.

61 **Data capture & management**

	Basic	Intermediate	Expert
Browse, search and filter data, information and digital content	○	○	○
Evaluate data, information and digital content	○	○	○
Manage data, information and digital content	○	○	○

62 Please list relevant skills that are not mentioned above

800 character(s) maximum

63 **Analytical methods**

	Basic	Intermediate	Expert
Application of statistical methods	○	○	○
Mathematical optimization	○	○	○
Application of data mining approaches	○	○	○
Perform big data analysis	○	○	○
Report analysis results	○	○	○
Predictive modelling/analysis	○	○	○

64 Please list relevant skills that are not mentioned above

800 character(s) maximum

65 **Computing tools and platforms**

	Basic	Intermediate	Expert
Usage of high performance computing resources and high availability systems	○	○	○
Accessing, analysis and visualization of data	○	○	○
Accessing, analysis and visualization of data on cloud infrastructures	○	○	○
Managing security and privacy issues on digital platforms	○	○	○

Administration of hardware infrastructure (web servers, workstations, etc.)			
Use of simulation tools			
Use of distributed software systems			

66 Please list relevant skills that are not mentioned above

800 character(s) maximum

67 **Programming, development and technology related**

	Basic	Intermediate	Expert
Creatively use digital technologies			
Development of prototypes and new analysis algorithms			
Use specific data analysis software			
Requirements analysis			
Development of web applications (JavaScript, HMTL, CSS etc)			
Design and development of applications (Python, Java, C++ etc)			
Query data from database (via SQL etc)			
Integration of sensor data and IoT applications			
System design competence			
Blockchain skills			
Understanding of cybersecurity			
Understanding and usage of communication technologies			

68 Please list relevant skills that are not mentioned above

800 character(s) maximum

5.1 Indicative courses

Please list 3 courses that are offered at this programme that, in your best knowledge, are more related to the digitalization of the energy system. Please indicate the **number of credits (e.g. ECTS)** attributed for each course, if applicable.

69 Course 1

800 character(s) maximum

70 Course 2

800 character(s) maximum

71 Course 3

800 character(s) maximum

6 Transversal & Business Skills

In the following list we provide transversal skill sets. Please specify which of the following skills are cultivated at your organization. You can choose the most relevant.

72 ***Transversal***

- [ ] Communication
- [ ] Team working
- [ ] Ease of learning
- [ ] Planning and organization
- [ ] Problem solving
- [ ] Innovation and creativity
- [ ] Leadership
- [ ] Systemic/holistic thinking
- [ ] Cross-disciplinary technical competences

73 Please list relevant transveral skills that are not mentioned above

74 Please indicate the business perspectives covered by your study programs that may be crucial for the digital transformation.

- [ ] Changing business landscapes within the European energy sector
- [ ] Regulatory and policy landscape within the European energy sector
- [ ] Changing customer preferences and user experience expectations
- [ ] Digital transformation (radical business development)
- [ ] New business models
- [ ] Platforms and eco systems
- [ ] Governance systems
- [ ] Enabling sustainability through digitalization

- [ ] Strategic cybersecurity
- [ ] Change management
- [ ] Other

75 Please elaborate

6.1 Green skills

"Green skills" or Skills for sustainability, are the technical skills, knowledge, values and attitudes needed in the workforce to develop and support sustainable social, economic and environmental outcomes in business, industry and the community.

76 Does your institution face the challenge of adapting its study program to climate-driven goals and policies?

- ( ) Yes
- ( ) No
- ( ) Not sure

77 Does your organization need the adaptation of new green skills that were not needed before?

- [ ] Yes
- [ ] No
- [ ] Not sure

78 Please elaborate

800 character(s) maximum

79 Do you face the need to add green components to existing skills?

For example, a driver may adjust his driving technique to make it more eco-friendly

- [ ] Yes
- [ ] No
- [ ] Not sure

80 Please specify

800 character(s) maximum

81 What are the main drivers towards green skills adaptation?

- [ ] Trends in policy

- [ ] Trends in industry/technology
- [ ] Environmental awareness
- [ ] Other

82 Please specify

800 character(s) maximum

7 Communication

83 Would you like to receive news regarding the results of the questionnaire?

- Yes
- No

84 Would you like to receive news and updates regarding the EDDIE project ?

- Yes
- No

85 Please provide us with your email address