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Education for Digitalisation of Energy

Deliverable 2.1

Current challenges in the energy sector and state of the art in education/training (Report)

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Abstract:

This report aims to provide insights on the current challenges in the energy sector, and the state of the art in education and training. The changes that are happening in the energy sector are being reviewed and the key drivers that lead to these changes are addressed. The economic, social, technical and regulatory challenges are identified for the energy system and its subsectors. A survey was conducted amongst important industrial stakeholders throughout Europe in order to identify challenges, tools, technologies, added value and skills needs. Moreover, a comprehensive review of Erasmus+ Blueprint projects, European educational projects/initiatives on energy and scientific literature is performed in order to obtain an overview of the current state of the art in education and training.

Keywords:

D2.1 Digitalisation, Energy, Education, Training, Challenges, Skills, Survey

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Definitions, Acronyms and Abbreviations

CEDEFOP	European Centre for the Development of Vocational Training
CEP	Clean Energy for all Europeans Package
CHP	Combined Heat and Power
CIS	Center for Internet Security
CNC	Computer Numerical Control
CVET	Continuous Vocational Education and Training
DER	Distributed Energy Resources
DG DIGIT	European Commission's Department for Digital services
DMS	Distribution Management System
DSO	Distribution System Operator
EASME	Executive Agency for Small and Medium-sized Enterprises
EC	European Commission
EQF	European Qualifications Framework
ERP	Enterprise Resource Planning
ESCO	European Skills/Competences, Qualification and Occupations
ETMS	Energy Trading Management System
EU	European Union
EV	Electric Vehicle
GHG	Greenhouse Gases
GIS	Geographic Information System
H2020	Horizon 2020
HMI	Human Machine Interface
HVAC	Heating Ventilation and Air Conditioning
ICT	Information and Communication Technologies
IED	Intelligent Electronic Device
IoT	Internet of Things
IRENA	International Renewable Energy Agency
IT	Information Technology
IVET	Initial Vocational Education and Training
PV	Photovoltaic
QoS	Quality of Service
R&D	Research and Development
SAS	Substation Automation System

SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goals
SDS	Sustainable Development Scenario
SO	System Operator
SSA	Sector Skills Alliance
T&D	Transmission and Distribution
TCFD	Task force on Climate Financial Disclosure
TEN-E	Trans European Network for Energy
TSO	Transmission System Operator
TWh	Tera Watt hours
VET	Vocational Education and Training
VRE	Variable Renewable Energy
WP	Work Package

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Executive Summary

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.** In order 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.

Among others, 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 future needs (required skills and level, drawing the occupational profiles in European Skills/Competences, Qualification and Occupations - ESCO, mobility, etc.) progress will be monitored as well as evolution of the demand and supply of skills.

This deliverable addresses the current situation in the Energy Sector and its digital transformation. It aims to establish the basis for the definition of the future skill needs, which will be the subject of following project documents (e.g. Deliverable D2.2). In order to jointly look for the future, VISION 2050, presented by European Technology & Innovation Platforms' Smart Networks for Energy Transition (ETIP SNET) as a consolidated vew of the main energy stakeholders in Europe has been used as a common framework of understanding. The VISION 2050 describes how the energy sectors are going to evolve, highlighting the role of the digitalisation in the evolution and analysing social, economic and technological areas and expected benefits from digitalisation.

At first, this deliverable presents a set of key messages on the energy transformation. It presents an overview of the changing regulatory framework, following the adoption of the Clean Energy for All Europeans Package and the EU Green Deal. Particularly relevant changes in consumer behaviour and knowledge are presented, as well as the energy industry's need to adapt to changes through digitalisation.

The EDDIE project's approach as an industry-driven activity, where the skills emerge as a need of practical application instead of the classic approach that starts from fundamentals to reach application, raises the need to consult the industry when addressing challenges in the energy sector. Taking this into account, the project's consortium developed a dedicated survey in order to obtain necessary feedback from actors across the whole energy system (all sectors), with diversity in terms of geographic location, size, type of organisation and operational focus (DSOs, TSOs, suppliers, service providers etc). The survey aims to address the main challenges the industry faces towards the digitalisation of the energy system, the technologies and tools usage, the added value produced, and the new skills needed towards the new digital era. The survey was answered by 57 reference stakeholders applying best practice solutions representing the whole energy value chain. The whole survey is accessible on Annex 3: Survey. The key findings are mentioned below:

- The **lack of adequate skills of employees** is pointed out by most of the participants as an important matter to tackle. This finding clearly substantiates the need for the EDDIE project actions.
- **Reduced costs** is seen as the most impactful added value from digitalisation.
- **Simplification of management** and **the improvement of Quality of Services (QoS)** have also significant positive impact.
- Digitalisation is regarded as a key factor for **enabling new and green technologies.**
- Most of the companies provide training to their employees with a preference to in-house training, which can be utilized for the digital and green transition.
- Digitalisation is increasingly adopted in the energy sector as the majority of organisations use digital tools and technologies daily.

- Challenges are not particularly differentiated among energy system sectors, since all sectors face similar challenges regarding digitalisation, as shown by the answers in the survey.
- **Business model adaptation** and **costs** are major issues from economic and organisational point of view
- **Acceptance of new technologies** and **privacy concerns** are the main social challenges.
- **Technology integration** and **data management** are important technical challenges.
- Several challenges do not have the same importance for companies from different countries. National policies and educational approaches play a role in this and will be further investigated during EDDIE's WP4 ("Assessment of policies and requirements for VET and beyond").
- The recent COVID-19 crisis underlined the importance of digitalisation in the energy system.

The second part of the deliverable deals with the state of the art in education and training. Erasmus+ Sector Skills Alliance (SSA) Blueprint projects are reviewed in order to obtain valuable insights from other sectors on how they approach their respective area of operation in terms of the targeted educational levels, skills and technologies as well as educational tools used to achieve the defined objectives. 9 projects were selected and reviewed, some only just starting while others are well advanced. Throughout these projects, partnerships from each project developed a sectoral skills strategy to support the overall growth strategy for the sector at EU level to enable the 'blueprint' for the sector to be rolled out at national and regional level. This is achieved via the cooperation with national and regional authorities and key stakeholders. This is a useful learning experience for the EDDIE project. Therefore, the projects' analysis includes several learnings and results to be used by EDDIE partners on this and later Work Packages (WPs). The second part of this deliverable includes the review and analysis of several European projects and initiatives related to education/training related to the energy system. The analysis of previous and ongoing projects and initiatives in the energy sector has been performed on the basis of 26 projects. This analysis is motivated by the need of reviewing the state of the art in similar educational projects in energy-related fields, aiming at identifying the main technologies and skills currently tackled by recent and ongoing initiatives. These projects address different issues related to the energy sector in Europe, focusing on the development of new skills and knowledge within the framework of European energy policies. Last, relevant literature has been reviewed in order to include a broader overview of the current state of the art in education/training for the energy sector, particularly related to digitalisation but not excluding general educational approaches. The review shows a clear gap concerning skill analysis for the digitalisation of the energy sector and the adoption of green technologies and skills.

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 within. 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 as also a major effect on the Energy Sector.

Europe has a unique opportunity to establish global leadership in the energy transition and shaping 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. In 2018 electricity mix in the world represents 19% of the final energy and 21% in Europe. From this electricity mix, 26% in the world and 33% in EU came from renewable generation. By 2040 with Sustainable Development Scenario (SDS), growth is estimated up to 31% globally and 37% in Europe [8] .

Global power demand is expected to grow by 57% between 2017 and 2050 and reach 38.770 TWh fundamentally driven by economic growth and increasing population. By 2050, renewables could reach as much as 87% of the electricity mix, with wind and solar playing a dominant role. Renewables, flexible demand and storage will be combined to shift the supply of the European power system from fossil fuels to a cleaner energy mix based on variable renewables and emissions-free energy sources [8].

Energy efficient technologies are also impacting global electricity demand growth. As developed regions switch to more efficient lighting, Heating Ventilation Air Conditioning (HVAC) other energy-related systems, total energy consumption is decreasing for much of the existing commercial and industrial use.

Customers will be the key driver in the future anticipating a system that is (almost) exclusively based on renewable energy sources and that is highly electrified. The formerly ‘passive’ consumers themselves are undergoing a radical change. With more people owning small-scale energy generation or storage units empowering consumers to produce their own electricity and heat and feeding self-generated electricity into the network, ‘active’ consumers or ‘prosumers’ are becoming more commonplace.

Moreover, consumers do not only become active as energy producers, they are also a valuable source of flexibility for the energy system, adjusting demand patterns to system needs, if given the right financial incentives. They can provide ancillary services to system operators, for instance by participating in demand-response schemes, temporarily lowering their demand in peak periods, or increasing energy demand during high renewable generation hours, if given the proper price signals.

Different scenarios involving new system paradigms in electrification, technology and sustainable resources, local energy communities and cultural preference will require a new mind-set. Designing the energy systems of the future, with legislative frameworks articulating sustainable cross-sectors regulations in energy sector, easing the implementation of all the technologies is needed for a smooth energy transition. This includes changes in design, construction, maintenance, inspection procedures and recovery practices for the network operators.

This evolution unlocks value creation and opportunities for innovation and technological development that will benefit society at large scale. The EDDIE project aims to create a Sector Skills Alliance (SSA) bringing together all the relevant stakeholders in the energy value chain such as industry, education and training providers, European organisations, social partners, and public authorities. The main objective of SSA is to develop a long-driven Blue-print for the digitalisation of the European Energy sector to enable the match between the current and future demand of skills necessary for the education and training in the digitalisation of the Energy sector and the provision of improved Vocational Education and Training (VET) systems and beyond.

The EDDIE project proposes an innovative strategic approach for Education in the Europe-an 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.

The cooperation between the EDDIE partners (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 at European level. This strategic approach will reinforce the competitiveness of the European Energy Sector in an efficient and innovative way helping create a highly skilled workforce, fostering smart, inclusive, and sustainable growth in line with the EU objectives and values.

It is evident that the attainment of our carbon reduction targets and climate ambitions – cannot succeed without having the key stakeholders on board of the energy transition; Therefore, different skills to different needs must be developed within different energy systems to include digitalisation, and associated skills, as a driver of the transformation required in the energy sector globally

2. Part A – Technological, social and economic drivers and challenges in the energy sector

2.1. Key messages

The key messages from the following analysis based on ETIPS NET Vision 2050 are presented in the list below [1]:

- Synergies among energy sectors and industries will reshape competition among energy vectors, requiring sustainable cross-sector regulation and innovative financial mechanisms. Industry skills should anticipate and actively enable sector integration.
- Digitalisation will enable companies and customer operations and processes to unlock a highly dynamic energy system at all layers and timescales. Digitalisation enables sharing economy and social participation evolving ownership relation between people and products with huge impacts on society dynamics and industry.
- Digitalisation, decarbonisation and decentralization tasks are paving the way for the *platformization* of the energy sector.
- Every energy sector will be transformed, including operational, technical, market and regulatory/ governance at local, national, and international level, including social behaviours
- Decentralization of the power system will require higher and extended visibility of the networks.
- Data intelligence and digital customer services will exponentially increase. Data will have a major technical and commercial value, to create services for society and industry with added value.
- Market disruptive dynamics, cybersecurity, large-scale social events and extreme climate conditions require a new approach to resilience. And a flexible back up system to cope with such disruptions
- Cross-sector partnerships, engagement of customers and new players are the key elements of this new approach, together with communities' and institutional support.
- The new innovative resilience approach requires stronger coordination among control layers and consider the new role of System Operators (SOs) as *'market catalyser's'*.
- A comprehensive 'resilient and sustainable by design' concept, including technical and regulatory dimensions, should be translated into plans, based on specific local needs and constraints as well as worldwide best practices.
- Technology innovation must be open to everyone and specially incentivize consumers' engagement and empowerment.
- The golden rule and protocols of experimentation should drive decisions and actions through inception through design, execution, and monitoring, to allow joint learning from demonstration projects, sharing expertise, best practices, and experiences.
- Initiatives should be based on co-ownership of experiments to lead desired changes in behaviour patterns as well as foster new business models due to successful actions/experiences.

2.2. Energy systems

European Union policies for the energy systems are based on three pillars:

- To protect the environment, by decreasing GHG, control pollution, minimising impact on ecosystem and promoting circular economy (**DECARBONIZATION).**

- To create affordable and market-based energy services (**AFFORDABILITY).**
- To ensure security, reliability and resilience of energy supply through an integrated energy system designed and operated to prevent or minimise the effects of contingencies (**SECURITY OF SUPPLY).**

The ETIP SNET 2050 Vision document considers the integration of all energy carriers including power conversion and storage key for the optimal operation of future energy systems with electricity networks as the backbone of these systems, as shown in Figure 1. The integrated energy system drives the economic growth and ensures the global competitiveness of European industry. Its structure consists of four inter-connected and inter-related layers, the market, communication, physical and digital infrastructure layer.

Digitalisation is the key enabler to meet the operational goals of the integrated system. The traditional main functions of digitalisation are to generate, collect and analyse data, alongside with new digital communication network technologies like IoT, Machine to Machine. At the same time, new challenges like Cybersecurity have emerged and the need to handle flexibility options, as demand response and improve efficiency in the energy sector. New challenges require highly skilled staff, which makes digital education and expertise for jobs in the energy field a crucial requirement.

The Vision 2050 states that new learning and teaching methods, including interdisciplinary and experimental approaches and continuous education for professionals will be explored and tested. EDDIE will contribute in this direction for future training of engineers, researchers, innovators and professionals to support the evolving needs of industry and research. Competitiveness in global economy is important to include the digitalisation and automation in the current job market. New markets create new business opportunities with new jobs which require professionals across the energy sector with the necessary in ICT and operating digital technologies.[1]

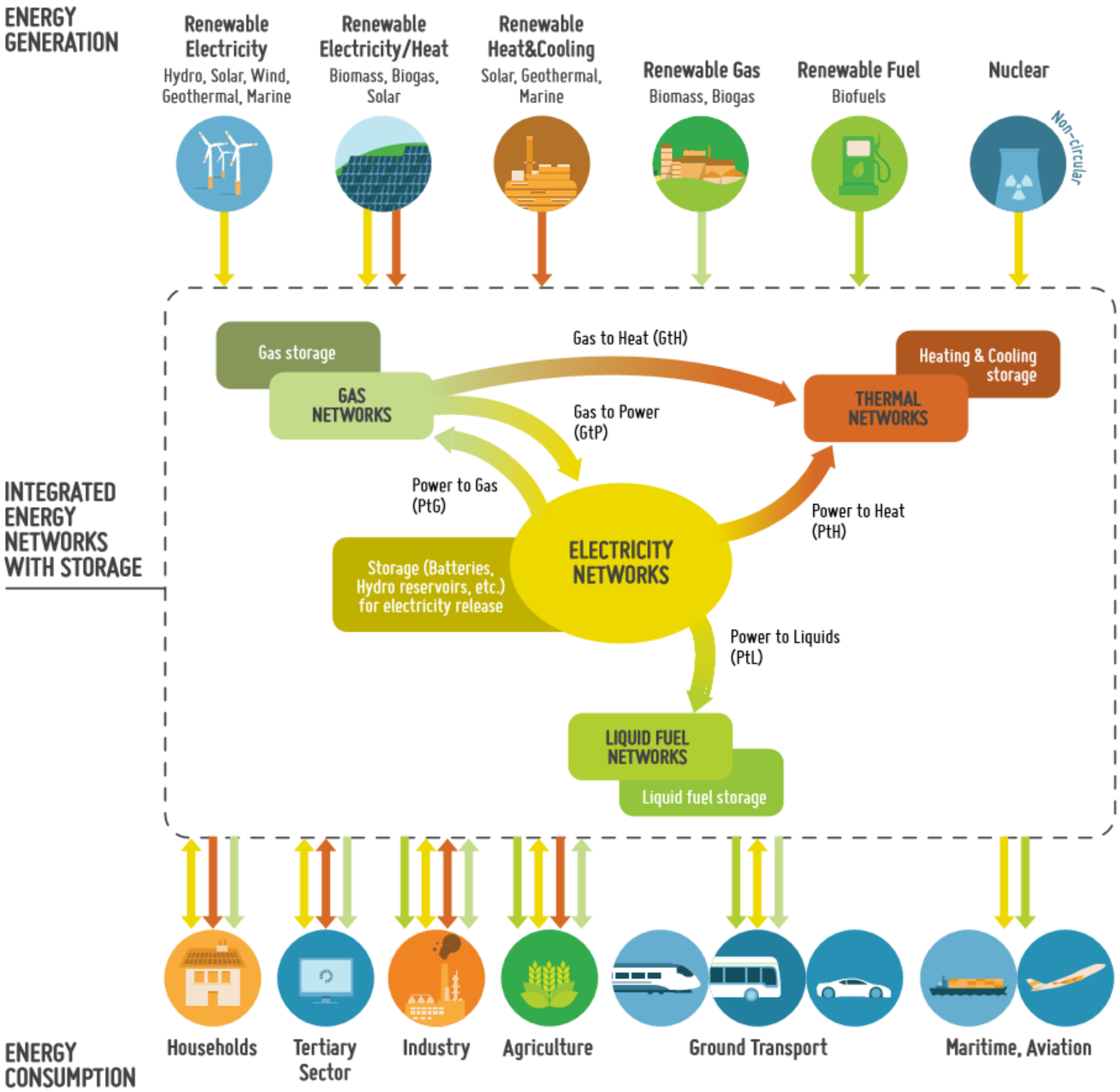

Figure 1 The future integrated energy systems with conversion and storage devices[1]

2.2.1. Electricity System

In order to decarbonise the current energy system, swift progress is needed towards more efficient energy uses based on emission-free energy sources. In this new setting**, electricity will play an essential role in the energy transition to a sustainable energy system,** due to its efficiency and flexibility and the technology is available to achieve its decarbonisation (onshore wind, offshore wind, solar photovoltaic, energy storage and electric vehicles are considered to be key due to their state of development and expected growing impact in the coming years).

The electricity system is amid a transformation, as technology and innovation disrupt traditional models from generation to beyond the meter. Three trends are converging to produce game-changing disruptions:

- Electrification of large sectors of the economy such as transport and heating.
- Decentralization, spurred by the sharp decrease in costs of distributed energy resources (DERs) like distributed storage, distributed generation, demand flexibility and energy efficiency.

- Digitalisation of both the grid, with smart metering, smart sensors, automation and other digital network technologies, and beyond the meter, with the advent of the Internet of Things (IoT) and a surge of power-consuming connected devices

These three trends act in a virtuous cycle, enabling, amplifying and reinforcing developments beyond their individual contributions.

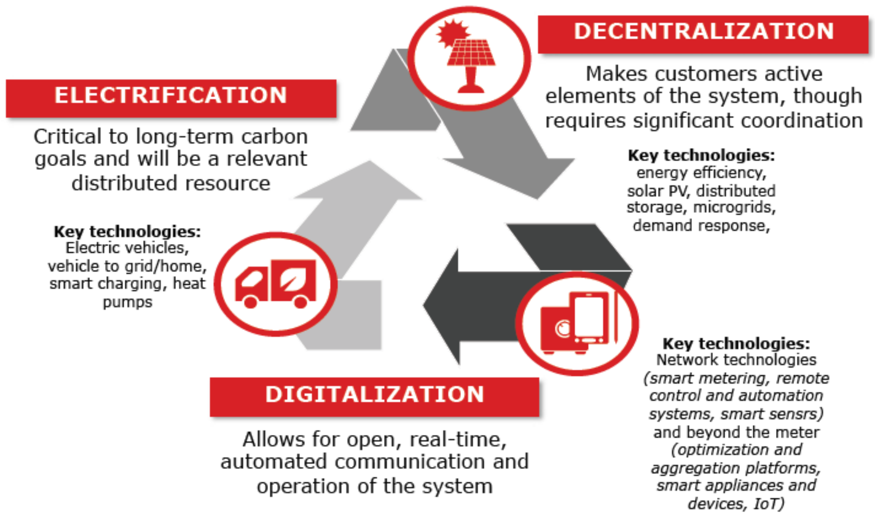

Figure 2 Overview of dependencies in energy trends and key technologies

The decarbonisation and electrification of the economy will considerably increase the penetration of electrical energy in final energy consumption and lead electricity production from renewable sources. In addition, decarbonisation and electrification will bring an added benefit: increased efficiency of the energy system. Decentralization will transform customers to active elements of the system requiring efficient coordination. Digitalisation supports the other trends by enabling more control, including automatic, real-time optimization of consumption and production and interaction with customers.[26]

Digital Initiatives: Value creation and disruption in electricity

The electricity sector is mature for realizing value from rapid digital transformation; It is estimated that there is $1.3 trillion of value to be captured globally, from 2016 to 2025. By leveraging the building blocks of digitization, such as service platforms, smart devices, the ‘cloud’ and advanced analytics, companies in the industry have the opportunity to increase the asset life cycle of infrastructure, optimize electricity network flows and innovate with customer-centric products.

Five initiatives ranging from managing the performance of assets, to real-time platforms, to integration of energy storage and customer solutions, can unlock respectively more than $100 billion over the next decade and must be prioritized for investment.

Yet, the maturity of digital initiatives in the industry varies: from projects using advanced analytics to optimize assets; and the widespread implementation of smart meters; to early moves by some utilities to manage and integrate distributed generation resources. Industry players agree on the need to make deeper customer engagement a priority and the pivotal role of digital technologies in making this a reality.

Energy technology providers are playing a key role in digitizing the industry, releasing a suite of smart generators and panels, and sensors for commercial infrastructure. They are also developing connectivity platforms for industrial, commercial and retail customers. Established players and start-up’s alike, are experimenting on the fringe of the industry. The burgeoning home energy market is a case in point, with more than 100 (non-utility) actors capturing value. With higher potential business value, smart industry and smart city markets are following suit in the business-to-business (B2B) and B2B-to-consumer spaces.

As the sector continues to adapt to the various transformations taking place, digitization must be a key priority, and indeed, can support development of new business models to respond to these industry shifts. Digital technologies have tremendous potential to contribute to growth in the sector and help deliver exceptional shareholder, customer and environmental value [25].

Four themes emerge for creating value:

1. **Asset life cycle management**: Technology solutions can enable real-time, remote-control or predictive maintenance to extend the life cycle or operating efficiency of the generation, transmission or distribution assets and infrastructure.

2. **Grid optimization and aggregation**: Grid optimization is possible through real-time load balancing, network controls and end-to-end connected markets, enabled by connected assets, machines, devices and advanced monitoring capability.

3. **Integrated customer services**: Innovative digitally enabled products and services relating to energy generation and energy management are bundled into an integrated customer service.

4. **Beyond the electron**: Hyper-personalized connected services beyond the electricity value chain, that adapt to the consumer. Electricity moves from being a commodity to becoming an experience.

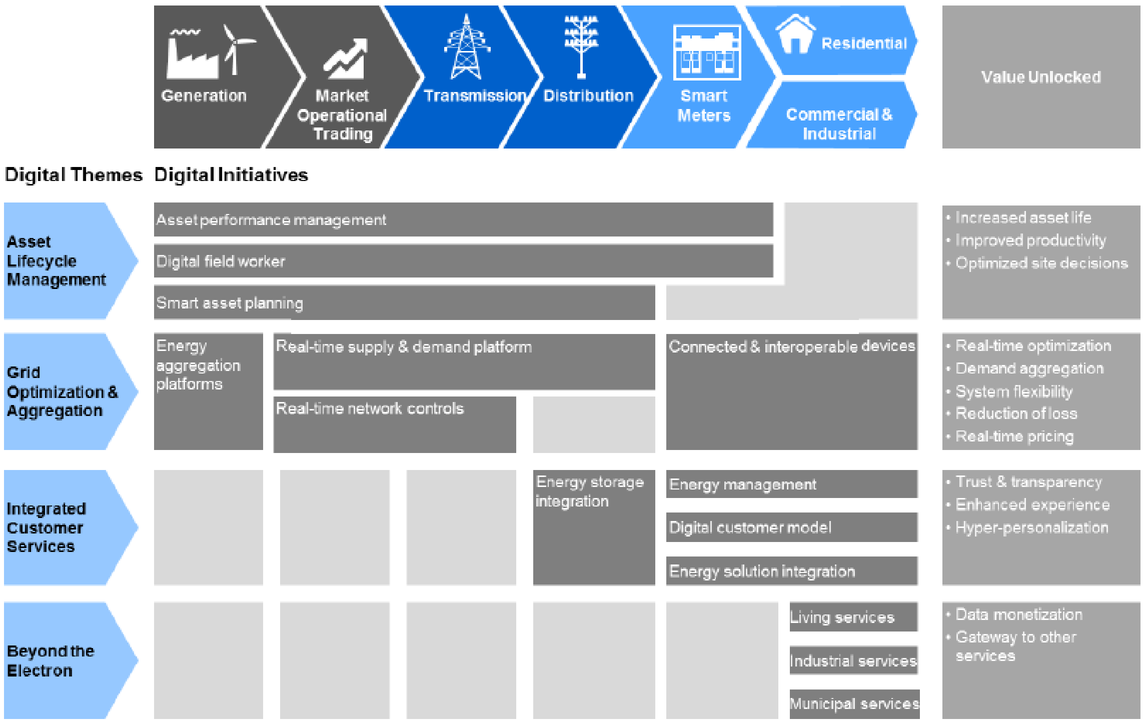

Figure 3 Structure of Energy value chain and linkage to digital themes

2.2.2. Oil and Gas System

Energy transition towards a low-emissions future.

A new energy model based on innovation and technology is necessary for the energy transition towards a low emissions future in the energy sector. The transition will take decades and will require different technologies that are still emerging today, themselves not exempt of uncertainties surrounding their pace of evolution and use.

The Oil & Gas sector will be a key player in the transition towards a low-emissions future, increasing the efficiency of its operations, reducing its direct GHG emissions and evolving towards a lower carbon intensity energy mix, with a greater presence of natural gas and commitment to new forms of energy drivers.

The sector's strong focus on innovation and technology will be key to playing a leading role in the energy transition and being part of the solution in the fight against climate change:[29][30][31]

- **Constantly striving to be more efficient**. Energy efficiency is one of the most effective ways to reduce greenhouse gas emissions. Controlling and reducing greenhouse gas emissions. Around 60% of a refinery's variable costs are related to energy. Improving the efficiency of processes solves the two-fold challenge of cutting costs and reducing GHG emissions.
- **Reducing carbon footprint,** by analysing their impact in all stages of their life cycle from **reducing emissions from flaring to working on fuel efficient engines in transportation**
- **Digital transformation:** To promote disruptive projects and new businesses.
- **Optimizing value chain.** Work based on a variety of technologies such as Springboard, Big Data, IoT, omnichannel strategies, robotization, and blockchain help professionals design digital products and services that directly benefit customers.
- **Advanced predicting models and smart sensors** to monitor seismic activity and to plan raw material extraction and keep our equipment in working order and drilling safety.
- **Software, and Cloud-based global information** for greater collaboration, improved connections, and improved safety and efficiency.
- **Artificial Intelligence and Automation** to manage operations, improve safety and achieve higher-quality products.
- **Vertical glocalization systems** to ease maintenance work at our industrial complexes and encourage mobility.

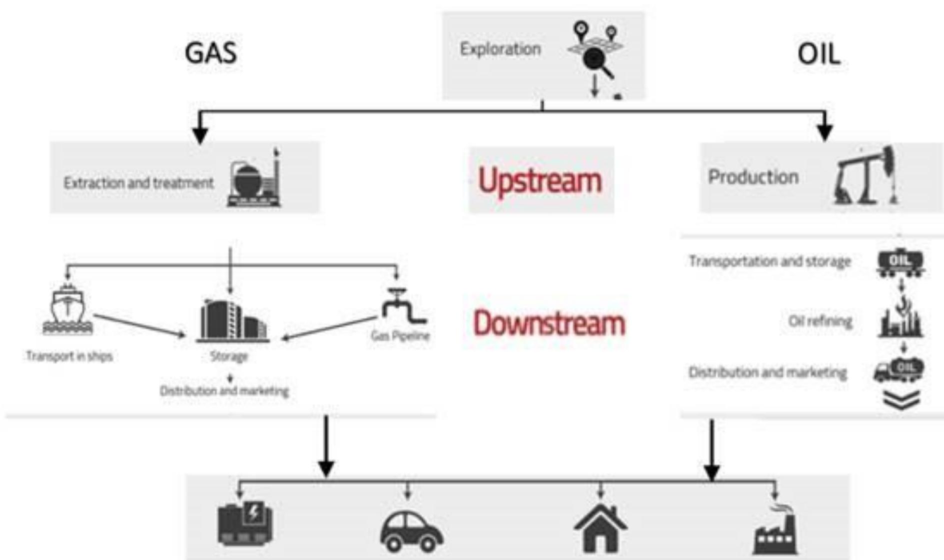

Figure 4 Flowchart of gas and oil sector value chain

2.2.3. Heating and Cooling System

Interconnectivity for a more resource efficient system integration which seeks synergies

Electrification of the domestic heat sector is ongoing via small heat pumps, and electric heaters are more frequently used for grid services and supplying heat to heating grids. It can be expected that progressively large MW scale heat pumps will be integrated in heating grids, including low temperature (water) heat storage.

Product flexibility is important, with regards to sector integration, to allow delivering on demand heat, electricity but also synthetic fuels in integrated plants. Product flexibility between fuels and electricity as an output is a core technology to make power output more flexible, while heat storage in CHP and district heating grids (hot water storage) is already State of the Art for de-coupling of electricity and heat markets. New CHP plants are also often equipped with electric heaters or in future with heat pumps to effectively utilise excess capacities of RES electricity.

Systems for electricity and heat supply are becoming more complex. To operate independently in the electricity and heating market, new district heating power plants are almost exclusively equipped with water heat storage. Thus, heat storage in GWh scale is technically feasible just as at the power plant Avedoere in Denmark or in the Küstenkraftwerk Kiel in Germany. Topping cycle gas turbines attached of steam power plants (Avedoere II) or the possibility to operate the heat recovery steam generator of CCPPs in air mode (no GT operation, only steam production) allow to respond quickly to positive or negative load demand. Fuel flexibility can also be implemented as in the power plant Avedoere, which in the boiler can be fired with mixtures of coal, biomass and natural gas over a wide range, allowing maximum fuel flexibility and security of supply.

Digitalisation for Heating and Cooling solutions (example of GETEC Heating player in Germany in partnership with Greencom Networks, an IoT provider for Energy residential customers) is represented through an increasingly interconnected world generating synergies between the different communication infrastructures. The use of smart infrastructures in the form of so-called “gateways” enables both classical requirements as well as to integrate and control state-of-the art sensor and actuator technology for the automation of homes and buildings centrally via an IT platform. The supply of Objects with heat continue the service beyond the generation in the basement boiler room. In addition to the continuous perfection of the control of systems on the basis of exterior temperatures, standard load profiles and the volumetric flow rate, by aggregating the distinctive usage profiles of individual units into a requirements profile for the building, the Digitalisation is capable to consider them for the optimisation of the system control - Data System [33].

2.2.4. Data energy system

Data Management and telecommunication systems is not a new “thing” and have faced incredible transformation in the last 10 years. Focus so far has been on the infrastructure operation and coherently the concept of Smart Grid has been the focus of research and applications. A good overview in this sense is offered by the position paper of the Smart Grid Technology Platform. The current concept of data & digitalisation is a broader concept encompassing also social aspects. A key reference in this sense is given by the Winter Package of the European Commission that clearly stated the central role of the customers in the future energy systems. In this sense, with respect to the traditional idea of a Smart Grid, the data & digitalisation process involves other new factors such as:

• Customer involvements and possible disruptive new business models that could emerge from this involvement

• Greater attention to sector coupling and then correspondingly a convergence of Smart Energy and Smart City

• New concepts that are emerging also at the physical layers thanks to a greater role played by electronics in the new system.

In this sense, the data & digital energy network paradigm is a broader concept than Smart Grid with significant social components and focused on service. The final goal is to enable a flexible open market of energy with equal possibility of participation of every player as envisioned by the Clean Energy Package.

Big Data gathering technologies such as sensors and smart meters collect data on energy use and other conditions affecting energy use. Data are processed into useful information through data analysis technologies such as artificial intelligence, Machine learning and Predictive Analytics algorithms. Finally, the processed information is sent to devices that can effect physical changes to optimise energy use. Some devices require human action to optimise energy use which could be done through a smartphone app which can suggest an energy efficient route to work. Other devices are capable of optimising energy efficiency more autonomously: For example, switches in a building's cooling system or robots in a production line. The benefits in terms of savings, better outcome, new business models, better management of the system peak demand, stability, efficiency, and output are significant leading sometimes to self-funded projects as ROI is impressive and breakeven short.

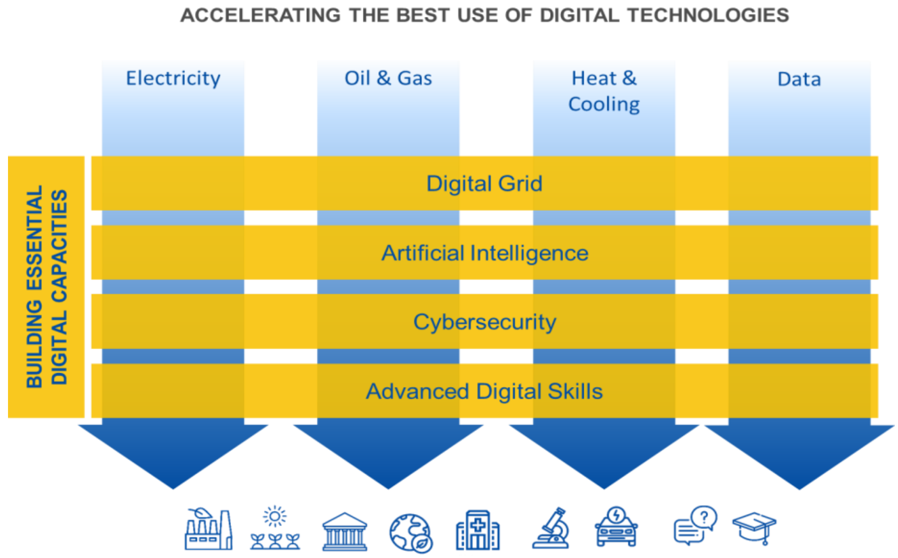

Figure 5 Energy Systems and Data interconnection matrix

2.3. Social framework

2.3.1. Decarbonization requirements

In November 2016, the European Commission proposed a comprehensive update of its energy policy called the Clean Energy for all Europeans Package (CEP). This package is adopted from 2019 and reinforces consumer rights and the environment putting them at the heart of the energy transition. The new rules will create growth and green jobs in a modern economy leaving no region and no citizen behind. Besides the growing role of consumers, the CEP also recognizes the important role of market parties and SOs.

With CEP, the European Commission addressed all 5 dimensions of the Energy Union:

1. Energy security.
2. The internal energy markets.
3. Energy efficiency.
4. Decarbonisation of the economy.
5. Research, innovation, and competitiveness.

Additionally, to the CEP, the new Green Deal and the digitalisation of Europe will be important new priorities of the European Commission. The main objective of the Green Deal is to achieve Climate Neutral Growth in the European Union by 2050 and, for every citizen and therefore consumer, setting an economic, legal, and social strategies.

The EU Green Deal strategy contains 50 measures, including a legally binding target of reducing EU emissions to net zero by 2050, a carbon border tax to prevent companies from relocating to avoid climate legislation, a policy not to conclude any free trade agreement with a country that is not a signatory to the Paris climate agreement, and a €100 billion just transition fund precisely oriented toward the most exposed regions in terms of decarbonisation challenges regarding the transition according to the level of employment potentially impacted (i. e. in industry where the carbon intensity of Greenhouse gas emissions exceeds the EU average, or the high level of employment involved in coal and lignite mining among others.)

Considering these projects, the revision of the TEN-E Regulation is also one of the 2020 priorities for the EC that wants to put forward a legislative proposal by the end of the year. The Transeuropean Energy (TEN-E) Regulation aims to support the integration of innovative technologies and the development of smart infrastructure, such as smart grids, hydrogen networks, energy storage, but also carbon capture, storage, and utilisation. The smart sector integration also called “sector coupling strategy” is therefore linked to these matters with the Green Deal’s scope.

2.3.2. The new energy consumer

Digitalisation has transformed how consumers behave, learn, research, and engage with companies. Everyday objects are being embedded with sensors and combined with intuitive visualization, empowering consumers to make faster, better decisions on their own terms. The evolution of the needs of consumers, increasingly informed and connected, requires a different management in the strategy of energy companies.

On one hand, the online experiences that customers are becoming used to in areas such as retailing, travel and media are setting a new norm, raising the standards expected for baseline aspects of a utility’s operations such as metering, billing, payment and outages and communications.

In addition, consumers already prefer online, mobile and social media as channels for interaction. Today, clients ask for two-way communication and expect a personalized service that meets their specific needs. The client begins to demand "experiences". That reality makes service design a critical capability and energy providers need to approach these networks properly, using social media as a valuable mechanism for gathering consumer feedback. For consumers, social media is becoming another channel for learning about products and services and receiving customer service.

Regarding customer expectation, customer strategies that responded satisfactorily to basic concerns of reliability, safety, pricing, information provision and resolution of any problems are now insufficient. Nowadays, the combination of energy transformation and technological innovation has led to a more far-reaching set of challenges: customers demand sustainable services, defining an energy transition strategy for their companies. They are increasingly concerned about their consumption, both efficient and renewable sources.

In this scenario, energy companies should take advantage of digitalisation, expanding their portfolio of products, providing sustainable, hyper-personalized and connected services that adapts to the changing consumer, business, and citizen. As adoption of rooftop solar and other distributed generation technologies increases, consumers’ knowledge and interest in home energy management solutions is on the rise.

Opportunities for energy providers to extend the value proposition are also identified, including innovative offerings to engage energy prosumers and the growing potential of platform-based models in the digital energy ecosystem.

2.3.3. Workforce and employment: Education and digital skills

As the digital transformation is moving ahead, the question of digital skills has become a societal challenge. And it is not just about hiring more data scientists and engineers—it is about upskilling and preparing the workforce for a new way of working.

To respond to these challenges, businesses and governments must bridge the gap between the capabilities of current employees and the skills that will be needed to drive future growth, and they must do this by upskilling the workforce. Continuous training, the maintenance of internal knowledge and the incorporation of young people with specific digital profiles will be essential.

Professionals supporting digital infrastructure will need specialised ICT skills, such as coding and cybersecurity, while across the energy sector, all professionals will need generic ICT skills to operate digital technologies. Complementary “soft” skills such as leadership, communication and teamwork skills will become increasingly important for the growing number of opportunities for ICT-enabled collaborative work.

Just as energy companies need to foster an individual mindset geared towards digitalisation, they also need to foster a collective one, one which goes to the core company culture and challenges our strategic and operational ways of working. Building a new company culture with digital at its core involves every employee buying into the organization’s digital goals and vision.

In addition, this new digital world requires education institutions to adapt and adopt digital technologies, methodologies and mindsets that encompass emerging digital skills [28]

Last, but not least, green skills will be needed as a fundamental base to understand the overall Energy Transition.

2.4. Economic framework

In reaching the new goals of the Commission aligned with the Paris Agreement the economic provides the necessity, due to quantification of the macroeconomic impact of doubling the global share of renewables. The study of the International Renewable Energy Agency (IRENA) on the energy system and the world economies shows for example that the linkage between Sustainable Development Goals and economic growth, also meets the objective to decarbonise through the increase of the share of renewables. **The labour-intensive nature of renewable energy sector could reach through indirect and direct employment 24.4 million people in 2030. [22]**

Digitalisation will have an eruptive impact on the economy even though major routine and repetitive labour will phase a high risk of automation, unpredictable work and those in digital infrastructure will need specialised ICT skills. Coding and Cybersecurity skills and knowledge will be a must across the sector. Complementary skills such as leadership, communication and teamwork will become increasingly important for the growing number of opportunities and considering a collaborative work in globalised world [7].

2.4.1. Economic disruption and job creation

The transition for a green future has a huge impact on local and global economies. Emerging trends in finance sector on releasing more transparent investments discloses and moving away the subsides from fossil-based resources to cleaner energy generations are the key actions to help the shift for the energy sectors.

However, the drastic economic shift is leading to a new opportunity in energy economy: the link between environmental and economy is strengthened with the new concepts of low-carbon technology, green growth, and circular economy. According to the latest figures published by IRENA, the global renewable energy sector employed 11 million people in 2018. This compares with 10.3 million in 2017. Jobs in renewable energy can be created directly and indirectly along the entire value chain, including in the manufacturing and distribution of equipment; the production of inputs such as chemicals; or even in services like project management, installation, operation, and maintenance. Among all, employment on efficient and renewable energy sector is expected to raise up to 250.000 jobs in the field and helping saving carbon, energy and money off bills for the customers.

New green jobs are among the quickest growing category in industries which concerns energy efficiency in buildings, pipe insulations, recycling activities and state-of-the-art energy production techniques; hence, a huge potential has been offered from the sustainable sector for job creation.

Likewise, the policies should implement important tool to support employees and employers for the structural change, securing the labour transition and foster the initiatives between policy bodies, governance and public-private partnerships. In this sense, training policies and dedicated labour market programmes focusing explicitly on new skill requirement can be an important complement, particularly for SMEs and some specific sectors

2.4.2. Decentralization

Trend is towards smaller, decentralized power systems that meet on-site electricity needs as opposed to traditional centrally located power plants that distribute electricity to customers through networks. Known collectively as distributed power technologies, aeroderivative turbines and reciprocating engines and solar photovoltaic (PV) systems are being connected mostly through distribution networks in increasing volumes.

Another advantageous aspect of distributed energy system is their ability to meet the heating, cooling or steam needs of end-users. Many industrial processes require heat as well as electricity as an input into production. Distributed, on-site generators such as reciprocating engines, steam turbines, and gas turbines can supply multiple products to meet customers' power, heating, cooling and steam needs. When operating in combined heat and power (CHP) or trigeneration mode, distributed technologies exhibit total efficiencies approaching 90 percent.

Also, energy storage solutions such as batteries enable distributed power systems to store energy from variable generation sources and discharge at periods of peak demand. Those systems will be also very useful for supplying an on-grid / off-grid microgrid with distributed renewable sources, especially in remote areas. Demand response technology will also have implication for the grid, enabling control of energy use during peak demand and high pricing periods, reducing peak demand [32].

2.4.3. Market development and design

An efficient transition towards this new energy system faces several challenges. Thus, the current regulatory paradigm do not always allow distributed resources to provide their full value to the system and uncertainty around rules prevents key stakeholders from deploying enabling infrastructure that could complement the grid as the backbone of the future energy system. Also, some segments resist a cultural change towards a different allocation of roles and new business models.

The Transformation of the system needs competitive markets instruments to meet these new requirements cost-effectively the system is evolving, which means that specific flexibility services are evolving or becoming more relevant. Newer areas of localised value recognised by system operators and network companies relate to local infrastructure deferral, voltage support, etc.

System operators and policy makers have a role in recognising and anticipating new flexibility requirements. This has two levels, as the system evolves a new host of ancillary services, redefinition of reserve criteria, contractual arrangements or operational practices may need to be introduced to account for new flexibility requirements. At a more fundamental level, wholesale market design may need to be adapted to account for the increasing value of flexibility.

Conventional market arrangements for system flexibility need to evolve to allow the participation of new technologies. Ideally, the needs recognised above should be met through instruments that recognise the set of new capabilities brought about by new technologies. These range from operational improvements in grids through digitalisation, improved price formation or even explicit market products. In the case of the latter entry requirements may need to be addressed but also operational requirements constructed around the capabilities of conventional assets.

Allowing access to multiple markets is key to ensure cost-effective deployment of DER but requires mitigating conflicting incentives between different levels of system operation by participating in multiple system services DER can maximise utilisation and optimise revenues across different sources. These may range from simple bill optimisation to active engagement in ancillary services or balancing the load of other market participants. As these services may be procured by different counterparts –SOs procuring reserves, generators in short-positions, i.e.- it may be necessary to coordinate contractual conditions to avoid conflicts of interest, particularly when this may impact system reliability.

Aligning price signals across energy markets, regulated businesses and end-consumer tariffs is key for system-friendly/cost-effective deployment of DER. In many cases, the revenue streams for distributed energy resources as alternatives to conventional investments may not be there, as in the case of conventional regulation for network business. In other cases, when behind-the-meter assets are used for bill optimisation, the implicit pricing signal may lead to a cost-shift to other consumers. In any case it is important that the price signals are structured so that they accurate remunerate DER wherever they contribute to the system cost effectively.

In addition to DERs, vehicle-to-grid (V2G) technology, through which the batteries of EV's are used as storage for locally produced electricity, will enable to explore new interactions between the transportation system and the electric grid, creating flexibility, stability, economic advantages, and opportunities to optimize renewable energy use. Moreover, it could also have its benefits for prevention of unexpected investments for grid operators in the existing grid infrastructure.

However, although electric vehicles are expected to become economically competitive in the next few years, several infrastructure challenges could limit its successful adoption. Reallocating EV subsidies from vehicles to charging stations over the next five years could enable the deployment of two to eight times as many charging stations compared to the number of EVs subsidized. Public infrastructure is also lagging mostly due to uncertainty related to the model of deployment, including costs, ownership, and technical requirements.

As more distributed energy resources (DERs) come online, demand response programmes may become even more flexible and by some estimates could reduce necessary annual investments in grid infrastructure. Demand response technology can create flexibility by providing price and volume signals and sometimes financial incentives to adjust the level of demand and generation resources (consumption, distributed generation, and storage) at strategic times of the day. Energy policies around the world increasingly acknowledge the importance of demand response and are beginning to solve the challenges that hinder its full uptake.

2.4.4. Invest into the future: R&D

The energy technologies are constantly relying on the advancing innovation coming from the research field, with improving the efficiency of renewable energies as core focus as well as discovering new techniques on how to reduce the impact of fossil fuel sources.

Research and development spending by companies and governments continues to play an important role in nurturing new green energy technologies. Last year, solar made up most of the activity, at $6.6 billion, followed by wind ($2.7 billion) and biofuels ($1.8 billions).

Overall, corporate R&D will have amounted to about $51 billion during the decade, with government-funded R&D very close to that (2010-2019), though private investment has been greater over the past few years. In addition, R&D have been centered in the European Commission interest with different programmes that subside green energy generation, storage technology and sustainable practices for a low-carbon future.

Horizon 2020 is the most powerful program developed that EU set up for a total funding of nearly €80 million from 2014 to 2020, over various platforms and tools; the scope is ambitious: identify innovative and breakthrough energy ideas, from industry or academia, and bring them into the market in a timely manner; furthermore, it encourages the cooperation of the consortium's member to continue collaborations all over Europe.

The upcoming framework programme for the near future is Horizon Europe, which has even a bigger funding budget, powered by European Commission. It has the bold mission of helping to achieve the SDS, fighting climate change at any level and boosting the Union's economic and technological growth among members. The structure has split up into 4 axes: Excellent Sciences, Global Challenges, European Industrial Competitiveness and Strengthen the European research area and Innovative Europe. This has a tremendous potential for subsiding the R&D application sector in the energy field, in line with the vision of the H2020 programme.

Additionally, to be able to apply smart grid solutions it is needed not only R&D projects and pilots to develop the technical solutions, but also changes in the regulation. European projects allow for companies to develop solution and skills thinking "outside the box" and should be allowed to be develop efficient solutions in regulatory sandboxes.

2.5. Technological framework

Through the digitalisation, benefits like lower cost services, larger integration of Distribution Energy Resources (DER) and energy efficiency mechanisms are possible. Due to the favourable prices of IT a better deployment of infrastructure at all levels of the power system value chain is enabled. But data alone is will not cut the deal for an effective digital transition. It is important to use a consistent and good quality Data, with clear principles for access and processing regarding security. It is important to specify which processes require which amount of digitalisation to improve the communication and make it more reliable for disruptions. Increasingly complex system needs still a quick response time and the flexibility to react accordingly.

2.5.1. Digitalisation & IoT

Over the last decades, European industry discovered and further investigated multiple digital technologies that might be applied in all the energy sectors, that could possibly alter the traditional range of energy applications, namely Internet of Things (IoT), big data analyses, advanced manufacturing, robotics, 3D printing, blockchain technologies and artificial intelligence. Thanks to the latest developments in this domain, Europe can guide the industry to share the emerging innovations for energy products and services in a recent future.

Currently, the digital transformation has been referred by merging advanced technologies with digital platforms, in accordance with innovative business models, by leading to the creation of smart products and services. Such as to operate and control Transmission and Distribution networks, to improve the performance of individual and fleets of power plants, and to optimize hybrid microgrid systems for example.

The state-of-the-art of the above-mentioned evolution is not fully exploited up to now, that is because of huge mismatch between large companies and SMEs, imbalance among regions and sectors considered. EC is further investing in the implementation of digital solutions for areas and industry sectors that did not operate toward this direction in the recent years, as declared in the recent op-ed “Shaping Europe’s digital future”(cybersecurity, IoT, machine learning, AI, robotics & automation, blockchain, analytics& big data, etc.).

2.5.2. Smart sector integration

The recent directive of EU policy stated that it is necessary to boost the sector integration of production and use of energies in electricity, heating, transport and industry. These need to have deep changes to allow their fully decarbonization, the aim is to unlock flexibility by energy storage and transformation between energy domains.

The integration in energy sectors consist of a series of technical innovation to be deployed at any layer of the energy chain, to achieve an energy consumption reduction and, in turn, increasing the efficiency of the whole system. Assessments of how the sectors could be connected, in parallel with removal of legislation hustles, thanks to a broad policy approach that covers Europe at any level, fostering the subsides of best practices and taxing the polluters will be undertaking.

As an example, understanding mobility needs and its power system integration opportunities is the first step to successfully integrate transport and power systems. Along with charging needs, flexibility, and resulting changes in overall electricity demand, peak load, and bulk power systems impacts. EVs are new loads that can introduce local stress to existing distribution systems, even at relatively low overall adoption levels (“neighbour” effects) and can trigger high electricity costs for public stations (demand charges). Effective system planning, smart charging (for residential/workplace charging), and distributed energy storage systems (especially for public fast charging) can help to cope with these potential issues.

The deployment of a sufficiently expanding public charging infrastructure of various transport modes needs to be coordinated with the development of network infrastructure. Availability in terms of the number of charging points and their location. Also, EV can help to facilitate the Variable Renewable Energy (VER) Integration, by applying smart charging strategies. Synergies require a closer collaboration of the different sectors and the players inside them to learn to each other and exchange needs and thoughts. [19]

2.5.3. Energy efficiency

The Energy Efficiency Directive 2012/27/EU stated that the energy efficiency target will be 20% by 2020, in December 2018 the amendment expressed the new target of 32,5% to be reached by 2030; the latter further push the contribution of each member to release a specific long-term plan to indicate the country-wise targets to be obtained, aligned with the Europe’s aims.

Energy efficiency is one of the most important paths to effectively tackle the reductions of final energy consumption and primary energy demand. The most important measures to put in place are the following:

- New buildings consume 50% less energy than the building did in the 1980s.
- European industry energy intensity decreased by 16% from 2005 to 2014.

- More efficient appliances are expected to save consumers €100 billion annually on their energy bills by 2020.

The roll out of nearly 200 million smart meters for electricity and 45 million for gas by 2020 to enable both consumers' saving and enhanced information share. Smart meters are by themselves the most basic form of demand response, when used to provide feedback to the consumers about their consumption so that they can take actions to reduce it. [18]

2.6. The benefits of digitalisation

The energy system is transforming, and part of this evolution stems from new legislation such as the Clean Energy Package, that foresees a more digital role of all players in the energy space. Education, especially for young generations, is a key player for a communication in energy transition, even though, the EU is committed through many programmes to assure a zero-carbon scenario future to all Europeans, the social awareness on how to implement this transition is rather low.

One of the roles of EDDIE is to disclose coherently the energy targets presented in EU2050 vision and the 2015 Paris agreement to an audience as wide as possible. Over the different Work Packages, a thorough analysis on how the communication in education must be addressed will consider all the challenges identified over this document, complementing it and paving the way for a reliable and coherent dissemination to all Europeans.

The potential economic benefits of energy digitization. According to the World Economic Forum, the value stream to the power industry for service platforms, smart devices, and advanced analytics is US$1.3 trillion. Asset performance management solutions alone have the potential to create US$387 billion in value by lowering operations costs and eliminated unplanned downtime. Digital solutions in the power industry can create over US$2 trillion dollars from the reduction in greenhouse gas emissions, new job creation and value for consumers [25]

Even more broadly, the global e-Sustainability Initiative recently found that an Industrial Internet-enabled world of 2030 can be cleaner, smarter and more prosperous. They estimated that ICT can bring about a twenty percent reduction in global carbon dioxide emissions by 2030 through the application of Internet-enabled solutions. This would also reduce costs by US$4.9 trillion by 2030, with US$1.2 trillion in reduced electricity expenditures, and US$1.1 trillion in reduced fuel expenses [26].

Besides the economy, environmental protection and emission reduction is key. As discussed, recent General Electric (GE) analysis also suggests that if digital grid technologies are fully deployed globally, electricity consumption could be reduced by as much as twelve percent and carbon dioxide emissions could be reduced by two billion metric tons by 2030 [6].

2.6.1. Opportunities & Challenges

Despite the potential and early success of energy digitization efforts, there remain several challenges that must be overcome to unlock the full potential of our digital energy future:

- Early digital energy adoption needs to be encouraged.
- Industry, government and universities must advance digital energy R&D.
- Data privacy and security concerns need to be successfully addressed.
- Cyber security to be increased.
- Talent should be cultivated.

With these clear objectives in mind, EDDIE will establish 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.

2.7. Survey on digitalisation of the energy system: technologies, tools, impact and challenges

2.7.1. Overview

The EDDIE project's approach as an industry-driven activity, where the skills emerge as a need of the practical application instead of the classic approach that starts from fundamentals to reach application, raises the need to consult the industry when addressing challenges in the energy sector. Taking this into account, the project's consortium developed a dedicated survey in order to gain necessary feedback from actors across the whole energy system, with diversity in terms of geographic location, size, type of organisation and operational focus (DSOs, TSOs, suppliers, service providers etc). The survey aims at addressing the main challenges the industry faces towards the digitalisation of the energy system and the new skills needed towards the new digital era.

Utilizing the addressed challenges, the EDDIE project will advance into identifying the necessary skills to overcome them (Skills demand). The skills will be assessed and categorized according to their relevance, importance, and impact in the context of digitalisation. Moreover, the current level of coverage of the aforementioned skills by professionals and graduates will be investigated (Skills offer) making possible the definition of the skill gaps which is one of the main outcomes for the current work package. The whole process described in this methodology was designed to replicate Skills Panorama [34] which is a skills intelligence process performed by the EU body European Centre for the Development of Vocational Training (CEDEFOP). Skill intelligence is the outcome of an expert-driven process of identifying, analysing, synthesising 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 remain relevant, skills intelligence must be kept up-to-date and adjusted when user needs change. This requires the expert-driven process to be continuous and iterative[35]. Skills panorama practical framework [36] provided by CEDEFOP, was considered in detail during the survey design.

The frameworks in which the challenges are addressed, as mentioned in previous chapters, are social, economic, and technical to cover all the aspects of operation an organization engages in. Also, the approach had to be aligned with EU bodies which engage in skills identification, forecast and classification. ESCO's (European Skills/Competences, qualification and occupations) reports were reviewed to identify relevant skills and occupations with digitalisation of the energy system.

The questionnaire was distributed to 132 stakeholders covering the majority of European countries as well as all the energy system's sub-sectors and types of organisation (generation, network, retail, etc.). The survey will remain open at least until the end of WP2, since it also addresses skills and skill gaps and in case significant changes to the present results are observed they will be included in the next deliverable D2.2. The analysis focuses on 57 answers provided by the contacted organisations having a good representation of sectors, type of operation and geographic location.

2.7.2. Methodology

The survey as a document serves two different purposes. On the first level it addresses the challenges the industry faces towards digitalisation and on the second level it attempts to investigate the skill needs for this transition as well as the current level of coverage within industrial organizations. This section focuses on the first level of the survey, as the second is tackled by EDDIE's task 2.3 and will be included in the deliverable D2.2. The complete survey is available at Annex 3: Survey.

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 questionnaire provides examples of challenges and skills and the interviewee is called to provide his input in relevance with the content that is already provided but can also add additional inputs as free text. To produce the relevant content, EDDIE's industrial partners (Iberdrola, General Electric, Repsol) provided initial information deriving from their experience in the energy sector. To further extend the content several reports were reviewed, such as ETIP SNET Vision 2050, "Jobs and Skills in the Energy Transition" by SETIS, "Skills for Smart Industrial Specialisation and Digital Transformation" written by PwC for EASME [37].

The survey is divided in 4 sections (excluding introduction and communication).

Section 1. Demographics

The first section gathers information about the interviewee's organization such as country of origin and operation, size, energy sub sector and training provision. These data are used for demographic statistics in order to be able to produce results in accordance to geographic dispersion, correlation of results and sector of operation (Oil&Gas, Electricity, Power, Heating and Cooling, Digital/Data) or type (DSO, TSO etc). Also, demographics allows us to get an insight on how people from different departments and positions across the value chain view the challenges their organization face.

Section 2. Technologies and Tools

The second section tackles different technologies and tools, related to digitalisation, to find their importance and frequency of use within organisations. Through the use of technologies and tools we are able to derive the relevant skills needed, relevant occupations and challenges needed to overcome in order to further incorporate the technologies in the organisation. The technologies and tools mentioned in the survey were produced through the partners' experience and the reviewed reports mentioned in the previous paragraphs.

	Technologies
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)

Table 1 List of technologies addressed at the survey

	Tools
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
13	Social media

Table 2 List of tools addressed at the survey

Section 3.Industry challenges

The next chapter refers to specific challenges but also to the added value produced by digitalisation to the organisations in order to measure the importance of the digital transition. The challenges were divided according to the framework changes that take place at the industrial level, which leads to the certain challenges. Also, a separate section was included to address challenges related to crisis operation, being highly relevant with the COVID-19 crisis we're currently going through. Namely, the frameworks were defined as:

- Economic and organisational
- Social
- Technical and regulatory
- Technology changes highly related to the energy system
- Extreme situations (e.g. pandemic, extreme weather conditions)

Added Value produced from digitalisation

Financial	Increase in revenue
Financial	Reduced costs
Business	Enhance brand name
Business	Create a point of difference from competition
Business	Goals/target tracking
Customer service	Add features to existing products
Customer service	Offering convenience
Customer service	Improve quality of service (QoS)
Management/Administration	Simplify management
Technical	Enabling new/green technologies
Technical	Crisis management

Table 3 Added value produced by digitalisation

Economic & Organisational Challenges

1	High economic costs
2	Business model adaptation
3	Funding
4	Low top-management commitment
5	Goals/target tracking

Table 4 Economic & Organisational Challenges

Social Challenges

1	Privacy concerns
2	Loss of jobs due to automatic processes
3	Acceptance of new technologies
4	Lack of citizen engagement

Table 5 Social Challenges

Technical & Regulatory Challenges

1	IT security issues
2	Reliability and stability need for machine to machine communication
3	Need to protect industrial know-how
4	Lack of adequate skills from employees
5	Data management
6	Data protection issues
7	Technology integration (compatibility with existing processes/technologies)
8	Lack of regulation, standards, and forms of certification
9	Unclear legal issues

Table 6 Technical & Regulatory Challenges

Energy System related Challenges

1	Customers	Remote services to customers
2	Customers	Dedicated information about their energy profiles
3	Customers	Remote fault announcement
4	Customers	Remote metering
5	Customers	Remote fault repairs
6	Network planning	Digital tools for network planning
7	Network planning	Geographical information systems
8	Network planning	Data for longer term load forecasting
9	Network planning	Load profiles
10	Network operation	Automation and fault clearance
11	Network operation	Remote switching
12	Network operation	Automatic fault indicators
13	Network operation	Crew management
14	Network operation	On-line security assessment
15	Network operation	Short-term load forecasting
16	Maintenance and asset management	Predictive maintenance
17	Maintenance and asset management	Asset management

Table 7 Energy System related Challenges

The final part of this chapter is devoted to crisis' management strategy and implementation. As shown by the recent COVID19-Crsis, flexible and ad-hoc reactions to immediate challenges are needed, which can influence the way we work and communicate. In this sense, but focusing on general crisis operation strategies, the survey attempts to address how organisations across Europe responded to the pandemic, what were the main challenges they faced, and the important lessons learned during this situation.

Section 4.Skills

The last chapter of the survey refers to the relevant skills needed to tackle the main challenges as identified in the previous chapters of the survey. The aim is to address as many as possible, ranging from technical skills to transversal, social and green skills. Another key feature of the survey form is that it allows the user to identify the importance/relevance of each skill for different categories of employees (engineers/researchers, managers, technicians) as well as the current level of coverage of each skill at the organisation. Further analysis regarding this chapter will be done in the deliverable D2.2 that tackles skill assessment and skill gaps.

Target group - Distribution

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 ETIPS NET Vision 2050, as Electricity, Oil& Gas, Heat & Cooling and Digital/data. Also, their respective type was considered (Generation, System Operator, Market etc.). Figures [6] [7] picture the electricity and gas sub sector accordingly.

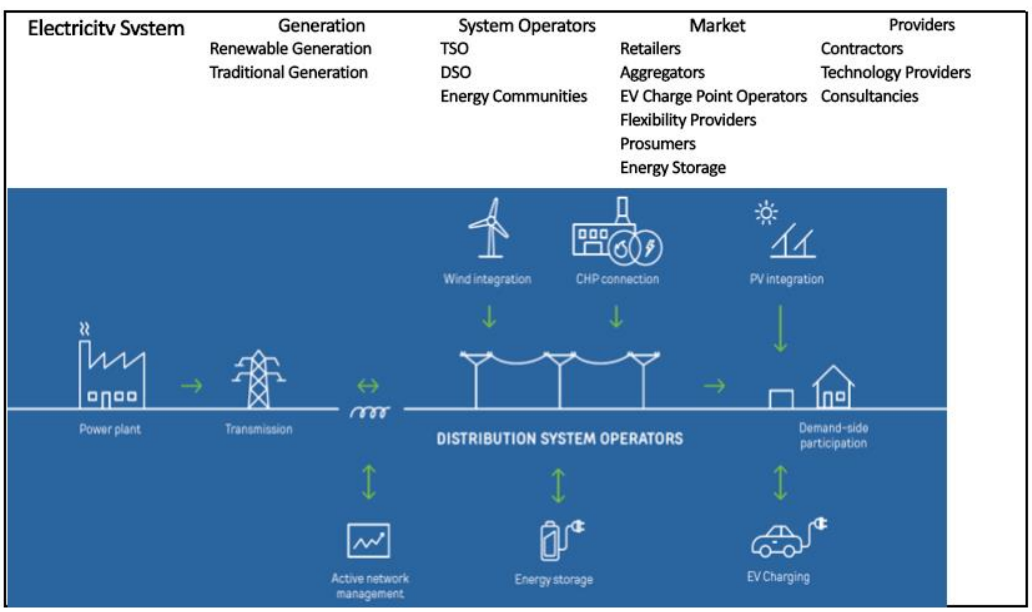

Figure 6 Electricity system stakeholders

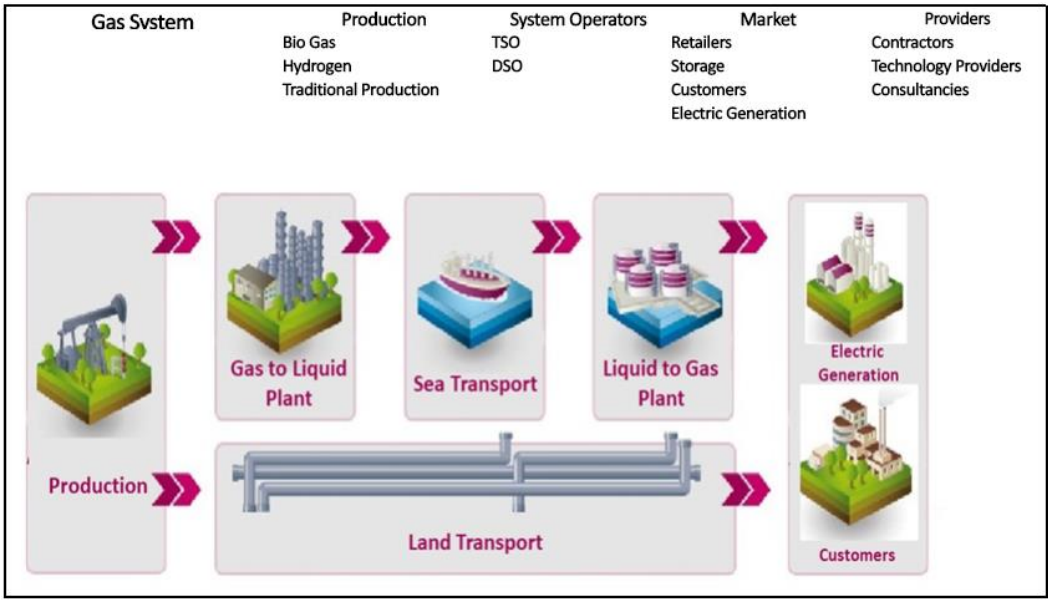

Figure 7 Gas System stakeholders

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 respondends operate in various sectors and have more than one operational focus, so good representation is achieved. In the following section more detailed demographics are presented.

Sector	Primary area of operation	*Quantity*
Power	Traditional Generation	10
	Renewable Generation	8
	TSO (associations included)	15
	DSO (associations included)	21
	Energy Services/Supplier	17
	Storage	5
	Associations	6
	Other (Research, Technology Providers etc)	18
Oil & Gas	Production	4
	Distribution (Retailer)	6
	TSO	3
	DSO	2
	Other (associations, innovation)	4
Heating & Cooling	Generation	3
Digital/Data	Digital/Data/Communication applications	10

Table 8 List of stakeholders contacted by sector and type of operation

Analysis methodology

For the analysis of the results, the metrics had to be set. The first thing under analysis was demographics. The dispersity of answers had to be checked. The initial idea was to include stakeholders throughout Europe and possibly some international and thus the distribution list mentioned in the previous section was created. Also, statistics had to be extracted regarding sector of operation and the size of the organisation. Last, each interviewee's business unit and position had to be considered to have an overview of how people from different business units view the whole digitalisation concept. The intention was to identify how people holding different positions across the value chain consider the challenges they face.

The impact of digitalisation as perceived by the stakeholders will be measured. This will be achieved through analysis of answers related to added value. The impact on added value will be distinguished in different areas. Financial impact will be measured according to estimated increase in revenue resulting from the use of digital technologies and also reduced costs resulting from the same cause. Another important addition from digitalisation can be seen in the business area. Brand building through digital technologies (digital marketing, digital branding, website, etc.) is a key aspect in business development. In addition, the use of new (digital) tools can create a point of difference from competition leading in acquiring bigger share in the market. Similar tools can also support goal/target tracking which in turn can help improve business efficiency. One more aspect of the added values produced by digitalisation is improved customer service. Adding features to existing products (e.g. remote billing for a retailer) can boost the company's profile and quality of service to its customers. Digitalisation can also assist in boosting green technologies and policy implementation. For example, using new technologies such as smart sensors, filters and measuring devices, a generation company can track its actual carbon footprint and proceed to measures of adjusting to green goals. So, by assessing this kind of value engaging from digital technologies related green skills can also be tackled. Analysing responses for added values and corelating them with relevant challenges will provide insights on the importance of improving the integration of digital technologies within organisations.

As described in previous sections, the survey tackles different digital technologies and tools used by organisations across the world. Analysing the importance and the frequency different organisations use them we're able to address which tools and technologies are prominent and will play key role in the emerging digital era.

An important metric is the relation between countries and challenges. This can prove to be useful in terms of policy-based challenges or even issues arising from different educational approaches which can be further investigated in the activities of other Working Packages of the project.

Analysis will be performed for the different sub-sectors of the energy system. It was attempted to identify the differences and similarities the sub sectors face. Considering digitalisation, it will be investigated whether challenges across sectors are similar, or considerable differences may arise. Nevertheless, especially bigger organisations, are expected to participate in more than one energy sub-sector and their answers should consider the whole operation, but for smaller or more specific-oriented organisations we can extract this kind of information. The analysis methodology aims to investigate separately the following sectors :

- Power
- Oil & Gas
- Heating & Cooling
- Digital/Data
- Other (input from participants will be considered separately)

Also, the analysis will focus on challenges for different actors across the value chain. In that, various statistics will be exported separately for:

- Generation (Traditional, renewable)
- Network operators (DSOs, TSOs, etc.)
- Retailers
- Service providers (consultants, aggregators etc.)
- Other (input from participants will be considered separately)

2.7.3. Survey results

The survey was answered by a total of 57 out of 132 organisations contacted, representing all the different subsectors of the energy system and there was a geographical representation from all over Europe. The key findings of the survey are mentioned below:

- The **lack of adequate skills of employees** is pointed out by most of the participants as an important matter to tackle. This finding clearly substantiates the need for the EDDIE project actions.
- **Reduced costs** is seen as the most impactful added value from digitalisation.
- **Simplification of management** and **the improvement of Quality of Services (QoS)** have also significant positive impact.
- Digitalisation is regarded as a key factor for **enabling new and green technologies.**
- Most of the companies provide training to their employees with a preference to in-house training, which can be utilized for the digital and green transition.
- Digitalisation is increasingly adopted in the energy sector as the majority of organisations use digital tools and technologies daily.
- Challenges are not particularly differentiated among energy system sectors, since all sectors face similar challenges regarding digitalisation, as shown by the answers in the survey.
- **Business model adaptation** and **costs** are major issues from economic and organisational point of view
- **Acceptance of new technologies** and **privacy concerns** are the main social challenges.
- **Technology integration** and **data management** are important technical challenges.
- Several challenges do not have the same importance for companies from different countries. National policies and educational approaches play a role in this and will be further investigated during EDDIE's WP4 ("Assessment of policies and requirements for VET and beyond").
- The recent COVID-19 crisis underlined the importance of digitalisation in the energy system.

Demographics

Figure 8 and Table 9 show the geographical dispersion of answers received for the survey. Two different questions were asked regarding geographical location. The first was where is the organisation's headquarters and the second the country the interviewee is working from. This way we are able to distinguish location-based challenges.

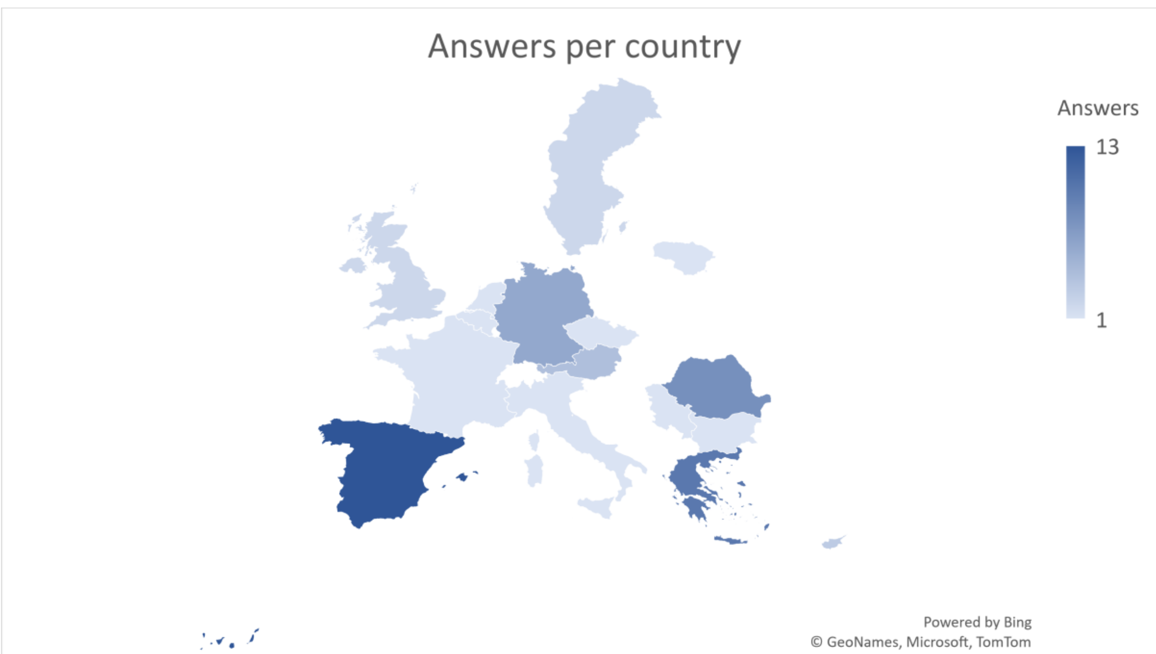

Figure 8 Survey answers per country

Country	Organisation's headquarters	*Participant's country of employment*
Spain	**13**	**12**

Greece	10	10
Romania	8	11
Germany	6	5
Austria	4	4
Cyprus	3	3
Sweden	2	2
United Kingdom	2	3
Belgium	1	1
Bulgaria	1	1
Czech Republic	1	0
France	1	0
Lithuania	1	1
Netherlands	1	1
Italy	1	1
Serbia	1	1

Table 9 Answers allocation per country

As shown in Figure 9 and Figure 10 , almost half of the answers came from large companies with over 1000 employees who, due to their size, can have a broad and clear view on challenges and the impact of digitalisation. Nevertheless, the whole spectrum of organisations in regard to their size is covered in order to make the results more concrete.

How can your organization be best described?

		Answers	Ratio
Public body		7	12.50 %
Non-profit		2	3.57 %
International organization		4	7.14 %
Small Medium Enterprise (SME)		9	16.07 %
Association		4	7.14 %
Large company		28	50.00 %
Legal person/Self-employed		1	1.79 %
Other		1	1.79 %
No Answer		0	0.00 %

Figure 9 Type of organisation

How many people does your organisation occupy (estimation)?

	Answers	Ratio
Less than 50	11	19.64 %
50-100	4	7.14 %
100-500	9	16.07 %
500-1000	5	8.93 %
More than 1000	27	48.21 %
No Answer	0	0.00 %

Figure 10 Size of organisations (employees)

According to the categorisation proposed by ETIP SNET Vision 2050 that was mentioned in section "Energy systems", analysis is performed for each energy sub-sector so that comparisons can be made. Moreover, information was collected regarding the type of company's operation in order to extract insights for different types, such as Generation operators (traditional and renewable), Network operators (TSOs, DSOs, etc), Retailers, Service providers and manufactures.

Figure 11 shows the answers from each different sector. It must be noted that several companies operate in more than one sectors, so the total answers exceed the sample. The majority of the stakeholders that took park in the survey operate in the electrical power sector, yet all the sectors are well represented by significant organisations. Also, some indicated that they operate in sectors such as Health, Transport, Desalination.

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

	Answers	Ratio
Oil&Gas	11	19.64 %
Heating and Cooling	7	12.50 %
Power	48	85.71 %
Digital/Data	19	33.93 %
Other	6	10.71 %
No Answer	0	0.00 %

Figure 11 Answers by sector

Figure 12 shows the type of operation for each company. The answers here are better distributed across all types, with Network operators being the most represented with 24 answers. Six (6) of the "Other" answers indicated that they are **research and development institutes** while one (1) is an **ICT solutions vendor/integrator/provider**.

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

		Answers	Ratio
Generation		12	21.43 %
Network (DSO, TSO etc)		24	42.86 %
Retailer		8	14.29 %
Service provider (Consultant, aggregator etc)		18	32.14 %
Manufacturer		6	10.71 %
Other		7	12.50 %
No Answer		0	0.00 %

Figure 12 Answers by type of operation

Education and training

Through Figure 13 to Figure 17 the different training methods provided by organisations were addressed. The idea was to measure how companies train their staff to tackle challenges and adapt to new technologies. The different types of training measures were distinguished between "Specialization" and "General knowledge training". In the specialization case, the effort was to address the type of training that refers to specific knowledge that is offered to employees to train them in particular subjects/tasks. General knowledge training refers to the training that is offered to the entirety or most of the work force to further develop their skills. The main points from this analysis were:

- Most of the companies prefer/provide in-house training to their employees both for general knowledge and specialization
- Workshops and distance learning are also a preferred solution for both types of training.
- Postgraduate studies and summer/winter schools are less preferred by companies.

Does your organization support training measures? If yes, which is/are the type(s) of training preferred in your organization? (You can choose more than one if applicable) : In-house training

		Answers	Ratio
General knowledge training		35	62.50 %
Specialization		42	75.00 %
No Answer		8	14.29 %

Figure 13 In-house training

Does your organization support training measures? If yes, which is/are the type(s) of training preferred in your organization? (You can choose more than one if applicable) : Workshops

		Answers	Ratio
General knowledge training		30	53.57 %
Specialization		39	69.64 %
No Answer		11	19.64 %

Figure 14 Workshops

Does your organization support training measures? If yes, which is/are the type(s) of training preferred in your organization? (You can choose more than one if applicable) : Postgraduate studies

		Answers	Ratio
General knowledge training		12	21.43 %
Specialization		18	32.14 %
No Answer		35	62.50 %

Figure 15 Postgraduate studies

Does your organization support training measures? If yes, which is/are the type(s) of training preferred in your organization? (You can choose more than one if applicable) : Distance learning (Online training)

		Answers	Ratio
General knowledge training		33	58.93 %
Specialization		26	46.43 %
No Answer		16	28.57 %

Figure 16 Distance learning

Does your organization support training measures? If yes, which is/are the type(s) of training preferred in your organization? (You can choose more than one if applicable) : Summer/Winter schools

		Answers	Ratio
General knowledge training		6	10.71 %
Specialization		3	5.36 %
No Answer		50	89.29 %

Figure 17 Summer/Winter schools

Impact from digitalisation

Figure 18 displays the added value that is produced from the transition to digital technologies and tools. The interviewees were asked to indicate which of the mentioned added values their organisation enjoys.

- 76.79% of participants indicated that digitalisation leads to **reduced costs**
- 69.29% said that **management is simplified** using digital tools
- 62.50% believe that **the quality of services (QoS) is improved**
- 57.14% claim that digitalisation **enables new/green technologies**

It was also indicated by a participant that ***Business processes automation*** is an added value that is produced by digitalisation.

Please indicate which of the following added values are produced by digitalization at your organization? (You can choose multiple)

		Answers	Ratio
Financial - Increase in revenue		21	37.50 %
Financial - Reduced costs		43	76.79 %
Business - Enhance brand name		24	42.86 %
Business - Create a point of difference from competition		22	39.29 %
Business - Goals/targets tracking		32	57.14 %
Customer service - Add features to existing products		24	42.86 %
Customer service - Offering convenience		21	37.50 %
Customer service - Improve Quality of Services (QoS)		35	62.50 %
Management/Administration - Simplify management.		36	64.29 %
Technical - Enabling new/green technologies		32	57.14 %
Technical - Crisis management		23	41.07 %
Other		2	3.57 %
No Answer		3	5.36 %

Figure 18 Added value from digitalisation

Tools and technologies

Analysing answers for the frequency stakeholders use different digital technologies and tools the following key points were noted:

- Cybersecurity, Digital Platforms, Cloud services, Communication technologies and Energy Management systems were the technologies used more frequently by the addressed companies (daily use).
- Artificial Intelligence, Internet of Things, Big Data/Data Analytics and Digital Asset Management were used mostly in monthly or weekly basis
- Blockchain, virtual product development were the least used technologies

Table 10 List of technologies

Technology	*Daily*	*Weekly*	*Monthly*	*Never*
Digital Platforms	73,21%	16,07%	1,79%	8,93%
Cloud services	71,43%	7,14%	7,14%	14,29%
Communication technologies	66,07%	8,93%	5,36%	19,64%
Cybersecurity	58,93%	12,50%	7,14%	21,43%
Energy management systems	57,14%	1,79%	16,07%	25,00%
Big Data/Data Analytics	33,93%	21,43%	26,79%	17,86%
Digital asset management	30,36%	10,71%	14,29%	44,64%
Internet of Things(IoT)	30,36%	17,86%	12,50%	39,29%
Virtual product development and testing	17,86%	3,57%	19,64%	58,93%
Artificial Intelligence	16,07%	8,93%	32,14%	42,86%
Blockchain	7,14%	1,79%	8,93%	82,14%
Other answers provided by participants:				
Virtual/augmented reality				
Digital twins				
Advanced FW/HW development				
Information Security Management System (ISMS)				
Robotic Process Automation (RPA)				

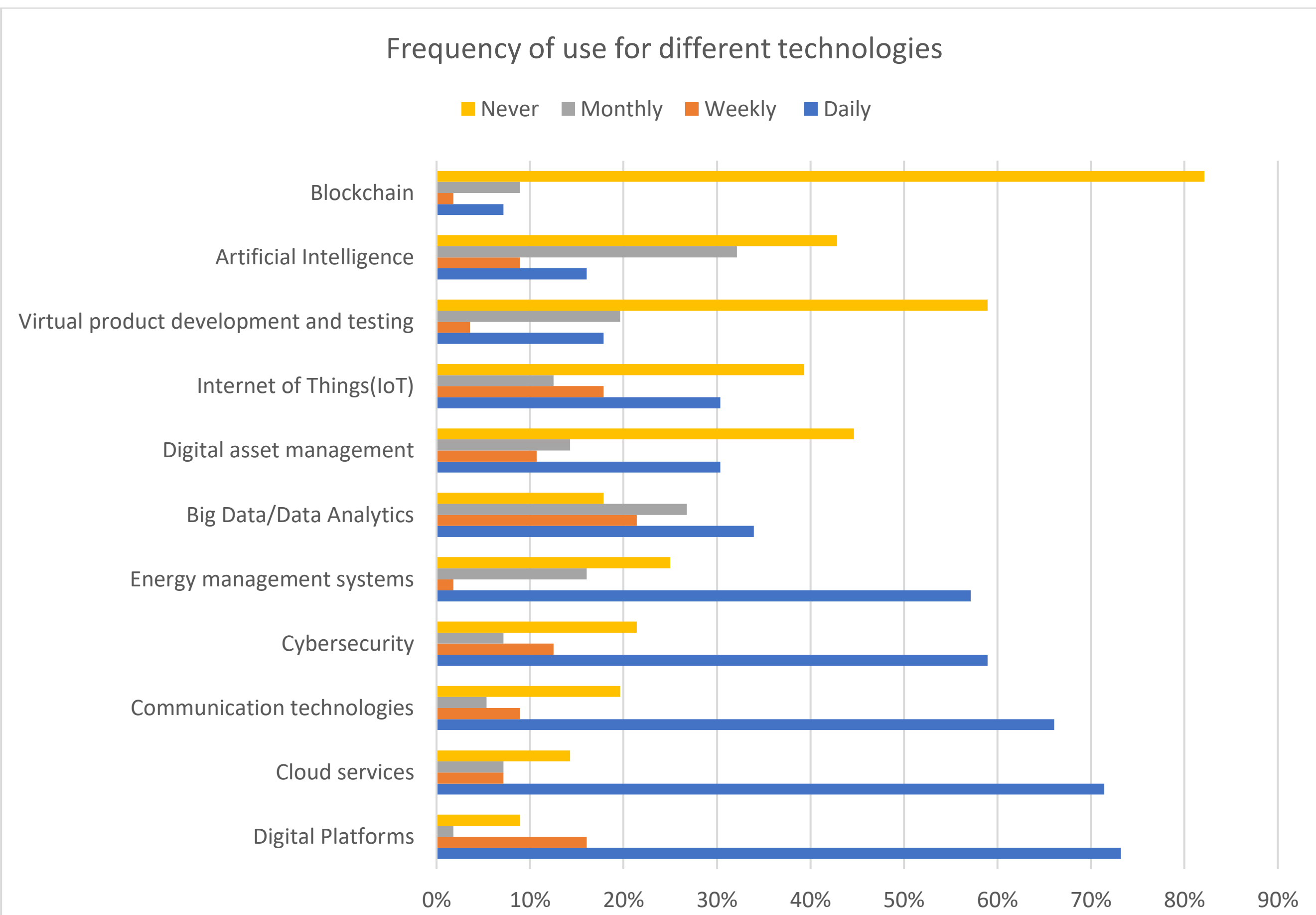

Figure 19 Frequency of use for different technologies

As far as digital tools go, the main points were the following:

- Cloud servers, SCADA/HMI Systems, Smart meters, Online collaboration platforms and social media are used in daily basis by a significant percentage of the participants
- Customers services, Geographic Information Systems, Intelligent maintenance systems, Distribution Management Systems, Peer to peer exchange tools are being used on a regular basis (weekly/monthly).
- Drones, Robotics/Advances manufacturing are less common amongst the participants.

Table 11 List of tools

Tool	*Daily*	*Weekly*	*Monthly*	*Never*
OnLine collaboration platforms	69,64%	5,36%	3,57%	21,43%
Cloud servers	67,86%	12,50%	7,14%	12,50%
SCADA/HMI systems	55,36%	14,29%	10,71%	19,64%
Smart meters	55,36%	1,79%	12,50%	30,36%
Social media	53,57%	21,43%	10,71%	14,29%
Smart sensors	46,43%	8,93%	17,86%	26,79%
Customer services	44,64%	8,93%	8,93%	37,50%
Peer to peer exchange tools	33,93%	7,14%	10,71%	48,21%
Geographic Information Systems (GIS)	33,93%	17,86%	14,29%	33,93%
Intelligent maintenance systems	28,57%	5,36%	21,43%	44,64%
Distribution Management Systems (DMS)	26,79%	8,93%	10,71%	53,57%
Drones	5,36%	7,14%	23,21%	64,29%
Robotics/advanced manufacturing	5,36%	1,79%	12,50%	80,36%
Other answers provided by participants:				
BI Reporting tools				
Automated developement environment				
IEC-ISO fulltext search				
Intelligent electronic devices (IEDs)				
Substation automation systems (SAS)				
CIS Benchmarks				
Energy Trading Management Systems (ETMS)				
Enterprise Resource Planning (ERP)				
Modelling and simulation tools				

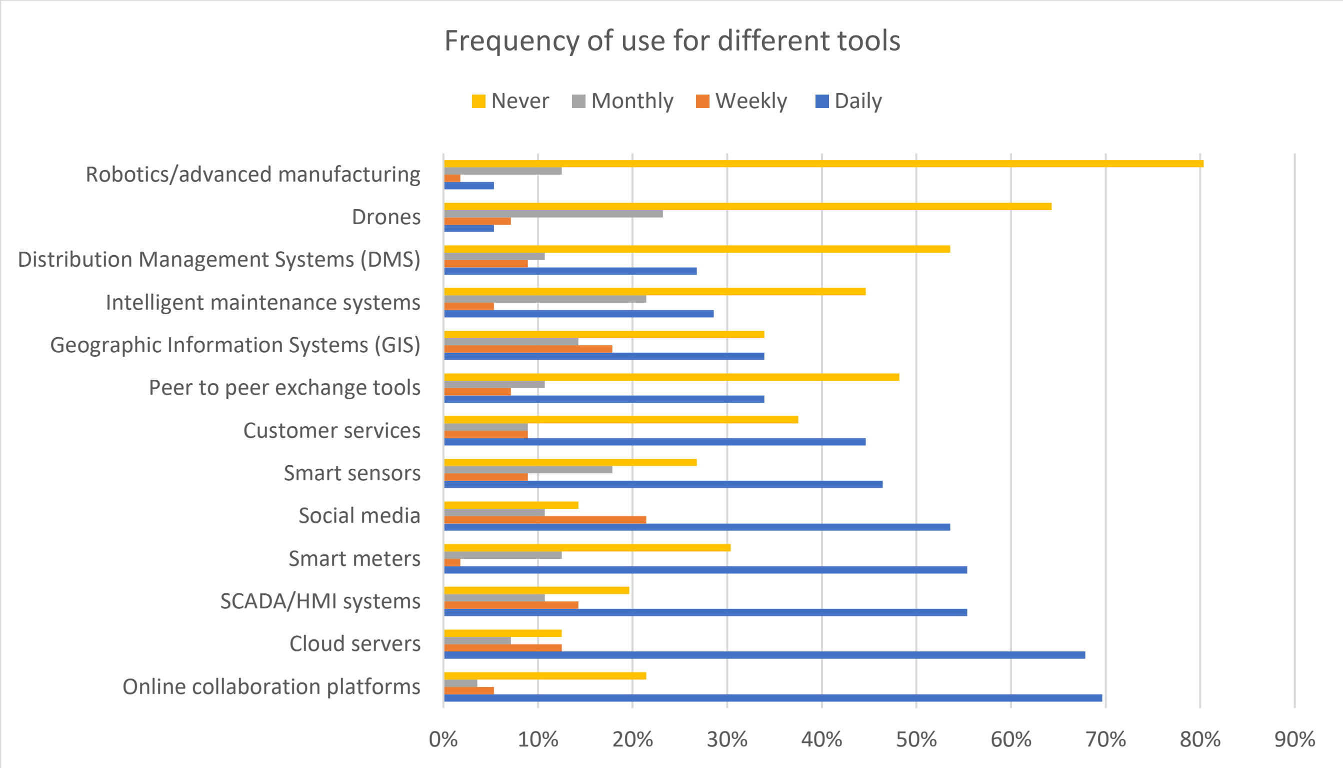

Figure 20 Frequency of use for different tools

Challenges by sector

Economic and organisational challenges

Table 12 and Figure 21 portray the economic and organisational challenges for the different sub sectors of the energy system. From these figures it can be easily observed that the **adaptation of certain business models** that will enable the digital transformation is a significant challenge for organisations. Moreover**, high economic costs** and **lack of funding** play also a role in this transition. Last, the **low top-management commitment** is not a great challenge for most of the participants. While the number of answers for the different subsectors vary, it is noticed that they metrics are quite similar which means that, concerning digitalisation, the economic and organisational challenges are similar regardless the specific sub-sector.

Table 12 Economic & Organisational challenges

Economic & Organisational Challenges	*Power sector*	*Oil & Gas*	*Heating & Cooling*	*Digital/Data*
High economic costs	29,63%	27,27%	14,29%	5,26%
Business model adaptation	64,81%	63,64%	71,43%	52,63%
Funding	33,33%	27,27%	14,29%	31,58%
Low top-management commitment	24,07%	18,18%	28,57%	10,53%
Other	7,41%	18,18%	0,00%	15,79%
No answer	5,56%	0,00%	0,00%	10,53%

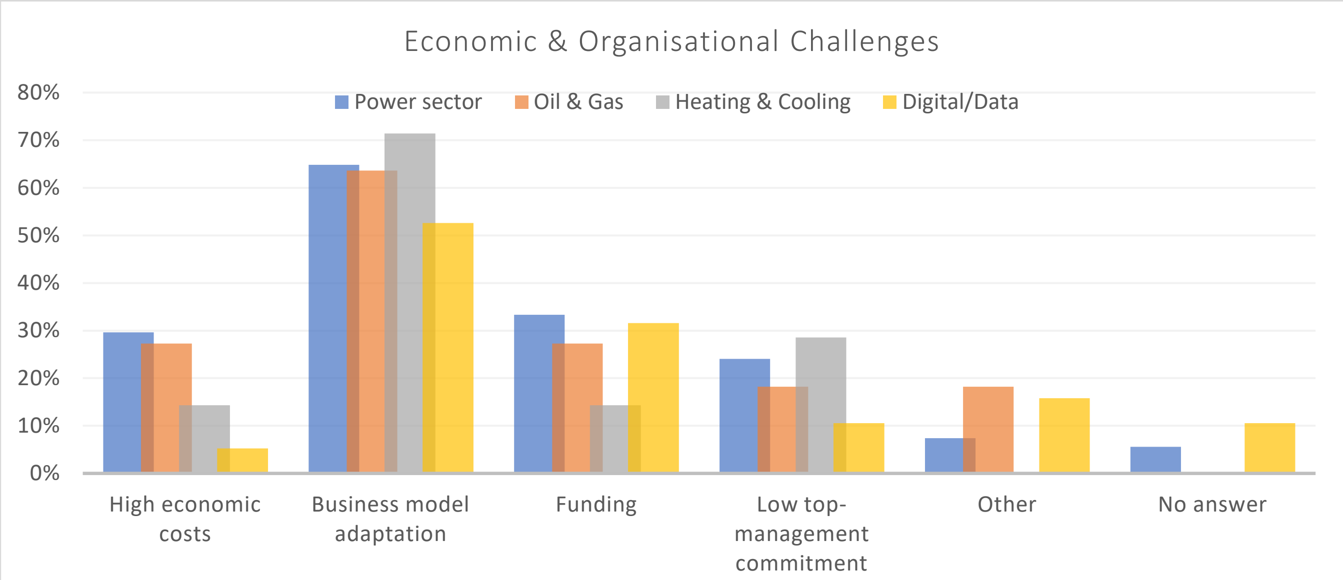

Figure 21 Economic & Organisational Challenges

Social Challenges

Table 13 Figure 22 show the participants' answers for the social challenges they face regarding digitalisation. Like economic and organisational challenges, the different sub-sectors responses were very similar. **Privacy concerns** and the **acceptance of new technologies** are the main social challenges **while lack of citizen engagement** is less significant especially for Heating & Cooling and Digital/Data subsectors. Also, Table 13 shows additional answers provided by the participants which stress the **generation gap in terms of digital fluency**. Digital fluency is the ability to select the right (digital) tools and technologies to achieve your objective.

Table 13 Social Challenges

Social challenges	*Power sector*	*Oil & Gas*	*Heating & Cooling*	*Digital/Data*
Privacy concerns	53,70%	63,64%	71,43%	31,58%
Loss of jobs due to automatic processes	11,11%	9,09%	0,00%	15,79%
Acceptance of new technologies	64,81%	54,55%	57,14%	57,89%
Lack of citizen engagement	25,93%	27,27%	14,29%	10,53%
Other	11,11%	18,18%	14,29%	15,79%
No answer	9,26%	9,09%	0,00%	15,79%
Other answers provided by participants				
Digital fluency (Generation gap)				
Screening/vetting requirements				

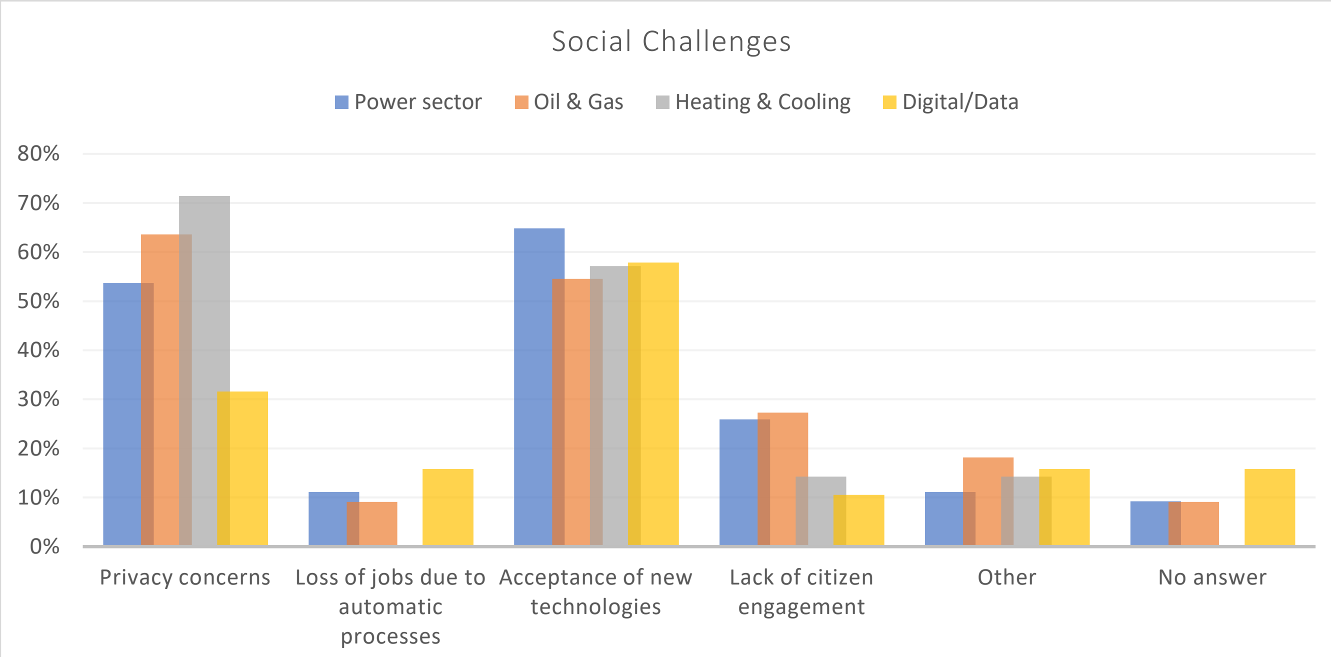

Figure 22 Social Challenges

Technical and Regulatory challenges

Technical and Regulatory challenges have a great impact on the digitalisation of the energy system since it requires the development, integration and use of various digital technologies and tools. Table 14 and Figure 23 present the results of the survey regarding technical and regulatory challenges. The key points to notice are the following:

- **Technology integration** and **IT security** issues are the main technical challenges organisations are facing in all the sub-sectors.
- **Lack of adequate skills from employees** is a very warning challenge and a useful insight for the EDDIE project since the blueprint will attempt to mitigate those skill gaps.
- **Data management** and **Data protection** are also significant challenges for the digital transition.
- **Lack of regulation** or **Unclear legal issues** are challenges that do not affect the entirety of stakeholders yet, they need to be addressed.

Table 14 Technical & Regulatory Challenges

Technical & Regulatory challenges	*Power*	*Oil & Gas*	*Heating & Cooling*	*Digital/Data*
IT security issues	75,93%	63,64%	71,43%	68,42%
Reliability and stability needed for machine to machine communication	42,59%	18,18%	28,57%	21,05%
Need to protect industrial know-how	35,19%	27,27%	42,86%	36,84%
Lack of adequate skills from employees	59,26%	36,36%	57,14%	52,63%
Data management	61,11%	81,82%	71,43%	36,84%
Data protection issues	46,30%	45,45%	28,57%	47,37%
Technology integration (compatibility with existing processes/technologies)	77,78%	72,73%	100,00%	68,42%

Lack of regulation, standards, and forms of certification	29,63%	18,18%	42,86%	36,84%
Unclear legal issues	20,37%	36,36%	28,57%	10,53%
Other	3,70%	9,09%	0,00%	5,26%
No answer	3,70%	0,00%	0,00%	0,00%

Other answers provided by participants
Reduction of expected product life-cycle (IT containing equipment manufactured for a 25 year life cycle mindset is an oxymoron)

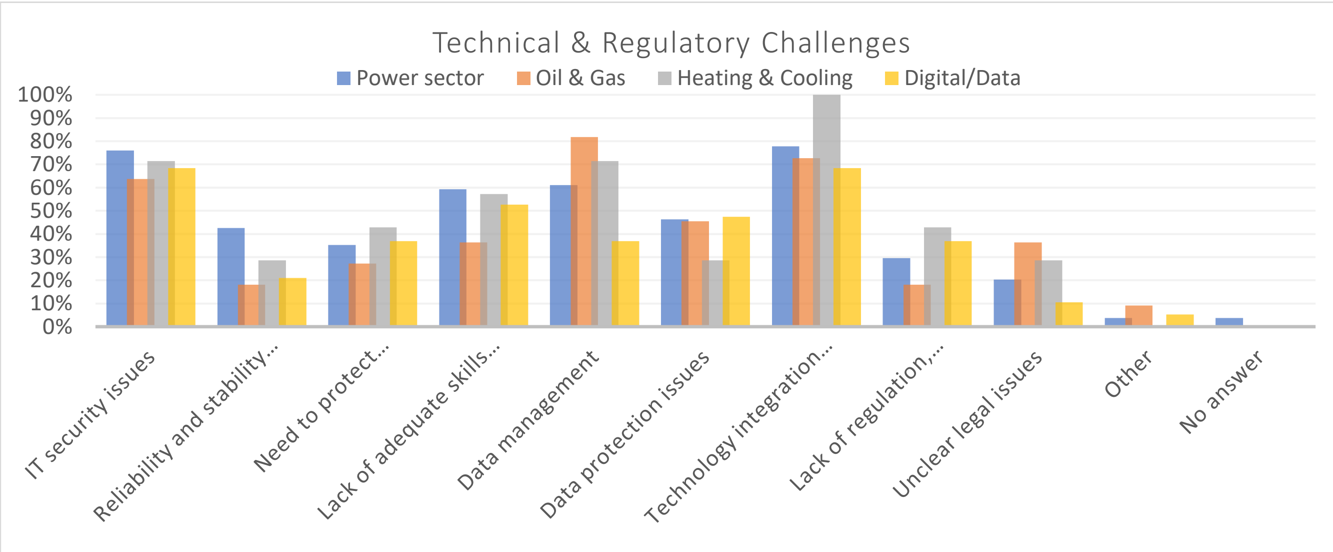

Figure 23 Technical & Regulatory Challenges

Energy related challenges

Apart from the higher-level technical challenges, the survey included specific challenges that are related to the energy system. They were addressed as a separate section since they are very specific on technical issues that are tackled by stakeholders on a regular basis. This is confirmed by the percentage of answers for each challenge which is significantly lower than the previous types of challenges. The key points are mentioned below:

- **Predictive maintenance** is emerging as a challenging issue for stakeholders especially in Power and Heating & Cooling sub-sectors
- **Digital tools for network planning** are necessary for the majority of stakeholders
- **Remote service to customers** is rather important for organisations in the energy system
- **Data for longer term forecasting** is needed in the industry

Table 15 Energy related challenges

Energy related challenges	*Power sector*	*Oil & Gas*	*Heating & Cooling*	*Digital/Data*
Customers - Remote service to customers	38,89%	45,45%	57,14%	26,32%
Customers - Dedicated information about their energy policies	48,15%	18,18%	42,86%	21,05%
Customers - Remote fault announcement	38,89%	18,18%	28,57%	5,26%
Customers - Remote metering	42,59%	27,27%	42,86%	26,32%
Customers - Remote fault repairs	29,63%	27,27%	42,86%	5,26%
Network Planning - Digital tools for network planning	20,37%	27,27%	57,14%	36,84%
Network Planning - Geographical Information Systems	42,59%	27,27%	57,14%	10,53%
Network Planning - Data for longer term load forecasting	33,33%	36,36%	57,14%	15,79%
Network Planning - Load profiles	33,33%	18,18%	28,57%	10,53%

Energy related challenges	*Power sector*	*Oil & Gas*	*Heating & Cooling*	*Digital/Data*
Network operation - Automation of fault clearance	18,52%	18,18%	42,86%	15,79%
Network operation - Remote switching	38,89%	27,27%	57,14%	31,58%
Network operation - Automatic fault indicators	31,48%	18,18%	28,57%	21,05%
Network operation - Crew management	25,93%	9,09%	28,57%	15,79%
Network operation - on-line security assessment	35,19%	18,18%	28,57%	10,53%
Network operation - Short-term load forecasting	27,78%	18,18%	42,86%	15,79%
Maintenance and asset management - Predictive maintenance	24,07%	36,36%	57,14%	26,32%
Maintenance and asset management - Asset management	22,22%	27,27%	42,86%	26,32%
Other	18,52%	9,09%	0,00%	10,53%
No answer	3,70%	27,27%	14,29%	36,84%

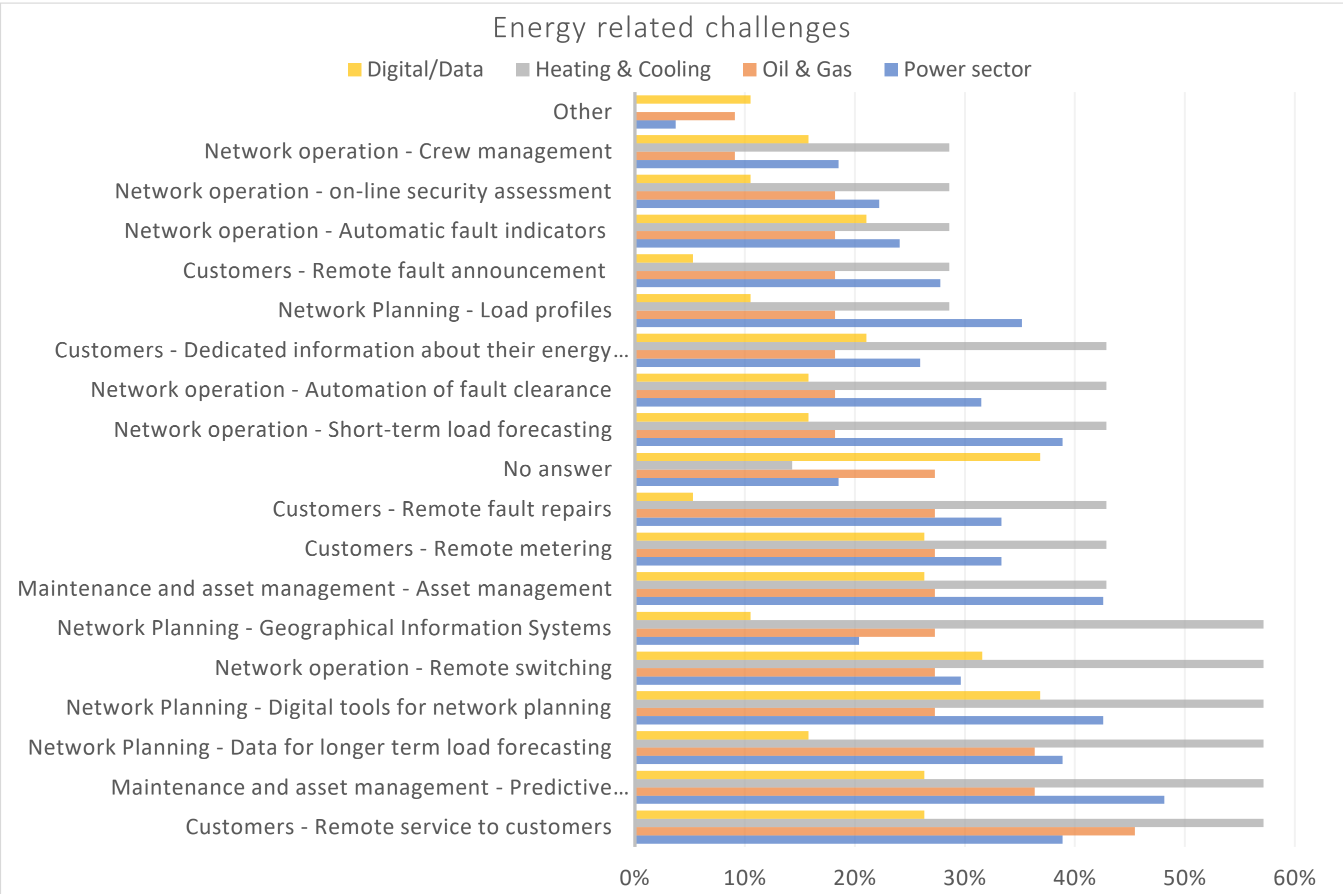

Figure 24 Energy related challenges

Challenges by type of operation

Different stakeholders across the energy system value-chain can face different challenges, or the same but with different significance. The following analysis attempts to provide some insights on how different type of operators (generation, network, retail, services, manufacturers, etc.) advance in the scope of digitalisation.

Economic and organisational challenges

- **Business model adaptation** is the challenge most of participants indicated, apart from manufacturers that indicated **high economic costs** as their main challenge.
- Service providers seems unaffected by **high economic costs** and **low top-management commitment**.

- Others, which are mainly research and development facilities, lack adequate **funding**.

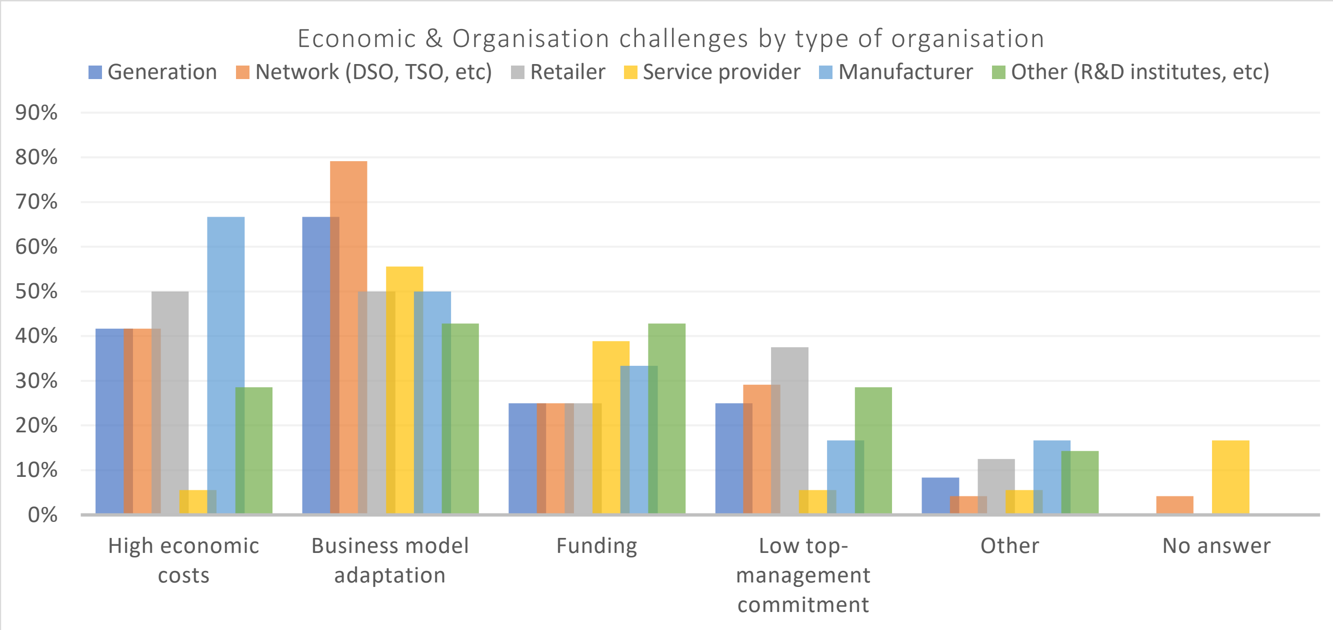

Figure 25 Economic and organisational challenges by type of organisation

Social Challenges

- Social challenges show a normal distribution of answers for most type of organisations.
- Manufacturers face the challenge of **loss of jobs due to automatic processes**, which is an expected outcome since the manufacturing industry is deeply revolutionised by industry 4.0 [38] and digitalisation (additive manufacturing or 3d printing, CNCs, etc.)

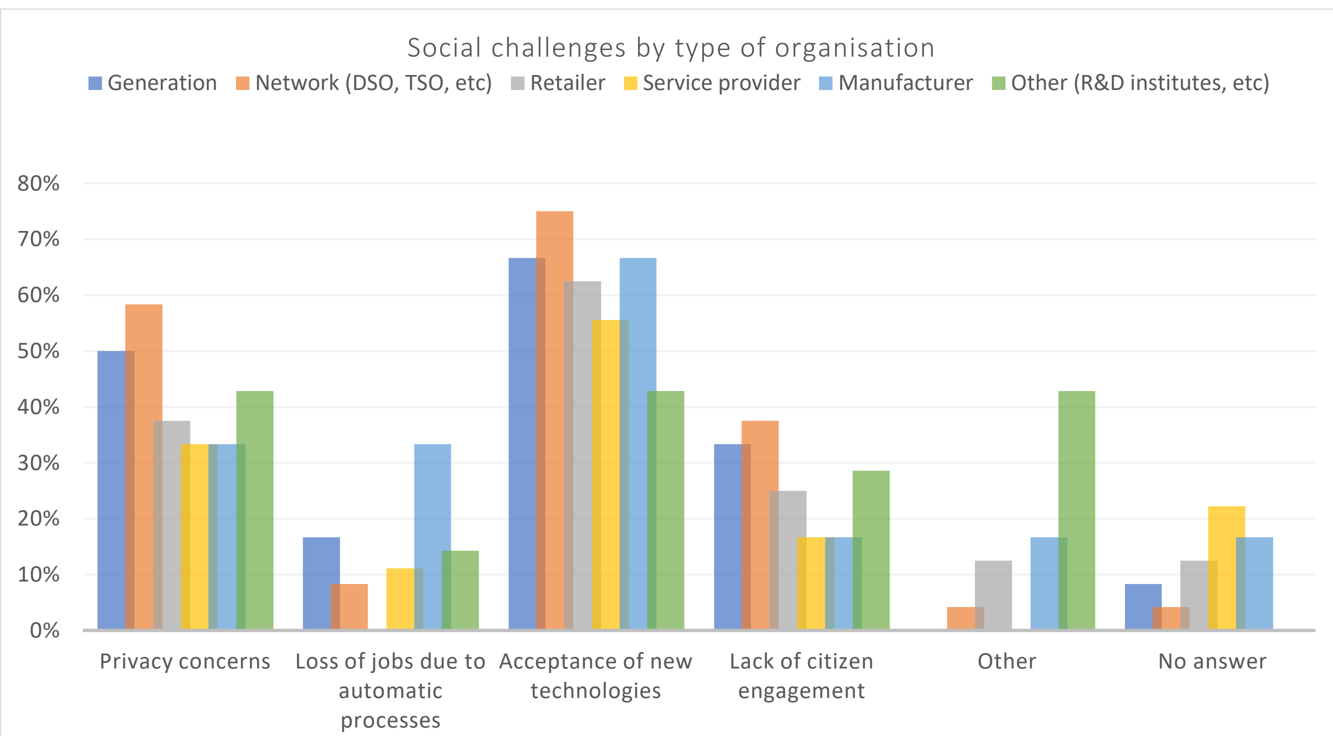

Figure 26 Social challenges by type of organisation

Technical and Regulatory challenges

- **Technology integration** and **lack of adequate skills from employees** are the major challenges for Research and Development institutes as well as Network operators.
- **IT security issues** are prominent in most of the organisations
- Lack of adequate skills is low for retailers and generation in contrast with the other areas of operation.
- **Data management and protection** are significant challenges for most organisations
- **Technology integration** is the issue that most of the survey's participants face.

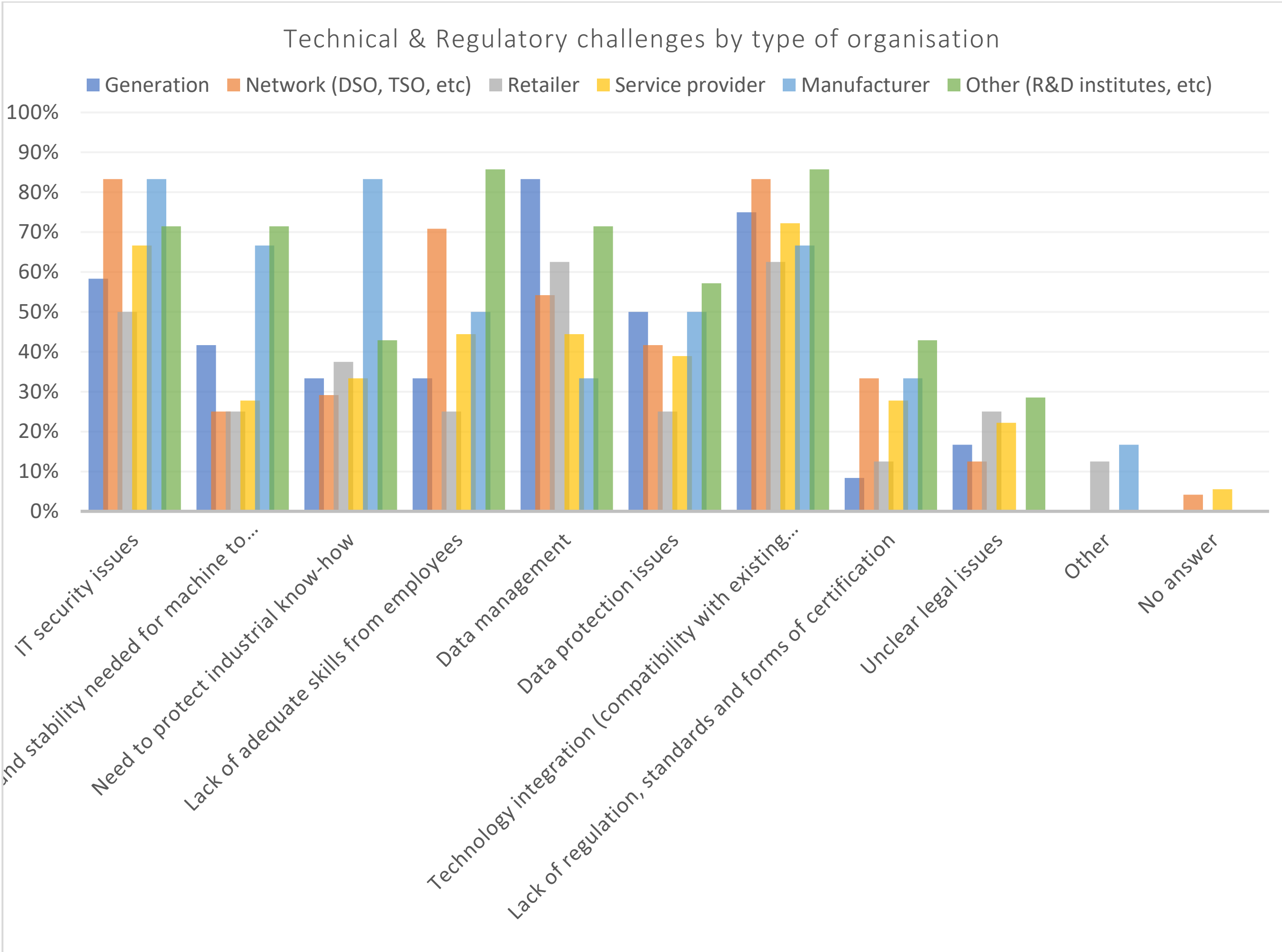

Figure 27 Technical and regulatory challenges by type of organisation

Energy related challenges

The finding for specific energy related challenges are presented in Figure 28. Some key notes are presented in the list below:

- As expected, network operators indicated the challenges that relate to network operation and planning as major challenges
- Also, network operators pointed also the importance of the services they offer to customers as important challenges

- Retailers face the challenge that relate to customer services, especially the dedicated information about energy policies and remote services
- Asset management and predictive maintenance are also important issues that need to be tackled

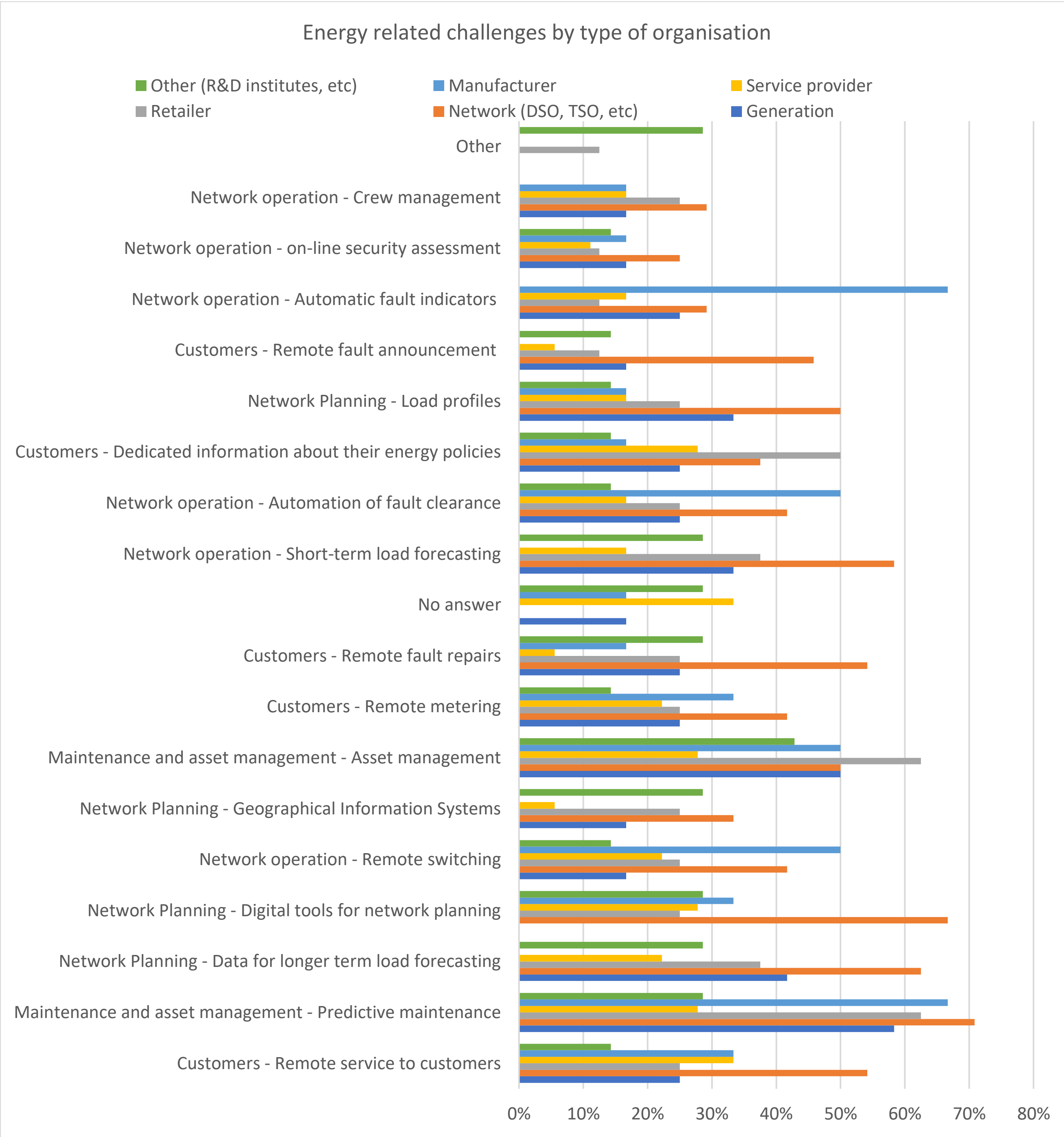

Figure 28 Energy related challenges by type of organisation

Challenges by country

To identify the different challenges presented in the previous sections by country, the following analysis was conducted. Only countries with several representations in the survey were selected in order to have valid results. The countries addressed below are Spain, Greece, Romania, Germany and Austria.

The aim of this analysis is to compare the different countries in terms of challenges. Along with work that will be conducted in WP4 "Assessment of policies and requirements for VET and beyond" the correlation between challenges, policies and educational approaches will by investigated in order for the blueprint to be able to mitigate the challenges. Also, best-practices can be identified and used when designing the blueprint in WP5.

Economic and organisational challenges

Figure 29 presents the economic and organisational challenges by country.

- **Business model adaptation** is the most significant challenge for Spain, Greece, Romania and Austria, while responses from Germany indicate that this is not a major challenge for them
- **Funding** issues are most prominent in Romania. Nevertheless, it is a present challenge in a significant percentage of participants from the other countries.
- **High economic costs** are regarded as a challenge by almost 40% of the participants from Spain and Germany, while Greece and Romania have lower percentages.

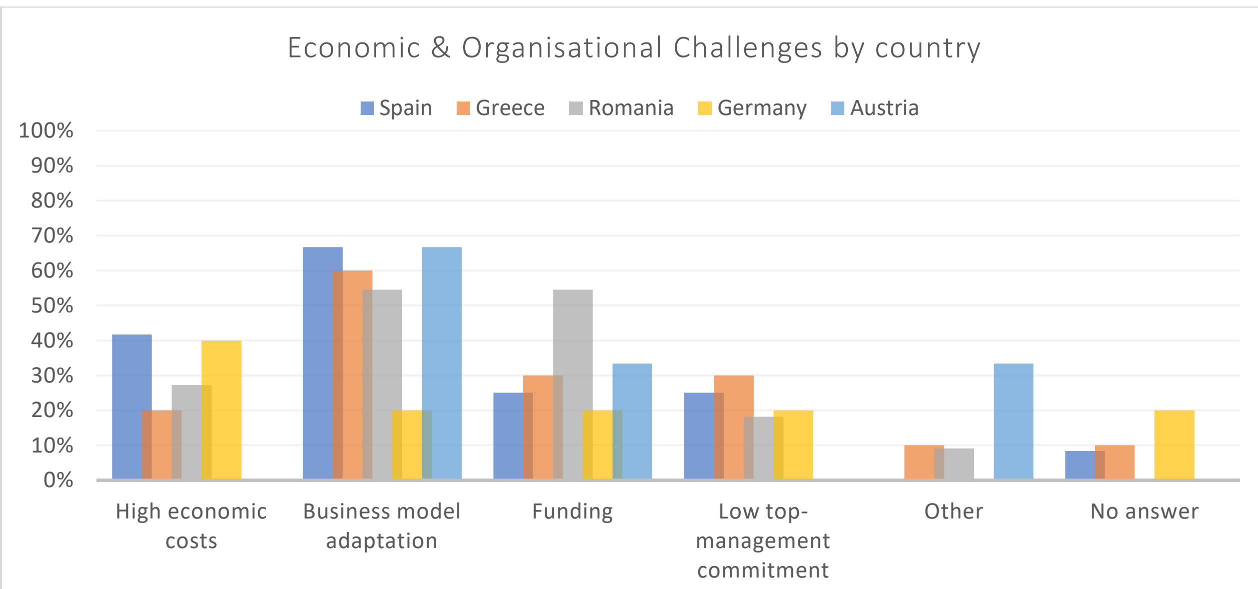

Figure 29 Economic and organisational challenges by country

Social Challenges

Regarding the social challenges by country the results are summarized in the following points:

- **Acceptance of new technologies** is the most significant challenge in this area with most participants from Spain, Germany and Austria indicating it as a challenge in their answer.
- About 80% of participants from Germany indicated **Privacy concerns** as a challenge (same percentage with the acceptance of new technologies). The rest of the countries have low percentages in this challenge
- **Lack of citizen engagement** is an emerging issue for respondent from Romania while Austria and Spain do not seem to face this issue as much.

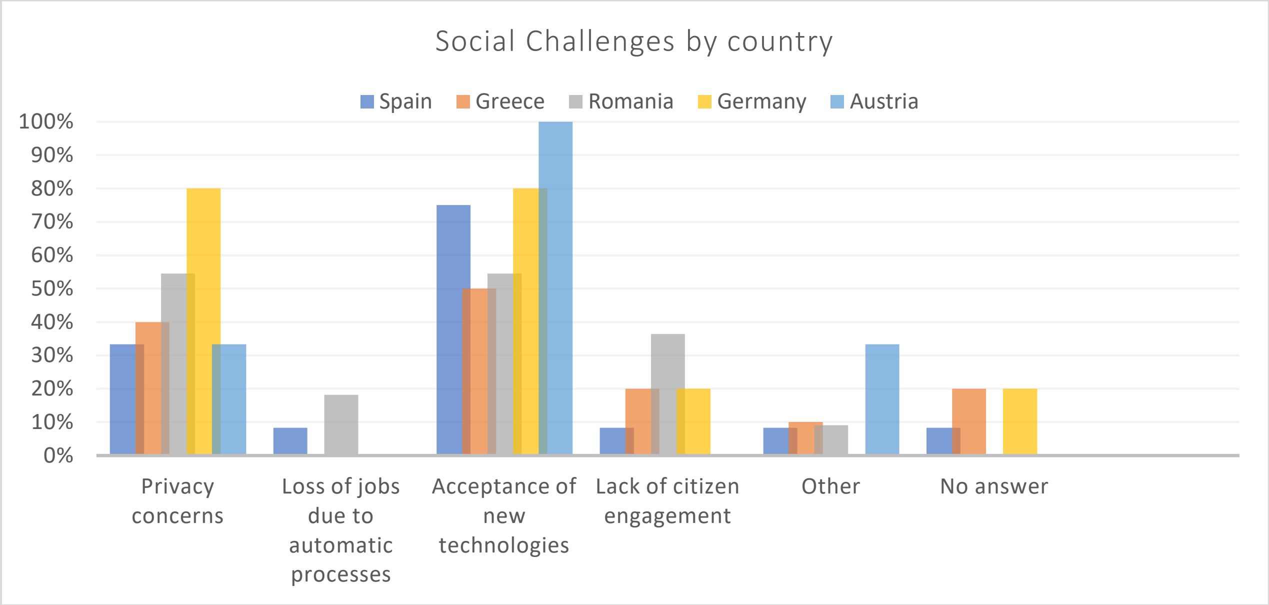

Figure 30 Social challenges by country

Technical and Regulatory challenges

- Germany's most responses considered **Lack of adequate skills, technology integration, data management and IT security issues** the main technical challenges.
- Spain, Romania and Austria consider **IT security** to be a main challenge for them, while the percentage for Greece is lower.
- Spanish companies regard the need to **protect their industrial know-how** also a challenge.
- **Reliability and stability required for machine to machine communication** is a major issue for most of the Greek participants.
- Overall, the **lack of adequate skills from employees** is present in all countries with Greeks and Austrians having lower percentages in their answers

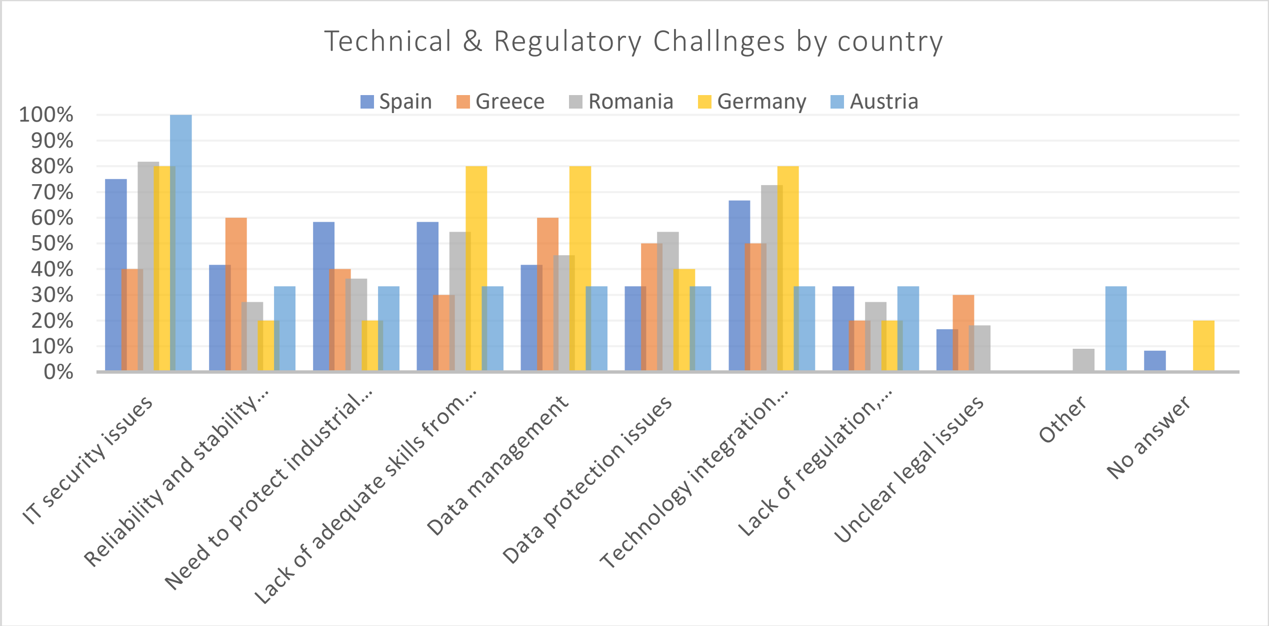

Figure 31 Technical and regulatory challenges by country

Energy related challenges

The more specific energy related challenges by country can be summarised in Figure 32.

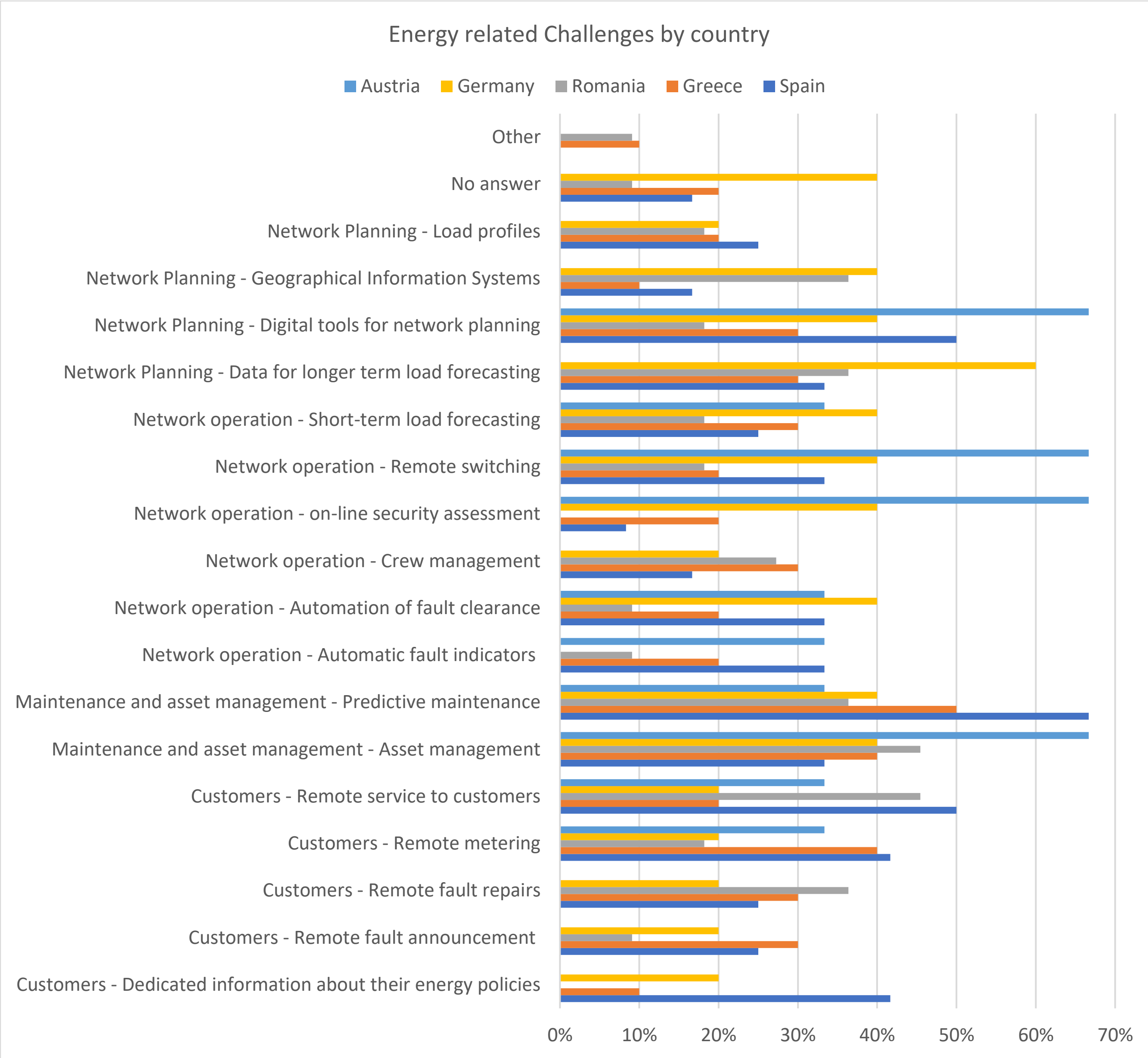

Figure 32 Energy related challenges by country

Challenges related to extreme conditions

Due to the recent COVID19-Crisis, flexible and ad-hoc reactions to immediate challenges were needed, which can influence the way we work and communicate. This applies to similar extreme conditions that may arise from extreme weather conditions or other crises. The importance of having protocols and strategies ready to be implemented is critical as the recent experience proved. The following figures present how the survey's participants responded to the recent crisis and whether they had and implemented a strategy or not.

It appears that most of the participants (73.68%) had a crisis operation strategy and the majority of them claim that the implementation was rather good. Moreover, most companies were ready for teleworking, especially the departments that do not necessarily need physical appearance to perform their tasks. The transition to teleworking seems to have been quite smooth for a significant amount of organisations.

Did your company have a Crisis Operations strategy (pandemic, extreme weather etc)?

	Answers	Ratio
Yes	42	73.68 %
No	12	21.05 %
Not sure	3	5.26 %
No Answer	0	0.00 %

Figure 33 Crisis operation strategy

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

	Answers	Ratio
1	18	31.58 %
2	9	15.79 %
3	5	8.77 %
4	4	7.02 %
5	5	8.77 %
No Answer	16	28.07 %

Figure 34 Crisis operation strategy implementation

Was your organisation ready for teleworking? (equipment, trained staff, software)

	Answers	Ratio
Yes	40	70.18 %
No	1	1.75 %
Partly (Some departments)	16	28.07 %
No Answer	0	0.00 %

Figure 35 Crisis operation – teleworking

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

	Answers	Ratio
1	22	38.60 %
2	15	26.32 %
3	6	10.53 %
4	4	7.02 %
5	7	12.28 %
No Answer	3	5.26 %

Figure 36 Crisis operation - teleworking implementation

Challenges and lessons learned

Participants provided their input regarding challenges other than teleworking and also lessons learned during this period. From an organisation point of view, organising work in full teleworking environment was a difficult challenge in order to maintain productivity and good time management. Also, the need to maintain good communication with clients was a rather challenging task. An important task for a good number of organisations was to define who can and cannot telework, define job duties and schedules. Also, the return back to the office was a critical task which had to ensure that the health and safety protocols were implemented and the transition back to normal handled smoothly. In terms of technical challenges, IT departments had to ensure that access to corporate tools and resources was provided to employees while maintaining security in the digital environment (cybersecurity issues). On-site activities had to be reorganised and only the essential could be performed. Economic challenges such as the oil price, travel bans and "lockdown" of several financial markets proved to be challenging issues for organisations.

The most important lesson learnt is that digitalisation is necessary for stakeholders across the whole value-chain of the energy system. As pointed out by a participant: "*Digitalisation is a priority. Keep working on a normal basis would have been impossible without digital tools and platforms. Digitalisation has been crucial and has shown it provides efficiency to processes and meetings - Travelling might be reduced in future; left to crucial meetings and a lot can be left to virtual"*. Digital technologies and tools provided the means to maintain productivity and activity during the crisis. Teleworking worked quite well for the majority of companies and it was pointed out that this a good lesson learned which will be implemented more on o regular basis for several organisations. There are new forms of work whose acceptance becomes much greater after this extreme event. The companies need to be increasingly flexible and adaptable to the transformations driven by digitalisation. Moreover, risk assessment and crisis strategies have to be revised regularly in order to be ready to adapt in extremely fast changing situations.

2.8. Conclusions

The energy system is transforming as part of the evolution to a sustainable future. The European policies, as expressed by the Clean Energy Package, foresee a more digital role of all stakeholders of the energy sector. Education/training, especially for young generations, is a key factor that will lead the energy digital and green transformation. Even though, the EU is committed through many programmes to assure a zero-carbon scenario future to all Europeans, the social awareness on how to implement this transition is rather low. In order to jointly look for the future, VISION 2050, as defined by ETIP SNET, has been used as a common framework of understanding. This VISION describes how the energy sectors are going to evolve highlighting the role of the digitalisation in the evolution. Analysing the social, economic and technological frameworks on which the industry is progressing, it is possible to provide a summary of the expected benefits coming out from the digitalisation as well as the challenges that need to be tackled. The key messages from the analysis, advanced in Section 2.1 are listed again below[1]:

- Digitalisation, decarbonisation and decentralization tasks are paving the way for the *platformization* of the energy sector.
- Digitalisation will enable companies and customer operations and processes to unlock a highly dynamic energy system at all layers and timescales.
- Every area will be transformed, including operational, technical, market and regulatory/ governance at local, national, and international level, including social behaviours
- Data intelligence and digital customer services will exponentially increase, with a predominant role of global IT companies. Data will have a major technical and commercial value, to create services for society and industry with added value.
- Synergies among energy sectors and industries will reshape competition among energy vectors, requiring sustainable cross-sector regulation and innovative financial mechanisms. Industry skills should anticipate and actively enable sector integration.

- Digitalisation enables sharing economy and social participation evolving ownership relation between people and products with huge impacts on society dynamics and industry.

Nevertheless, in order to advance into a digital environment, the following key points have to be considered:

- **Early digital energy adoption needs to be encouraged.**
- **Industry, government and universities must advance digital energy R&D.**
- **Data privacy and security concerns need to be successfully addressed.**
- **Cyber security to be increased.**
- **The right environment should be provided for talents to emerge.**

All the above are validated by the industry itself. Through the dedicated survey it was possible to identify the main challenges the whole energy value-chain needs to overcome towards digitalisation. Digital technologies and tools are universal and can be implemented in various sectors. This is pointed out, since no significant variances are observed in the sectoral analysis that is performed in this document. Economic, organizational, social, technical and regulatory challenges present a similar distribution of answers from organisation across Europe. National policies and educational approaches are possible factors that produce differences in challenges for different countries. The key points that were extracted from the survey are presented in the list below:

- The **lack of adequate skills of employees** is pointed out by most of the participants as an important matter to tackle. This finding clearly substantiates the need for the EDDIE project actions.
- **Reduced costs** is seen as the most impactful added value from digitalisation.
- **Simplification of management** and **the improvement of Quality of Services (QoS)** have also significant positive impact.
- Digitalisation is regarded as a key factor for **enabling new and green technologies.**
- Most of the companies provide training to their employees with a preference to in-house training, which can be utilized for the digital and green transition.
- Digitalisation is increasingly adopted in the energy sector as the majority of organisations use digital tools and technologies daily.
- Challenges are not particularly differentiated among energy system sectors, since all sectors face similar challenges regarding digitalisation, as shown by the answers in the survey.
- **Business model adaptation** and **costs** are major issues from economic and organisational point of view
- **Acceptance of new technologies** and **privacy concerns** are the main social challenges.
- **Technology integration** and **data management** are important technical challenges.
- Several challenges do not have the same importance for companies from different countries. National policies and educational approaches play a role in this and will be further investigated during EDDIE’s WP4 (“Assessment of policies and requirements for VET and beyond”).
- The recent COVID-19 crisis underlined the importance of digitalisation in the energy system.

3. Part B – State of the art in education/training

3.1. Review of Erasmus+ Sector Skills Alliance projects: Blueprints

3.1.1. Overview

This section includes an overview of Erasmus+, Blueprints, SSA projects considered for analysis in terms of the targeted educational levels, skills and technologies as well as educational tools used to achieve the defined objectives. The purpose of this task is to extract interesting practices that may be beneficial for project EDDIE. Nine projects, all associated to diverse sectors such as agriculture, space geo-information, maritime sector, tourism, automotive, textile and clothing, additive manufacturing, and construction industry have been considered in the particular analysis [39]. The projects are listed in Table 16. The majority of the projects are still ongoing but in an advanced stage (60%) time-wise, one is fully completed and three of them are roughly at 40% before their completion stage. All of the projects are funded by Erasmus+ SSA and with the exception of project SAGRI, they are Blueprint projects.

Table 16 Previous and ongoing projects/initiatives in various sectors: Erasmus+, Blueprints, SSA

	Project title	Sector	Stage
1	**SAGRI**: Skills Alliance for Sustainable Agriculture [40]	Agriculture	100%
2	**EO4GEO**: Towards an innovative strategy for skills development and capacity building in the space geo-information sector [41]	Space Geo-information	60%
3	**MATES**: Maritime Alliance for fostering the European Blue Economy through a Marine Technology Skilling Strategy [42]	Maritime	60%
4	**NTG**: The Next Tourism Generation Alliance [43]	Tourism	60%
5	**DRIVES**: Development and Research on Innovative Vocational Educational Skills [44]	Automotive	60%
6	**Skills4Smart TCLF**: Skills for Smart Textile, Clothing, leather and Footwear industries [45]	Textile & Clothing	60%
7	**SAM**: Sector Skills Strategy in Additive Manufacturing [46]	Additive	40%
8	**Construction Blueprint**: Skills Blueprint for the Construction Industry[47]	Construction	40%

9	**SKILLSEA**: Futureproof Skills for the Maritime Transport Sector [48]	Maritime	40%

The blueprint for sectoral cooperation on skills is one of the key initiatives of the new skills agenda for Europe. Under the blueprint, stakeholders work together in sector-specific partnerships, also called sectoral skills alliances, to develop and implement strategies to address skills gaps in these sectors [39]. These sector-specific partnerships gather key stakeholders, including:

- business
- trade unions
- research institutions
- education and training institutions
- public authorities

Throughout these projects, partnerships from each project developed a sectoral skills strategy to support the overall growth strategy for the sector at EU level so as the 'blueprint' for the sector to be rolled out at national and regional level. This is achieved via the cooperation with national and regional authorities as well as key stakeholders.

For instance, EO4GEO is an Erasmus+ Sector Skills Alliance gathering 26 partners from 13 EU countries. Coming from academia, public or private sector, they are all active in the education and training fields of the space / geospatial sectors [41]. The EO4GEO team will create the strategy which is targeted at the Earth Observation/Geographical Information (EO/GI) ecosystem including the policy makers both at EU and national level. Based on the main guidelines the project is drafting within the Sectoral Skills Strategy, a major role is given to a regional rollout, also with the identification and involvement of key players at a national / regional and even local level [48][49].

Another example is the project associated to maritime transport [48]. In this case, a platform of cooperation between all relevant EU stakeholders, is one of the solutions to eliminate the mismatch between educational supply and demand at European level. During the project, similar networks will be set-up on a regional/national level. The aim is to establish a strategic cooperation between key stakeholders (maritime shipping industry, unions, research, education and training institutes, public authorities) is an industry-led initiative. All these parties may communicate among each other and create value through the European, national and regional dimension.

More info for the projects is available at Annex 1: Summary of Eramus+ SSA Blueprint projects.

3.1.2. Educational levels and skills addressed

Table 17 contains the 8 EQF levels as these are described in [50]. Each EQF level is defined by a set of descriptors indicating the learning outcomes relevant to qualifications at that level in any system of qualifications.

Table 17 Descriptors defining levels in the European Qualifications Framework (EQF)[50]

	Knowledge	Skills	Responsibility and autonomy
Level 1	Basic general knowledge	Basic skills required to carry out simple tasks	Work or study under direct supervision in a structured context

Level 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
Level 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 problems
Level 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
Level 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
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	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
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 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
Level 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	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or

		redefine existing knowledge or professional practice	processes at the forefront of work or study contexts including research

The gathered projects mainly focus on Vocational Education and Training (VET). VET aims to equip people with knowledge, know-how, skills and/or competences required in particular occupations, or more broadly within the labour market. The publication found in [51], presents a concise picture of essential features of VET in Europe, for each EU Member State, Iceland and Norway. The three major VET categories are the Initial Vocational Education and training (I-VET), the Continuing VET (C-VET) and VET in higher education [52].

IVET refers to the vocational education and training carried out in the initial education system, usually carried out at upper secondary level before entering working life [53]. IVET is typically school-based however it can be organised in a work-based setting, such as training centres and companies [52].

On the other hand, continuing vocational education and training (CVET) is ‘education or training after initial education or entry into working life, aimed at helping individuals to improve or update their knowledge and/or skills; acquire new skills for a career move or retraining; continue their personal or professional development’[54]. In that sense, CVET is basically a part of adult learning oriented towards professional development and is largely work-based with the majority of learning taking place in a workplace [52] [55].

Finally, vocationally oriented education and training at higher qualifications level (higher education level) means education and training that can contain aspects of both academic and vocational areas typically with the majority of vocational aspects. It is usually located at levels equivalent to levels 6 to 8 of the European Qualifications Famework (EQF)[56].

Information acquired from [51] was used to summarise the various EQF levels (in Table 18) that can be achieved through IVET, CVET and VET at higher education in the EU countries (national level).

Table 18 VET qualifications in EU countries based on [51].

Country	School-based VET/IVET (Secondary and post-secondary level)	Adult learning/CVET	Tertiary/Higher education VET
Austria	EQF 3 – EQF 5	EQF undefined	
Belgium	EQF undefined	EQF undefined	
Bulgaria	EQF 2 – EQF 5	EQF 2 – EQF 4	
Croatia	EQF 2 – EQF 4	EQF 5	EQF 5 – EQF 6
Cyprus	EQF 2 – EQF 4	EQF undefined	EQF 5
Czech Republic	EQF 2 – EQF 4	EQF undefined	EQF 5 – EQF 6
Denmark	EQF 2 – EQF 5	EQF 2 – EQF 5	EQF 5
Estonia	EQF 2 – EQF 5	EQF 2 – EQF 4	
Finland	EQF undefined	EQF undefined	
France	EQF 3 – EQF 4	EQF undefined	EQF 5 – EQF 7
Germany	EQF 2 – EQF 4	EQF undefined	EQF 6 – EQF 7
Greece	EQF 3 – EQF 5	No formal qualification	
Hungary	EQF undefined	EQF undefined	EQF undefined
Iceland	EQF 4 – EQF 5	EQF undefined	EQF 6
Ireland		EQF 1 – EQF 5	EQF 5 – EQF 6

Italy	EQF 3 – EQF 4	EQF undefined	EQF 5 (Higher technical programmes)
Latvia	EQF 2 – EQF 4	EQF 2 – EQF 4	EQF 5 – EQF 7
Lithuania	EQF 2 – EQF 4	EQF 2 – EQF 4	EQF 6
Luxembourg	EQF 1 – EQF 4	EQF undefined	EQF 5 – EQF 7
Malta	EQF 1 – EQF 4	EQF 1 – EQF 5	EQF 5 – EQF 7
Netherlands	EQF 1 – EQF 4	EQF undefined	EQF 5 – EQF 7
Norway	EQF 4	EQF undefined	EQF 5 (VET colleges leading to tertiary education)
Poland	EQF 3 – EQF 4	EQF undefined	EQF 5
Portugal	EQF 2 – EQF 4	EQF 2 – EQF 4	EQF 5
Romania	EQF 3 – EQF 4	EQF 1 – EQF 4	
Slovenia	EQF 3 – EQF 4	EQF 2 – EQF 5	EQF 5 (Higher VET programmes leading to tertiary education)
Slovakia	EQF 1 – EQF 4	EQF undefined	
Spain	EQF undefined	EQF undefined	EQF undefined
Sweden	EQF 2 – EQF 4	EQF undefined	EQF 6
United Kingdom	EQF 2 – EQF 4	EQF undefined	EQF 5 – EQF 7

An additional VET category to the three aforementioned (IVET, CVET and VET in higher education), so called Technical and Vocational Education and Training (TVET), is used in project DRIVES. The particular project focuses on the development of human capital solutions for all levels of the automotive value chain. TVET is concerned with the lifelong learning and acquisition of knowledge and skills for the world of work. Throughout the course of history, various terms have been used to describe elements of the field that are now considered as comprising TVET. These include: Apprenticeship Training, Vocational Education, Technical Education, Technical-Vocational Education (TVE), Occupational Education (OE), Vocational Education and Training (VET), Professional and Vocational Education (PVE), Career and Technical Education (CTE), Workforce Education (WE), Workplace Education (WE), etc. Several of these terms are commonly used in specific geographic areas [57].

All projects under investigation, listed in Table 16, have considered a wide range of educational levels, meaning EQF 3 – EQF 8. For instance, project SKILLSEA focuses on a broad spectrum of education levels provided by Maritime Education and Training (MET). It is stated that, maritime education (EQF 6 – EQF 8) is offered by maritime academies and universities and lasts several terms (semesters) or whole academic years, while maritime training (EQF 3 – EQF 5) is offered by training centres, and the courses are shorter and relatively independent, with a strong focus on hands-on experience [58]. Similarly, projects DRIVES and MATES, dedicated to automotive and maritime industry respectively, have elaborated on the skills demand associated to the EQF levels 3-8, hence considering both secondary and tertiary education [57], [60].

In project EO4GEO, it is stated that the training and education resources dedicated to earth observation and geo-information (EO/GI) sector could be divided into three main categories: academic courses and lectures at Master level (EQ7), academic courses and lectures at Bachelor level (EQF 5/6) and vocational training modules and packages (EQF 4) [61]. Therefore, the range of the education levels, EQF 4 – EQF 7, is slightly shorter than those of the aforementioned projects, however it still covers both secondary and tertiary levels.

Moreover, in project SAM a survey [62] showed that 97 courses being implemented in additive manufacturing range from EQF level 4 to 8. It is remarked that the majority of the courses are dedicated to PhD level (EQF level 8), which is due to the fact that AM is an innovative technology, currently being investigated in several universities. Short courses, seminars, summers schools and workshops represent 48% of all courses under examination.

Furthermore, projects DRIVES, EO4GEO, MATES, SAM, SKILLSEA and NTG provided valuable information which is analysed in order to identify various skill-set demands across several sectors i.e. automotive, maritime, etc. The main categories identified are the technical, including digital and sector specific skills, green skills and soft skills. The latter are skills that are cross-cutting across jobs and sectors and relate to personal competences (confidence, discipline, self-management) and social competences (teamwork, communication, emotional intelligence) [63].

In project DRIVES, five main categories, or clusters of skills have been identified throughout the project DRIVES. Four of these are "technical" and the fifth belongs to the group of "soft skills".

- Technical knowledge profiles: This category includes the following skills, referring to the background of people in terms of education and expertise: electrical / electronic, electrochemical, material sciences, mechanical, mechatronics, software development, sustainability and technical knowledge (generic). This final normalised skill refers to the technical knowledge requested for positions that do not require a high specialisation level.
- Vehicle systems: This category refers to knowledge and expertise relating to the different new systems and functions in the vehicle as a product (in alphabetical order): alternative Internal Combustion Engine (ICE) powertrains and fuels, automated driving, connectivity, drivetrain, electrification, functional safety, system architecture. For electrification, several subcategories have been identified : batteries, electric motors, energy management, power electronics, system integration, thermal management.
- Life cycle / product – process chain: This category refers to the different steps in the vehicle life cycle, covering the whole product and process chain (in sequential order): market analysis, Research and Development (R&D), design, product development, simulation, testing / validation, process engineering, production / manufacturing, internal logistics, sales, after-sales service, mobility services. For production / manufacturing, several subcategories have been identified: automation / robotics, maintenance, production organisation, specific manufacturing processes (for those cases where they were indicated).
- Digitalisation: This category refers to the specific digital enablers and the digital skills: 3D printing, artificial intelligence, big data / data analytics, cybersecurity, digital networks, digital twins, IoT & cloud, predictive maintenance, virtual product development & virtual testing.
- Soft skills: (in alphabetical order): adaptability / flexibility, behavioural agility, change management, communication, continuous improvement, creativity, critical thinking, entrepreneurship, foreign languages, learnability, management & leadership, networking, problem solving, project management, resilience, teamwork.

In project EO4GEO, a survey on EO/GI sector specific education and skills demand [64] was complemented by a job advertisement analysis. Findings from the analysis of advertisements for jobs in the EO/GI sector lead to various occupational profiles, including more traditional profiles such as cartographers and remote sensing experts, but also several types of geographic information system (GIS) associated profiles, such as developers, data specialists, analysts and technicians. Moreover, current job advertisements demonstrated the existence of different types of GIS Specialists, of which the profile of GIS Developer is the most prominent highlighting the importance of skills related to 'Programming and development' [61]. At the same time, skills related to the predefined skills sets 'Institutional, Organizational and Society' and especially 'Computing resources and Platforms' seem to be much less relevant in most of the recently published job advertisements. Therefore, the importance of recognizing soft skills was emphasised. Other remarks throughout the study were the need to link EO4GEO studies and other activities with policy initiatives at national and European level; the better integration of EO and GI education and training; improving stakeholders' input to the definition of learning outcomes and the emergence of new occupational profiles in the EO/GI sector.

It is highlighted that, the evidence collected in various activities of this project does not necessarily deal with skills shortages and skills gaps, but is rather about the mismatch between skills as addressed and developed in EO/GI education and the skills required by the EO/GI job market. So, it should be noticed that also a situation might arise or exist where the supply of skills is greater than demand in the market for skills. As a result, over-skilled or over-educated professionals might not be able to find an appropriate job or could be in work but not fully utilize their skills and knowledge in their current workplace. Also, in this way, there might be a mismatch between supply and demand for skills.

Project MATES [42] focuses on the development of a skills strategy that addresses the main drivers of change to the maritime industry, in particular shipbuilding and offshore renewable energy. A research defining the current shortages and gaps in necessary skills and competences that the existing workforce currently presents was undertaken throughout this project [60]. Based on the findings, it was observed that in addition to the engineering skills, the identified transferable skills were critical thinking and problem-solving, Information and Communication Technologies (ICT) literacy, communication and collaboration as well as flexibility and adaptability. This kind of skills-set is consistently demanded in several paradigm shifters such as vessel automation, digitalisation, 3D printing, drones etc.

Project NTG [43] focuses on the major skills-sets associated to tourism - social, green and digital skills. The Next Tourism Generation Alliance interviewed over 200 tourism directors, head of departments and entrepreneurs in total in UK to acquire an in-depth understanding and insights into the future of digital, green and social skills from the perspective of people working in the tourism industry [65]. The survey generated the following remarks. Skills needs, shortages and training provision differ across tour operators and travel agents, however, social skills and especially customer service skills are generally strong amongst the workforce. Leadership skills are at times lacking within the industry, especially in terms of how to upskill staff, motivate employees and see potential in recruits who might not have extensive experience. Furthermore, it was found that there is a deficit of digital skills across the industry with a large proportion of companies lacking basic digital skills such as setting and managing a facebook page. Many companies rely on customers booking in person. However, there are opportunities in using digital tools to complement that. Last but not least, it is stated that the industry in an example country like UK is lacking green skills and initiatives. One organisation suggests this could be due to British consumers traditionally wanting package holidays and have been used to ease of travel so have not really considered sustainable options as much as perhaps people do in other countries.

Based on the Desk Research Summary on the Future of Digital, Green and Social Skills in Tourism [66], prepared for project NTG, several influential organizations (OECD, Cedefop, World Economic Forum) indicate that higher levels of qualifications in general as well as the following transversal skills will be needed for everybody to survive in an increasingly digitalized world:

- Self-learning capacities (permanent education, adaptability, agility, and flexibility: necessary to cope with digital innovations and disruptive business models)
- Digital fluency
- Cognitive (such as problem-solving, creative, entrepreneurial) skills;
- Socio-emotional (communicative, collaborative) skills and multicultural dexterity

The project SAM [46] – associated to Additive Manufacturing (AM) – presented the outcomes of the literature review of AM professionals in the industry [62]. It showed that several countries in Europe recognise that there is a pressing need for the current workforce to be trained and educated, as well as having more regulations to safeguard the AM personnel. Competency transformation is one of the key challenges for the AM industry which will see a growth and emphasis on the use of software, analytics and IT technologies. An overview of the skill gaps identified is introduced below:

- Growing use of software, connectivity and analytics will lead to skills required for software development and IT technologies, such as mechatronics experts with software skills.
- Cognitive competence to deal with a changing technological environment (mathematics, logic, data processing, project management) and non-cognitive skills (critical thinking, teamwork, achievement of goals, interpersonal relationship skills, or troubleshooting abilities) will be fundamental for future technicians;
- Skills related to information and data processing, organizational and process understanding and interaction skills with humans and machines will be crucial for professionals;
- Knowledge on metrology is also required for AM industries to ensure technological confidence of being able to produce high quality AM-built parts, controlling and optimizing the production parameters by better utilization of feed materials, yet increasing production, reducing part rejection, enhancing energy efficiency and decreasing post-processing requirements
- Digital-industrial skills or a mix of traditional mechanical skills and software skills will be needed;
- There will be a demand for jobs including technicians, trouble-shooters, repairmen, and even programmers

Interesting conclusions arose throughout a task of project SKILLSEA [48] aiming to map the current skills needs of Maritime Transport Sector. It was mentioned that an important issue, caused by the rapidly accelerating changes in technology, is the set of professional core skills that a person should master. In the past, a narrow well-defined set of skills was successfully used for decades. Today, a set of necessary skills for a particular job might be of only partial use when applying for a similar job, even within the same industry or sector. Consequently, employees need a broad set of skills or ability to update or upgrade their set of skills, as may be appropriate, in order to achieve their full potential, both at work and in society. Therefore, nowadays a person looking for a job needs a set of transitional skills, as well as sector-specific and cross-sectoral skills.

The study continues with the need of digital skills. Those enable a person to use or interact, either professionally or as a citizen, with different digital services. The number of digital services is constantly increasing and the ability to use these services is becoming highly important. According to the study, in shipping industry attention must be paid to the skills required to maintain cyber security, either on board or on shore. Digital competence as a component of the value chain has also gained an increasing importance in the particular sector. This includes IT systems, engineering for integrated logistics, and block chain technology for value chain integration.

Another important extension of the set of core skills mentioned in SKILSEA, is the green skill set. This kind of skills are required to limit pollution and environmentally damaging emissions caused by the routine operations of ships or in the event of an emergency. They also cover the proper use of different tools and equipment to achieve these objectives, and to maintain energy efficiency. Although not critical in respect of the economic viability of business activity, these skills have become extremely important, mostly because of their impact on climate changes, increasingly strict regulatory requirements, and for the overall image of companies and industry [58][58] .

In addition to the listed projects considered for the skills analysis, project VET-GPS provided interesting remarks. In particular, it evidences the importance of Soft Skills which is becoming more and more predominant in our society and VET providers are engaging in delivering educational programmes focused more on soft skills due to the demand of the job market. Since employers are considering soft skills as the main factor during the hiring process, VET centres and schools have accepted them as a privilege for the employability of their students and trainees [67].

Moreover, the 2010 Bruges Communiqué on Enhanced European Cooperation in Vocational Education and Training [68] focuses on the flexibility and high quality of education and training systems which address to the labour market needs. The document highlights the importance of improving the 'capacity of VET to respond to the changing requirements of the labour market’, and goes on to state that ‘We need to adapt VET content, infrastructure and methods regularly’. For this reasons, labour market actors, VET providers and public authorities need to be involved in a constant dialogue for developing and renewing standards in order to fight against skills mismatches. This requires close and systematic cooperation between authorities and providers in this field.

According to this aspects, the possible relation between the project settings and the educational level addressed projects linked to VET, lead to take into consideration three outcomes:

Impact on Skills and Competences:

- How the project is connected with the increase of learner confidence, self-esteem and desire for education and the development of their digitalisation skills required.
- How help learners with the development of their professional identity that enables individuals to take control of their work life and also to influence conditions in the workplace due to the autonomy and problem-solving.

Relationship with other individuals:

- How mentoring learners are educated to offer support and advice for young people in training, helping them developing their technological skills and attitude.
- What different types of mentoring are involved in the project to help the development of network between learners and between learners and teachers, mentors, masters and employers.

Potential for success in the labour market:

- How the firm provide specific training to their employees, or if there is an incentive to provide training for new technological skills.
- If in the project facilitate students and trainees to have more control over their work, with a sense of agency and autonomy which results in increased self-esteem.

The Automation and the future of work in Portugal study [69] assessing the country’s automation potential until 2030 was presented in January 2019. It highlights the upcoming and profound technological transformations and the need to reskill and requalify professionals. Moreover, the study describes the main challenges caused by automation and its effects on salaries, and suggests that public and private policies should aim at diminishing job losses and focus on adult learning and VET. It also confirms that the education and training system, especially VET, have to respond to business needs. Finally, the study sets an important and relevant warning about the necessity of the VET Education to adequate framework promoting business adaptability to the labour market's changing needs and the adoption of new technologies and processes.

Summary

In this section, the definition of the different VET categories and the targeted skills to be developed throughout the various identified EU projects have been addressed. Firstly, the VET categories have been discriminated into the three following categories:

1. IVET
2. CVET
3. VET in higher education

Table 18 gives an indicative picture of the EQF levels correspondence to the aforementioned categories in national level. The particular information highlights the importance of VET education in all EU countries based on the observation that VET students can reach a wide range of EQF levels, from EQF 2 up to EQF 7.

The projects listed in Table 16 aim to identify most needed profiles and related skills. It is clear that all projects have given special focus on digital, cognitive and non-cognitive as well as green skills.

Soft skills are becoming more and more important in our society and VET providers shape educational programmes to focus more on soft skills due to the job market demand. This is observed across the total of the examined projects. That means that soft skills constitute a common need for all sectors and VET providers should redirect their programs in all EQF levels to address the particular issue.

Moreover, it is apparent that the era of digitalisation impacts all different sectors such as automotive, EO/GI, maritime, tourism etc. A wide range of skills like 3D printing, artificial intelligence, big data / data analytics, cybersecurity, digital networks, IoT, virtual product development are some of the so called cross-sectoral digital skills.

In addition, another trend across the different projects was noted related to the green skills. These have become a requirement, due to the global concern of climate change, in order the various organisations to achieve energy efficiency, limit produced pollution and environmentally-damaging emissions, comply with increasingly strict regulatory requirements and present an overall environmentally friendly image.

Another interesting conclusion is that in contrary to the past, when a narrow well-defined set of skills was successfully used in long term, professionals need a wide set of skills or ability to upgrade their skills in order to achieve their full potential. Therefore, nowadays job candidates need a set of transitional skills, as well as sector-specific and cross-sectoral skills.

Last but not least, it was highlighted that the collected evidence does not focus only on skills shortages and skills gaps, but it is more about the mismatch between skills as addressed and developed in the education of the relevant sector and the skills required by the corresponding job market. In conclusion, a mismatch could arise when the provided skill-set is greater than the demand resulting to over-skilled or over-educated professionals. The latter could struggle to find an appropriate job, or have a job without fully exploiting their skills and education.

3.1.3. Digitalisation and green technologies covered

According to the EU strategic long-term vision for a climate-neutral EU, emissions from the power sector need to be reduced to close to zero by 2050 [70]. A mix of digital and green technologies are required to shape the anticipated future of low carbon economy [71]. The projects under analysis provide useful information regarding the emerging technologies of this era.

An EO4GEO report gathered the trends and challenges in the space/geospatial sector. The space market is expanding rapidly and EO products and services will be part of value chains different from their original ones. Whereas a data value chain in the space market is a framework through which people can view the flow of geospatial data from the instant it is collected throughout its entire lifecycle. Each vertical industry has its own flow of data, but eventually, that data intersects with analytics that can turn individual points of information into all different kinds of actionable intelligence. It means that each single step of the space services value chain could be integrated in different market sectors. The more it happens, the more space market needs to improve its maturity. Today the geospatial market is influenced by other emerging technologies. The most relevant emerging technologies having an impact on the geospatial data are listed below [72]:

- Cloud computing
- Big data analytics
- IoT
- Artificial Intelligence
- Automation
- AR/VR
- Block Chain

Technological advancements are rapidly penetrating also the maritime industry and the proper use of ever increasing data is essential for maximizing potential benefits including environmental ones, besides many others [73]. In the same report, special attention has been given to the digitalisation of the offshore renewable energy sector. Digitalisation is being regarded as the main technological trend of the future which can contribute towards the further growth of the sector, attracting an increased investment interest and the participation of several industry actors, facilitating in that way the implementation of a large number of offshore renewable energy projects that in turn will heavily increase employability levels in the respective countries. A wide and diverse set of different technologies is currently under consideration presenting different levels of market maturity and deployment. Those include:

- automation,
- robotics,
- data science analytics,
- Artificial Intelligence (AI),
- 3D printing etc.

It is stated that, their uptake is expected to revolutionize the offshore renewable energy industry by reducing capital and operational costs and increasing productivity levels.

Similarly, according to the report in [74] of the project DRIVES, digitalisation in automotive sector refers to the specific digital enablers and technologies:

- 3D printing
- artificial intelligence
- big data / data analytics
- cybersecurity, digital networks
- digital twins
- IoT & cloud, predictive maintenance
- virtual product development & virtual testing

Furthermore, examples of the ongoing digital transformation in construction sector include 3D scanning, Building Information Modelling (BIM) or use of automated equipment [75]. Digitalisation will also impact the final products of construction, for example smart connected cities and smart homes that adjust their functioning according to the needs of citizens and inhabitants. More specifically, four key technological trends concern the construction value chain [75]. These include:

- digital data and access
- networks and connectivity
- automation and robots
- virtual and augmented reality
- 3D printing
- geo-localisation

Additionally, a lot of interest has been noted in green technologies which promote sustainable and environmental practices. According to [76], green technologies are environmentally friendly by definition and take into account energy efficiency, recycling, health and safety concerns, renewable resources and more.

The report in [77] of project MATES, defines the green technologies as a term referring to a continuously evolving group of methods and materials, from techniques generating energy to non-toxic cleaning products. In another report [73] of the same project, it is mentioned that in order to meet the new environmental requirements (e.g. reducing the vessels' air, noise and water emissions thus enhancing their overall energy efficiency in the shipbuilding sector), different operational approaches and a redefinition of maintenance and repairing activities throughout the life cycle of a vessel are required. In addition, the post-production phase of the value chain was also affected, since the current, to that time, single bottom / hull vessels failing to meet the relevant requirements had to be retrofitted or taken out of service and dismantled within a specific period of time. New technological solutions enhancing the environmental and energy performance of vessels include:

- advanced ship designs
- dual-fuel engines or engines only using alternative fuels (e.g. LNG)
- installation of open- or close-loop scrubber systems
- antifouling paints, etc.

Also, Construction Blueprint project discusses technical solutions for energy optimisation and building efficiency. These include:

- high-performance building shells;
- efficient heating and cooling;
- sun control, shading and passive solar heating
- efficient lighting and increased daylighting
- smart system control technologies optimizing energy use within the building

Special focus is put on information technology to reduce the environmental impact of buildings in general, as well as the energy consumption and environmental impacts of the IT sector itself. There are several 'action areas' that directly relate to buildings and office efficiency, including: energy-efficient buildings; visualization of energy and electricity usage (including individual metering and charging); digital meetings; digital document processing; greener IT sector (eco-friendly and cost-efficient IT procurement); green data centres and telecommunications; standardized energy-efficient workplaces; and more efficient printouts [78].

Summary

This section discusses the technological trends and needs with emphasis to the digitalisation and green technologies covered through VET education. Nowadays, new environmental policies lead to technological advancements which are rapidly penetrating the industry leveraging the use of ever-increasing data and a wide and diverse set of digitalisation technologies.

Digitalisation is considered the main technological trend of the future which can facilitate the further growth of different sectors as well as their environmental impact and eventually define the associated skills requirements in the labour market. For instance, information technology can reduce the environmental impact of buildings in the construction sector via the development of the energy and electricity consumption visualisation. The following technologies are digital enablers attracting an increased investment interest and the participation of several industry actors across various sectors:

- IoT
- Cloud computing
- Big data analytics
- Artificial Intelligence
- Automation
- AR/VR
- Block Chain
- automation
- robotics
- Artificial Intelligence (AI)
- 3D printing
- cybersecurity
- geo-localisation

In addition, significant evolution in green technologies has been evidenced across multiple sectors. Eco-friendly practices and smart technologies have been merged to achieve the future goals of low carbon economies and eliminate the adverse environmental impact. Therefore, energy efficiency, recycling, health and safety concerns, renewable resources and more are already on the table of various projects dedicated to the vocational education and training aiming to satisfy the requirements of this era.

3.1.4. Educational tools and methods

This section focuses on the educational methods and specific tools used in the various projects under investigation.

In project SAGRI [40], the training modules will be based on the findings of an analysis of skills needs for agricultural professionals to develop innovative and flexible techniques that respond to their specific education needs. The programme will abide by the European Qualifications Framework for lifelong learning (EQF) and the European Credit System for Vocational Education and Training (ECVET) standards. In the particular project, a developed platform (OER) will offer an interactive resource for promoting and virtual learning, making all training resources widely available as Open Educational Resources. It will raise national and European awareness of the project in order to ensure maximum outreach, longer impact and sustainability. In SAGRI website is mentioned that the particular platform will embed the “EU Project Websites – Best Practice Guidelines” (EC, DG Research and Innovation) and take advantage of the lasted HTLM5 good practice to create enjoyable, attractive and informative layout, contents, image sliders and subtle animations. The SAGRI OER platform will create an accessible Massive Online Open Course (MOOC) that will contain the teaching and assessment material as well as a Virtual Community space. In order to ensure user acceptance, the SAGRI platform will be assessed by the focus group in design meetings that will take place in each of the consortium countries. The SAGRI platform will be linked to the SAGRI website. Also, in order to ensure visibility, all partners will be responsible to ensure detectable cross-linking between the SAGRI platform and their institutional websites so audiences can easily access it [40].

In EO4GEO project, an e-learning platform is aimed to be developed and be compatible with most mature learning management system (LMS) systems available today. Throughout the particular project, it has been observed that, no single LMS could be selected for use within the project. The main reason for this is that different (educational) institutions usually already have an LMS in place, so the focus shifted to ensuring interoperability with various LMS systems. Also, the EO Platform (based on the MEP PROBA-V EO Platform) is being used for EO4GEO project. This allows EO4GEO project to benefit from an extensive set of EO platform functionality that has been developed over the years [79].

The project DRIVES establishes an apprenticeship comparison tool aiming to help both employers and individuals to navigate the confusing apprenticeship landscape and compare offers in different countries. A key component of the DRIVES Project is the establishment of an online brokerage tool to source training serving specific new and evolving job roles within the EU automotive sector. The purpose of this tool is to simplify the search and matching of training with the needs of the automotive sector and to widen access to all stakeholders. This is termed the DRIVES Framework. It has been agreed that the scope of the Framework will be extended to encompass apprenticeships in order to help comparison of different apprenticeship offers. It is envisaged this will enable simple comparison between different apprenticeships in relation to:

- EQF level
- Job roles covered
- Occupations covered
- Relevant skills/skills domains
- Duration of apprenticeship
- Countries apprenticeship is available
- Provider type/location

Summary

In Section 3.1.4, the identified tools and platforms deployed or planned to be developed and used for different Blueprint projects are encompassed and explained. One of the major goals of the various projects is the generated material and information to be visible and accessible. Under this prism, project SAGRI developed the platform OER in order to offer virtual learning making all training resources widely available. In addition, OER platform is able to raise national and European awareness of the project in order to ensure maximum outreach, longer impact and sustainability.

Another e-learning platform was developed by EO4GEO project which aims to the compatibility with all available learning management systems (LMS) across the various universities in Europe.

DRIVES Framework aims to the simplification of the search and matching of training with the needs of the particular sector and to widen access to all stakeholders. It has been agreed that the scope of the Framework will be extended to encompass apprenticeships in order to help comparison of different apprenticeship offers.

In conclusion the identified tools across the various projects target to features like accessibility, interoperability, compatibility, comparison and matching (training – sector needs) capability.

3.1.5. Project results and learnings for EDDIE

This section encompasses the expected results identified at the websites of the ongoing projects listed in Table 16, indicating the most relevant identified for the objectives and scope of EDDIE

The project EO4GEO focusing on the EO/GI sector will provide academic institutions and end users with open tools supporting Copernicus education and training. A commonly agreed Body of Knowledge (BoK) describing an ontology for the space/geospatial domain that can be permanently updated by making use of a set of collaborative tools will be developed throughout this project. In addition, BoK use will be maximised throughout a carefully designed series of curricula which will be adapted to a group of occupational profiles in the sector. Furthermore, the particular project aims to the creation of a portfolio of VET training modules based on existing training materials or newly developed ones and a case-based learning method that is applicable for different scenarios and in any sub-sector of the space/geospatial domain. Series of training actions for different case-based learning scenarios in the sub-sectors 'integrated applications', 'smart cities' and 'climate change' including group work and internships making use of collaborative methods and tools are also planned to be delivered throughout the project EO4GEO.

The expected results of project MATES are listed below:

- Development of a long-term Strategy and Action Plan to tackle the current and future skills shortages.
- Establishment and involvement of a Europe-wide network of projects, initiatives, organisations and experts.
- Identification of future skills and competence needs and the development of corresponding training and curricula.
- Greater alignment of industry needs and occupational profiles with training and curricula.
- Validation of training and education pathways for effectively increasing employability and career opportunities.
- Successful completion of 11 Pilot Experiences and identification of recommendations for the long-term strategy.

In project MATES, Pilot Experiences are considered vital components of the overall strategic design of the project. These experiences will be composed of a series of activities which will provide practical insights into the priority lines of action and training needs identified. Target beneficiaries include students, teachers, trainers, skilled professionals, and those who have recently joined the workforce. It is hoped that the Pilot Experiences will include e-learning courses, hackathons, upskilling workshops, careers seminars and more. The outcomes of the Pilot Experiences will provide vital knowledge for bridging the maritime skills gap and increasing the sector's overall competitiveness and attractiveness. Insights will feed directly into the long-term action plan, which will be developed by MATES, informing policy recommendations and best practices.

In NTG a skills assessment methodology will be developed. This is a research-based, structural mechanism for the analysis of rapidly changing skills and skills needs in order to develop strategies for addressing skills gaps in the EU tourism sector. The Skills Assessment Methodology will support the tourism industry, education and training providers as well as government bodies to continuously and longitudinally identify, assess, and monitor skills needs in order to make strategic choices to eradicate skills gaps for a future-proof tourism industry in the EU. The Skills Assessment Methodology includes the following steps [80]:

1. Establish a NTG Skills Collaborative Platform
2. Create a Country/Region/Destination Skills Profile
3. Conduct a NTG Survey on the future of Digital, Green and Social Skills
4. Conduct NTG interviews on the Future of Digital, Green and Social Skills
5. Organize NTG Collaborative Platform Stakeholder Meetings
6. Formulate Skills Assessment Response Strategies

Also, a report providing information regarding the strategy on how to communicate/promote NTG and the survey to potential participants via email or a letter [81]. Furthermore, the NTG survey [82] will be able to give a complete look at what is driving the tourism subsectors from the current skills gaps and competencies that underpin the need for future skill sets, aiming to get an initial snapshot of how the (next generation) tourism professionals are functioning and the overall future perspective of a country fostered within the tourism sector.

Among other deliverables of the project DRIVES is the identification of the occupational profiles. Those will be investigated through a detailed analysis of the outcomes of the Automotive Skills Council and comparison with ESCO requirements. Then, the appropriate occupational profiles on which the project DRIVES should focus will have to be selected. Furthermore, the characterisation of the occupational profiles will facilitate the precise identification of the demanded skills. The validation of the identified and characterised profiles will be validated with the aid of the active involvement of the relevant stakeholders. The latter will have to be identified resulting to a European level stakeholder database, updated and being accessible by all partners.

In addition, project DRIVES aims to work with national organisations across Europe to extract technology roadmaps and pieces from industry leaders identifying trends and to provide a timeline relating to insights and likely impact dates. Moreover, VET and training offered in European level will be analysed leading to the identification of training gaps which need to be filled based on the characterised (described above) occupations.

In Table 19, the relevant lessons learned are summarized from the analyzed blueprint projects and their direct applicability to the different WPs of EDDIE.

Table 19 Blueprints projects learned lessons

Conclusions from 2.2.1	**Work Package**
VET categories have been discriminated into the three following categories: 1. IVET 2. CVET 3. VET in higher education All projects have given special focus on digital, soft and green skills. Soft skills constitute a common need for all sectors and VET providers should redirect their programs in all EQF levels to address the particular issue. The trend and advancements of digitalisation era impact all different sectors and a number of cross-sectoral digital skills have been identified in all projects. Green skills have become a requirement, due to the global concern of climate change and the increasingly strict regulatory requirements. Nowadays job candidates need a combination of transitional, sector-specific and cross-sectoral skills. The collected evidence does not focus only on skills shortages, but also on the mismatch between skills addressed and the ones required by the job market of the relevant sector. A mismatch could arise when the provided skill-set is greater than the demand resulting to over-skilled professionals.	WP2: Identification of current and future skill needs in the Energy Sector
Active involvement of the relevant to the sector stakeholders will aid to the accurate and efficient characterisation of occupational profiles as well as result to the validation of this critical task. A recommended practice is the creation of a European level stakeholder database, updated and being accessible by all partners.	WP3: Stakeholder mapping and strategic network building
SAGRI will abide by the European Qualifications Framework for lifelong learning (EQF) and the European Credit System for Vocational Education and Training (ECVET) standards. In the particular project, a developed platform (OER) will offer an interactive resource for virtual learning, making all training resources widely available as Open Educational Resources. The SAGRI OER platform will create an accessible Massive Online Open Course (MOOC) that will contain the teaching and assessment material as well as a Virtual Community space. In order to ensure visibility, all partners will be responsible to ensure detectable cross-linking between the SAGRI platform and their institutional websites so audiences can easily access it [72]. In EO4GEO, the aim is to develop an e-learning platform which will be compatible with most mature learning management system (LMS) systems available today. Different educational institutions usually have an LMS in place, so the focus shifted to ensuring interoperability with various LMS systems. A key component of the DRIVES Project is the establishment of an online brokerage tool to source training serving specific new and evolving job roles within the EU automotive sector. The purpose of this tool is to simplify the search and matching of training with the needs of the automotive sector and to widen access	WP4: Assessment of policies and requirements for VET and beyond

to all stakeholders. It has been agreed that the scope of the Framework will be extended to encompass apprenticeships in order to help comparison of different apprenticeship offers in relation to: • EQF level • Job roles covered • Occupations covered • Relevant skills/skills domains • Duration of apprenticeship • Countries apprenticeship is available • Provider type/location	
In project MATES, Pilot Experiences are considered vital components of the overall strategic design of the project. They will provide practical insights into the priority lines of action and training needs identified. They will include e-learning courses, hackathons, upskilling workshops, careers seminars and more. Experiences aim to bridge the skills gap and increasing the sector's overall competitiveness and attractiveness. Insights will feed directly into the long-term action plan, which will be developed by the particular project, informing policy recommendations and best practices. In NTG a skills assessment methodology will be developed. This is a research-based, structural mechanism for the analysis of rapidly changing skills and skills needs in order to develop strategies for addressing skills gaps in the EU tourism sector. It will support the tourism industry, education and training providers as well as government bodies to dynamically assess and monitor skills needs in order to strategically eradicate skills gaps in the particular sector.	WP5: Blueprint for the Digitalisation of the European Energy Sector development
The Lines of Action of project MATES defined in [83] were developed using the data collected as part of the Baseline Report of the MATES Project. Each of these Lines of Action was scored according to a set of criteria in order to assess their importance in relation to the skills gaps within the current and future workforces for the SB and ORE sectors. These criteria include: • Sector relevance • Geographical relevance • Political support • Urgency • Cost • Impact on employability • Attractiveness	WP6: Blueprint: Roll out and action plan
EO4GEO website features links to active social network channels (Twitter and Medium - @EO4GEOtalks) to widely promoting the project in different communities and attracting participation of stakeholders [84]. Leaflet, roll-up and poster are used from the same project for brief presentation of the objectives and the partnership both in digital (distributed through the web site)	WP7: Dissemination, Exploitation and Policy recommendations

and in hard-copy format, in order to assure the most possible diffusion among potential stakeholders and target users. Newsletter is considered an effective mean for communicating the project results, news and achievements in project EO4GEO; it is managed by MailChimp6, an online email marketing solution. The Newsletter is electronically edited and automatically sent to all members of the EO4GEO mailing list every six months. Each partner distributed the newsletter to its reference network in order to reach a wider panorama of stakeholders. Also, dissemination actions were taken to raise awareness of the project EO4GEO via different activities: Promotion of the online surveys on supply and on demand of skills to companies, public organisations and research institutes/universities, etc. Contacts with stakeholders potentially interested in becoming external experts for the Body of Knowledge or other collaboration opportunities. Networking activities, collecting useful info on worldwide ongoing education initiatives, tools and collaborative platforms, were also carried out in different meetings and conferences. The communication was made by the partners also in the national languages, which greatly helped the dissemination of the project awareness at national level [84]. The purpose of piloting the VET curricula developed, of project SKILLS4SMART TCLF [85] is to test them, make sure they are effective, and apply changes before they are distributed and offered widely. As referred in WP VIII "Pilot Implementation (Delivering Educational Curricula)", a significant task is associated to the continuous pedagogical assessment of the pilot deployment in a way to ensure that the VET curricula developed match the SKILLS4SMART TCLF needed profiles [85].	

3.2. Review of energy education/training related projects and initiatives

3.2.1. Overview

The analysis of previous and ongoing project and initiatives related with education/training in the energy sector has been performed on the basis of 26 projects. This analysis is motivated by the need of reviewing the state of the art in similar educational projects in energy-related fields, aiming at identifying the main technologies and skills currently tackled by either recent or ongoing initiatives. These projects address different issues related to the energy sector in Europe, focusing in the development of new skills and knowledge within the framework of European energy policies.

The projects considered in the analysis are gathered in Table 20, together with the keyword employed to identify them throughout the document. In this first section a review of the topics addressed, scope and partners involved in these projects will be presented, providing a general overview. Next section will offer a classification of these initiatives according to the educational level of implementation and skills addressed. Section 3.2.3 will present the technologies covered in the analysis, focusing on digitalisation and green technologies, whereas in section 3.2.4, educational methodologies and digital tools employed are analyzed. Last section provides a summary of the outcomes of these projects and the main conclusions as learnings for EDDIE. More info for each project is available at Annex 2: Summary of energy related educational/training projects.

Table 20 List of projects

#	Keyword	Project title
1	UNISET	UNISET – UNIversities in the SET-Plan
2	ATLAS	European Atlas of Universities in Energy Research and Education
3	ASSET	ASSET - Advanced System Studies for Energy Transition
4	SMAGRINET	SMAGRINET - Smart Grids for an Efficient, Sustainable and Human-Centric Energy System
5	TEACHERNET	Teachener – Integrating Social Sciences and Humanities into Teaching about Energy
6	ERIGRID	ERIGrid - European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out
7	VESTE	VESTE - Further Vocational Training for Energy Service Technicians
8	ENTRAN	ASSET Energy Transition
9	SHIFTS	Energy-SHIFTS – Energy Social sciences and Humanities Innovation Forum Targeting the SET-Plan
10	ESEIAETP	eseia ETP - Education and Training Programme
11	SUPERGRID	Training Programme - SuperGrid Institute
12	EMTEU	EMTEU - Energy Management Technician in Europe
13	SKILLS	Skills for the green economy
14	YOUNGEN	Young Energy Europe
15	PROSPECT	PROSPECT Peer-powered cities and regions
16	YOUNGINN	Young Innovators
17	50/50	50/50 Networking Platform
18	ENEFFIENCY	Educational program “Energetic Efficiency” – Las Palmas de Gran Canaria
19	ENERGYBITS	The ENERGY-BITS program
20	DHC+	DHC+ Education and Training
21	ENEN+	ENEN + (European Nuclear Education Network)
22	GAS	Vocational Education and Training across the Gas sector in Europe
23	COTEDIVORE	Vocational training in the sector of renewable energies and energy efficiency in Côte d’Ivoire
24	WAMSS	Wind & Marine Energy Systems & Structures (CDT-WAMSS)
25	SMARTEM	Energyducation: Exploring “Smart Energy Management”
26	CHALLENGES	Energy Challenges

Methodology

At first the methodology applied for the analysis is described. After a first overview of ongoing projects and European initiatives and policies [112] [113], some keywords related to the specific field or technologies tackled by similar projects were selected. The level of specialization of knowledge and skills aimed to achieve by these projects were also gathered in certain keywords related to different educational stages addressed. European Qualification Framework levels (EQF), were also considered aiming to categorize the projects regarding European standards. These keywords were then used to browse relevant projects. 26 of them were selected in respect of their importance, evaluated according to the number of institutions and partners involved. In this selection, similarities to EDDIE project regarding their objectives and funding were also considered.

These 26 projects were then classified taking into account the keywords used in the browse but also other aspects such as the profile of the partners involved in their development, the start and end dates, (if not ongoing), the kind of deliverables provided and the scope of their implementation.

After gathering all the relevant information about the 26 projects considered, a second review was performed aiming to deduce the main outputs of each project regarding the skills addressed, digitalisation and green technologies covered, the educational tools and methods and the project results and continuation perspectives. As a final stage, general conclusions were obtained for each of these sections.

Statistics

26 projects have been considered for this analysis. Figure 37, 38, 39, 40 provide some information about their specific topics, partners, funders and scope respectively.

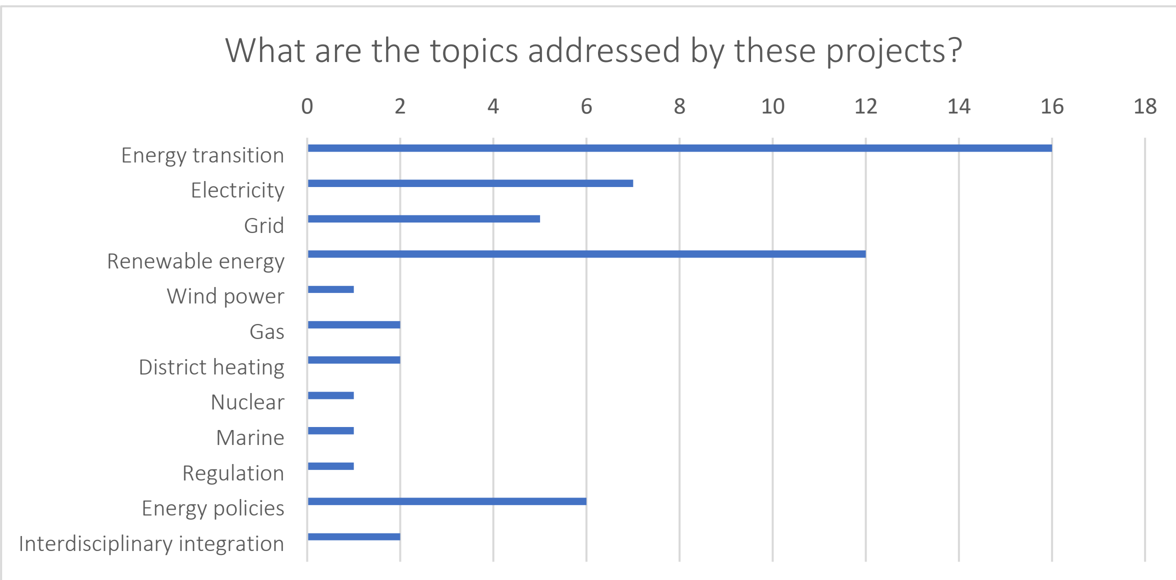

Figure 37 Topics addressed by projects

- 16 out of 26 (62%) of these projects focus on the energy transition, addressing different topics and strategies in the framework of European energy policies [112] [113]. In particular, 23% of the projects directly address energy policies as part of their main content and one of them focuses also in the current regulations.
- Almost 50% of the projects, 12 out of 26, are related to renewable energy sources in general. One of them addresses wind power in particular.
- Moreover, 7 projects focus only on electricity, and 5 out of these 7 are related to electricity grids.
- Projects tackling other energy sources have been also considered. It's the case of one of the projects related to gas, one to nuclear and one to marine energy. Also, 2 out of 26 deal with district heating.
- Finally, among all the projects analyzed, two of them include also other non-energy-related disciplines in their approach, trying to apply an interdisciplinary approach when dealing with energy transition.

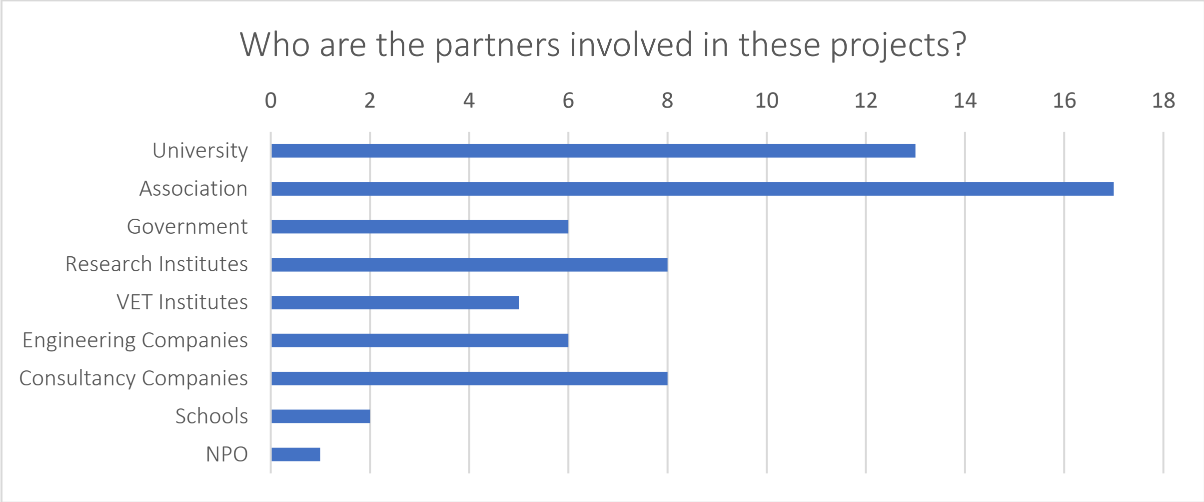

Figure 38 Partners involved in the projects

- Regarding the partners involved in the development of those projects, in half of them there is at least one university or higher education institution participating as a partner.
- In more than 65% of them there is at least one association, gathering universities, like EUA (European University Association), members of the industry or institutions with the same objectives, like *Euroheat and Power* or *Baltic Sea Academy*, taking active part in the realization of the project.
- In 6 out of 26 projects there are governments involved, national governments in 3 of them, and regional governments in 3 of them, in particular, local authorities from regions of Austria, Portugal and Slovakia and Spain in [95], [100] and [103] respectively.
- Research institutes directly participate in 8 of the projects.
- VET institutes directly participate as partners in 5 of the projects.
- In 2 out of 26, there are schools involved in the development of the project, even though there are more projects where schools can apply as participants.
- More than 50% of the projects cooperate with at least one private company as a partner. In 8 of the projects, they are consultancy companies and 6 out of 26 collaborate with at least one engineering company.

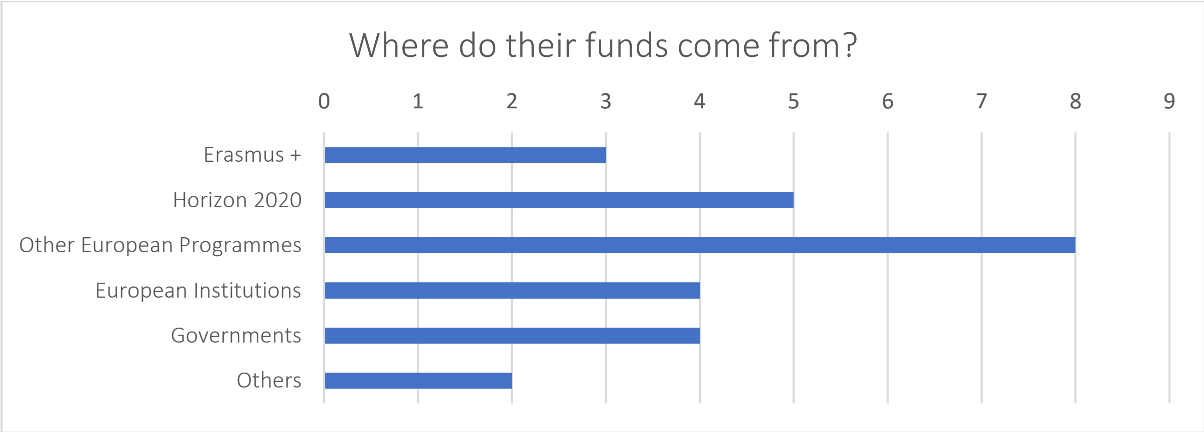

Figure 39 Funding

- More than 75% of these projects (20 out of 26) are funded by the European Union.

- 3 out of 26 of these projects are funded in the framework of the *Erasmus+* programme, whereas 5 have received fund from the European Union's *Horizon 2020 research and innovation* programme.
- Around 30% of the projects, 8 out of 26, have also received funds from other European Union's programmes, some of them already finished as *Intelligent Energy Europe* or *Leonardo da Vinci* programme among others.
- 4 of the projects receive funds from other European Institutions and centers, as CEDEFOP or the *European Institute of Innovation and Technology*, EIT.
- 4 projects are funded by governments from Germany (2 of them), Austria and France.
- 2 projects are funded by private initiatives.

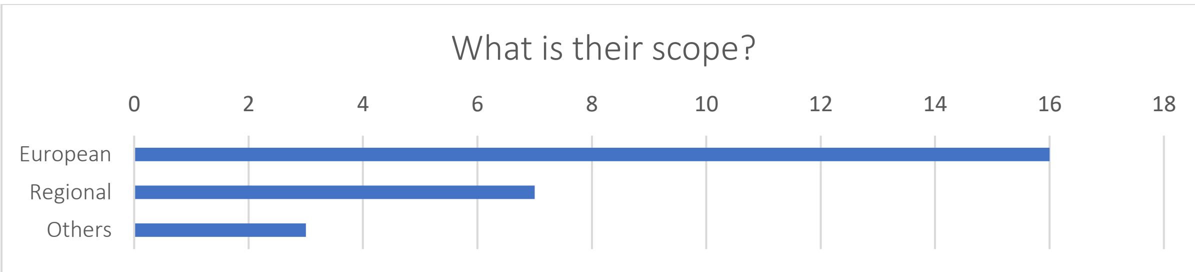

Figure 40 Scope of the projects

- Most of the projects are carried out in Europe and developed in the framework of European energy policies. However, only 16 could be considered as European projects regarding where they implement their activities, i.e. their activities can be implemented in different countries within Europe, depending on where the participants some from.
- 26% of the projects (7 out of 26) could be considered regional regarding their scope, since the activities implemented and the partners involved in their development belong to the same region, therefore, the schools, institutes, universities or professionals participating belong to the same area. In most of the cases (6 out of 7), this region belongs to the same country, whereas in one case, the project is implemented in the Baltic region [92]. Moreover, 4 of these 7 regional countries, receive funding from the European Union, despite being implemented at a regional level.
- As for the rest, 1 of the projects focuses in national studies, therefore it has a national scope, but the same study has been developed in different European countries [107].
- There is 1 project coordinated by the German government but implemented out of Europe, in Ivory Coast [108]. The German government also funds and collaborate in another project, which is carried out in several countries (Bulgaria, Greece, Hungary and Czech Republic). Activities are locally implemented in these countries, even though there exists a coordination between them and Germany [99].

Finally, it is important to consider for the analysis that most of the projects are still ongoing:

- 18 out of 26 of the projects considered are still ongoing. 1 of these is intended to end by the end of 2020, 3 of them will finish in 2021 and 1 in 2022. The rest of the projects, either they will finish in 2023 and afterwards, or the end dates are not clearly defined, since some of them are initiatives that intend to continue indefinitely.
- 2 of them ended in 2019, 3 on 2018, 1 on 2016, 1 in 2014 and 1 was carried out in 2012 (it started and ended).
- Regarding the starting dates, 2 of them started in 2020, 7 started in 2019, 2 in 2018, 2 in 2017, 3 in 2016, 2 in 2015, 3 in 2014, 1 in 2013, 1 in 2011 and there are 3 projects starting in 2012, 2010 and 2009

respectively which are still ongoing. Regarding these projects ESEIAETP [95] , EMTEU [97] and DHC+ [105] they are based in the implementation of courses or training activities that were created and developed as an outcome of past initiatives, but have adapted their content and resources to continue to take place.

- Summarizing, and considering that EDDIE will finish with 2023, 14 out of the 26 analyzed projects will finish before EDDIE ends. The rest of the projects will be a matter of attention during the Blueprint's future activities

3.2.2. Educational levels and skills addressed

The projects considered for this analysis focus in the development of skills and knowledge in different educational levels and professional environments. In order to facilitate the analysis, they have been classified regarding their scope of activity: school, university of high education institutions, research institutes, Vocational Education and Training institutions and long-life learning. For each of these stages, correspondent EQF levels have been identified.

Based on the information gathered, it is possible to identify four categories in educational levels addressed:

i) Category 1 (EQF 4, EQF 5):

The following six projects can be considered within this category: YOUNGINN [101], 50/50 [102], ENEFICCIENCY [103], ENERGYBITS [104], ENEN+ [106], and CHALLENGES [111]. These projects implement their activities in secondary schools, with the exception of project CHALLENGES [111] that has also presence in primary schools. Their targets can be considered to lie between the levels 4 and 5 of the EQF. In four out six of the cases the activities are coordinated by European associations, such as the Executive Agency for SMEs (EASME) in ENERGYBITS [104] or the European Nuclear Education Network in ENEN+ [106].

The main goal of most of these projects is to provide general knowledge about renewable energies and energy transition, trying to increase the awareness among the students on the importance on new energy strategies and promote their involvement. They offer the students the information on the challenges faced in energy transition and these are encouraged to provide solutions to improve the energy efficiency of their schools or communities. In projects ENEFFIENCY [103] and CHALLENGES [111] both implemented at regional level, the students have the chance to implement new measures on energy saving in their schools and they have access to measurement equipment to evaluate the results of the application of their solutions.

An exception is found on project ENEN+ [106], where the focus is not in energy transition, but in nuclear power. The main objective of this project is to attract new talents to nuclear careers and increase the interest in this sector among secondary school pupils by introducing them to some specific aspects of the nuclear power and their applications.

The activities implemented such as competitions and learning modules, are supervised by the teachers but the students might have some degree of self-management within their own workgroups.

ii) Category 2 (EQF 5, EQF 6):

Projects VESTE [102], EMTEU [97], SKILLS [98], YOUNGEN [99][107], GAS [107] and COTEDIVORE [108] can be considered to belong to this second category. These projects address the education of skilled technicians, either by setting and implementing educational modules for VET programs or by identifying the required skills in different sectors. The knowledge and skills pursued by these projects are lined up with those from levels 5 and 6 in the EQF.

This is the case of project SKILLS [98], *Skills for the green economy,* carried out by the European Centre for the Development of Vocational Training, CEDEFOP. This project identifies the impact of new energy policies and energy transition in skills requirements and competences and how these need to be adapted to new occupations in the 'green sector'. Also project GAS [107] tackles the identification of skills and VET institutions in the gas sector, aiming to build a better understanding of the VET infrastructure and provide the sector with a skilled workforce. Both projects focus on the situation or strategies of different European countries to achieve general conclusions.

Projects VESTE [102], EMTEU [97], YOUNGEN [99] and COTEDIVORE [108] offer the implementation of different training programs to enhance the skills of technicians to boost their knowledge in specific technologies within the renewable energy sector and energy transition, such as renewable energy management or efficiency in buildings. Most of the participants of these training programs are already developing their professional career but they are required to update their knowledge in these fields.

Moreover, project VESTE [102] also focuses in the development of management skills for professionals working in environments where solutions related to energy transition are to be implemented, in order to enable them to lead the change.

iii) Category 3 (EQF 6, EQF 7):

The six projects classified in this category, TEACHENER [90], SHIFTS [94], SUPERGRID [96], PROSPECT [100], DHC+ [105] and SMARTEM [110], are carried out in collaboration with high education institutions, i.e. universities, VET institutes, associations and companies. The knowledge and skills targeted are within the limits of levels 6 and 7 of the EQF. As the main difference with the previous category, the participants of the different training programs and education schemes are required to come up with new solutions for new problems that arise in the energy scenario. They introduce an innovative element in their scope in comparison with other projects tackling similar topics.

In the case of projects TEACHENER [90] and SHIFTS [94], the innovation lies in the introduction of energy-related Social Sciences and Humanities in the energy portfolio and therefore considering interaction between different fields. Moreover, in project SHIFTS [94] some the participants of this project are required to take responsibility in energy policies decision-making.

Project SUPERGRID [96], developed by the SuperGrid Institute in collaboration with technical universities and institutes in the south of France, aims at explaining what a SuperGrid is and provide training on this technology. For some of the implemented activities the highest level of specialized knowledge is required. However, the most interesting output regarding education is developing in secondary schools with VET students, where the level of skills and autonomy required is limited. In project SMARTEM [110] also VET students are provided with technological skills in the smart energy sector.

Project PROSPECT [100] targets local and regional authorities across Europe, with decision-making responsibility. The objective is to empower the exchange of knowledge and experience on innovative solutions and new strategy approaches to energy transition. In particular, the participants’ knowledge in electricity grids, district heating and energy policies in European cities is enhanced. With a similar perspective, project DHC+ [105] introduces cross-sectoral collaboration on the developing projects related to district heating.

iv) Category 4 (EQF 7, EQF 8):

The eight projects considered in this category, UNISET [86], ATLAS [87], ASSET [88], SMAGRINET [89], ERIGRID [91], ENTRAN [93], ESEIAETP [95] and WAMSS [109] are implemented mostly by universities and research centers. The participants of these projects and the technologies addressed are at the forefront of knowledge in energy-related topics, thus they are considered to cover levels 7 and 8 of the EQF.

The purpose of most of this projects, in particular of projects UNISET [86], ATLAS [87], ERIGRID [91], ENTRAN [93] and ESEIAETP [95], is to create a network to enhance collaboration among high education and research programmes to enable innovation in energy-related fields. This way, universities and research institutes work together in the development of new solutions and new skills leading the transition towards a new energy scenario. Therefore, these projects are implemented at European level and present a global scope.

Nevertheless, in comparison with the other examples, project ERIGRID [91] attempts to create a collaboration network of researchers within a particular technology, smart grids. Project WAMSS [109], as project ERIGRID [91] also focuses in a specific technology, in this case wind and marine energy systems, promoting focused training and development of doctoral research to boost the innovation in these fields.

Project ASSET [88] provides high specialized knowledge in a wide range of topics to postgraduate students and experts in energy-related issues. Its goal is to give support to European energy policies and therefore to those responsible for the strategic approach to different energy domains.

Summary

Regarding the skills levels addressed by the projects discussed, four categories have been identified. The level of specialization of knowledge and skills required for the implementation of the content and activities suggested by these projects increases in each category. The educational methods and approaches to training schemes are oriented to achieve different goals for each category, likewise the outcome required from the participants depends on these categories:

- In category 1, projects aim at increasing the awareness and participants are required to implement small solutions in their local area.
- In category 2, participants present a technical profile and they are encouraged to improve their skills and stay updated on new technologies in the energy sector
- In category 3, knowledge from different fields is incorporated and the participants of the projects are required to assume certain responsibilities in decision-making

In category 4, projects intend to suggest innovative solutions by promoting the sharing of knowledge. Participants are called to lead the progress in energy-related fields.

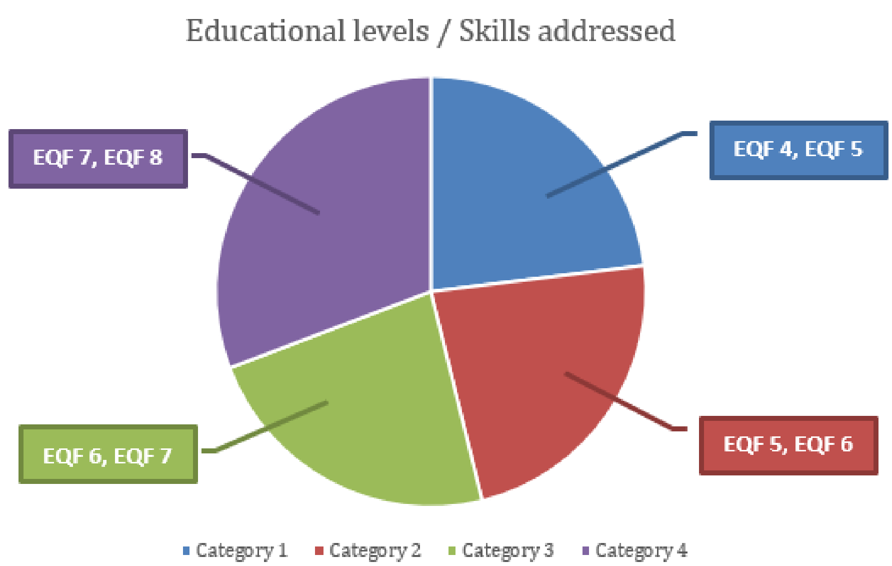

Figure 41 Education levels and skills addressed

3.2.3. Digitalisation and green technologies covered

Most of the projects considered for this analysis are closely related to the development of green technologies that will enable the energy transition, higher integration of renewable energies or smarter management of the power system in the framework of European energy policies. Moreover, the level of specification and detail in the approach to green technologies will depend on the scope of the project and the skills level of the targeted groups. In the same way, digitalisation skills will be subjected to the needs of each particular project. However, it is possible to make a differentiation between two large groups: some projects aim at setting the state of the art of certain technologies and enhance the knowledge in these topics and some others go a step forward and contribute to the further development of the technologies addressed.

Project ASSET [88] is a clear example of the first group, since it aims at deliver studies to summarize the state-of-the-art in energy-related fields in support to European policies. Some examples of the focus of the studies are:

- Penetration of renewables
- Technology pathways in decarbonisation scenarios

- Cross-border transmission capacity
- Role of Gas DSOs and distribution networks in energy transition

Renewable energies and energy efficiency are an important part of the topics addressed by many of the projects. In particular, project EMTEU [97] includes energy saving plans, solar photovoltaic technology and regulation and safety notions in its training curricula, whereas project 50/50 [102] deals with the concept of 50/50, that involves schools in energy-saving by providing economic incentives both for the schools, 50%, and for the local authorities.

Projects PROSPECT [100] and DHC+ [105] integrates also district heating and technologies for urban developing and planning, such as efficiency in public and private buildings and public lighting. Moreover, project PROSPECT [100], together with others projects as VESTE [92] or YOUNGEN [99] introduce modules on management and leadership in the application of energy policies and solutions.

Project WAMSS [109] focuses in research in wind and marine energy by providing specialized training in these fields. This projects present an example on how the training for researchers and specialists seeks for matching the needs of the industry to ensure the innovation and development in wind and marine power.

Project SMAGRINET [89] tackles smart grids and its goal is to create a competence hub to improve the capacity of European universities in research and innovation by including the following modules in their curriculum:

- Artificial intelligence in power systems
- Economic operation and planning in smart grids

In the same context, it also seeks for involving industry and important societal actors by updating their skills and knowledge.

Regarding smart grids, project ERIGRID [91] is a good example of a project that goes a step forward because not only tries to boost the competences in smart grids for industry and academia, but it also aims at providing researchers transnational access to smart grids infrastructure developed by the partners of the project. This way, researchers from different countries and institutions can access to the 19 available installations, creating a cyber-physical system to bring together and promote outstanding research.

There are some other projects that also enable their participants to actively participate in the creation and development of new technologies. Project SUPERGRID [96] also addresses electricity and grids. In this case, its participants, students from the Digital Department in the Lycée Edouard Branly, are encouraged to work in an interactive learning application based on HVDC cable systems. This application is developed by the students in an interactive game to learn about designing, sizing and choosing materials for high voltage DC cables according to their use.

VET students are also encouraged to make their contribution to the smart energy sector in project WAMSS [109] by collaborating in the creation of learning modules and providing their own solutions regarding the digital skills required for the development of smart energy management. In project CHALLENGES [111] smart metering concepts are introduced to facilitate students the evaluation of their energy saving solutions.

The example of project ENEN+ [106] is also interesting because it focuses in a different industry within the energy sector: nuclear power. In particular, it addresses nuclear reactor engineering and safety, waste management and geological disposal, radiation protection and medical applications.

Projects TEACHENER [90] and SHIFTS [94] integrate social sciences and humanities in energy education by introducing these topics in the online learning modules they provide in their trainings. For example, in project TEACHENER [90] an online platform, EDUKIT, has been developed to teachers can have access to modules covering, among others:

- Philosophy and ethics of energy development
- Social impact on energy technologies
- Smart metering
- Decentralized energy systems

Summary

Energy transition, renewable energies and solutions to improve energy efficiency are a common denominator in most of the projects analyzed. In view of this, many of the projects address these topics in general terms, providing a general scope, meanwhile some others focus in specific technologies, such as smart grids or smart metering.

Furthermore, the integration of social sciences and multidisciplinary skills when dealing with green technologies become relevant in the approach of some of the projects

3.2.4. Educational tools and methods

The educational tools and methods employed in the projects considered depends on the skills level of the participants targeted and the specification of the knowledge aiming to provide. Therefore, there is a correlation between the educational methods and the different categories previously described in relation with the skills levels addressed. Nevertheless, it is possible to find common patterns in the kind of activities implemented.

Methodology and implemented activities

Firstly, one of the techniques to provide the required knowledge in different topics is to develop learning modules gathering the content intended to be covered by the projects. Through the settling of these modules, more precise definition of the project scope is achieved. For example, project PROSPECT [100] includes five thematic learning modules in efficient urban development whereas project SMAGRINET [89] present modules in artificial intelligence in power systems, economic operation and the planning aspect of smart grids. In some case, as in the last examples, these modules are integrated in the curriculum of already existing courses of institutes and universities whereas in other projects, as TEACHENER [90], eight modules covering social aspects of energy development are gathered in an online platform.

Secondly, most of the projects organized workshops and on-site trainings of different duration to provide the required knowledge and skills to the participants. The duration of trainings and the degree of innovation presented usually depends on the objectives of the projects and its scope. For example, project VESTE [92] presents two traditional training models, of 70-80 or 300 hours where the participants complete compact of comprehensive courses respectively on the use of renewable energies and identification of energy savings. There are some examples, ESEIAETP [95], DHC+ [105], in which the trainings can be implemented in summer schools, where the participants spend some days during summer attending to conferences and participating in workshop and discussion groups. Project YOUNGEN [99] presents an example of application of the knowledge acquired in the trainings, since after a four-day workshop, an energy efficiency project is actually developed and implemented by the participants in their own company as part of the training.

One of the most extended methodology to improve the educational level of the projects is to give support to those in charge of the teaching to make sure they receive the required qualification for the implementation of the courses and training. Project SMAGRINET [89] and VESTE [92] implement the initiative Train-the-trainer, where teachers receive the tools needed to carry out the courses independently

Aiming to increase the involvement of the participants, some projects organize competitions among several groups of students. In projects ENEN+ [106] and SMARTEM [110] participants compete with other groups across Europe, showing their involvement and understanding of the topics to get to the final, where they are invited to an international event. Project CHALLENGES [111] in interesting because students form groups with their classmates and they compete against other groups of their same school to implement the most efficient energy-saving measures.

Project PROSPECT [100] presents the initiative of peer-mentoring, in which one-to-one relationships are established between the participants and their mentors, carefully chosen to match the interests and needs of the mentees to achieve a most efficient problem solving.

Digital tools

Some of the digital tools used in this projects have been already mentioned, as the online platforms where teachers and educators but sometimes also the students can have access to the information and the contents developed in the framework of the project. In project TEACHENER [90] this online platform, EDUKIT, has been especially designed for the project implementation, and not only provide access to the learning modules but also other materials such as class plans and exercises. Others projects, as ENTRAN [93], utilized already existing technologies, like EMMA, European Multiple MOOC Aggregator, where participants can have access to MOOC covering a wide range of topics.

The case of project ATLAS [87] is particularly interesting when considering digital tools because this project is based on the development of a browse tool to offer information on energy-focused master's and research programmes across Europe, facilitating the access to the range of possibilities in energy education within Europe.

Projects with young participants, implemented in secondary schools, tend more likely to use innovative techniques to increase the involvement. This is the case of projects ENERGYBITS [104], ENEN+ [106] and SMARTEM [110] where participants are encouraged to record a video covering different energy-related topics as part of the competition. Moreover, in project SMARTEM [110] the students contribute to the development of the Toolkit on "Smart Energy Management", getting to apply themselves the digital skills needed for the design of the course content. In this same direction, project SUPERGRID [96] also promotes the active participation of the students in the development of technologies used as part of the course content by collaborating in the development on an app to assess HVDC cables technologies, as mentioned in previous sections. These two projects are examples in which the students not only learn and get benefits from the utilization of a certain technology as part as they learning outcome, but they also contribute to its development.

Project ENERGYBITS [104] introduces energy issues related to sustainable development through an online game where students are supposed to fulfill 9 interactive missions. The performance of the students in this game can be used as an assessment of the acquired skills.

Another example of digital tool employed can be found in the implementation of project 50/50 [102] where participants are encouraged to use social media to publish post about activities carried out within the framework of the project and share photos to extend the concept of 50/50.

In those projects in which the participants are invited to provide solutions to improve the energy efficiency of their school, as project CHALLENGES [111] and ENEFFIENCY [103], smart metering devices are used to evaluate the impact of the measures taken. This means that the students get to familiarize with these tools, at the same time their interest in the use of new solutions and technologies is promoted.

Summary

Even though there is a wide range of different activities implemented depending the scope of each projects, there seem to be some guidelines in the methodological approach.

First, the content of the courses and trainings is intended to be clearly defined through learning modules. Secondly, these trainings are implemented in different formats and platforms, they are usually combined with activities such as competitions or one-to-one mentoring and adapted to the targeted participants accordingly to their age or level of specialization. digital tools have an important presence in the development of activities and digital skills are required in many of the projects. However, only few projects focus on enhancing digital skills of the participants by promoting their collaboration on the development of these tools.

3.2.5. Education on Smart Grids and Digitalisation

In this section literature and initiave's review is performed and presented, which focuses on education on Smart Grids, as they are on the forefront of the digital transformation of the energy system.

Recent years have witnessed significant efforts in improving electrical engineering education to foster the energy transition. In this subsection, we provide a review of a selection of relevant initiatives carried out in the last decade in the area of education on smart grids and digitalisation, highlighting the main focusses of each them. Although the report may not include all initiatives, we believe that those mentioned, are relevant to illustrate what, and at which level, the issue has been tackled so far and to focus the gaps.

Education and training in the area of intelligent energy systems, especially on smart grids, can be built on communicating the concepts of modelling and simulating components to understand how they work as a system. When engineers design intelligent concepts like energy management systems, voltage control, etc., they need to understand the paradigms of centralized and distributed control, how to use different tools, know their strength and weaknesses and how to interconnect them. This topic is well addressed in [114]. The paper reviews the challenging needs and requirements for educating current and future researchers and engineers in the domain of intelligent power and energy systems. Corresponding possibilities and necessary tools are described as well, not only focusing on the classroom but also on laboratory-based learning methods, and experiences of using notebooks, co-simulation approaches, hardware-in-the-loop methods and remote labs experiments are discussed

In the context of education on smart grids and digitalisation, several initiatives have been going on since the last decade, at an international level.

For example, since 2010, the Robert W. Galvin Center for Electricity Innovation at the Illinois Institute of Technology (Chicago, Illinois, US) is home to the Smart Grid Workforce Education and Training Center - a $12.6 million project, supported by the U.S. Department of Energy and the State of Illinois, to educate and train the nation's workforce to meet the global challenges and opportunities of the Smart Grid [115]. This initiative has worked since then to educate and train thousands of people on Smart Grid and new energy topics, developing new curriculum through a network of partners, from basic schools to community colleges, university degree programs, and industry professional development short courses. In June 2011, the Galvin Center released a report outlining the skill deficiencies of the existing workforce to meet the demands and needs of the Smart Grid economy of the future. Two main points were pinpointed namely: 1) the technologies and systems introduced through Smart Grid initiatives would require a highly-trained and flexible workforce to fully realize the smart grid promise, deploying and maintaining the national clean-energy smart grid infrastructure; 2) growing and training the smart grid workforce would only be possible if the industry commits to intensive, sophisticated, and integrated workforce-development initiatives. The Galving Center's program on Smart Grids Education has been active in the organization of workshops, seminars and conferences also open to the public, and still ongoing.

Several entities are helping in Smart Grid workforce development including the Australian Center For Energy Workforce Development (CEWD), the IEEE Power and Energy Society, National Science Foundation (NSF), the Power Systems Engineering Research Center (PSERC) and the U.S. Department of Energy (US DOE), in collaboration with several power industry members. In the recent past, the US DOE supported several projects for workforce development in the so called "smarter electric grid", offering various new educational and training opportunities in collaboration with industry, and supporting strategic training and education for multidisciplinary initiatives at the educational institutions. These initiatives provided opportunities to both train new hires and retrain existing workforce in electric utilities for advanced topics in smarter electric grid. In this context, the authors of [116] present details of course development process, challenges faced and lessons learned in developing such a multi-disciplinary course at the Washington State University. The faculty course includes topics such as fundamentals of power engineering, associated controls, communication system, computing, data management and cybersecurity aspects with a threefold objective: 1) enabling the students to better design and understand 'other' design aspects of an industry project related to the smarter electric grid; 2) enabling the students also to understand the cyber-physical nature of the smart grid as well as the constraints posed by 'other' disciplines ; 3) enabling the students to understand the interplay of cyber and physical infrastructure within smarter electric grids, as well as to analyze the interdependencies and design advanced technological solutions for next generation smarter electric grid. The audience for the course and materials are undergraduate and graduate students in engineering and computer science as well as university-level instructors.

Another interesting step towards potential curriculum changes is that of a project centered on the development of a Smart Home Test Bed based on the pedagogical model of project-based learning for undergraduate education, for the program of Electrical and Computer Engineering of the University of Tennessee, Knoxville, Tn (USA). This project is described in [117], and consists in the development of a smart home energy management system initially designed as a Research Experience for Undergraduates (REU) program in the field of Electrical and Computer Engineering and gradually evolved to a platform for senior design, so becoming a significant milestone in bridging the gap between traditional power systems curriculum and smart grid. Various electrical engineering-related technologies can be integrated into the test bed, such as demand response, electricity market, machine learning, pattern recognition, wireless sensor networks, Web UI design, circuit design, and databases

In Europe, the École nationale supérieure de l'énergie, l'eau et l'environnement (ENSE3 – Grenoble INP) in Grenonle, France, has an ongoing project on education to Intertnet of Things (IoT). Paper [118] presents this "learning by doing" lab project of ENSE3 with support from IdEx program of Université Grenoble Alpes, aimed at developing a multidisciplinary, open and remotely accessible lab for learning-by-doing education specifically on the subject of IoT. The lab is now completed and operating in full mode, providing energy data from different sources through different digital technologies servers (SCADA, EMS, DERMS, AMI, SIEM) and then making them accessible remotely. It comprises six main blocks, namely:

1) Industrial Control System Lab, formed by a set of networked PLC and IED covering most of the communication technologies (Modbus, CAN, Profibus, Profinet, Ethernet/IP, Ethercat, IEC 60870 and IEC 61850) from which the users can build various industrial control and power grid protection architectures. The lab is completely reconfigurable and still developing in functions and size.
2) ENSE3 Power Grid Control Room lab based on ATOS Worldgrid technology and connected with a distribution network demonstrator.
3) Distribution network experimental bench. Our own small size distribution network allows us to test real faults and smart-grid reconfiguration on realistic distribution networks.
4) Distributed Energy Resources experimental bench. A mix of photovoltaic, wind, cogeneration and fuel cells allow to reproduce at a reduced scale a distributed energy asset network.
5) Intelligent building lab: An IIoT network deployed on one of the building classrooms allows the study of smart-home communication networks and HEMS and BEMS technologies.
6) GreEn-ER: The building hosting ENSE3 (called GreEn-ER: Grenoble Energy – Education and Research) is a full-size industrial case of smart building and smart-energy management plant. B. Education project ECO-lab is intended to be used in an innovative pedagogy education: we combine the learning-by-doing practical education in a project-like environment with a distant selfeducation o digital technology.

Authors in [119] presented last year a similar idea developed by Finnish universities, to use IoT for elearning purposes. A very original prototype platform has been, in fact, built at LUT University, to provide elearning solutions in the Electrical Engineering program as well as in several research programs of the university. The platform builds upon the Trojan Room coffee pot [120], a coffee machine located next to the so-called Trojan Room in the old Computer Laboratory of the University of Cambridge, England, which in 1991 provided the inspiration for the world's first webcam. To save people working in the building from the disappointment of finding the coffee machine empty after making the trip to the room, a camera was set up providing a live picture of the coffee pot to all desktop computers on the office network. After the camera was connected to the Internet a few years later, the coffee pot gained international notoriety as a feature of the fledgling World Wide Web, until it was retired in 2001. Following Stafford-Fraser's footsteps, a coffee maker was selected as the building ground for the IoT platform, given its simplicity and frequent use. The platform represents an example of an IoT application where different sources of data of various forms and data types are connected. The technologies and tools used in building the platform, such as APIs and edge computing, are viable and used on a large industrial scale. Hands-on experience with a real IoT platform brings definite advantages, which may otherwise be difficult to achieve, and the technologies learned when students work on the platform are important skills to master after graduation.

Also KTH-the Royal Institute of Technology in Sweden is making efforts to developed courses aimed at bridging the Electrical Engineering and Information Communication Technology disciplines in [121]. The course portfolio at KTH is designed to complement several master programs offered by the university, and the intended audience are students and practitioners both with and without the power engineering background. The course deal with properties of underlying ICT infrastructures for automation, operation, and control of transmission and distribution systems. The portfolio aims to prepare students for work within the fields of management and control of active distribution grids as well as within transmission system operation. The inputs used for this design are both experiences from traditional teaching at KTH and benchmarking of developments at other universities worldwide. To ensure that the portfolio caters the needs of students, a survey on student expectations was performed to provide additional input to the portfolio design. The keystone course in the portfolio, Computer Applications in Power Systems (CAPS), provides students with varying backgrounds an introduction to automation and control of active distribution grids and transmission systems. The course consists of three course modules that cover the topics of power system automation and protection devices, power system communication systems, and control room applications. After this course, the portfolio offers students two main options, a continuation project that includes analysis, design, and implementation of a distributed control function for active distribution grids utilizing agent-based technology; or a master degree project on the subject of power system operation and control. Results from course evaluations from different perspectives are presented in this paper, generally indicating an increasingly positive trend in terms of student satisfaction.

Similarly, to the two initiatives abovementioned, a simulation-based training platform for educating students and power systems professionals in complex Smart Grid applications is presented in [122]. The platform covers traditional power systems topics, grid components, communication systems and automation infrastructure. In addition to the co-simulation approach, the coupling of operation and control systems within real-time constraints bring together the domains of planning and operation. The platform enables various options to validate simulation (e.g., power system) by connecting to production run-time systems (e.g., control system platform and SCADA).The training and education platform is used in a Master degrees' course at the University of Applied Sciences Technikum Vienna. In addition, the training platform was also successfully used to train test engineers in a Smart Grid validation and test laboratories.

Finally, it is a good example to mention here the Master Degree in Science of Smart Grids given at the Pontifical University Comillas (ICAI School of Engineering) along with the University of Strathclyde in Glasgow and supported by Iberdrola. The objective is to educate engineers with a minimum 4 years degree in both technologies power systems and telecommunications, complemented by a practical internship with a content assigned according to the real needs of the industrial company (Iberdrola) for its Smart Grids operations [129].

Paper [123] presents the design and implementation of an interactive platform to assess Advanced Distribution Automation (ADA) with applications and solutions focused on relaying solutions for educational purposes on smart grid. The proposed architecture integrates hardware/software tools to emulate the distribution system's behavior and recreate selected signals. Different features are presented and validated from a basic case study, from where students can understand the main concepts of relaying devices. The operational functionality of the platform offers the required flexibility to link theory with practice, which is suitable to enhance the learning process and encourage the class innovation. The user can incorporate protective algorithms and automation solutions under a real-time environment with hardware-in-the-loop techniques, such as adaptive protections and reconfiguration methods to optimize the grid. The impact of this platform in educational courses and the development of undergraduate thesis was assessed over the last 5 years in the faculty of Electrical and Electronic Engineering of the Universidad de los Andes, in Bogota.

The European Commission's Strategic Energy Technology (SET) Plan and the SET Plan Roadmap Education and Training[86] encourages higher education institutions and business to establish adequate co-operative education, training schemes and learning systems to face the challenges posed by the energy transition in Europe.

In the SET Plan context, in [124] a literature study and a data-base search on existing co-operative education formats are carried out. Additional, seven actual case study reports drawn for the European BioEnergyTrain (BET) project are analyzed. The study discusses cooperative education regarding its roots, types, role of business, type of rotation, salary, and legal issues as well as efforts on a European level to create and put into practice adequate forms of co-operative education supplemented by case studies. The results show that most of the dual study programmes are on a bachelor's level and partly related to a limited sharing of collective university information on comprehensive platforms. As a conclusion, there is not much available data on co-operative study programmes, probably because these programmes play a minor role in the overall education system. Apart from dual study programmes, co-operative education and training formats usually are ambiguously defined and those focused on meeting the challenges posed by the energy transition is low.

In the same context of the SET Plan, another publication [125] presents different scenarios:

- Electric Power Engineering Education in the United Kingdom: it presents the main issues British universities need to focus on to ensure an adequate number of appropriately trained electrical engineering graduates are available to join the power and energy. It also presents the Engineering and Physical Sciences Research Council Centre for Doctoral Training in Power Networks, fund created to promote Ph.D. research projects.

- Electrical Engineering Education in Italy: describes the educational scheme in Italian universities, focusing in electrical engineering. It provides an overview of the following:

- Electrical Engineering Courses in Italy
- Students Enrolled and Graduated

- Threats to the Electrical Engineer Brand
- Employment Opportunities for Electrical Engineers
- Initiatives to Promote Electrical Engineering Courses

As a conclusion, this publication establishes that it seems that given the increase of electrification in cities and communities, the number of students who join electrical engineering programmes is not increasing enough. Consequently, meetings and international conferences organized by the IEEE PES and sister Societies should intensify the promotion of the professional role of the electric power engineer through the media and social networks.

The basis to turn the existing power system into an intelligent entity (smart grid) resides in sophisticated design approaches and intelligent automation. System-level testing will play a significant role in the development of new solutions for sustainable energy supply, and there is a need of proper validation approaches, concepts and corresponding tools. New generation scenario together with partially controllable loads, changes of regulatory rules, technology developments and liberalization of energy markets require more complex operation of the distribution grid for network operators and adaptation of the system operation. Authors of [126] address these aspects in the integrated Pan-European research infrastructure project ERIGrid where proper validation methods and tools are being developed since 2016 for validating smart grid systems and solutions. The paper first exposes the need of a higher digitalisation of distribution networks and integrated and holistic power system testing. Then it presents the project ERIGrid, introducing its main goals, research lines and the status of the corresponding technology development, which regard specifically holistic testing of smart grid configurations, improved assessment methods and integrated Pan-European research infrastructure. The paper also dedicates one section to interdisciplinary education of researchers and engineers, since the ERIGrid project provides proper education and training for researchers and engineers, mainly in the following topics:

- Physical behaviour of smart grid systems and its connected subsystems and components
- Automation and control systems
- Communication networks
- Advanced control, optimization, and data analytics

There is recent discussion about how can skills development best support development that is sustainable for individuals and communities. In [127] they criticize the idea of green skills for the green economy since they think it is inadequate for achieve transformed and transformative VET that shifts the target from economic growth to the wellbeing of individuals, enabling vocational education to play a role in challenging and transforming society and work. Instead, they focus on the idea that human development and sustainable development are inseparable, so VET needs to be planned and evaluated regarding its contribution to these. This approach is based on a view of work that is decent, life-enhancing, solidary, environmentally sensitive and intergenerationally-aware. It states that current VET prepared people for works that lacks some of these characteristics. VET must be concerned with poverty, inequality and injustice, contribute to their eradication and be supportive of individuals. It must also minimize the costs and risks of any transformation for the poor and seek to lock them into better individual and communal lives, and it must transform skills regarding all of these principles.

In this paper, sustainable development and green skills for a green economy are presented. It provides a vision of green skills as a hollow promise, giving reasons for this skepticism. Finally, it provides a more radical approach in skills for sustainability with some principles for an integrated sustainable development:

- a strong focus on human development
- a theory of sustainable work
- a political economy of skills account
- a theory and practice of change that minimize the costs and risks, and maximizes the likely benefits, of any transformation for the poor

This paper talks against the vast majority of research and policy thinking in the VET field and point towards a new way of doing VET research that genuinely engages with questions about its purpose, that should be grounded in a view of work, and hence skills for work, according to the principles previously described.

In the context of photovoltaic market growth, PV industry faces achallenges due to the lack of adequate skilled force for the PV installation and maintenance, which may lead to poorly installed system with negative impact on the PV industry. The PVTRIN, an Intelligent Energy Europe (IEE) project, addresses to these issues, by developing a training and certification scheme for the technicians/electricians/engineers that activate in the installation and maintenance of small-scale PV systems. In this context, publication [128] presents the methodology on how this is going to be implemented by developing an action plan aiming to achieve certain goals regarding the creation of a qualified skill force in this sector. The project has different expected outcomes regarding courses implementations and providing of training material. The final goal is to increase the penetration of PV technology in the energy mix.

3.2.6. Projects results and learnings for EDDIE

Regarding the project and result continuation, it is important to consider that 17 out of the 26 projects considered are still ongoing. Some of them are intended to end in the next few years and some others have not explicitly established an end date. This entails a certain difficulty when it comes to evaluate the impact of these projects, since it is not possible to yet identify some of their outcomes.

Some of the projects analyzed focused on the dissemination of the state of the art of certain technologies or skills needed to deal with them. This is the example of projects SKILLS [98] and GAS [107], which provide an insight in the skills needed to meet the future demand of skilled technicians in the energy transition field and in the gas sector respectively. Project ASSET [88] is still ongoing but has already published some relevant studies regarding the state-of-the-art in energy-related domains, such as efficiency in smart energy systems. These studies, same as those developed in the framework of project SHIFTS [94], are oriented to have an impact in European policy-making regarding the energy sector. But of course, the ultimate impact of these kind of projects and whether they end up reflected in European policies will depend in the scope of their outcomes and the number stakeholders reached, which is difficult to evaluate on the short-term. In this sense, in project SHIFTS [94] for example, the initiative of a pan-European conference, bringing together 130 stakeholders, is being developed to widely share the findings of the project.

Those projects that provide specialized training to their participants, such as projects VESTE [92], ESEIAETP [95], EMTEU [97], YOUNGEN [99], COTEDIVORE [108] or WAMSS [109] collaborate to boost the development of the energy sector by enlarging the knowledge and the skills of the professionals working in it. Moreover, in some cases, as in project YOUNGEN [99], they add an extra asset to the companies the participants belong to, since in the practical phase of this training, they implement an energy efficiency project in the companies. Furthermore, higher skilled professionals are an asset by themselves.

The case of project ESEIAETP [95] is particularly interesting because it started its activities in 2010 and it has been adapting the content of its training courses and summer school since then. Also, the training courses offered in project EMTEU [97] have been provided since 2009. These training courses in particular, enable to obtain a certain accreditation to work as technician in renewable energies, which might be attractive for professionals to continue to participate in this program.

Some of the projects implementing train-the-trainer activities aim at providing teachers and trainers the skills to continue developing the education programs after the end of the project. It is the case of projects VESTE [92] and SMAGRINET [89], which offer a specific program for lecturers at universities so the teachers get qualified for the independent implementation of courses. In the case of project SMAGRINET [89], these courses are three learning modules that it aims at integrating in the curriculum of the participating universities. Hence, they are intended to survive the scope of the project.

Many of the projects intend to create a knowledge network, especially among research programmes. Projects UNISET [86] and ATLAS [87] intend to mobilize the research and the innovation of European universities by building a network where information about the different educational programmes is available. Project ERIGRID [91] aims at integrating the available research infrastructure for smart grids. In project ENTRAN [93], the objective is also to strengthen collaboration between academia and industry. By increasing the collaboration between different actors within the energy sector possible synergies might be exploited for its progress. In this case, the main advantage of these initiatives is that the networks and collaboration developed in the framework of the projects may as well survive after the end of the activities of the project. For example, in project PROSPECT [100] the peer mentoring established between mentor and mentee build bridges for further collaborations between the authorities of the regions they belong to.

Finally, the purpose of increase the awareness on energy-related topics in the framework of European energy-policies and guidelines is implicit in most of the project. This increase of the awareness is an outcome by itself, which is achieved in higher or lesser measure depending on the project. In this sense, projects such as YOUNGINN [101], 50/50 [102], ENEFFIENCY [103], ENERGYBITS [104], CHALLENGES [111] and SMARTEM [110], whose activities are implemented in schools, might open the door to integrate some of the contents they addressed as part of the educational curricula with its corresponding long-term results.

Table 21 Learnings and lessons learned

Conclusions from 2.2.2	Work Package
Regarding the skills levels addressed by the projects discussed, four categories have been identified. The level of specialization of knowledge and skills required for the implementation of the content and activities suggested by these projects increases in each category. The educational methods and approaches to training schemes are oriented to achieve different goals for each category, likewise the outcome required from the participants depends on these categories: - In category 1, projects aim at increasing the awareness and participants are required to implement small solutions in their local area. - In category 2, participants present a technical profile and they are encouraged to improved their skills and stay updated on new technologies in the energy sector - In category 3, knowledge from different fields is incorporated and the participants of the projects are required to assume certain responsibilities in decision-making - In category 4, projects intend to suggest innovative solutions by promoting the sharing of knowledge. Participants are called to lead the progress in energy-related fields.	WP2: Identification of current and future skill needs in the Energy Sector
Many of the projects intend to create a knowledge network, especially among research programmes. The tendency is to mobilize the research and the innovation of European universities by building a network where information about the different educational programmes is available, boosting the knowledge exchange. Some projects also aim at strengthening collaboration between academia and industry by combining efforts to implement training schemes that respond to the needs of both.	WP3: Stakeholder mapping and strategic network building
Even though there is a wide range of different activities implemented depending the scope of each projects, there seem to be some guidelines in the methodological approach. First, the content of the courses and trainings is intended to be clearly defined through learning modules. Secondly, these trainings are implemented in different formats and platforms, they are usually combined with activities such as competitions or one-to-one mentoring and adapted to the targeted participants accordingly to their age or level of specialization. Those projects developing their activity in academia and research centers are more likely to be implemented at European level. However, it seems necessary	WP4: Assessment of policies and requirements for VET and beyond

to enlarge the scope of those projects targeting VET institutions to boost further collaborations at European level.	
Digital tools have an important presence in the development of activities and digital skills are required in many of the projects. However, only few project focus on enhancing digital skills of the participants by promoting their collaboration on the development of these tools. Energy transition, renewable energies and solutions to improve energy efficiency are a common denominator in most of the projects analyzed. In view of this, many of the projects address these topics in general terms, providing a general scope, meanwhile some others focus in specific technologies, such as smart grids or smart metering. Furthermore, the integration of social sciences and multidisciplinary skills when dealing with green technologies become relevant in the approach of some of the projects.	WP5: Blueprint for the Digitalisation of the European Energy Sector development
The added value of each project to education, depends on many factors, such as the context of each participant, institute, company or country. It seems important to keep this in mind when implementing the project activities, since there is a difference in the actions plans developed for each educational level addressed.	WP6: Blueprint: Roll out and action plan
It is difficult to analyze the result of the projects considered since most of them are still ongoing. Those project focused on the analysis of certain fields within the sector can be applied to the decision-making in energy-policies and development of educational schemes. Those that provide training allow to continue benefiting if the required training is provided for the trainers to implement the trainings independently. Enhancing collaboration and networking between universities, research and industry leaves the door open to build permanent relationships between these actors. Finally, those projects focused on awareness-increase could be only assessed in the long-term.	WP7: Dissemination, Exploitation and Policy recommendations

3.3. Conclusions

At first, the review focuses on the analysis of 9 Erasmus+ SSA Blueprint projects representing different industries. The review aimed to obtain valuable insights regarding educational levels and skills, technologies, tools and general learnings for EDDIE. Regarding the different educational levels, significant remarks were made and the targeted skills to be developed throughout the various identified Erasmus+ projects were addressed. Even if many of the projects are still ongoing, the way of addressing and establishing the sustainable Blueprint has been analyzed as of particular importance to apply, whenever suitable, to EDDIE.

Table 18 gives an indicative picture of the EQF levels correspondence to the aforementioned categories in national level. The particular information highlights the importance of VET education in all EU countries based on the observation that VET students can reach a wide range of EQF levels, from EQF 2 up to EQF 7.

Soft skills are becoming more and more important in our society and VET providers shape educational programmes to focus more on soft skills due to the job market demand. This is observed across the total of the examined projects. That means that soft skills constitute a common need for all sectors and VET providers should redirect their programs in all EQF levels to address the particular issue.

Moreover, it is obvious that the era of digitalisation impacts all different sectors such as automotive, EO/GI, maritime, tourism etc. A wide range of skills like 3D printing, artificial intelligence, big data / data analytics, cybersecurity, digital networks, IoT, virtual product development are some of the so called cross-sectoral digital skills.

In addition, another trend across the different projects was noted related to the green skills. These have become a requirement, due to the global concern of climate change, in order the various organisations to achieve energy efficiency, limit produced pollution and environmentally-damaging emissions, comply with increasingly strict regulatory requirements and present an overall environmentally friendly image.

Another interesting conclusion is that in contrary to the past, when a narrow well-defined set of skills was successfully used in long term, professionals need a wide set of skills or ability to upgrade their skills in order to achieve their full potential. Therefore, nowadays job candidates need a set of transitional skills, as well as sector-specific and cross-sectoral skills.

Last but not least, it was highlighted that the collected evidence does not focus only on skills shortages and skills gaps, but it is more about the mismatch between skills as addressed and developed in the education of the relevant sector and the skills required by the corresponding job market. In conclusion, a mismatch could arise when the provided skill-set is greater than the demand resulting to over-skilled or over-educated professionals. The latter could struggle to find an appropriate job, or have a job without fully exploiting their skills and education

The next focus is on technological trends and needs with emphasis to the digitalisation and green technologies covered through VET education. Nowadays, new environmental policies lead to technological advancements which are rapidly penetrating the industry leveraging the use of ever-increasing data and a wide and diverse set of digitalisation technologies.

Digitalisation is considered the main technological trend of the future which can facilitate the further growth of different sectors as well as their environmental impact and eventually define the associated skills requirements in the labour market. For instance, information technology can reduce the environmental impact of buildings in the construction sector via the development of the energy and electricity consumption visualisation. The following technologies are digital enablers attracting an increased investment interest and the participation of several industry actors across various sectors:

- Telecommunications
- IoT
- Cloud computing
- Big data analytics
- Artificial Intelligence
- Automation
- AR/VR
- Block Chain
- automation
- robotics
- Artificial Intelligence (AI)
- 3D printing
- cybersecurity
- geo-localisation

In addition, significant evolution in green technologies has been evidenced across multiple sectors. Eco-friendly practices and smart technologies have been merged to achieve the future goals of low carbon economies and eliminate the adverse environmental impact. Therefore, energy efficiency, recycling, health and safety concerns, renewable resources and more are already on the table of various projects dedicated to the vocational education and training aiming to satisfy the requirements of this era.

Also, an identification of tools and platforms deployed or planned to be developed and used for different Blueprints projects is conducted. Summarizing the results, the identified tools across the various projects target to features like accessibility, interoperability, compatibility, comparison and matching (training – sector needs) capability.

The next part of the analysis is focused on educational related projects and initiatives in the energy sector as well as literature review on related publications. For the projects/initiatives' analysis, 26 projects were included. The areas the review focuses are similar to the Erasmus+ projects. Educational levels and skills, technologies, tools and learnings for EDDIE are considered.

Regarding the educational levels and levels addressed by the projects discussed, four categories have been identified. The level of specialization of knowledge and skills required for the implementation of the content and activities suggested by these projects increases in each category. The educational methods and approaches to training schemes are oriented to achieve different goals for each category, likewise the outcome required from the participants depends on these categories:

- In category 1 (EQF 4-5), projects aim at increasing the awareness and participants are required to implement small solutions in their local area.
- In category 2 (EQF 5-6), participants present a technical profile and they are encouraged to improve their skills and stay updated on new technologies in the energy sector
- In category 3 (EQF 6-7), knowledge from different fields is incorporated and the participants of the projects are required to assume certain responsibilities in decision-making
- In category 4 (EQF 7-8), projects intend to suggest innovative solutions by promoting the sharing of knowledge. Participants are called to lead the progress in energy-related fields.

When addressing digitalisation, it is noted that, energy transition, renewable energies and solutions to improve energy efficiency are a common denominator in most of the projects analyzed. In view of this, many of the projects address these topics in general terms, providing a general scope, meanwhile some others focus on specific technologies, such as smart grids or smart metering.

Furthermore, the integration of social sciences and multidisciplinary skills when dealing with green technologies become relevant in the approach of some of the projects

When addressing educational tools and methods, even though there is a wide range of different activities implemented depending the scope of each projects, there seem to be some guidelines in the methodological approach. First, the content of the courses and trainings is intended to be clearly defined through learning modules. Secondly, these trainings are implemented in different formats and platforms, they are usually combined with activities such as competitions or one-to-one mentoring and adapted to the targeted participants accordingly to their age or level of specialization. digital tools have an important presence in the development of activities and digital skills are required in many of the projects. However, only few projects focus on enhancing digital skills of the participants by promoting their collaboration on the development of these tools.

The review shows a clear gap concerning skill analysis for the digitalisation of the energy sector and the adoption of green technologies and skills

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5. Annex 1: Summary of Eramus+ SSA Blueprint projects

1	**Skills Alliance for Sustainable Agriculture** http://www.sagriproject.eu/
2	**EO4GEO: Towards an innovative strategy for skills development and capacity building in the space geo-information sector** http://www.eo4geo.eu/
3	**Maritime Alliance for fostering the European Blue Economy through a Marine Technology Skilling Strategy** https://www.projectmates.eu/
4	**The Next Tourism Generation Alliance** https://nexttourismgeneration.eu/
5	**Development and Research on Innovative Vocational Educational Skills** https://www.project-drives.eu/en/home
6	**Skills for Smart Textile, Clothing, leather and Footwear industries** http://www.s4tclfblueprint.eu/
7	**Sector Skills Strategy in Additive Manufacturing** http://www.skills4am.eu/
8	**Skills Blueprint for the Construction Industry** http://constructionblueprint.eu/
9	**Futureproof Skills for the Maritime Transport Sector** https://www.skillsea.eu/

Project #1	**Skills Alliance for Sustainable Agriculture** http://www.sagriproject.eu/
Project goals	The purpose of the SAGRI project is to provide farmers and agricultural stakeholders with knowledge, skills and competencies in the field of agro-environmental technology for sustainable agriculture.

Project partners	• AGRICULTURAL UNIVERSITY OF ATHENS – Greece • EUROTRAINING – Greece • INSTITOUTO AGROTIKIS KAI SINETAIRISTIKIS OIKONOMIAS “INASO-PASEGES” – Greece • SWISS APPROVAL TECHNISCHE BEWERTUNG S.A – Switzerland • The University of Évora – Portugal • Regibio – Portugal • Confederação dos Agricultores de Portugal – Portugal • University of Basilicata • School of Agricultural, Forestry, Food and Environmental Sciences – Italy • ERIFO – Ente per la Formazione e la Ricerca – Italy • CONFEDERAZIONE GENERALE DELL’AGRICOLTURA ITALIANA - Italy
Start / End dates	2016 / 2019
Project deliverables	• Management and Coordination • Analysis of skills needs for agricultural professionals • Development of the training, assessment and accreditation • Open Educational Resources (OER) platform • Course delivery and pilot testing • Quality Assurance • Evaluation • Dissemination • Exploitation
Sector	Sustainable Agriculture
Link to education	Lifelong Learning and Vocational Education and Training (VET)
Summary: The SAGRI project, will allow agricultural professionals to acquire the skills, knowledge and ability to understand and analyse agroenvironmental systems as natural ecosystems modified by human activity, though with an emphasis on environmental technologies that can be applied to achieve crop sustainable production by means of improved systems’ management.	

Project #2	**O4GEO: Towards an innovative strategy for skills development and capacity building in the space geo-information sector**

	http://www.eo4geo.eu/
Project goals	• EO4GEO aims to bridge the skills gap between the supply and demand of education and training in the space/geospatial sectors, fostering the uptake and integration of space/geospatial data and services in a broad range of application domains.
Project partners	• GISIG - European Association on Geographical Information • KU Leuven • Paris-Lodron-Universität Salzburg • EIT Climate-KIC • Institute for Environmental Solutions (VRI IES) • Universitat Jaume I (UJI) • University of Zagreb (GEOF) • University of Patras (UPAT • University of Twente (UT-ITC) • Friedrich-Schiller University Jena (FSU-EO) • University of Basilicata (UNIBAS) • Planetek Italia • Institute of Geodesy and Cartography (IGiK) • IGEA Ltd. • Epsilon Italia • NOVOGIT AB • Geografiska Informationsbyrån (GiB) • Spatial Services GmbH (SPASE) • EARSC, the European Association of Remote Sensing Companies • Romanian Space Agency (ROSA) • Environmental Information Centre UNEP/GRID-Warsaw • NEREUS' (Network of European Regions Using Space Technologies) • VITO • CNR-IREA • ISPRA - Institute for Environmental Protection and Research • ALFA, Regional Agency for employment
Start / End dates	2018 / 2021
Project outcomes	• Creation and maintenance of an ontology-based Body of Knowledge for the space/geospatial sector based on previous efforts.

	• Design and development of a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programmes. • Development of a dynamic collaborative platform with associated open tools. • Conduct a series of training actions for a selected set of scenarios in three sub-sectors – integrated applications, smart cities and climate change to test and validate the approach.
Sector	Space/Geospatial Information
Link to education	Sector Skills Alliance/ Vocational Education and Training (VET) providers
Summary: The VISION of the Sector Skills Strategy is to foster the growth of the European EO/GI sector ensuring a workforce with the right skills, in the right place, at the right time. The MISSION of the Sector Skills Strategy is to ensure the strategic cooperation among stakeholders on skills development in the EO/GI sector (Sector Skills Alliance). EO4GEO aims to help bridging the skills gap in the space/geospatial sector by creating a strong alliance of players from the sector/community. Our main objective is to reinforce the existing EO/GI training and education ecosystem and fostering the uptake and integration of space/geospatial data and services in end-user applications. EO4GEO will define a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors. EO4GEO will work in an multi- and interdisciplinary way and apply innovative solutions for its education and training actions including: case based and collaborative learning scenarios; learning-while-doing in a living lab environment; on-the-job training; the co-creation of knowledge, skills and competencies; etc.	

Project #3	**Maritime Alliance for fostering the European Blue Economy through a Marine Technology Skilling Strategy** https://www.projectmates.eu/
Project goals	MATES' objective is to develop a skills strategy that addresses the main drivers of change to the maritime industry, in particular shipbuilding and offshore renewable energy. Both sectors are strongly linked and require new capacities to succeed in an increasingly digital, green and knowledge driven economy. As a transversal line of action, MATES will carry out a robust dissemination and outreach plan. This aims to increase the attractiveness of the maritime industry, particularly careers in the shipbuilding and offshore renewable energy sectors, while also ensuring future adoption of the strategy.

	MATES will validate actions and priorities suggested by the skills strategy through the setup of 11 pilot case studies. These case studies will test the MATES concepts on digital skills, green skills, mobility, innovation management, curricula development and ocean literacy. Furthermore, the project will widen perceptions of Ocean Literacy initiatives by embedding an appropriate industrial perspective. It will spread an updated image for the maritime industry and send out a convincing message concerning the high-tech and long-term future of the maritime sector.
Project partners	• Fundación CETMAR • ASIME • CT Ingenieros • AQUATERA • Indigo-Med • AMC • AquaTT • Forum Oveano • FRCT • UGent • WEGEMT • COSNAV Engineering • UvA • UDC • CERTH • Xunta de Galicia • NAOME
Start / End dates	2018 / 2021
Project outcomes	• Development of a long-term Strategy and Action Plan to tackle the current and future skills shortages. • Establishment and involvement of a Europe-wide network of projects, initiatives, organisations and experts. • Identification of future skills and competence needs and the development of corresponding training and curricula. • Greater alignment of industry needs and occupational profiles with training and curricula. • Validation of training and education pathways for effectively increasing employability and career opportunities. • Successful completion of 11 Pilot Experiences and identification of recommendations for the long-term strategy.

	• Targeted industries better equipped to respond to challenges posed by digital, data and green technologies, through access to a more qualified labour force. • Greater resilience in the maritime job market and the safeguarding of stable employment in the shipbuilding and offshore renewable energy sectors. • A more competitive European maritime industry with increased attractiveness of maritime careers for graduates and early-career skilled professionals. • Transfer and exploitation of knowledge in support of Blue Growth.
Sector	Maritime technologies
Link to education	Lifelong Learning, Professional Training, VET, Higher Education, Secondary Education
Summary: The objective of this project is to deliver studies related to EU electricity systems and to large-scale integration of renewable energy sources. In particular, some of the studies include: • Job creation and sustainable growth related to renewables • Islands and Energy Islands in the EU Energy System • EU energy communities • A foresight perspective of the electricity sector evolution by 2050 • Technology pathways in decarbonisation scenarios • Cross-border transmission capacity calculation: analysis of the key parameters • Dynamic retail energy prices • Sectorial integration long-term perspective in the EU energy system • Format and procedures for electricity (and gas) data access and exchange in member states These studies aims to provide a summary of the state of the start in these domains, conduct detailed analysis, including quantitative considerations, on the basis of recognized techniques and to identify the needs to dedicate research and innovation actions to these topics. Moreover, they include also an study of the connections between the electricity grid and other networks and the synergies established between them.	

Project #4	**The Next Tourism Generation Alliance** https://nexttourismgeneration.eu/
Project goals	• The Next Tourism Generation Alliance (NTG) is the first European partnership and alliance for improving a collaborative and productive relationship between education and industry. The NTG Alliance will provide employees, employers, entrepreneurs, teachers, trainers and students with a set of Core NTG modules in digital, green and social skills.

	• To improve the relationship between Industry and Educational Providers in the Tourism sector; • To provide concrete innovative and highly relevant skills products and tools and respond to skills need; • To provide a detailed assessment of the current and anticipated skills shortages, gaps and mismatches in the sector; • To develop a common methodology for assessing the current situation, anticipating future needs and monitor progress to respond to skills gaps; • To identify, describing and indicating priorities for the review or the establishment of new qualifications; • To improve image of tourism career pathways at company and educational level.
Project partners	• Federturismo Confindustria – Italy • Technological University Dublin – Ireland • UnionCamere – Italy. • University of Sopron – Hungary. • Eurogites. • Cardiff Metropolitan University – United Kingdom • Deutsches Seminar für Tourismus (DSFT) Berlin – Germany. • Alicante University – Spain. • People 1st International – United Kingdom. • Breda University of Applied Sciences – the Netherlands • VIMOSZ – Hungary
Start / End dates	2018 / 2021
Project outcomes	• Skills Assessment – Responses methodology • 8 Skills Industry led group • NTG Skills Matrix • Next Generation Tourism Skills toolkit • Human Resources Framework • Quality Framework for NTG products • Ten Case Studies of Best Practices • 3 Pan European NTG Modules reflecting the 3 Core Skills Sets Long term

	• BluePrint Strategy and Action Plan • The NTG Established Partnership • NTG Regional Hubs • Multiplier effects through regional funds in the eight countries and behind
Sector	Tourism
Link to education	VET
Summary: The Next Tourism Generation Alliance (NTG) is the first European partnership and alliance for improving a collaborative and productive relationship between education and industry. The NTG Alliance will provide employees, employers, entrepreneurs, teachers, trainers and students with a set of Core NTG modules in digital, green and social skills.	

Project #5	**Development and Research on Innovative Vocational Educational Skills** https://www.project-drives.eu/en/home
Project goals	• Assessing and inclusion of existing and proven Skills Frameworks in European countries, modernize them to cope with future automotive trends (using expert analysis companies), and deployment into other countries. • Enabling mutual recognition of awards and certificates between formal and informal automotive education, VET and universities, and across Europe in order to enhance the use and success of government funded mobility programmes such as Erasmus+. • Implementation of a common European automotive skills umbrella and integration of existing skills frameworks (Sector skills council, ECQA, AQUA, SkillMan, Skills Passport, etc.) including pilot trainings. • Deployment of the Apprenticeship Marketplace by enhancing its effectiveness for automotive job seekers. Creation of IT infrastructure to facilitate dissemination of common job requirements, which will be available for job seekers, training providers (namely universities), VET providers and other stakeholders. Promotion of the portal as a labour market place on local, national and European levels.
Project partners	• ISCN – Austria • TU Graz – Austria • FH Joanneum – Austria • ETRMA – Belgium • ACEA – Belgium • CLEPA– Belgium

	• Efvet – Belgium • VSB-TU – Czech Republic • Budapest University of Technology and Economics – Hungary • SPIN 360 - Italy • Confindustria – Italy • U Twente – Netherlands • Symbol Business Improvement – Netherlands • East Automotive Alliance – Poland • APIA – Romania • SERNAUTO – Spain • Mondragon University – Spain • AIC – Spain • GESTAMP – Spain • IPV – Portugal • IDESCOM – Portugal • Universidade do Minho – Portugal • Eupportunity – Portugal • SEMTA - UK
Start / End dates	2018/2021
Project outcomes	• PROFILES: Occupational profiles in ESCO format, Automotive Skills Strategic Roadmap or establishing a pool of skills under defined norms. • RECOGNITION: Encompassing already used tools such as OASQF - Open Automotive Skills and Quality Framework, ERFA - European Recognition Framework for Automotive or harmonised skills passport for harmonised ERFA. • IMPLEMENTATION: Integrated Online Campus or European certificates. • APPRENTICESHIP: Understanding the Marketplace and Promoting the apprenticeship marketplace. • EVALUATION: Recommendations on common European standards of automotive job descriptions or actions towards national and European stakeholders.
Sector	Automotive
Link to education	Formal and informal automotive education, VET and universities.
Summary: The Development and Research on Innovative Vocational Educational Skills project (DRIVES) will deliver human capital solutions to the whole automotive supply chain through the establishment of an Automotive	

Sector Skills Alliance, covering all levels of the value chain (vehicle production, automotive suppliers and automotive sales and aftermarket services). Through the network of the partners, DRIVES outcomes will be disseminated EU-wide to more than 300 associations, bringing together more than 270,450 companies of all sizes, representing over 7 million professionals.

Project #6	**Skills for Smart Textile, Clothing, leather and Footwear industries** http://www.s4tclfblueprint.eu/
Project goals	• The identification of concrete actions and tools in order to anticipate and match skills' supply with demand, • The improvement of skills intelligence and information mechanisms by creating networks and partnerships, • The attractiveness of the sector to engage newcomers, families, companies, and policy makers at regional, national and EU levels, • The creation of a network of VET providers, public authorities, and other stakeholders working together on skills development for the modernisation and growth of these sectors, • The engagement of regions and private stakeholders promoting skills and innovation in TCLF sectors in order to ensure the project outcomes sustainability.
Project partners	• Euratex – Belgium • European Confederation of the Footwear Industry (CEC) – Belgium • COTANCE – Belgium • CIAPE – Italy • CITEVE – Portugal • CNDIPT – Romania • COBOT – Belgium • CTCP – Portugal • Hellenic Management Association – Greece • Fundación Estatal para la Formación en el Empleo – Spain • IVOC – Belgium • INESCOP – Spain • UNITEX – France • PIN – Italy • POLITECNICO CALZATURIERO – Italy • SPIN360 – Italy

	• TUIASI – Romania • TUL – Poland • Universitat Politècnica de Catalunya – Spain • PIRIN-TEX EOOD – Bulgaria • Universitat de Lleida – Spain • VIRTUAL CAMPUS – Portugal
Start / End dates	2018/2021
Project outcomes	• Report on project results in TCLF at EU, national and regional level • Research methodology to identify occupations and skills needs. Analysis of the outcomes coming from the Skills Council Report • Future needed skills and trends for the TCLF sectors • First Draft of the Sectoral Skills Strategy – key information
Sector	Textile, Clothing, Leather, and Footwear (TCLF)
Link to education	VET
Summary: The project aims to enhance the modernisation and competitiveness of the EU Textile, Clothing, Leather, and Footwear (TCLF) sectors through the development of a sustainable upskilling and reskilling strategy, which is supported by a communication campaign to attract social, economic and political actors.	

Project #7	**Sector Skills Strategy in Additive Manufacturing (SAM)** http://www.skills4am.eu/
Project goals	• Build a sector skills strategy in AM; • Assess and anticipate skills (gaps and shortages) in AM; • Support with data the AM European Qualification System and foster wideness of its scope; • (Re)design professional profiles according to the industry requirements; • Develop specific relevant qualifications to be delivered for the AM Sector; • Increase the attractiveness of the sector to young people, whilst promoting gender balance; • Strengthen education-research-industry partnerships and encourage creativity "in companies and relevant educational and scientific institutions";

	• Track students, trainees and job seekers and promote match making between job offer and search.
Project partners	• Aitiip – Spain • Brunel University – UK • Cecimo – Belgium • EPMA – Belgium • EWF – Belgium • Granta – UK • Idonial – Spain • IK4-LORTEK – Spain • ISQ – Portugal • LMS – Greece • Centrale Nantes – France • Renishaw – UK • LZH Laser Akademie – Germany • Materialise – Belgium • MTC – UK • Politecnico - Italy
Start / End dates	2019/2022
Project outcomes	• Methodology assessment. Current & future skills • Methodology design & review. Professional profiles • Development of qualifications/competence units & online catalogue • Action plan exploitation of results & roll-out at National Regional levels • Promotion of attractiveness. AM sector & stakeholders engagement
Sector	Additive Manufacturing
Link to education	Primary, general education, Vocational Education and Training (VET) and higher education.
Summary: SAM project, i.e., Sector Skills Strategy in Additive Manufacturing (AM), aims to deliver together with all partners and stakeholders a shared vision and collaborative skills solutions capable to foster and support the growth, the innovation and competitiveness of the AM sector. SAM's main features are: • A Skills Strategy in Additive Manufacturing providing solutions capable to foster and support the growth, the innovation and competitiveness of the AM sector;	

• A methodology for a sustainable and continuous assessment of current and future skills needs in AM trough the Observatory in Additive Manufacturing, providing just in time mapping and monitoring of the AM industry technological trends, skills shortages and mismatches, policies and figures; • Design, review and deployment of relevant qualifications in the AM sector, built with a learning outcomes approach and linked with EU Frameworks and Tools such as the EQF, e-CF, EntreComp, ECVocational Education and Training (VET) and ECTS; • Promotion of the attractiveness of the AM sector as a career choice for primary, general education, Vocational Education and Training (VET)ational Education and Training (VET) and university's students Awareness Campaign in the field of AM; • One online Qualifications Catalogue to continuously update and enlarge the European AM Qualification System, integrating all the developed and to be developed sectoral qualifications.

Project #8	**Skills Blueprint for the Construction Industry** http://constructionblueprint.eu/
Project goals	This Blueprint will be arranged through a Sectoral Skills Strategy, that will bring together lessons learned from other initiatives and will be outlines from a holistic approach, identifying political, economic, social, technological, legal and environmental factors which may be affecting sector skills and training offer. Encompassed with activities, milestones, outcomes and outputs, the following activities will be developed during the course of the project: • Collecting good practices at national and regional level to illustrate and promote other initiatives addressing skill gaps. • Designing and deliver a MOOC (Massive Open Online Course) to raise awareness among construction professionals about new skills drivers: digitalisation, energy efficiency and circular economy. • Creating a tool (Observatory) to provide valuable information about particular skill needs at least at regional/national level. • Building upon a revision methodology of construction professional profiles and qualifications. • Carrying out an outreach campaign for the Construction industry to promote its attractiveness among youngsters and women, identifying and promoting solutions to facilitate mobility of construction professionals in Europe. • Creating a new virtual tool (website) where all project outputs will be available for stakeholders, as well as a Sector Skills Alliance platform for collaborative work. Blueprint will be starting deployed by getting main market players involved (Education-Economic-Political-Environment-Civil Society/Cultural) taking up opportunities to make the best of their talents. They will constitute together with the partnership, the Sector Skills Alliance, the necessary driver to push a sustainable sectoral strategy and Blueprint implementation.

Project partners	• Fundación Laboral de la Construcción (COORDINATOR) – Spain • Confederación Nacional de la Construcción (CNC) – Spain • Confédération Construction (CC) – Belgium • Fédération Française du Bâtiment (FFB) – France • Panhellenic Association of Engineers Contractor of Public Works (PEDMEDE) – Greece • Zentralverband des Deutschen Baugewerbes (ZDB) – Germany • Associazione Nazionale Costruttori Edili (Ance) – Italy • Lithuanian Builders Association (LSA) – Lithuania • Gospodarska Zbornica Slovenije (CCIS) – Slovenia • Budowlani – Poland • European Construction Industry Federation (FIEC) – Belgium • Centre IFAPME Liège-Huy-Verviers – Belgium • Satakunnan Koulutuskuntayhtymä (Sataedu) – Finland • Comité de Concertation et de Coordination de l'Apprentissage du Bâtiment et des Travaux Publics (CCCA-BTP) - France • Institute of Vocational Training (AKMI) – Greece • Bildungszentren des Baugewerbes e.V. (BZB) – Germany • Berufsförderungswerk der Bauindustrie NRW gGmbH (BFW-NRW) – Germany • Ente per la Formazione e l'addestramento professionale nell'edilizia (Formedil) – Italy • Viesoji istaiga Vilniaus statybininku rengimo centras (VSRC) – Lithuania • Centro de Formação Profissional da Indústria da Construção Civil e Obras Públicas do Sul (Cenfic) – Portugal • Šolski center Kranj (SCKR) – Slovenia • Limerick Institute of Technology (LIT) - Ireland
Start / End dates	2019/2022
Project outcomes	• PESTLE Analysis: Report about the Political, Economic, Social, Technological, Legal and Environmental factors, which may impact the Construction industry and may be affecting in turn skills shortages, gaps and mismatches. • Status Quo report on Sectoral Skills: Report with the current "state of the art" of Construction industry sectoral skills, showing: discrepancy between current and future skills, in order to establish the training needs of professionals in the sector in the short and medium term; estimation of the number of professionals that should be trained as well as in which vocational profile; and measures, recommendations, actions, etc. for the Blueprint deployment.

	• Roadmap and Action Plan: Roadmap report with the strategies, measures, activities, results and plan of action to be applied to adapt skills demand and current offer, which will conform the Sectoral Skills Strategy that will be also a fundamental part to deploy the Construction industry Blueprint. • Interactive Map: Digital resource with the collection of good practices and/or innovative initiatives which are tackling with gaps and mismatched skills, as well as best practices to reap the benefits of EU funding to support different career paths, mobility projects, entrepreneurship opportunities, etc. • Skills+ Training Action: Online Course that will raise awareness and provide a basic upgrading of skills on Energy Efficiency, Digitalisation and Circular Economy. The successful completion of the course will provide a certificate endorsed by a Memorandum of Understanding. • Observatory: Web-based tool to anticipate skills needs by using a Big Data methodology at national and regional level, by the combination of the information coming from primary sources (survey) and secondary ones. This tool will support partners in making decisions concerning training offer. • List of profiles to be updated and prioritisation: Report about the methodology to proceed in a systematic way with the identification of occupational profiles that need to be reviewed, updated or eventually created in the Construction industry. • Prioritisation of qualifications that need to be updated: Report about the priorities for revision of existing qualifications as well as to propose new skills depending on the occupational profiles, if any, to be introduced in each National Qualification Framework. • Materials for the campaign: Web-based information and promotional material that cover the objective of increasing the attractiveness of the Construction industry. • The Quintuple Helix model and the Construction SSA: Report under the criteria of the Quintuple Helix Model that will help to create the Sector Skills Alliance (SSA) and deploy the Blueprint in a systematic way, guaranteeing the involvement and endorsement of key stakeholders as well as a longstanding Alliance. • Endorsement events reports: After each endorsement seminar held in each participant country, the host partner will write down a report with the results obtained. • SSA Portal: Website where all project outputs will be available, including the developed online tools such as the Interactive map and the Observatory, information about news and events, social media connection, etc. It will also host a Sector Skills Alliance (SSA) platform for collaborative work, to bring around the table relevant stakeholders who will help to define and implement the Blueprint. • Widespread dissemination: Dissemination activities and actions carried out by partners: digital newsletters, project information on partners' corporative websites, articles on professional magazines, publications in congresses, targeted emailing, etc.

	• Advertisement campaign: Several advertisement items to inform in a very vivid and graphic way the project activities and results: leaflets, posters, stickers, etc. • Infodays: During the project lifetime, several infodays will be organised, in order to inform the audience about the project and ongoing results as well as reinforcing the alliance between project partners and relevant stakeholders. • Dissemination action report: Report about the presentation of the project made by partners in international networks. • Final dissemination day: A final event to close the project and inform all the stakeholders about the outcomes obtained after project execution. After that, a report will be produced including the presentations provided, a participant list, the outcomes of the workshop, pictures of the event, etc.
Sector	Construction
Link to education	VET and Higher Education
Summary: Skills Blueprint for the Construction Industry is a project funded by the 2018 Call of the Erasmus+ Programme of the European Union, inscribed within Key Action 2 of the Sector Skills Alliances (Lot 3) for implementing a new strategic approach (Blueprint) to sectoral cooperation on skills. The main objective of Construction Blueprint is to develop a new sectoral strategic approach to cooperate on skills in the Construction industry, and support a better matching between skills need of companies and skills provided by training centres. To achieve this goal successfully, the project gathers three Sectoral European Organizations, along with nine National Sectoral representatives and twelve Vocational Education and Training (VET) and Higher Education providers from twelve European Union countries.	

Project #9	**Futureproof Skills for the Maritime Transport Sector** https://www.skillsea.eu/
Project goals	• Analysing the effect of technological developments on the industry's skills requirements • An even better match between the industry's skills needs and the education and training of maritime professionals • Overcoming barriers to the mobility of maritime professionals • Improving cooperation and synergy between education providers, maritime authorities and the industry • Ensuring that Europe retains a world-leading access to maritime skills and experience for improved competitiveness
Project partners	• Stichting STC Group (STC- Group) (COORDINATOR) – Netherlands • European Community Shipowners' Associations (ECSA) – EU & Norway

	• European Transport Professionals Federation (ETF) – EU, EEA, Eastern European countries • Universitatea Maritimă din Constanța – Romania • Danish Maritime Authority – Denmark • Danish Shipping – Denmark • ECSA – Belgium • ESA GROUP – Italy • TALTECH – Estonia • European Transport Professionals' Federation (ETF) – Belgium • EUGENIDES FOUNDATION – Greece • B&FC – UK • ForMare – Italy • ENSM – France • HSBA – Germany • HSB – Germany • Liverpool John Moores University – UK • NMCI – Ireland • Nautilus International – UK • NTNU Norway • PSU – Poland • Sea Europe • Secrétariat général de la mer (SGMer) – France • SIMAC – Denmark • SLN • STC GROUP – Netherlands • Stena Line – Sweden • University of Aegean – Greece • UCA – Spain • University of Rijeka - Croatia
Start / End dates	2019/2022
Project outcomes	SKILLS NEEDS IDENTIFICATION: • Methodology • Current and skills needs (Reality & Mapping) • Future Skills and competence needs (Possible future development) • Skills and Competence GAP between current and future needs

	• Identification of mismatches on a structural basis • Impact on occupational profiles • Recommendations for Education and Training FUTURE PROOF EDUCATION AND TRAINING: • Guide on Design and Implementation of Education Packages • Educational Packages for specified skills • Structural Cooperation • Guide on Business/Education Partnerships STRATEGY: • Measuring evaluation strategies in MET • Employability, Anticipating Skills needs and GAP measurement • Internationalized Strategies in Maritime Education Training • Maritime Education Training and its stakeholders: interconnections and strategies • BLUEPRINT Maritime Shipping Portal • Strategy key findings AWARENESS RAISING AND STAKEHOLDERS MOBILIZATION: • Dissemination materials • Dissemination Activities IMPLEMENTATION: • The Roadmap towards a sustainable skills strategy PROJECT AND QUALITY MANAGEMENT: • Analysis of existing research regarding skills mismatches in the maritime shipping sector • Analysis of existing policies regarding the human factor in the maritime shipping industry
Sector	Maritime transport
Link to education	VET
Summary: Technology and digitalisation are transforming the shipping industry. ‘Smart’ ships are coming into service, creating demand for a new generation of competent, highly-skilled maritime professionals. Europe is a traditional global source of maritime expertise and the four-year SKILLSEA project is launched with the aim of ensuring that the region’s maritime professionals possess key digital, green and soft management skills for the	

rapidly-changing maritime labour market. It seeks to not only produce a sustainable skills strategy for European maritime professionals, but also to increase the number of these professionals - enhancing the safety and efficiency of this vital sector.

The future-proofing project is developed by the industry's social partners, the European Community Shipowners' Associations (ECSA) and the European Transport Professionals' Federation (ETF) and is comprised of a consortium from national maritime authorities, shipping companies, shipowners' associations, maritime trade unions and maritime education providers from 16 countries in Europe.

6. Annex 2: Summary of energy related educational/training projects

1	**UNISET – UNIversities in the SET-Plan**
2	**European Atlas of Universities in Energy Research and Education** https://energy.eua.eu/
3	**ASSET - Advanced System Studies for Energy Transition** https://asset-ec.eu/
4	**SMAGRINET - Smart Grids for an Efficient, Sustainable and Human-Centric Energy System** https://www.smagrinet.eu/
5	**Teachener – Integrating Social Sciences and Humanities into Teaching about Energy** https://www.teachener.eu/
6	**ERIGrid - European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out** https://erigrid.eu/
7	**VESTE - Further Vocational Training for Energy Service Technicians** http://veste-project.eu/
8	**ASSET Energy Transition** https://energytransition.academy/
9	**Energy-SHIFTS - Energy Social sciences and Humanities Innovation Forum Targeting the SET-Plan** https://energy-shifts.eu/
10	**eseia ETP - Education and Training Programme** www.etp.eseia.eu/
11	**Training Programme - SuperGrid Institute** https://www.supergrid-institute.com/en/learning-sharing/
12	**EMTEU - Energy Management Technician in Europe** https://www.euenergycentre.org/our-activities/european-projects/

13	**Skills for the green economy** https://www.cedefop.europa.eu/es/events-and-projects/projects/skills-green-economy
14	**Young Energy Europe** https://young-energy-europe.eu/en/home/
15	**PROSPECT Peer-powered cities and regions** https://www.h2020prospect.eu/
16	**Young Innovators** https://younginnovators.climate-kic.org/
17	**50/50 Networking Platform** http://www.euronet50-50max.eu/en/50-50-networking-platform
18	**Educational program "Energetic Efficiency" – Las Palmas de Gran Canaria (Spain)** https://energialaspalmasgc.es/actuaciones/formacion-y-difusion/
19	**The ENERGY-BITS program** http://www.2020energy.eu/en/about-project
20	**DHC+ Education and Training** https://www.euroheat.org/dhc/education-training/
21	**ENEN + (European Nuclear Education Network)** https://plus.enen.eu/competition/
22	**"Vocational Education and Training across the Gas sector in Europe"** https://www.epsu.org/sites/default/files/article/files/Findings_for_VET_in_the_EU_Gas_Sector_v2.pdf
23	**Vocational training in the sector of renewable energies and energy efficiency in Côte d'Ivoire** https://www.giz.de/en/worldwide/79018.html"
24	**Wind & Marine Energy Systems & Structures (CDT-WAMSS)** **https://bit.ly/3ajLhsQ**
25	**Energyducation: Exploring "Smart Energy Management"** **http://www.energyducation.eu/**
26	**Energy Challenges** https://www.energychallenges.nl/en/

27	**VET-GPS Guiding tools for Professional Skills development in VET** https://www.vetgps.eu/

PROJECTS DESCRIPTION:

Project #1	**UNISET – UNIversities in the SET-Plan** https://eua.eu/101-projects/606-uni-set.html
Project goals	● Mobilising the research, innovation and educational capacities of Europe's universities in the SET plan
Project partners	● EUA European University Association (A) - https://eua.eu/ ● KU Leuven (U) - https://www.kuleuven.be/english/ ● KIC InnoEnergy (A, R) - https://www.innoenergy.com/
Start / End dates	September 2014 / 2018
Project deliverables	● Briefing *The Energy Challenge: Why Policymaking Needs Universities*, February 2018 ● Report *Energy Research and Education at European Universities*, December 2017 ● Position *Roadmap for European Universities in Energy*, December 2016 ● Video EUA Webinar: *Recent activities in energy - UNI-SET and the University Energy Atlas*, January 2016
Energy sector	Renewable energy / energy transition / energy policies
Education level	EQF 7, EQF 8 / University, research

Summary:

UNISET project is a Coordination and Support Action funded by the European Commission's (EC) Seventh Framework Programme (FP). It started in September 2014 and lasted three years. The main objective was to mobilise universities to work together in the development of research, innovation and educational actions in the frame of the SET plan. During its activity, six events, "Energy Clustering Events" were organised to discuss and stimulate the development of innovative research and education programmes.

The main outcomes are summarized in the following deliverables:

- *Roadmap for European Universities in Energy*: it foresees a platform where universities can share knowledge and combine their efforts to have an impact at European level. It presents particular actions to be implemented in the areas of research, education collaboration and outreach [1].

- *Energy Research and Education at European Universities: The UNI-SET Universities Survey Report:* conducted to gather information on universities research and education programmes at different levels. It provides empirical evidence about the state of energy research and education at Europe's universities [2].

Once the UNISET project concluded its period of activity, the EUA Energy and Environment Platform took charge of the outcomes of this project to continue developing its activity with new approaches and initiatives.

Project #2	**European Atlas of Universities in Energy Research and Education** https://energy.eua.eu/european-atlas.html
Project goals	• Offer information on energy-focused master's programmes, research topics and doctoral training schemes at universities in Europe
Project partners	• EUA European University Association (A) - https://eua.eu/ • KU Leuven (U) - https://www.kuleuven.be/english/ • KIC InnoEnergy (A, R) - https://www.innoenergy.com/ • KTH (U) - https://www.kth.se/en • Grenoble INP (U) - http://www.grenoble-inp.fr/en • Technical University of Catalonia (U) - http://www.upc.edu • Jagiellonian University in Kraków (U) - https://en.uj.edu.pl/en_GB/start • Karlsruhe Institute of Technology (U) - https://www.kit.edu/english/
Start / End dates	2015 / 2018
Project deliverables	• Browse tool: Energy Master's Programmes - https://energy.eua.eu/energy-education.html • Browse tool: Research and Doctoral Programmes - https://energy.eua.eu/energy-research.html
Energy sector	Renewable energy / energy transition
Education level	EQF 7, EQF 8 / University, research

Summary:

The Atlas was originally developed as part of the UNISET project, but was further maintained by the EUA Energy and Environment Platform. This platform connects EUA members and partners that are active in energy and environment research and represents universities working in the framework of the SET plan. It was active since 2008 but after the UNISET project was funded in 2014, the EUA Energy and Environment Platform started focusing in the priorities and outcomes outlined by UNISET.

In this context, the European Atlas of Universities in Energy Research and Education, started growing thanks to the collaboration of the EUA, the community of InnoEnergy and different participant universities, by including information on energy-focused master's programmes, research topics and doctoral training schemes at universities in Europe.

Both universities and potential master's student or doctoral candidates can beneficiate from this tool, since it allows to identify partners and build multidisciplinary and inter-European networks according to the educational or research interests. Companies and employers can also use this map to identify possible opportunities for collaboration, training programmes and potential partners within universities across Europe. Student placement works are also outlined.

The initiatives included in the Atlas cover science, engineering and technology fields, but also economics, social sciences and humanities with focus on energy-related domains.

Project #3	**ASSET - Advanced System Studies for Energy Transition** https://asset-ec.eu/
Project goals	• Deliver studies in support to EU policy making in the field of energy • Summarize the state-of-the-art in energy-related domains Im(e.g. efficiency in smart energy systems, connections between electricity grids and other networks) • Provide an analysis of energy-related topics in terms of technologies, regulation market design and business models • Study the need for the dedication of research and innovation actions.
Project partners	• Tractebel (EC, CC) - https://tractebel-engie.be/en • Ecofys (CC) - www.ecofys.com/en/ • E3 - Modelling (R) - https://e3modelling.com/
Start / End dates	2016 / Ongoing
Project deliverables	Reports: 17 performed studies, 1 ongoing
Energy sector	Renewable energy / electricity /grid
Education level	EQF 7, EQF 8 / Research
Summary: The objective of this project is to deliver studies related to EU electricity systems and to large-scale integration of renewable energy sources. In particular, some of the studies include: - Job creation and sustainable growth related to renewables - Islands and Energy Islands in the EU Energy System - EU energy communities	

- A foresight perspective of the electricity sector evolution by 2050
- Technology pathways in decarbonisation scenarios
- Cross-border transmission capacity calculation: analysis of the key parameters
- Dynamic retail energy prices
- Sectorial integration long-term perspective in the EU energy system
- Format and procedures for electricity (and gas) data access and exchange in member states

These studies aims to provide a summary of the state of the start in these domains, conduct detailed analysis, including quantitative considerations, on the basis of recognized techniques and to identify the needs to dedicate research and innovation actions to these topics. Moreover, they include also an study of the connections between the electricity grid and other networks and the synergies established between them.

Project #4	**SMAGRINET - Smart Grids for an Efficient, Sustainable and Human-Centric Energy System** https://www.smagrinet.eu/
Project goals	• Enhance the capacity of European universities in energy research and innovation • Involve industry and key societal actors to respond to the challenges of energy transition
Project partners	• TalTech (U) - https://www.ttu.ee/en • Univerza v Ljubljani (U) - https://www.fe.uni-lj.si/en • Technische Universität Dresden (U) - https://tu-dresden.de/ • LOBA.cx (CC) - https://www.loba.pt/pt/ • Civitta Estonia (CC) - https://civitta.com/ • Kaunas University of Technology (U) - https://ktu.edu/ • Technische Universität Berlin (U) - https://www.sense.tu-berlin.de/menue/start/ • Union of Electricity Industries of Estonia (A) - http://www.elektriliit.ee/ • Université de Lorraine (U) - https://welcome.univ-lorraine.fr/
Start / End dates	April 2019 / September 2021
Project deliverables	soon available in https://www.smagrinet.eu/about/public-reports/
Energy sector	Electricity / grids
Education level	EQF 7, EQF 8 / University, research, lifelong learning

Summary:

The SMAGRINET project aims to create a smart grid competence hub called POWER ON in the area of smart and flexible energy systems with the objectives described in the project goals. In this framework, the main agents addressed by the project are: academia/universities, municipalities/governments, general public and energy industries.

The project is undertaking a set of activities for experts, researches, industry and academia that will work as basis for the services that SMAGRINET is currently developing. The first set of services foresses to improve the skills of the industry and to enlarge the capacities of academic organisations are:

- Challenge and Case-Based Modules: three modules focused on artificial intelligence in power systems, economic operation and planning in smart grids will be integrated in the curriculum of the participating universities during the first half of 2020.
- International Mobility Program: hands-on approach, with possibilities of traineeships at enterprises for students.
- Short-term Blended Learning Programs: response to industrial need in terms of skills and knowledge
- Train-the-trainers' pilot: education of local experts to enable them to perform the teaching of modules and programs developed, aiming further replication.

Project #5	**Teachener – Integrating Social Sciences and Humanities into Teaching about Energy** https://www.teachener.eu/
Project goals	● Improve the quality of teaching in high education institutions by integrating interdisciplinary skills and competences ● Contribute to enhance the socio-technical perspective in the current education of engineers.
Project partners	● Nicolaus Copernicus University in Torun (U) - http://www.umk.pl ● Gdansk University of Technology (U) - http://www.pg.edu.pl/en ● Czech Technical University in Prague (U) - http://www.cvut.cz ● Institute of Sociology of the Academy of Sciences of the Czech Republic (U) - http://www.soc.cas.cz ● Helmholtz Centre for Environmental Research (R) - http://www.ufz.de ● Technical University of Catalonia (U) - http://www.upc.edu ● Merience SCP (CC) - http://www.merience.eu
Start / End dates	September 2016 / August 2019
Project deliverables	Online platform: EDUKIT, set of teaching modules (ebook, syllabus, class plans among others) http://teachener.umk.pl/

Energy sector	Renewable energy / energy transition / interdisciplinary integration
Education level	EQF 7 / University
Summary: TEACHENER aims to fill the gap between social sciences, humanities and energy teaching at technical universities in Europe and transposing social science and humanities knowledge to the domain of higher technical education. It is focused on providing the graduates of technical energy studies with interdisciplinary skills, knowledge and competences in social sciences and humanities throughout innovative educational practices. Furthermore, it aims for cooperation and network at all levels (international cooperation between institutions), give support to teachers and students and provide teaching tools and materials. The project includes two parts. In the first part, the purpose is to provide an overview about the existing relations between social sciences and humanities and teaching about energy in the participating universities and other institutions. A survey was conducted, together with different workshops to identify the gaps in SSH in energy teaching and needs and expectations of students and teachers in these topics. In the second part, the focus is set on designing and developing EDUKIT. This tool include a set of teaching modules covering 8 topics associated with social aspects of energy for educating Master and PhD students.	

Project #6	**ERIGrid - European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out** https://erigrid.eu/
Project goals	• Provide a single entry point to the available research infrastructure for Smart Grids • Integrate and enhance the necessary research services for analysing, validating and testing smart grid configurations • Provide system level support and education for industrial and academic researchers
Project partners	• AIT Austrian Institute of Technology (U) - https://www.ait.ac.at/ • CEA Commissariat à l'énergie atomique et aux énergies alternatives (A) - http://www.cea.fr/english • CRES Centre for Renewable Energy Sources and Saving (R) - http://www.cres.gr/kape/index_eng.htm • DERlab European Distributed Energy Resources Laboratories e.V. (R) - http://www.der-lab.net/ • DNV GL Netherlands B.V. (EC, CC) - https://www.dnvgl.com/energy

	• DTU Danmarks Tekniske Universitet (U) - https://www.elektro.dtu.dk/english • INP Insitute Polytechnique de Grenoble (U) - http://www.grenoble-inp.fr/welcome • Institute for Communication and Computer Systems NTUA ICCS (U) - http://www.iccs.gr/en/?noredirect=en_US • Fraunhofer IEE (R) - https://www.iee.fraunhofer.de/en.html • Ormazabal Corporate Technology A.I.E (EC, R) - https://www.ormazabal.com/en/about-us/our-own-technology/technological-innovation-center • OFFIS EV Institute for Information Technology (R) - https://www.offis.de/en.html • RSE Ricerca sul Sistema Energetico (R) - https://erigrid.eu/the-project/consortium/ • SINTEF Energy Research (R) - https://www.sintef.no/energy • TECNALIA Research and Innovation ® - http://www.tecnalia.com/en • Delft University of Technology (U) - https://www.tudelft.nl/en/ • University of Strathclyde (U) - https://www.strath.ac.uk/research/subjects/electronicelectricalengineering/instituteforenergyenvironment/ • VTT Technical Research Centre of Finland (R) - https://www.vttresearch.com/en • Hellenic Electricity Distribution Network Operator (EC) - http://www.deddie.gr/en
Start / End dates	2016 / Ongoing
Project deliverables	• All the downloadable deliverables/reports, results, publications, press information and newsletter ca be found in https://erigrid.eu/dissemination/
Energy sector	Electricity / grids
Education level	EQF 7, EQF 8 / Research

Summary:

This project supports the technology development as well as the roll out of Smart Grids solutions and concepts in Europe. It integrates 18 European research centres and institutions with outstanding research infrastructure in a holistic, cyber-physical system, bringing together their know-how and improving research infrastructures within the smart grid sector.

The project is divided in three main groups of activities:

- Networking Activities: validating smart grid technologies and developments requires a holistic view on the overall process- Beside the technical components it has to compris also customers, markets, regulation, etc. The networking activities aims to integrate all the agents involved and train the next generation of researchers and engineers.

- Joint Research Activities: the project partners provide 19 installations in total available for transnational access projects, providing an integrated research structure.
- Transnational Access:industrial and academic researchers active in the smart grid domain are provided with free transnational access to the ERIGrid infrastructure. The access is funded by the project and it is offered to researchers planning to carry out projects at high level of excellence and innovation.

Two calls for proposals are organised every year for the researchers submit their projects. The successful applicants are provided with free travelling, accommodation and lab testing to special equipment and advances facilities. They also have access to concentrated know-how and best practices in smart grids and DER.

Activities and resources linked to education, such as courses, lab exercises, presentations, publications, remote labs, software and webinars are also provided in the framework of this project for co-simulation, real-time simulation, smart grid validation and remote/ICT labs.

Project #7	**VESTE - Further Vocational Training for Energy Service Technicians** http://veste-project.eu/
Project goals	• Enhance qualifications of managers and personal in SMEs to increase energy efficiency and renewable energy use by advance training programs. • Recruit additional managers and professionals for SMEs • Integration program and offer of course placement to unemployed persons in permanent jobs • Develop high-quality, comprehensive advance training with strong employment-related training components • Provide targeted training for teachers/trainers
Project partners	• BSA Baltic Sea Academy (A) - https://www.baltic-sea-academy.eu/ • University of Corporate Education Hamburg BAHH (U) - https://www.uni-hamburg.de/en.html • Eastern Europe Business Association of Germany ODW (A) https://www.oaoev.de/de/german-eastern-business-association • Chamber of Crafts and SME in Katowice CCK (A) - https://www.ir.katowice.pl/ • Hanseatic Academy of Management in Slupsk WHSZ (U) - https://www.apsl.edu.pl/O-uczelni/WHSZ • Võru County Vocational Training Centre VCV (VET) - https://www.vkhk.ee/en • KONTIKI-SZAKKÉPZÕ Zrt.(VET) - https://www.kontikizrt.hu/

<table>
<tr><td>Start / End dates</td><td>2015 / 2018</td></tr>
<tr><td>Project deliverables</td><td>Document:Basics, qualification needs and concepts
Document:Curricula and teaching materials for two further training courses
Document: Exemplary sample report for an Energetic Refurbishment
Document: Further vocational training Solar energy – Technology and Applications for SMEs
Document: Further vocational training Energy Efficient Construction and Application of Renewable Energy for SMEs
Document:Train the Trainer Course
Document: Examination regulations, evaluations and recognition</td></tr>
<tr><td>Energy sector</td><td>Renewable energy / energy transition</td></tr>
<tr><td>Education level</td><td>EQF 6, EQF 7 / Universities, VET, Lifelong learning</td></tr>
<tr><td colspan="2">Summary:

This project aims to secure the supply of skilled-labour and increase skills in the energy sector in the Baltic Sea Region countries throughout advanced training models.It seeks for the creation of opportunities in these states and the set-up for comparable information and advisory services for energy conservation and for alternative energy sources, making available an holistic approach to these topics by providing a complete package of legal, technical and economical content, depending on each country need.

With this objective, studies on the development of economy, population, education and labour markets for the energy sector are evaluated and an analysis of the qualification demand in the partners countries is performed. On this basis, a dual training models is developed:
- Compact course: 70-80 hours course targeting company owners to initiate the effective entry of companies into energy conservation and the use of renewable energies.
- Comprehensive course: broad course of 300 hours, consisting of core and elective modules addressing the identification of potential energy savings, assessment of the building envelope and systems engineering, etc. Target groups are managers and experienced professionals from SMEs sector, architects and engineers.

For both courses, curricula and teaching material are developed and different tests and evaluations are defined to test all possible combination of modules in the different countries involved.

The project also include the “train-the-trainer” program, targeted for lectures of universities, chambers and other education providers. The goal of to offer this program to universities in a permanent basis so teachers get qualified for the ongoing independent implementation of courses.</td></tr>
</table>

Project #8	**ASSET Energy Transition** https://energytransition.academy/
Project goals	• Define a conceptual framework to facilitate and accelerate the creation of new learning modules and update the currently available programmes. • Promote interdisciplinary research, innovation and education services • Strengthen collaborations between academia and industry • Support trainers to cultivate new talents. • Develop innovative programmes to educate students, trainers, employees and citizens.
Project partners	• Atos Spain SA (EC) - https://atos.net/en/ • University of Naples Federico II (U) - http://www.unina.it • RWTH Aachen University (U) - https://www.rwth-aachen.de • OTE Academy (VET) - https://oteacademy.gr/ • Aalborg University (U) - https://www.aau.dk/ • University of West Attica (U) - https://www.uniwa.gr/ • Polytechnic University of Valencia (U) - http://www.upv.es/ • Logical Soft (EC) - https://www.logical.it/ • ÈNostra Società Cooperativa (EC) - https://www.enostra.it/ • Ecopower (EC) - https://www.ecopower.be/ • EASE (R) - https://ease-storage.eu/
Start / End dates	2019 / Ongoing
Project deliverables	• Project deliverables available at https://www.energytransition.academy/deliverables
Energy sector	Energy transition / energy policies
Education level	EQF 7, EQF 8 / University, research, lifelong learning

Summary:

The implementation of this project will take place in 3 phases:

- Ecosystem Set-Up: engage relevant actor to identify the knowledge, skills and competences gaps in order to design appropriate services.
- ASSET Services: educational and research programmes that meet the requirements, based on the skills gaps and social science researches.
- Delivery: deliver the developed research innovation services to universities, companies and societies.

The different actors it addresses are: universities, research centres, training actors, policy makers, authorities, public administrations, market regulators, societal actors, companies from the energy sector, students from university and new employees and energy citizens. Implemented through the platform: EMMA European Multiple MOOC Aggregator - https://platform.europeanmoocs.eu/

Project #9	**Energy-SHIFTS - Energy Social sciences and Humanities Innovation Forum Targeting the SET-Plan** https://energy-shifts.eu/
Project goals	● Contributing to EU European Energy Union by developing Europe's leadership in using and applying energy-related Social Sciences and Humanities
Project partners	● EERA European Energy Research Alliance (A) - https://www.eera-set.eu/ ● Anglia Ruskin University (U) - Global Sustainability Institute - https://aru.ac.uk/global-sustainability-institute-gsi ● DRIFT Dutch Research Institute for Transitions BV (R) - https://drift.eur.nl/ ● Aceto Comunicación (CC) - http://www.acentocomunicacion.com/ ● Jagiellonian University (U) - https://en.uj.edu.pl/en_GB/start ● NTNU Norwegian University of Science and Technology (U) - https://www.ntnu.edu/ ● E3G (NPO) - https://www.e3g.org/
Start / End dates	April 2019 / March 2021
Project deliverables	Documents: ● *Working Group guidelines for systematic Horizon Scanning* ● *Working Groups - Terms of Reference* ● *Guide to the SET-Plan* ● *Guide to the ETIPs* ● *Scoping workshop reports* ● *Plan for dissemination, exploitation and communication*
Energy sector	Energy transition / energy policies / interdisciplinary integration
Education level	EQF 6, EQF 7 / University, lifelong learning
Summary:	

The project focuses on developing activities to provide accessible guides to Social Sciences and Humanities (SSH) in EU policy. The goal is to provide an insight for the short-term direction of the EU energy policy and the foundations for longer-term mechanisms to enable energy-SSH insights in energy policies.

To achieve its objectives, it aims to develop:

- 4 Working Groups: focused around high-level strategic SET-plan actions, will engaged members with senior expertise across SSH disciplines.
- Policy Fellowship scheme: enabling one-to-one dialogue between policy professionals and energy experts in SSH.
- Early-Stage Researcher programme: to create conditions to exchange knowledge and experience in the field of policymaking, in the framework of the scientific research topic.
- Masterclasses:to synthesize the outcomes and foster the SET-Plan implementation.
- 4 online citizen debates: to open the Forum to all voices.
- pan-European conference: to widely share the main findings of the project.

Project #10	**eseia ETP - Education and Training Programme** http://www.etp.eseia.eu/
Project goals	• Provide hands-on skills training joining latests research results with practical knowledge
Project partners	• eseia European Sustainable Energy Innovation Alliance (A) - http://www.eseia.eu/ • Styrian Government in Austria (G) • Graz University of Technology (U) - https://www.tugraz.at/home/
Start / End dates	2010 / Ongoing
Project deliverables	• eseia Best Lecture Library - http://www.etp.eseia.eu/cms/2/18680/
Energy sector	Energy transition
Education level	EQF 7, EQF 8 / University, research, lifelong learning
Summary: This project started as an international life-long learning platform for sustainable energies organised by the Graz University of Technology in cooperation with strategic partners: the Styrian Academy for Sustainable Energies. Between 2010 and 2012, the Styrian Academy organised international training events such as summer schools, business training seminars and workshops. The eseia Education and Training Programme was developed out of this project, aiming to continue with its goal.	

The eseia ETP offers high-training level opportunities to students, academics and professionals aiming to develop their professional and research skills within the field of Smart Energy Systems and Energy Transition:

- eseia International Summer Schools: two-week intensive training courses for excellent post-graduate students. The aim is to provide them an overview of technology, economic and social development in sustainable energy innovation.
- eseia International On-Site Student Camps: four-day total immersion for post-graduate students to train their skills for designing energy solutions exposing the to a real site.
- eseia Pilot Plant Industrial Research Labs: participant students work in groups in pilot industrial labs to prepare them for professional environment and strength their interaction with industry partners.
- eseia Inter-Regional Training Workshops for Decision-Makers: three-day training workshop for key staff from regional authorities. It allows the comparison of different strategic sustainable development options brought up by the regional decision-makers and working in new pathways on the basis on new technological developments.

Project #11	**Training Programme - SuperGrid Institute** https://www.supergrid-institute.com/en/learning-sharing/
Project goals	● Explain what a supergrid is and provide this information to all by supporting educational institutions in the development of their training offers on HVDC and supergrid technologies
Project partners	● INSA Lyon (U) - https://www.insa-lyon.fr/en/ ● Conservatoire National des Arts et Métiers (U) - http://www.cnam.eu/site-en/ ● Lycée Arbez Carme (VET) - https://arbez-carme.ent.auvergnerhonealpes.fr/ ● INP Grenoble (U) - http://www.grenoble-inp.fr/en ● Lycée Edouard Branly (VET) - http://branly.etab.ac-lyon.fr/spip/
Start / End dates	2014 / Ongoing
Project deliverables	● Online platform - *collaborate.supergrid-institute.com/* ● Browse tool: virtual library - *collaborate.supergrid-institute.com/enrol/index.php?id=3* ● *Online platform: Cablia* - learning application https://www.supergrid-institute.com/fr/2019/07/18/supergrid-institute-collaborates-with-edouard-branly-schools-undergraduate-students-for-their-end-of-year-project/
Energy sector	Electricity / grids

<table>
<tr><td>Education level</td><td>EQF 5, EQF 6 / University, research, VET</td></tr>
<tr><td colspan="2">Summary:

The SuperGrid Institute is an independent research centre that provides technological support in developing electric power systems, offering both technologies and services through research programmes, test platforms and training and consulting services.

In particular, the Training Programme focuses both in individuals and in higher education or professional organisations. For individuals, it offers the online E-learning platform, to enrol in different learning modules, or lifelong-learning courses developed together with its partners. Regarding its agreements framework with different organisations, we can find 4 main target areas for education where the Institute have different goals:
- Secondary education: encourage the students to take an interest in electrical power systems by running outreach events and visits to its research facilities. They also work with teachers to develop projects to facilitate the discussion of energy efficiency issues.
- Higher education: develop curricula that include projects in HVDC supergrids. Additionally, they offer internships and PhD opportunities.
- Professional training: help companies working with HVDC supergrids and integration of renewable energies to keep up with technological developments and acquire the necessary competences.
- Product knowledge training: provide personalized, in-depth product knowledge training that addresses specifically to the companies' needs and offers support in the integration phase of the new technological assets.</td></tr>
</table>

Project #12	**EMTEU - Energy Management Technician in Europe** https://www.euenergycentre.org/our-activities/european-projects/ https://www.euenergycentre.org/training/
Project goals	● Provide training for skilled technicians in: - Developing of energy saving plans - Management of the efficient use of energy and water - Collaboration in the process of energy certification of buildings - Promotion of Renewable Energy facilities - Optimisation of human resources, complying with the applicable regulations and safety conditions ● Provide the certification of efficient installations
Project partners	● European Centre of Technology (A) - https://theect.org/ ● European Energy Centre (A) - https://www.euenergycentre.org/ ● The University of London (U) ● Centro Studi Galileo (VET) - https://www.centrogalileo.it/
Start / End dates	2009 / Ongoing

Project deliverables	
Energy sector	Energy transition / renewable energy / regulation
Education level	EQF 6, EQF 7 / VET, lifelong learning

Summary:

This project focuses on creating highly skilled and quality practitioners in Europe. In particular, it addresses to the following beneficiaries:

- Companies: by creating of expert technicians y the sector
- Professionals: by updating their knowledge in renewable energy and new technologies involved
- Educational administrations: by providing didactic material that will make it possible to promote and update educational systems
- Social partners: by giving access to training that allows the application of this technology
- Society: by getting people involved in the protection of the environment and sustainability
- Training centers: by implementing sector training programmes

The training courses provided in the framework of this project cover different topics such as renewable energy management and finance, solar photovoltaic qualification or electric vehicles among others. These courses can be followed online or attending to the presencial course in the University of London.

Those who complete the course obtained the internationally recognised Galileo Master Certificate, who allows them to be recognised as having both the theoretical and the practical skills to be a quality technician.

Project #13	**Skills for green jobs** https://www.cedefop.europa.eu/es/events-and-projects/projects/skills-green-economy
Project goals	• Investigate the expected impact of environmental and climate change policies on future skills demands within and across sectors • Provide insights for effective training and education policies and initiatives
Project partners	• Cedefop (A) - https://www.cedefop.europa.eu/en
Start / End dates	2017 / Ongoing
Project deliverables	• Report: Skills for green jobs: 2018 update - https://www.cedefop.europa.eu/files/3078_en.pdf • Video: synthesis video - https://www.cedefop.europa.eu/en/publications-and-resources/videos/skills-green-jobs-video

Energy sector	Energy Transition
Education level	EQF 5, EQF 6, EQF 7 / VET, lifelong learning

Summary:

This project is based in the initiative *Skills for green jobs,* in which Cedefop and the ILO (International Labour Organization) agreed to update the country studies produced for the report *Skills for Green Jobs: A Global View* (2011). As a result, Cedefop updated reports for six EU countries: Denmark [3], Estonia [4], France [5], Germany [6], Spain [7] and the UK [8]. A European Synthesis report based on these six documents and a video presenting the results were elaborated.

In these documents, Cedefop explores employment effects, skills requirements and policy implications of the transmission towards a greener economy. Their view is that since the environmental change is an increasingly important driver of labour demand and skills supply across sector, the positive impacts of the transition to a greener economy can be maximised by simultaneously developing the skills, knowledge and competences required by resource-efficient processes and technologies and integrating these into business and communities.

Therefore, in the relevant Cedefop publications, specific economic activities and occupational profiles are highlighted to identify where existing competences are being enhanced; additional or new competences are emerging and other competences are becoming obsolete as a result of the greening of the European economy. By comparing experiences and strategic responses across countries, Cedefop provides stakeholders and social partners with examples of good practice to shape the way in which education and training systems can be adjusted, upgraded and/or refocused so that learners and professionals are suitably equipped with the right skills.

Project #14	**Young Energy Europe** https://young-energy-europe.eu/en/home/
Project goals	• Enable professionals to extend their education in the fields of energy and resource efficiency • Provide tools to learn to analyse and reveal saving potentials for energy and resources in their companies
Project partners	• German Chambers of Commerce Abroad AHK (A) - https://www.ahk.de/en/ • German Chamber of Commerce and Industry DIHK (A) - https://www.dihk.de/de • German-Bulgarian Chamber of Commerce and Industry (A) - https://bulgarien.ahk.de/bg/ • German-Greek Chamber of Commerce and Industry (A) - https://griechenland.ahk.de/ • German-Czech Chamber of Commerce and Industry(A) - https://tschechien.ahk.de/cz/

	• German-Hungarian Chamber of Commerce and Industry (A) - https://www.ahkungarn.hu/hu/ • BMU German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (G) - https://www.bmu.de/en/ • European Climate Initiative EUKI (A) - https://www.euki.de/
Start / End dates	2019 / Ongoing
Project deliverables	• Monthly presentation of Energy Scout projects - https://young-energy-europe.eu/en/best-practice-en/
Energy sector	Renewable Energy
Education level	EQF 6, EQF 7 / VET, Lifelong learning
Summary: The general focus of this project lies upon the promotion of vocational training in Germany and abroad and the strengthening of German business abroad by enhancing the future potential of many small and medium-size enterprises. The project has been implemented with the AHKs in Bulgaria, Greece, Hungary and Czechia, that offer the qualification module *Energy Scout,* consisting in provide information for young employees in a four-day workshop for them to learn how to identify and raise potential energy saving in their companies. This way, both employees and companies get benefited. The first phase *Energy Scout* training programme is the four-day workshop where the participants are provided with basic understanding of the subject of energy. Project management, handling of measuring instruments and tools for internal communication are also discuss to facilitate the implementation of energy efficiency measures. This is followed by a practical training phase where the participants develop and implement an energy efficiency project for their company and later, they present it in a final workshop.	

Project #15	**PROSPECT Peer-powered cities and regions** https://www.h2020prospect.eu/
Project goals	• Encourage the exchange of knowledge and experience on innovative financing schemes used to implement sustainable energy and climate plans. • Empower local and regional authorities to make use of best practices in developing financing for sustainable energy plans.
Project partners	• IHS Institute for housing and urban development studies (R) - https://www.ihs.nl/en • IEECP Institute for European Energy and Climate Policy (R) - http://www.ieecp.org/ • S.ENERGIA Agência Regional de Energia (G) - http://www.senergia.pt/

	• TEESlab Technoeconomics of Energy and Environmental Systems Laboratory (R) - https://teeslab.unipi.gr/ • Mesto Trnava (G) - https://www.trnava.sk/en • Energy Cities (A) - https://energy-cities.eu/ • OÖ Energiesparverband (CC) - https://www.energiesparverband.at/ • EIT Climate KIC (A) - https://www.climate-kic.org/ • FEDARENE European Federation of Agencies and Regions for Energy and the Environment (A) - https://www.fedarene.org/ • EUROCITIES (A) - http://www.eurocities.eu/
Start / End dates	June 2017 / Ongoing
Project deliverables	• Document: *Peer Mentoring Booklet* https://h2020prospect.eu/images/site-images/PROSPECT_BookletPeerMentoring.pdf • Document: *Study Visits Booklet* https://h2020prospect.eu/images/site-images/PROSPECT_BookletStudyVisit.pdf • Document: *Learning Module Handbooks*: - Public Buildings: https://www.h2020prospect.eu/images/deliverables/D51_PROSPECT_Benchmark_for_integrated_learning.pdf - Private Buildings: https://www.h2020prospect.eu/images/Module_Handbooks/Module-on-Private-Buildings.pdf - Public Lighting: https://www.h2020prospect.eu/images/Module_Handbooks/Module-on-Public-Lighting.pdf - Transport: https://www.h2020prospect.eu/images/Module_Handbooks/Module-on-Transport.pdf - Cross-Sectoral: https://www.h2020prospect.eu/images/Module_Handbooks/Module-on-Cross-Sectoral.pdf • Report: PROSPECT Benchmark for integrated learning https://www.h2020prospect.eu/images/deliverables/D51_PROSPECT_Benchmark_for_integrated_learning.pdf • Tool: Recommendations-Decision Matrix https://www.h2020prospect.eu/library/recommendations-decision-matrix • Other online material: https://www.h2020prospect.eu/library/library-online-materials
Energy sector	Energy transition / electricity / grid / district heating / energy policies

<table>
<tr><td>Education level</td><td>EQF 6, EQF 7 / Lifelong learning</td></tr>
<tr><td colspan="2">Summary:

PROSPECT aims to carry out its goal of encouraging the exchange of knowledge and experience throughput innovative financing schemes, i.e. non-traditional ways of raising funds and facilitating sustainable energy and climate investments by mixing different sources and engaging different partners. Some examples are: energy performance contracting, third party financing, revolving funds, cooperatives, crowdfunding among others.

The learning programme has five thematic learning modules (public buildings, private buildings, transport, public lighting and cross sectoral), in which regional and local authorities, who can serve as mentors or mentees, will learn in two ways:
- Peer Mentoring: one-to-one relationship between mentor and mentee characterised by in-depth counselling and joint problem solving. · online meetings and 1 physical meeting are carried out during the process.
- Study Visits: group of mentees visit a mentor to exchange knowledge, learn from best practises and interact with key stakeholders.

The learning programme has three learning cycles: each of them offers 5 peer mentoring and 5 study visits.

The process starts by identifying eligible mentors and mentees to later match them with each other based on the matchmaking criteria. These criteria include similar interests/experience in an innovative financing scheme or in theme/modules, the type of project or scheme the mentee seeks to learn about, the type of peer-to-peer learning agreement preferred by the mentor, the size of the municipality, and finally linguistic proximity and geographical location proximity of mentor and mentees.</td></tr>
</table>

Project #16	**Young Innovators** https://younginnovators.climate-kic.org/
Project goals	• Introduce a systems innovation approach to 12 - 18 years old to foster social awareness and entrepreneurial thinking towards tackling climate change challenges in the school environment through visual thinking and participatory techniques.
Project partners	• Universitat de València (U) - https://www.uv.es/ • myclimate (CC) - https://www.myclimate.org/ • Stichting Technotrend (A) - https://stichtingtechnotrend.nl/ • AESS Enegy and Sustainable Development Agency (A) - https://www.aess-modena.it/en/

	• Solutions for the planet (A) - https://solutionsfortheplanet.co.uk/
Start / End dates	2019 / Ongoing
Project deliverables	• Online tools for educators at: - Pentagonal Problem - Context Map - Cover Story https://younginnovators.climate-kic.org/educators/
Energy sector	Renewable energy / energy transition / energy policies
Education level	EQF 4 / School

Summary:

This project aims to offer students the methodological approach, visual tools and entrepreneurial mindset to change the economy and society immediately. This approach is based in three components:

- School Innovators: train teachers and students to use tools with depth methodological frameworks and real-life challenges
- Young Climathon: empower students, teachers and youth to create bottom-up, meaningful, long-lasting climate actions based on real-life challenges
- Young Changemakers: bring the solutions to life and change society around the schools and the city.

The tools provided within the framework of the project help to facilitate the understanding of complex realities and the co-creation of knowledge in a secondary school context with group work activities, visual thinking tools or challenge-led activity among others. They can be implemented by educators tackling problems projects related to Environmental Sustainability.

Project #17	**EURONET 50/50 MAX** http://www.euronet50-50max.eu/en/50-50-networking-platform
Project goals	• To connect and exchange experience, ideas and opinions with other members of the network who undertook the ambitious task of implementing 50/50 concept and of saving energy by changing behaviours. • Mobilizing energy savings in public buildings through the implementation of the 50/50 methodology in 500 schools and nearly 50 other public buildings from 13 EU countries

Project partners	● Secondary Schools http://www.euronet50-50max.eu/en/area-for-schools/catalogue-of-schools-involved-in-euronet-50-50-max?country=ALL&school_type=SECONDARY&school_size=ALL&source_type=ALL
Start / End dates	2013 / 2016
Project deliverables	Short reports about your progress in the implementation of the 50/50 concept and the achievements of your energy team http://www.euronet50-50max.eu/en/area-for-schools/reporting
Energy sector	Energy Transition
Education level	EQF 4 / VET, lifelong learning
Summary: Our 50/50 Networking Platform is based on Facebook tool, as it is free, easy to use and already used by many schools and public institutions. If you don't have a Facebook profile yet, create one (some useful instructions may be found below) and link with our EURONET 50/50 MAX profile to: ● Observe our most interesting activities, as well as activities & achievements of other schools, public buildings and municipalities involved in the 50/50 Network ● Publish posts about your activities ● Present your ideas and innovative approaches ● Share photos ● Inspire others and get inspired by them.	

Project #18	**Educational program "Energetic Efficiency" – Las Palmas de Gran Canaria (Spain)** https://lpgcsostenible.laspalmasgc.es/eficiencia-energetica/
Project goals	● Inform the School Community about energy and water technologies, in the most realistic way ● Underline the importance of the use of renewable energies and the saving of water and energy, in order to achieve an improvement in the environment and sustainable development ● Have real and upcoming demonstration and experimentation equipment, which will allow students to check all these techniques and evaluate the results of their application

Project partners	European Regional Development Fund https://ec.europa.eu/regional_policy/en/funding/erdf/ City Council of Las Palmas de Gran Canaria https://energialaspalmasgc.es/actuaciones/formacion-y-difusion/
Start / End dates	2019
Project deliverables	Training Action: Responsible consumption. Energy Saving and Efficiency https://energialaspalmasgc.es/actuaciones/formacion-y-difusion/
Energy sector	Energy transition / energy policies
Education level	EQF 4 / VET, lifelong learning
Summary: Within the framework of this educational program of the City Council of “Las Palmas de Gran Canaria”, the project "Energy Efficient Schools in the City of LPGC" is developed, in which several educational materials have been developed.	

Project #19	**The ENERGY-BITS programme** **http://www.2020energy.eu/en/about-project**
Project goals	● The Energy-Bits programme has a collaborative dimension and invites the young, individually or collectively in their educative sphere, to get mobilized. ● Participate in the contest “Have your say” by directing videos, games and watching documentaries with your class on the theme of Energy.
Project partners	● IEE – INTELLIGENT ENERGY EUROPE https://ec.europa.eu/easme/en/section/energy/intelligent-energy-europe ● TRALALERE - www.tralalere.net ● UNIVERSCIENCE - www.universcience.fr
Start / End dates	2020 / Ongoing
Project deliverables	Training Action: Responsible consumption. Energy Saving and Efficiency https://energialaspalmasgc.es/actuaciones/formacion-y-difusion/

Energy sector	Energy transition / Renewable energy
Education level	EQF 4, EQF 6 / VET, Lifelong learning

Summary:

The serious game 2020 Energy was designed within the framework of ENERGY-BITS a European cross-media awareness programme for teenagers (14-18 years old) financed by the Intelligent Energy Europe programme. Energy-BITS encourages more responsible and efficient behaviours in energy consumption and promotes renewable energies.

ENERGY-BITS, for educators and the general public:

- 24 documentaries
- 1 webdocumentary
- 1 serious game
- 1 collaborative and social space

These resources were created by 13 partners across Europe and are available in 9 European languages on the platform www.energybits.eu

Project #20	**DHC+ Education and Training** https://www.euroheat.org/dhc/education-training/
Project goals	• Support students all over the world in their research activities on district heating and cooling and its technological, environmental, social and legal aspects. • Offer a course on district heating combining theoretical lectures with practical applications, site visits and networking opportunities.
Project partners	• Euroheat and Power (A) - https://www.euroheat.org/
Start / End dates	2012 / Ongoing
Project deliverables	-
Energy sector	Renewable energy / district heating
Education level	EQF 6, EQF 7 / University, Research, Lifelong learning

Summary:

The DHC+ Summer Schools are carried out by DHC+ Technology Platform, one big part of the Euroheat & Power association.

DHC+ develops a number of services to foster the cooperation and networking within district heating and cooling community, allowing a more important cross-sectorial collaboration on project proposals. As part of this initiative, an education and training programme is implemented. It includes two main activities: - DHC+ Student Awards: highlights outstanding and original contributions to district heating and cooling related research, including economic and technological aspects, energy management and environmental consequences of energy utilization. - DHC+ Summer School: is organised every year and brings together Master's and PhD students and professionals from all over Europe working in the fields of district heating and cooling, marketing and urban planning. During one week, participants learn about current energy trends in district heating technology, integration of renewable energy sources, design and modelling of heat networks and EU funding opportunities.

Project #21	**ENEN + (European Nuclear Education Network)** https://plus.enen.eu/competition/
Project goals	• Attract new talents to careers in nuclear • Develop the attracted talents beyond academic curricula • Increase the retention of attracted talents in nuclear careers • Involve the nuclear stakeholders within the EU and beyond • Sustain the revived interest for nuclear careers.
Project partners	• ENEN (A) - https://enen.eu/ • https://plus.enen.eu/competition/partner.php
Start / End dates	2018 / 2019
Project deliverables	• Document: list of e-material • Posters https://plus.enen.eu/competition/materials.php
Energy sector	Nuclear

Education level	EQF 4, EQF 5 / School
Summary: This project aims to substantially contribute to the revival of the interest of young generations in careers in the nuclear sector. In particular, it focuses on the following topics: - Nuclear reactor engineering and safety, - Waste management and geological disposal, - Radiation protection - Medical applications. The project is implemented by running a competition in which the participants will compose a 3-minute video on one or more of the mentioned disciplines. The competition is open to secondary school pupils, in groups on two students and one teacher. The 15 finalist teams are invited and financially supported to attend the European Nuclear Competition and Summer School, where they will have to present their video.	

Project #22	**Vocational Education and Training across the Gas sector in Europe** https://www.epsu.org/sites/default/files/article/files/Findings_for_VET_in_the_EU_Gas_Sector_v2.pdf
Project goals	• Build a better understanding of the VET infrastructure in the gas sector across the European Countries, providing the sector with a skilled workforce • Begin discussion with relevant bodies within the gas sector with a view to create a Sector Council for the European gas industry.
Project partners	• Syndex (CC) - https://www.syndex.eu/
Start / End dates	September 2012

Project deliverables	• Report: "Vocational Education and Training across the Gas sector in Europe" https://www.epsu.org/sites/default/files/article/files/Findings_for_VET_in_the_EU_Gas_Sector_v2.pdf
Energy sector	Gas
Education level	EQF 5, EQF 6 / VET

Summary:

This report was elaborated based on the research commissioned by the gas sector European social partners, Eurogas, EPSU and IndustriAll to provide an overview in the sector and identify those VET institutions whose involvement is necessary in any discussion about a Sector Council.

Ii aims to provide a map of the organisations and institutions in Europe on a country by country bases, for those countries whose information was available. It also presents the different models in the approach to VET:

- Market model: where market forces regulate training, which is generally work-base. It is the case of the UK.
- State model: where the state regulated training, which is mostly school-based training, as in France or Sweden.
- Dual model: where the regulation is both from the state and the market and there is a combination of training venues. It is the case of Germany or Austria.

There are numerous institutions within the gas sector which carry out research to identify changes in demand for skills from the sector and i is necessary to establish a link between vocational training and the labour market at the sector level, promoting continuing training and improving the responsiveness of the education sector in relation to labour market demands and the exchange of information.

The report concludes with a list of bodies recommended within the gas sector involved in VET from the different countries to take part in a Sector Council.

Project *#23*	**Vocational training in the sector of renewable energies and energy efficiency** https://www.giz.de/en/worldwide/79018.html

Project goals	· The Government of Côte d'Ivoire is increasingly making specialised local technical expertise and management know-how available to the market for renewable energy and energy efficiency. The project aids this effort focusing on: · Human resources development · Organisational development · Network-building · Advising public, private and civil society vocational schools and corporate associations on how to improve their core processes for cooperative training and market development in the area of renewable energy and energy efficiency.
Project partners	· Government of Côte d'Ivoire · German Federal Ministry for Economic Cooperation and Development · G20 Compact with Africa
Start / End dates	· 2019 to 2021
Project deliverables	· Further development and implementation of qualification measures for renewable energy and energy efficiency. · Establishment of a multi-actor coordination mechanism for vocational training in the area of renewable energy and energy efficiency. · Supporting companies in market development and assists them in gaining initial experience with photovoltaics and energy efficiency.
Energy sector	Renewable energy and energy efficiency
Education level	VET (Vocational Education and Training)
Summary: The project is part of the reform partnership between the Government of Côte d'Ivoire and the German Federal Ministry for Economic Cooperation and Development (BMZ), together with the G20 Compact with Africa initiative. It has various different priority areas and focuses in particular on human resources development, organisational development and network-building. It assists selected individuals working in vocational education in boosting their skills and supports them in passing on task-based skills in the area of renewable energy and energy efficiency.	

Project *#24*	**Wind & Marine Energy Systems & Structures (CDT-WAMSS)** https://bit.ly/3ajLhsQ
Project goals	The Wind and Marine Energy Systems and Structures CDT has the following aims (https://bit.ly/3bvfxkm):

Project partners	Universities: · University of Strathclyde · The University of Edinburgh · University of Oxford Various industrial collaborators have been involved and have supported research projects throughout the running years of the CDT. Some of them are listed below: · Atkins EDF Energy · Energy Technology Centre · Energy Technology Partnership · FloWave TT Limited Gamesa · Garrad Hassan & Partners Ltd · Lloyd's Register Foundation · NAREC National Renewable Energy Centre · Offshore Renewable Energy Catapult · Renewable Energy Systems Ltd · Romax Technology Limited · Scottish and Southern Energy (SSE) · Scottish Power · SgurrEnergy Ltd · Siemens plc (UK) · Sinclair Knight Merz(Europe) Ltd(Jacobs) · Subsea 7 Limited · Technip Offshore Wind Ltd UK
Start / End dates	2014 to 2022
Project deliverables	· Academic training programme providing taught modules · Research programme leading to PhD
Energy sector	Wind and marine energy engineering
Education level	EQF level 8

Summary: This centre offers the UK's only comprehensive doctoral training programme in Wind & Marine Energy, bringing together the leading UK research groups in Wind Energy at Strathclyde University, Marine Energy at Edinburgh University and Offshore Structures at Oxford University. The Centre is committed to

Project #25	**Energyducation: Exploring "Smart Energy Management"** http://www.energyducation.eu/
Project goals	· Enhance technological skills of VET students and their teachers about using digital tools in energy management · Train VET teachers/providers in ECVET principles, · Improve problem solving behaviours of VET students through Project Based Learning (PBL), their skills in using digital training material, and their international mobilities.
Project partners	· CIFP Usurbil LHII (Project Coordinator) · ZubiGune Fundazioa · Münster School Of Vocational Education (MSVE) · Alfa-College · Lulea Kommun · NTI-MMM · Myclimate
Start / End dates	2018 - 2020
Project deliverables	· Training VET teachers/providers in ECVET principles · Partners will work collaboratively together to deliver the content of the Toolkit · Partner will learn how to use and implement the training tools in MOOC courses · VET providers will undertake a piloting with their students and implement student projects · VET providers will organize a student competition among participating VET students · Partner will deliver a Handbook for supporting the didactical approach of the student project, which are based on project based learning methodology.
Energy sector	Smart energy sector (Smart Energy Management)
Education level	VET

Summary: The new-generation information technologies such as the Internet of Things, robotics, and smart connected objects open new horizons for industry and the energy markets. The experiences of the VET partners involved in the projects points to the fact that the VET providers have to get in line with the new technical competencies required by the smart energy sector and in specifically of energy management. Furthermore, all schools wish to follow the EU recommendations to implement ECVET principles to enhance student mobilities. The main objective of this program is to enhance the technological skills of VET students and their teachers about using digital tools in energy management.

Project #26	**Energy Challenges** https://www.energychallenges.nl/en/
Project goals	● Challenge students from elementary- and high schools to campaign for energy saving and sustainability on their schools.
Project partners	● https://www.energychallenges.nl/en/partners
Start / End dates	2020 / Ongoing
Project deliverables	● Online tool: *Energie Manager Online* (EMO)
Energy sector	Renewable energy / energy transition
Education level	EQF 4 / Schools

Summary:

The project is implemented as follows: each school forms a team of 'Energizers' who take the lead in making the school and environment more sustainable. During the campaign season, the teams venture out in the world of energy, technology and sustainability and move from knowledge to action and results. They teams gets a big poster on which they can earn stars for their achievements. The steps of the stars challenge them to come up with original and creative actions which correspond to school, environment or their own talents. Steps taken are:

1. Behaviour: changing behaviour to reduce energy usage.

2. Technology: the technology makes the energy-usage and saving immediately visible for participating youths. Moreover, technical inventories are done, which contribute to making the school building more sustainable.
3. Saving (measurable and visible): participating schools are equipped with smart meters and measuring equipment to give real time insight in the gas, electricity and water usage.

As part of the technology course this project involves, tailor.made advice is given to the school to make school building more sustainable. This advice offers perspective on enhancing sustainability extensively by looking at the construction, installation methods and energy management. An energy monitoring tool, *Energie Manager Online* (EMO) is provided to help to reduce the energy-usage of the school. It is a website that shows the usage and the costs of gas and electricity. Children can daily measure the school energy-usage and see the effect of their actions.

Project #27	**VET-GPS Guiding tools for Professional Skills development in VET** https://www.vetgps.eu/
Project goals	The partnership promoted a set of activities involving key-stakeholders, aiming at designing and providing complementary tools for VET professionals.
Project partners	**Coordinator:** MENTORTEC - Servicos de Apoio a Projectos Tecnologicos AS, Portugal. **Partners:** 1. BLICK - Blickpunkt Identität, Austria 2. C.E.C.E. - Confederacion Espanola de Centros de Ensenanza Asociacion, Spain 3. ANESPO - Associação Nacional de Escolas Profissionais, Portugal 4. PIXEL - Pixel Associazione, Italy 5. Connectis, Italy 6. Politeknika Ikastegia Txorierri S.Coop, Spain 7. European Forum of Technical and Vocational Education and Training (EfVET), Belgium
Start / End dates	2017 - 2019
Project deliverables	Including: 1. A guide for integration of the Soft-Skills in VET 2. A toolkit for professional guidance & coaching 3. A programme for Professional Development of Trainers/Tutors 4. A quality framework & platform for the cooperation in VET system

Energy sector	Technological projects
Education level	VET
Summary: Soft skills are recognized to be the success factor enabling individuals' well-being, self-confidence, autonomy and responsibility, fulfilment of education/social and professional lives, career development and higher income. However, the set of soft skills is often referred to be as non-measurable skills by conventional tests or exams, as they include a wide range of skills related to the individual mind-set, such as: capacity building, learning to learn, persistence, resilience, creativity, selfdiscipline, self-reflectiveness, acting autonomously. Capitalizing the outcomes from 2 previous projects, (Employ project - http://employproject.eu - and In-VET project - http://invet-project.eu/), VET_GPS aims at promoting the integration of the soft skills in regular VET offer and, by this way, prevent the early VET leaving and increase the possibility of employment of trainees.	

7. Annex 3: Survey

EDDIE Project - Digitization of Energy System Challenges

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 addressing the main challenges the industry faces towards the digitalization of the energy system and the new skills needed. Challenges will be listed and relevant skills will be identified and classified in accordance to their impact and importance.

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?

- Public body
- Non-profit
- International organization
- Small Medium Enterprise (SME)
- Association
- Large company
- Legal person/Self-employed
- Other

2 Please specify

* 3 How many people does your organisation occupy (estimation)?

- Less than 50
- 50-100
- 100-500
- 500-1000
- More than 1000

4 In which country is your organisation based?

5 In which country do you work?

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

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

7 Please specify

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

- ☐ Generation
- ☐ Network (DSO, TSO etc)
- ☐ Retailer
- ☐ Service provider (Consultant, aggregator etc)
- ☐ Manufacturer
- ☐ Other

9 Please specify

* 10 Which of the below best describes your current department?

- ○ Management
- ○ Human Resources
- ○ Technical department
- ○ Administration
- ○ Other

11 Please indicate your current business unit and position

500 character(s) maximum

12 Does your organization support training measures? If yes, which is/are the type(s) of training preferred in your organization? (You can choose more than one if applicable)

	General knowledge training	Specialization
Distance learning (Online training)	☐	☐

In-house training	☐	☐
Workshops	☐	☐
Postgraduate studies	☐	☐
Summer/Winter schools	☐	☐
Other	☐	☐

13 If "Other" please specify

3 Technologies and Tools

14 Which of the following technologies do you use and how often?

	Never	Daily	Weekly	Monthly
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)	○	○	○	○

15 Please list technologies you're using, related to Energy system digitalization that are not mentioned above

800 character(s) maximum

16 Which of the following tools do you use and how often?

	Never	Daily	Weekly	Monthly
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)	○	○	○	○
Customer services	○	○	○	○
Drones	○	○	○	○
Robotics/advanced manufacturing	○	○	○	○
Online collaboration platforms	○	○	○	○
Social media	○	○	○	○

17 Please list tools you're using, related to Energy system digitalization that are not mentioned above

800 character(s) maximum

4 Industry Challenges

18 Please indicate which of the following added values are produced by digitalization at your organization? (You can choose multiple)

- ☐ Financial - Increase in revenue
- ☐ Financial - Reduced costs
- ☐ Business - Enhance brand name
- ☐ Business - Create a point of difference from competition
- ☐ Business - Goals/targets tracking
- ☐ Customer service - Add features to existing products
- ☐ Customer service - Offering convenience
- ☐ Customer service - Improve Quality of Services (QoS)
- ☐ Management/Administration - Simplify management.
- ☐ Technical - Enabling new/green technologies
- ☐ Technical - Crisis management
- ☐ Other

19 Please specify

500 character(s) maximum

20 Please indicate relevant new occupation/job needs arising from digitalization

Which of the following challenges does your organization face regarding digitalization?

21 **Economic & Organisational** Challenges (You can choose multiple)

- [ ] High economic costs
- [ ] Business model adaptation
- [ ] Funding
- [ ] Low top-management commitment
- [ ] Other

22 Please specify

500 character(s) maximum

23 **Social** Challenges (You can choose multiple)

- [ ] Privacy concerns
- [ ] Loss of jobs due to automatic processes
- [ ] Acceptance of new technologies
- [ ] Lack of citizen engagement
- [ ] Other

24 Please specify

500 character(s) maximum

25 **Technical & Regulatory** Challenges (You can choose multiple)

- [ ] IT security issues
- [ ] Reliability and stability needed for machine to machine communication
- [ ] Need to protect industrial know-how
- [ ] Lack of adequate skills from employees
- [ ] Data management
- [ ] Data protection issues
- [ ] Technology integration (compatibility with existing processes/technologies)
- [ ] Lack of regulation, standards and forms of certification
- [ ] Unclear legal issues
- [ ] Other

26 Please specify

500 character(s) maximum

27 **Energy System related** Challenges (You can choose multiple)

- Customers - Remote service to customers
- Customers - Dedicated information about their energy profiles
- Customers - Remote fault announcement
- Customers - Remote metering
- Customers - Remote fault repairs
- Network Planning - Digital tools for network planning
- Network Planning - Geographical information systems
- Network Planning - Data for longer term load forecasting
- Network Planning - Load profiles
- Network operation - Automation of fault clearance
- Network operation - Remote switching
- Network operation - Automatic fault indicators
- Network operation - Crew management
- Network operation - on-line security assessment
- Network operation - Short-term load forecasting
- Maintenance and asset management - Predictive maintenance
- Maintenance and asset management - Asset management
- Other

28 Please specify

500 character(s) maximum

29 Does your organisation participate in digitalization related associations - events where good practices can be shared? (Forums, working groups, clusters)

- Yes
- No

30 If "Yes" please provide some examples

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.

31 Did your company have a Crisis Operations strategy (pandemic, extreme weather etc)?

- Yes
- No
- Not sure

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

- 1
- 2
- 3
- 4
- 5

33 Was your organisation ready for teleworking? (equipment, trained staff, software)

- Yes
- No
- Partly (Some departments)

34 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

35 What are the main challenges besides teleworking that your organisation had to face in the beginning of the crisis and how well did it respond?

1000 character(s) maximum

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

1000 character(s) maximum

5 Skills

In the following matrices we provide digitalization of energy related skill sets. Please specify which of the following skills are required at your organization.
Two ticks are needed for each skill, one in the first colums ("basic", "intermediate", "expert") to indicate the **level of expertise needed**, and another in the last colums ("not covered", "partly covered", "covered") to indicate the **level of coverage within your institution**."

5.1 Data capture & management

37 **Managers/Administration** - 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	☐	☐	☐	☐	☐	☐

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	☐	☐	☐	☐	☐	☐

39 **Technicians/Specialists** - 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	☐	☐	☐	☐	☐	☐

40 Please list relevant skills that are not mentioned above

800 character(s) maximum

5.2 Analytical Methods

41 **Managers/Administration** - Analytical methods

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

42 **Engineers/Researchers** - Analytical methods

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

43 **Technicians/Specialists** - Analytical methods

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

44 Please list relevant skills that are not mentioned above

800 character(s) maximum

5.3 Computing Tools and Platforms

45 **Managers/Administration** - Computing tools and Platforms

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
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	☐	☐	☐	☐	☐	☐

46 **Engineers/Researchers** - Computing tools and Platforms

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
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	☐	☐	☐	☐	☐	☐

47 **Technicians/Specialists** - Computing tools and Platforms

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
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	☐	☐	☐	☐	☐	☐

48 Please list relevant skills that are not mentioned above

800 character(s) maximum

5.4 Programming, development and technology related

49 **Managers/Administration** - Programming, development and technology related

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

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	☐	☐	☐	☐	☐	☐

50 **Engineers/Researchers** - Programming, development and technology related

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
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	☐	☐	☐	☐	☐	☐

51 **Technicians/Specialists** - Programming, development and technology related

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
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	☐	☐	☐	☐	☐	☐

52 Please list relevant skills that are not mentioned above

800 character(s) maximum

5.5 Transversal Skills

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

53 **Managers/Administration** - Transversal

	Basic	Intermediate	Expert
Communication	☐	☐	☐
Team working	☐	☐	☐
Ease of learning	☐	☐	☐
Planning and organization	☐	☐	☐
Customer handling	☐	☐	☐
Problem solving	☐	☐	☐
Innovation and creativity	☐	☐	☐
Leadership	☐	☐	☐
Systemic/holistic thinking	☐	☐	☐
Cross-disciplinary technical competences	☐	☐	☐

54 **Engineers/Researchers** - Transversal

	Basic	Intermediate	Expert
Communication	☐	☐	☐
Team working	☐	☐	☐
Ease of learning	☐	☐	☐
Planning and organization	☐	☐	☐
Customer handling	☐	☐	☐
Problem solving	☐	☐	☐

Innovation and creativity	☐	☐	☐
Leadership	☐	☐	☐
Systemic/holistic thinking	☐	☐	☐
Cross-disciplinary technical competences	☐	☐	☐

55 **Technicians/Specialists** - Transversal

	Basic	Intermediate	Expert
Communication	☐	☐	☐
Team working	☐	☐	☐
Ease of learning	☐	☐	☐
Planning and organization	☐	☐	☐
Customer handling	☐	☐	☐
Problem solving	☐	☐	☐
Innovation and creativity	☐	☐	☐
Leadership	☐	☐	☐
Systemic/holistic thinking	☐	☐	☐
Cross-disciplinary technical competences	☐	☐	☐

56 Please list relevant transveral skills that are not mentioned above

5.6 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.

57 Does your organization face the challenge of adapting to climate-driven goals and policies?
- ○ Yes
- ○ No
- ○ Not sure

58 Does your organization engage in activities that require green skills as described above?
- ○ Yes
- ○ No
- ○ Not sure

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

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

60 Please elaborate

800 character(s) maximum

61 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

62 Please specify

800 character(s) maximum

63 What are the main drivers towards green skills adaptation?

- [ ] Economic cycle
- [ ] Trends in policy
- [ ] Trends in industry/technology
- [ ] Environmental awareness
- [ ] Other

64 Please specify

800 character(s) maximum

5.7 Tasks

Please describe 3 tasks that are performed at your organisation regurarly, related to the digitalization of the energy system

65 Task 1

800 character(s) maximum

66 Task 2

800 character(s) maximum

67 Task 3

800 character(s) maximum

68 In the context of digitalization, please indicate future tasks/neccesities foreseen to be needed. (Write freely)

6 Communication

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

- Yes
- No

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

- Yes
- No

71 Please provide us with your email address