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Education for Digitalization of Energy

Deliverable 4.4

Report on Best Practice for Lifelong Learning Programmes (LLP)

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Abstract:

This report aims at the presentation of good practices developed and implemented in lifelong learning provision in the field of energy transition. The desk research focused on recent projects, to take into consideration the latest EU directives across the EU. The practices selected and presented in this report demonstrate a good indication on the work carried out (mainly) from the private sector towards training the workforce in the context of energy efficiency and sustainability with the incorporation of digital tools in the learning provision. Finally, the solutions presented are very well designed and implemented efforts to address the skills mismatches in the sector.

Keywords:

Best practices, lifelong learning design, skills enhancement, Skills, Competencies, Occupations, Energy, Education, Training

DISCLAIMER

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10	IBERDROLA	IBERDROLA	Spain
11	GE Energy Products France SNC	GE	France
12	DNV Business assurance Spain SL	DNV	Spain
13	EDSO for Smart Grids	E.DSO	Belgium
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Definitions, Acronyms and Abbreviations

AI	Artificial Intelligence
ATI	Advanced Technologies for Industry
BACS	Building Automation and Control System
BEMS	Behavioural Energy Management System
BMBF	German Federal Ministry of Education and Research
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMWI	Ministry for Economic Affairs and Energy
BSDE	Blueprint Strategy for the Digitalisation of the Energy
CCS	Carbon Capture and Storage
CCU	Carbon Capture Utilisation
CDTI	Centre for Industrial Technological Development
CEDEFOP	European Centre for the Development of Vocational Training
CPF	Individual learning account
CVET	Continuous VET
DHS	District Heating System
DigiComp	European Digital Competence Framework
DMA	Digital Markets Act
DSA	Digital Services Act
EACI	Executive Agency for Competitiveness and Innovation
EASME	Executive Agency for Small and Medium-sized Enterprises
EC	European Commission
ECTS	European Credit Transfer and Accumulation System
ECVET	European Credit System for VET
EDSC	European Digital Skills Certificate
EE	Energy Efficiency
EEFIG	Energy Efficiency Financial Institutions Group
EERA	European Energy Research Alliance
EL	Greece
EM	Energy Management
EP	Energy Production
EPC	Energy Performance Contracting
EQF	European Qualifications Framework
ER	Energy Reduction
ESC	Energy Supply Contracting
ET	Education & Training
ETIP	European Technology and Innovation Platform
EU	European Union
EUREM	European Energy Manager
FI	Finland
GDPR	General Data Protection Regulation

HEI	Higher Education Institution
HR	Human Resources
HTC	High Throughput Computing
ICT	Information and Communication Technologies
IEA	International Energy Agency
IS	Interdisciplinary Skills
IT	Information Technologies
JP	Joint Programme
KSC	Knowledge Skills and Competencies
LLL	Lifelong Learning
LLP	Lifelong Learning Programmes
NAS	National Advisory Services
NIN	National Nanotechnology Initiative
nZEB	near-zero Energy Buildings
OECD	Organisation for Economic Co-operation and Development
PES	Public Employment Service
PIACC	Programme for the International Assessment of Adult Competencies
R&I	Research and Innovation
RES	Renewable Energy Sources
SALTO	Support, Advanced Learning and Training Opportunities
SET	Strategic Energy Technology
SETIS	SET Plan Information System
SI	Smart Industry
SK	Slovakia
STEM	Science Technology Engineering Mathematics
UK	United Kingdom
US	United States
UX	User Experience
VET	Vocational Education and Training
WP	Work Package
XR	Extended Reality

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Executive Summary

This report has been drafted in the context of the EDDIE project, with the intention of mapping best practices designed and implemented for lifelong learning provision in an attempt to tackle skills mismatches in the Energy Sector.

For the compilation of the report, the Researcher focused on the identification of practices on the following principles:

- Lifelong learning programmes that were effectively combined with work-based learning
- Lifelong learning programmes which were ICT facilitated and in the context of digital transformation challenge
- Lifelong learning programmes that aimed at the engagement of the individuals and the change of mind set in what relates to the critical issue of energy digitalization.

It can be concluded that to date, there have been meaningful and commendable initiatives in LLP towards upskilling the workforce regarding energy digitalization. However, it is important for LLP provision to continue working towards strengthening its links to the labour market, to ensure its consistency with the changing requirements and enhance its attractiveness in the economies of the Member States. By strengthening collaboration between education and industry, lifelong learning programs have the potential to drive not only individual success but also the success of the energy digitalization. Continual investment in these programs and their alignment with industry needs will be key to ensuring the long-term sustainability of the energy sector.

In this context, the overarching objective of the EDDIE project appears to be more valid than ever, considering also the EC strategies towards digital transformation as a horizontal need even further pronounced following the impact of the pandemic.

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 to play towards it. Following and complementing past actions, the European Green Deal expresses the response of the EU to climate change, thus setting it as a worldwide leader in this fight.

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

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

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

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

The EDDIE project proposes an innovative strategic approach for education in the 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.

In this framework, the identification of good practices in the field of lifelong learning provision is important in order to understand the work that has already been carried out and can be considered as a good practice, to measure the extent to which these practices could be transferred in other countries and learn from these, to make the EDDIE results even more effective to reach the overarching objective of the project.

1.1. Structure of the document

The document is structured in five sections, the first one of which is the introduction. The second section of the document provides an analytical presentation of all EU strategies, action plans and roadmaps that relate to Lifelong Learning Policy, elements of digital transformation and the incorporation of digital tools in Lifelong Learning provision and, finally, the regulatory framework on energy efficiency, as defined for EU Members States.

The third section of the document describes the logic behind the criteria set for the identification of the best practices presented in this deliverable, while section four includes the best practices identified in the field of Lifelong Learning for energy digitalization or efficiency, as well as the digitalisation of Lifelong Learning Programmes for improved outcomes for energy efficiency. It also includes some good examples and success stories that, although not being directly connected to energy digitalization, can provide valuable insights regarding successful strategies and methodologies in the VET sector. The fifth section presents the conclusions related to the lessons learnt from the practices identified.

The report aims to set the basis on what can be recognised as a best practice and under which conditions in the topics addressed by the EDDIE project. It can serve as a guidelines document on the preconditions to be taken into consideration for the development of results that do not just serve the purpose of addressing the principle needs identified, but also to become a benchmark for the implementation of similar projects in the future.

2. Background

2.1. Review of EU strategies, action plans and roadmaps

For the compilation of this deliverable, the consortium took into consideration the strategies, action plans and road maps developed and introduced from the EC and for the policy and regulatory framework for all energy transition and digitalisation initiatives.

The section begins with the presentation of the EU lifelong learning Policy and the needs it aspires to cover. The Digital Education Plan is then presented to highlight the need for incorporating emerging technologies in lifelong learning to contribute to the introduction of state-of-the-art interventions that lead to energy efficiency.

The section then focuses on the presentation of the European Strategic Energy Technology Plan (SET Plan) and SET Plan update, Advanced Technologies for Industry, the European Energy Research Alliance and the Programme on the Digitalization of the energy sector, the European digital strategy and digital roadmap, the Digital Services Act and the existing policies on Digitalisation in Energy.

Finally, an overview of data from deliverable D.2.2 is presented regarding the skills mismatches between education and the market, in combination with the needs of the latter. The practices identified in order to address these gaps are discussed in this framework.

2.1.1. Digital Education Action Plan

The COVID-19 crisis has had a strong impact on education and training from the digital point of view, accelerating the digitalization process. It has also brought out the need to develop an efficient strategy to support and implement the digital transformation in education, by supporting the development of digital skills by both teachers/educators and learners. This digital transformation is important because it offers new and renewed learning patterns.

However, there are some important challenges that the EU needs to consider, such as:

- the need for technological tools, platforms and pedagogy to be inclusive and to allow learners with disabilities to participate in the digital transformation;
- the development of digital capacities of education and training institutions;
- the need for individuals from disadvantaged backgrounds to have access to digital tools.

The following Section describes the Action put in place in terms of recommendation and policy by the EU commission to address the previously described challenges thus fostering the advancement of education and training, while defining a long-term vision for European digital education.

At the Lifelong Learning level, it takes into consideration two main Actions delivered by the EU Commission and described in the European Education Area[1] that seem interesting for the EDDIE project as best practices in terms of policies:

- the digital Education Action Plan
- Council Recommendation on Key Competences for Lifelong Learning
- the European Approach to Micro credentials

Digital Education Action Plan (2021-2027)

The Digital Education Action Plan (2021-2027) has been designed basing on the previous and first Digital Education Action Plan (2018- 2020), which was focused on three main priority areas:

- making better use of digital technology for teaching and learning
- developing digital competencies and skills

[1] https://ec.europa.eu/education/education-in-the-eu/about-education-and-training-in-the-eu_en

- improving education through better data analysis and foresight

This first Digital Education Action Plan (2018-2020) was focused on the importance of the Digital transformation on education and training. However, the COVID-19 pandemic proved to be the deciding factor that made it clear that having an education and training system which is fit for the digital age is essential to design and implement sustainable and effective training experiences, at all educational levels.

After these considerations, The EU started a process of Stakeholders Consultations (**Resetting education and training for the digital age**) to draft a series of guiding principles aimed at making education and training systems fit for the digital age.

The priority areas and actions are the following:

- Fostering the **development of a high performing digital education ecosystem**
- **Enhancing digital skills and competences** for the digital transformation

These priorities will be achieved through several actions, addressing several educational levels. The actions that seem particularly interesting for LLL propose:

- The usage of European projects to support digital transformation.
- The focalization on specific high level digital skills (e.g.: AI).
- The creation and diffusion of the European digital skill certificate to recognise the digital skills.

The Commission will establish a **European Digital Education Hub** by 2022, to support the following actions.

1. Fostering the development of a high performing digital education ecosystem

To achieve this objective, the EU has developed a series of actions:

- **Action 1**: Strategic Dialogue with Member States on the enabling factors for successful digital education
- **Action 2**: Council Recommendation on blended learning for primary and secondary education
- **Action 3**: European Digital Education Content Framework
- **Action 4**: Connectivity and digital equipment for education
- **Action 5**: Digital transformation plans for education and training institutions
- **Action 6**: Artificial intelligence and data usage in education and training

ACTION 5: Use Erasmus cooperation projects to support the **digital transformation plans** of primary, secondary, vocational education and training (VET), higher, and adult-education institutions, as well as **support digital pedagogy and expertise** in the **use of digital tools**.

This action has two main objectives: the first one is to ensure that educational institutions develop and strengthen their digital capabilities and capacity; the second one is to support teachers, working in different educational levels, in the development of their digital skills.

The Action will be implemented through several funded projects. The first funding was opened in April 2021, and will be made available annually until 2027, through the Erasmus+ call.

This Action will develop and align the development of the digital skills of all the educational institutions of the Member States thus indirectly supporting the educational Actions put in place by the EDDIE project.

ACTION 6: Implement Artificial intelligence and data usage in education and training and launch of the call on extended reality (XR) in education and training by the end of 2022.

It is important that **European citizens** have a basic knowledge of Artificial Intelligence in order to exploit its potential. In particular, Artificial Intelligence could be used in schools in a wide variety of ways, for example to reduce early school leaving, **to support teachers in teaching** subjects such as languages, or to reduce learning difficulties.

The European Commission will then **develop ethical guidelines on AI** and the use of data in teaching and learning (in 2022) and at the same time will support research and innovation activities through the Horizon Europe programme by developing a training programme for researchers and students.

This Action will indirectly support the EDDIE project, fostering the development of the training sector.

2. Enhancing digital skills and competences for the digital transformation

To achieve this objective, the EU has developed a series of actions:

- **Action 7**: Common guidelines for teachers and educators to foster digital literacy and tackle disinformation through education and training
- **Action 8**: Update the European Digital Competence Framework to include AI and data-related skills
- **Action 9**: European Digital Skills Certificate (EDSC)
- **Action 10**: Council recommendation on improving the provision of digital skills in education and training
- **Action 11**: Cross-national collection of data on student digital skills and introduce an EU target for student digital competence
- **Action 12**: Digital Opportunity Traineeships
- **Action 13**: Women's participation in STEM
- **Digital Education Hub**

The actions that seem particularly interesting for Lifelong Learning Programmes (LLP) are the ones which support the development of digital skills both in teachers and individuals/citizens though specific projects and guidelines.

ACTION 8: Update the **European Digital Competence Framework** to include **AI and data-related skills**.

The aim of this action is to enable **EU citizens** to acquire technological knowledge so that they can use the new tools securely and at the same time acquire awareness of related issues such as privacy, ethics, sustainability and discrimination.

Specifically, during 2021 and 2022, Artificial Intelligence will be added to the Digital Competence Framework so that it can be implemented in education and training.

This **ACTION** will produce **an important output for the EDDIE project** that is the compilation of **Digital Competence Framework 2.2 by March 2022**. The Digital Competence Framework could be used as a valuable reference in the programs and courses implemented and supported by the EDDIE project.

ACTION 9: Develop a **European Digital Skills Certificate** (EDSC) that may be recognised and accepted by governments, employers and other stakeholders across Europe, by 2023.

The objective of this action is to develop a European Digital Skills Certificate because in Europe there is a wide range of digital skills certifications that need to be recognized, in order to allow the citizens to indicate their digital skills level according to the DigComp.

This Action will align the Member States in the recognition of the digital skills, furthermore it will ensure that by 2025 70% of people aged 16-74 will have basic digital skills and that by 2030 at least 80% of the population will have basic digital skills.

The main outcome will be the European Digital Skills Certificate (EDSC) recognized and accepted by governments, employers and other stakeholders in Europe. The output of this action will be relevant for EDDIE which could use the digital certificate as a base for specific training experiences focused on the digitalization of energy.

European Digital Education Hub: In order to **improve cooperation on digital education at the EU level**, the Commission will establish a **European Digital Education Hub** by 2022.

The European Digital Education Hub will be focused on three main actions:

- creating and developing a **community of practice for cooperation** (CoP)
- creating a **network of National Advisory Services (NAS)**
- collecting best practices through the new **Support, Advanced Learning and Training Opportunities (SALTO) resource centre for digital education**

In particular, the CoP will:

- provide a cross-sectorial space;
- encourage knowledge and information sharing, cooperation and mapping;
- support the acceleration of digital innovation in education.

The NAS will foster the "Strategic Dialogue on Enabling Factors in Digital Education".

The SALTO will train the staff of the National Agency; will guide beneficiaries and applicants providing them with all the necessary tools; and will also take charge of the best practices.

Council Recommendation on Key Competences for Lifelong Learning

The Council has adopted in 2018 a **Recommendation on Key Competences for Lifelong Learning**. The Recommendation identifies eight key competences every citizen should develop for "personal fulfilment, a healthy and sustainable lifestyle, employability, active citizenship and social inclusion". One of these key competences are "Digital and technology-based competences".

Digital competences are focused on the "confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society". They include:

- information and data literacy,
- communication and collaboration,
- media literacy,
- digital content creation (including programming),
- safety (including digital well-being and competences related to cybersecurity),
- intellectual property related questions,
- problem solving and critical thinking.

The Recommendations describe essential knowledge, skills and attitudes related to this competence to support a proper design and implementation of training paths[2].

To support the development of digital competences the European Commission has already developed the Digital Competence Framework 2.0. (https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework) which will be updated (through ACTION 8) to include to include AI and data-related skills.

The Recommendations and The Digital Competence Framework (revised) are setting the base for designing and implementing training activities which can be specifically focused on the Digitalization of energy. Each area defined in the recommendation and framework could be analysed, then defining all the training experiences and actions needed to focus the framework in the Energy sector.

A European Approach to micro-credentials

Micro-credentials are offered by **higher and vocational education and training (VET) institutions**, as well as by private organisations dealing with LLL courses.

They can be particularly useful for people want to:

- build on their knowledge **without completing a full higher education programme;**
- **upskill or reskill** to meet labour market needs or to develop professionally after starting work.

Maintaining and acquiring new competences is essential to foster advancement in Europe. However, **without common standards** ensuring quality, transparency, cross-border comparability, recognition and portability, **micro-credentials cannot reach their full potential.** The Commission, therefore, seeks to develop **a common definition and European standards for micro-credentials**, which are independent from the awarding body, building on existing tools as far as possible.

[2] https://op.europa.eu/en/publication-detail/-/publication/297a33c8-a1f3-11e9-9d01-01aa75ed71a1/language-en

In spring 2020, an ad-hoc consultation group formed of experts in higher education proposed a common European definition, common characteristics and a roadmap of actions.

This roadmap puts forward suggestions for actions needed at the European and national levels to develop and implement a European approach and proposes a timeline. The suggested actions concentrate mainly on higher education, but also address other levels and sectors of education and training.

The roadmap focuses on the following actions:

- **developing common European standards** for quality and transparency, together with all involved stakeholders;
- exploring the **inclusion of micro-credentials in national qualification frameworks** with possible reference to the European Qualifications Framework;
- developing a **list of trusted providers** and fostering quality assurance processes;
- exploring **how the European Credit Transfer and Accumulation System (ECTS) can be used** in the context of micro-credentials at other education levels and in other sectors;
- working on guidelines for **more rapid recognition** by adapting existing validation and recognition instruments or by developing new ones;
- making it easier for individuals to **store and showcase their micro-credentials through Europass** and its digital credentials infrastructure, **as well as the European Student Card initiative;**
- using **micro-credentials to improve access to lifelong learning opportunities** by ensuring better permeability between education and training sectors and ensuring an informed learner choice by expanding guidance services underpinned by real time labour market data;
- providing EU support through the Erasmus+ Programme and Structural Funds for **higher education, VET and other education and training institutions and providers to promote** the uptake of **micro-credentials.**

The approach to micro-credential at European level is particularly interesting for the EDDIE project: it proposes a “common certification” to stackable competences, and it provides a clear description of the skills acquired by everyone. The recommendation is to integrate “micro-credentials” recognized at European level in the EDDIE training offer.

2.1.2. European Strategic Energy Technology Plan (SET Plan) and SET Plan update

The SET Plan structure

The SET Plan was launched in January 2007 after acknowledging the need to reshape the European energy sector in order to make it possible to face the important challenges that come with the climate change. Its main objectives are to lower the cost of clean energy and to allow Europe to play a key role in the low-carbon technology scenario.

The SET plan is envisioned to be instrumental in funding Research and Innovation (R&I) activities by promoting a targeted and efficient spending, and by driving national and private financial sources.

It consists of the SET Plan Steering Group, the European Technology and Innovation Platforms (ETIPs), the European Energy Research Alliance (EERA), and the SET Plan Information System (SETIS).

It is worth bearing in mind the composition and the roles that each of these groups play in allowing the SET Plan to be efficient:

- The **SET Plan Steering Group** consists of high-level representatives from EU countries, as well as Iceland, Norway, Switzerland, and Turkey. It ensures better alignment between the different research and innovation programmes at EU and national level, as well as the SET Plan priorities. It also increases cooperation between national programmes to avoid duplication and heightens the impact of public investment.
- The **European Technology and Innovation Platforms** (ETIPs) were created to support the implementation of the SET Plan by bringing together EU countries, industry, and researchers in key areas. They promote the market uptake of key energy technologies by pooling funding, skills, and research facilities. There are 9 ETIPs.

- The **European Energy Research Alliance** (EERA) aims to accelerate new energy technology development by cooperation on pan-European programmes. It brings together more than 175 research organisations from 27 countries, involved in 17 joint programmes. It plays an important role in promoting coordination among energy researchers along the SET Plan objectives and in the technology transfer to the industry.
- The EU's **SET Plan Information System** (SETIS) provides information on the state of low-carbon technologies. It also assesses the impact of energy technology policies, reviews the costs and benefits of various technological options, and estimates implementation costs. This information is useful for the European industrial initiatives, private companies, trade associations, the European Energy Research Alliance, international organisations, and financial institutions.

As can be seen in the SET Plan infographic, the plan is articulated into 10 key actions:

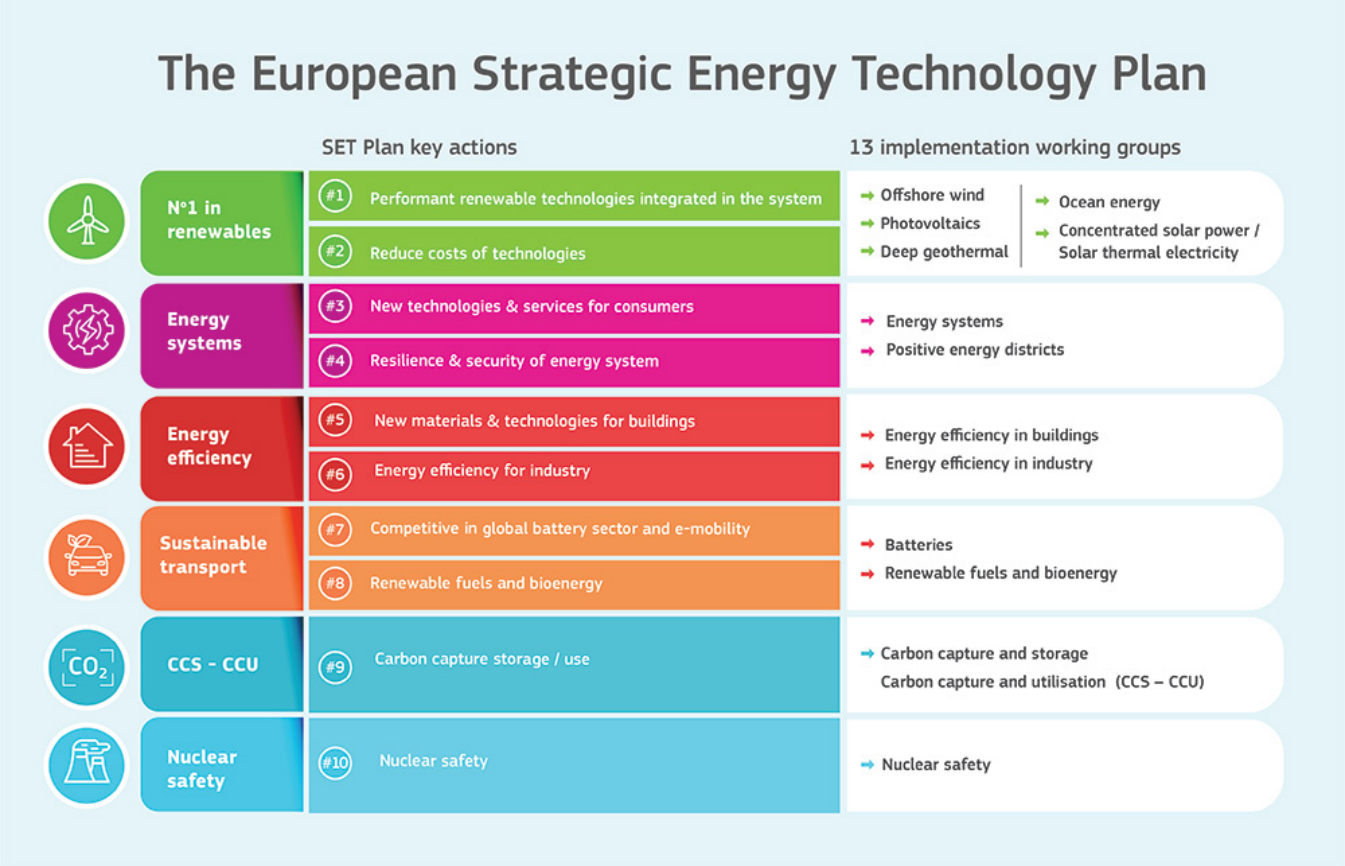
- Integrating renewable technologies in the energy systems
- Reducing costs of technologies
- New technologies and services for consumers
- Resilience and security of energy systems
- New materials and technologies for buildings
- Energy efficiency for industry
- Competitiveness in global battery sector and e-mobility
- Renewable fuels and bioenergy
- Carbon capture and storage
- Nuclear safety

These actions are grouped into 6 domains, which to some extent reveal the strategic lines envisioned by the plan.

- Becoming world number one in renewables. Actions 1, 2.
- Delivering a smart consumer-centric energy system. Actions 3, 4.
- Develop and strengthen energy-efficient systems. Actions 5, 6.
- Diversify and strengthen energy options for sustainable transport. Actions 7, 8.
- Driving ambition in carbon capture, utilization and storage. Action 9.
- Increase safety in the use of nuclear energy. Action 10.

Finally, there are 13 implementation working groups, which reflect the same number of low-carbon energy sectors:

- Offshore wind
- Photovoltaic
- Deep geothermal
- Ocean energy
- Concentrated solar power / Solar thermal electricity
- Energy systems
- Positive energy districts
- Energy efficiency in buildings
- Energy efficiency in industry
- Batteries
- Renewable fuels and bioenergy
- Carbon Capture and Storage (CCS) – Carbon Capture Utilisation (CCU)
- Nuclear safety



SET Plan infographic. Source: https://ec.europa.eu/energy/sites/default/files/media/set_plan_bis_002.jpg

Some reflections and roadmap for education and training

SET Plan conducted a study on Energy Education and Training in Europe in 2014. Working Groups compiled assessment reports in twelve key low-carbon energy fields (such as “Electricity grids” and “Energy Storage”) and also on horizontal issues shedding light in four directions: “Current Situation”, “Ongoing Actions”, “Needs and gaps, in particular main barriers or bottlenecks for the different sectors and their markets” and “Recommendations at EU and Member State level within specific target dates”.

Those assessment reports were published autonomously under the title “SET Plan Study on Energy Education and Training in Europe, Assessment Reports of the Expert Working Groups”. They were also used to create the “Roadmap on Education and Training, Availability and mobilization of appropriately skilled human resources”. We make here an analysis of the main Recommendations/Best practices with an emphasis on digitalization.

One of the key pillars recognized by SET Plan in advancing the energy technology innovation is the availability and mobilization of appropriately skilled human resources.

The paradigm shift that happens in the energy field calls for multidisciplinary and system integration education. That means that the specialists need to understand how their work interacts with the other technical fields and the managerial decisions, and the planners and managers need to have a strong technical background.

The three objectives that the SET Plan Roadmap has are the following:

- To address knowledge, skills and competences needs and gaps via building networks, pooling capacities and allowing quick and wide replication.
- To reinforce the education and training system’s link with the business and research environment.
- To plan and enable skill development and mutual recognition, at the same time facilitating the dissemination of new knowledge, techniques and tools.

Objective 1: Knowledge, Skills and Competences gap

For this objective the main recommendation is to fill the gaps via building networks, pooling resources and aim for all solutions to allow quick scale-up. So, it is encouraged to build Networks of Universities with links to Business and Research and Vocational Education and Training networks.

Network of Universities will help in the development of new curricula, the upgrade of the existing and the adoption of those changes. They will also facilitate the creation of joint degree programmes that of course have as prerequisite the integration of the accreditation systems, the learning material etc. The connection between universities and research centres will open the way for a more advanced training for both the students and the staff.

VET Networks will involve many different actors like technical training centres, companies from related industries, vocational career guidance bodies, and bodies that handle the certification. They will have as key objective to enable the existing workforce to reskill and upskill by creating new and upgrade the existing curricula and strengthen the element of practical education preferably in the business setting.

The Master and PhD programmes as outcomes of the networks, should follow the innovative educational methods that have a holistic approach and include not only technical but also human related skills. The Networks should involve as much as possible the European bodies with relevant expertise and create curricula that are open to neighbouring countries (through e-learning) especially to those that Europe has common practical objectives.

Objective 2: Reinforce the connection between the education and Business/Research

The two types of actions for this objective include Mobility and Cooperation Partnerships among Academia, Research institutes and Businesses and Infrastructure Support to Education and Vocational Training.

Through the Mobility and Cooperation Partnerships the students can have valuable practical experience and the teaching staff can exchange knowledge and know-how with the researchers and business staff. This procedure will also bring closer the curricula with the needs of the labour market.

Through Infrastructure Support to Higher Education and Vocational Training the aim is to give access to laboratories, demo sites, and research infrastructure facilities either standalone or as part of an industry. A platform can be created to enable practice in education in multiple levels, not only for the students but also for the research and business staff.

Objective 3: Planning and enabling skills development, transfer and recognition

The types of actions under this objective include Virtual Learning and Information Platforms, KSC Recognition and Transfer Programmes and Human Resources and Skills Observatories. Those actions are the more closely connected with the field of Digitalization.

The Virtual Learning and Information Platforms will enable few highly specialized experts reach not only the widespread group of students (either pre- or post- graduates) but also the general public that have an interest to be aware of the new energy technologies. The possibility of remote access is not only a way to better connect with infrastructures and data but it has become essential due to the Covid-19 crisis.

The Knowledge, Skills and Competences Recognition and Transfer Programmes should define the learning outcomes for all the EQF levels and aim on the application of the ECVET and ECTS. In this way the mobility will be made easier and developing countries can have access to already established programmes.

The Human Resources and Skills Observatories can be of many kinds with different focuses. They can include a database of what are the needed human resources and be a point of reference of learning outcomes thus enabling both the cooperation between different educational systems and the tracking of applied changes.

Other Recommendations and Best Practices

Energy efficiency and sustainability with respect to the environment should be a core part of all the educational programmes of the future. In order to inspire younger generations to be part of the energy field workforce, informational campaigns can be used that can also be used to let the general public know how they can implement locally the new technologies.

Transition from analysis to action

In 2016, 154 umbrella organizations were involved in the formulation of a set of targets for the low-carbon energy sectors aforementioned and other energy topics. The commitment to meeting these targets has then been framed into 13 implementation plans, each of which is devoted to the low-carbon energy sectors.

The implementation plans are participated by a subset of the participant countries, being one or two of them chairs of the working group. They specify the volume of investment to be mobilized, and a clear list of R&I activities where the R&I efforts are to be focused.

Goals and implementation plans can be accessed on the SETIS system, as aforementioned.

Considerations in the perspective of Lifelong Learning Programmes

The transition to the new digital economy has created new businesses around education. The widespread of new MOOCs and other digital formats, together with the necessity of workers of continuously adapt to new tasks, have fostered a new approach to learning, which has in turn generated a great demand of specific education contents.

In this sense, Lifelong Learning Programmes, being relatively new, suffer less than university and VET in the digital-technology context. Nevertheless, it is of paramount importance that these programmes are in close contact with the networks of universities and VET, and with the ecosystems that will arise around these networks to have efficient transactions with research centres and industry.

LLPs in their current form are inherently flexible and adaptive, and maybe their main challenge lays on how they standardize accreditation for industry to have a clearer understanding on the effect of these programmes on their employees.

2.1.3. Advanced Technologies for Industry (ATI) project

The ATI project has been created as a solution for developing a competitive European industry by giving an overview of the current situation regarding technological trends and data on advanced technologies. Those type of technologies will enable and help industries to successfully manage a shift towards a low-carbon and knowledge-based economy. The report includes information available through the new Advanced Technologies for Industry Website within the relevant sections (Policy Briefs, EU Reports, International Reports, Sectoral Watch and Technology Watch). The Policy Briefs analyses national and regional policy measures focused on a specific policy challenge, technological area or mode of implementation and explore policy tools that have been designed and implemented with the aim of fostering the generation and uptake of advanced technologies. [1] As part of this section, there are multiple documents and analysis made in the area of cybersecurity (*Cybersecurity: more investment and better skills*), components of the energy sector (*Meeting the sectoral skills challenge in advanced technologies)* and digitalization (*"Responsible digital transformation – the bridge between digital and circular economy policies"*).

Some relevant examples are given on policy initiatives where advanced and digital technologies are promoted to deliver solutions to pressing environmental problems and the climate crisis and promote good practices.

Circular economy and digital policies go in parallel rather than being explicitly connected although there are interesting initiatives and a growing understanding of the interlinkages between them. In several countries the issue is that even if the industrial strategy aims to be climate friendly, it is often constrained by the needs of priority sectors which are both energy intensive and use carbon in their raw materials. In terms of governance, while several Member States have already developed a new institutional set-up allowing better coordination across different policy areas, further work has to be done in creating synergies between the digital and circular economies. The areas where digital and sustainability are most often coupled relate to energy efficiency,

resource efficiency and smart cities including smart mobility. The use of artificial intelligence, blockchain and sensors appears among the referenced opportunities which can help monitoring, trace origins and secure quality and efficiency.

Currently, there are a very limited number of policy measures that aim explicitly at fostering the use of digital technologies to solve climate or environment-related challenges. The most common policy initiatives target energy, resource efficiency and mobility. Digital solutions to environmental problems have been supported through various R&D and innovation programmes, although not as an explicit objective of these policy measures. Several countries also use the concept of smart cities, clusters and local ecosystems to trigger positive linkages. Regulatory initiatives related to digital transformation of society and the environment have also been launched. In several countries, we find interesting voluntary initiatives by local and industrial stakeholders. [2]

Cloud computing is a key enabler of the European Commission's digital agenda – "Shaping Europe's Digital Future". Cloud can deliver business and technical benefits to both public institutions and private enterprises in Europe. It is also linked to other technology trends, such as edge computing and green IT, which are expected to play a relevant role in implementing the European Data Strategy, the European Industrial Strategy and the European Green Deal.

Regarding the EC communication entitled "Shaping Europe's Digital Future", cloud computing will continue to play a key role in tackling the Digital Challenge in Europe, complementing and extending actions defined in previous strategies. The cloud computing role is to unlock access to future and emerging technologies, such as: 5G, Artificial Intelligence, High Performance Computing, the Internet of Things and Distributed Ledgers.

Cloud computing and digital technologies in general will play an even stronger role in the European economy and society by embracing core European values, spanning fundamental individual rights - security and data privacy; market openness - interoperability and free flow of data; and environmental friendliness - reduced carbon footprint and energy consumption to support the transition to a sustainable planet. [3]

Germany

In 2019, Germany launched some promising reforms to improve upskilling and reskilling, yet there is potential to do more. Participation in adult learning, at 8.2%, is below the EU average of 10.8%. In addition, on average only 4.1% of the low-skilled participated in training (in the 4 weeks before being surveyed), just short of the EU average of 4.3% (Eurostat, 2019). Recent reform initiatives include the "Qualifications Opportunities Act" (Qualifizierungschancengesetz), which improves access to and financial support for further education of employees whose jobs are at risk of being replaced by new technologies. The national skills strategy (Nationale Weiterbildungsstrategie), adopted in 2019, combines federal with regional programmes. It is expected to improve transparency and accessibility, better recognise informal skills and guide the low-skilled to formal qualifications, including through partial qualifications. [4]

The two-key socio-demographic factors influencing adult learning are employment status (and sector of employment) and qualification level. From this, participation of employees in the private sector, particularly medium-qualified employees, is likely to have the most significant impact on adult learning participation rates, due to their large number and moderate participation rates. The second significant group are inactive adults, which is the second-largest population group as well as the group with the lowest participation rate in the EU. Indeed, these insights are confirmed when the number of non-learners is quantified in each of these socio-demographic groups. [5]

Cyber defence training pact - A training collaboration initiative by the German Armed Forces and Deutsche Telekom to jointly train 15 000 soldiers and civilians by 2022. The initiative will be implemented through a network of commercial and federal information security hubs, regular information exchange and hosting of cyber experts for skill exchanges. [6]

The Action Plan called "Natural.Digital.Sustainable" launched by the German Federal Ministry of Education and Research (BMBF) aims to lay the foundation for responsible and sustainable digitalisation. It includes education for competences for a sustainable, digital future. A new initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) is the development of an Environmental Digital Agenda. The agenda now presents 10 theses:

- Make full use of the potential of digitalisation to support climate action
- Digital monitoring to promote the enforcement of environmental law
- Artificial intelligence to benefit people and the environment
- Environmental information to be easily accessible, freely available, valid and transparent
- Digitalisation to put clear limits on energy and resource consumption
- Digitalisation should create closed product cycles and make business more accountable to ensure the economic transformation is sustainable
- Digitalisation to promote sustainable consumption and mobility, and to raise awareness of the environmental impacts of our actions
- Digitalisation to be driven by sustainability-oriented research
- Digitalisation to be based on a strong civil society, broad participation, and good digital and environmental education
- Digitalisation in which today's new forms of work and collaboration are reflected in organisational cultures. [7]

In Germany, a programme for climate protection in relation to data centres has been launched. This programme is intended to support local authorities in investing and optimising data centres. These measures can include, for example, the future use of free cooling, heat-flow management, or possibilities for waste heat utilisation. The investments will also be used to retrofit or improve hardware components such as servers, cooling systems and emergency power supplies, as well as to carry out energy monitoring. The implementation of these measures is a prerequisite for the certification of data centres with the 'Blue Angel' label. The programme can also be used to finance staff training. [7]

Aclima, the Basque Environmental Cluster has committed itself to the Basque Environment 4.0 strategic areas and to exploring the opportunities offered by the Internet of Things, big data, robotics, artificial intelligence, etc. The positive potential impacts of digital technologies are seen in resource efficiency, risk management, monitoring and management of biodiversity and sustainable cities. [7]

Technology sovereignty on the German industrial strategy agenda The German Ministry for Economic Affairs and Energy, which also covers industry associations and clusters, has put technology sovereignty (back) on the agenda of the future Germany industrial strategy. The most intensive discussions about sovereignty concern questions around vaccine development, 5G technology infrastructure and Artificial Intelligence. [8]

Based on the report on future skills, 60% of workers in Germany will have to acquire advanced technological skills. According to businesses, this demand can be covered in different ways: First, through targeted recruitment of graduates from the relevant disciplines. Second, the existing workforce can be helped to build these skills through appropriate further training, for example providing machine engineers with further training in smart hardware and robotics. Third, technological skills can also be passed on more as part of dual training, for example in web development or UX design. Fourth, German companies are increasingly active in the global labour market and can recruit tech specialists worldwide. Some businesses also indicate that they may base their technology activities in countries in which technology specialists are available in sufficient numbers.

"Industrie 4.0" (I40) is a national strategic initiative from the German government through the Ministry of Education and Research (BMBF) and the Ministry for Economic Affairs and Energy (BMWI). It aims to drive digital manufacturing forward by increasing digitisation and the interconnection of products, value chains and business models. It also aims to support research, the networking of industry partners and standardisation.

As a leading supplier of industrial equipment at the global level, the digital restructuring of industry offers plenty of opportunities to boost international competitiveness of German production and better conditions for job creation. [9]

Spain

Adult participation in learning activities slightly improved from 10.5% in 2018 to 10.6% in 2019 (EU average 10.8%). In 2019, 43% of people aged 16-74 lacked basic digital skills (EU average 42%) (European Commission, 2020b). The main challenges for digital education are to provide adults with devices and quality internet access and to improve teacher training for the digital education of adults. [10]

National Cyber Security Strategy (2013) - A comprehensive strategy outlining objectives and lines of actions. It covers security of information and telecommunication systems; security and resilience of networks and information systems and critical infrastructures; prevention and coordination capabilities; cyberspace awareness; capacity building in terms of know-how and technology; and international collaboration. [11]

The Spanish Government presented its guidelines for the new 'Spanish Industrial Policy 2030' in February 2019. The ecological transition is identified as a main challenge for the industry together with digitalisation. This new strategy defines as the second of its five key pillars to "Reconcile the progress of the industry with the sustainability and decarbonisation objectives of the economy". The main energy cost of Spanish industries is expected to increase, this is why the predictability, stability and competitiveness of electricity prices is essential in order to facilitate sustainable industrial activity. The decarbonisation of the energy system will meet this expectation. Until it becomes a reality, the evolution of the energy cost of the industry must be monitored. [12]

In Spain, the link between digital technologies and sustainability is addressed through the selection of research and innovation projects for support. The Centre for Industrial Technological Development (CDTI) supports industrial R&D projects focused on the fight against climate change, energy efficiency, circular economy and sustainability. Another instrument, called Cervera Transfer Projects, supports individual R&D projects by companies collaborating with National Technology Centres and focusing on technologies defined as priorities. Some of the priority technologies respond directly to the problems of sustainability, such as eco innovation and energy transition. [12]

Electric vehicle technology is being significantly promoted by a range of aid programmes, as well as the coordination and development of a National Framework of Action for alternative fuels along with their reports and follow-up. Initiatives include collaboration with third countries such as with the Chinese business platform for the EV100 electric vehicle. Strategic documents, such as the Comprehensive Strategy to support the automotive sector, lay the foundation for the transformation of the sector towards new sustainable mobility. [12]

Vives Emplea: team empowerment for labour integration – Spain - National project consisting of the in the creation of a working team of unemployed people at risk of exclusion working together to improve their social skills and skills for employment. The objective is improving people's employability through their participation in teamwork pathways for social and labour integration, helping them to access the job market or return to education. Unemployed people registered as job seekers, aged between 18 and 60: they must have knowledge of the Spanish language, a basic literacy level and a basic knowledge of new technologies are the target groups. The implementation level is national and continuous since 2013. [13]

From a policy design perspective, it was rapidly agreed that the best formula to establish the model of the initiative would be in the form of a public-private-partnership supported by the Ministry of Industry and the Directorates of Industry and SMEs as well as Telecommunication and Information Society.

A central theme of the initiative is to provide industrial companies with information and implementation support to exploit the opportunities provided by Industry 4.0 in Spain. Furthermore, digital enablers play a key role in Spain's Industry 4.0 model. Divided into three main categories - intra and interenterprise application, communication and data treatment and hybridisation of the physical and the digital – digital enablers refer to the main digital technologies driving industry digitisation forward. The initiative prioritises intra and inter-enterprise enablers, e.g., digital platforms, big data, collaborative applications, etc. [14]

Romania

Several initiatives have been introduced to promote adult learning, but there is still little policy innovation in this area. In 2019, only 1.3% of adults had had a recent learning experience. This is one of the lowest levels in the EU, significantly below the EU average of 10.8%. In 2019, a methodology for managing the national register of qualifications was adopted to help bring the descriptions of all qualifications acquired through initial,

continuing and tertiary education and training together in one place. In 2020, the national authority for qualifications launched a project to systematise and simplify registries for qualifications. There are limited resources for awareness campaigns, counselling services, or for setting up the proposed community centres for lifelong learning, although the necessary regulations were adopted in 2019. Ensuring skills development for a just transition will require sustained effort aimed at improving skills through quality upskilling and reskilling opportunities.

Despite the high need for training to keep up with trends in the economy and to improve the resilience of the workforce, participation in adult learning programmes is very low.

Greece

The Programme for the International Assessment of Adult Competencies (PIACC) reveals that 20.2% of adults surveyed had no prior experience with computers and lacked basic digital skills (OECD, 2016). According to a recent national study, the lack of digital skills prevents people from finding employment. It also poses a job risk for those employees whose work is already or will soon be affected by digitalisation (Lapatsioras et al., 2020). Some trainees completed their classes via distance learning during the lockdown in order to take the final training/apprenticeship examinations after educational institutions reopened. In some organisations, all continuous VET (CVET) courses were postponed except for a small percentage offered through distance learning. Remedial measures after schools' reopening included extending the training period, increasing hours for study and practical work, adjusting exam conditions. The 2020 country-specific recommendation urges Greece to develop a 'very-high-capacity digital infrastructure and skills.' (Council of the EU, 2020).

Raising participation in adult education remains a key challenge. The share of adults participating in learning decreased from 4.5%, in 2018, to 3.9% in 2019 (EU average: 10.8%). The percentage of low-qualified adults participating in learning is, at only 0.8%, among the lowest in Europe (EU average: 4.3%). A dedicated project has been launched to increase the participation of low-skilled adults in learning and improve their core skills, including digital skills. The development and validation of distance teaching and counselling skills for educators in the public and private sector is vital. Quality e-learning training programmes are underdeveloped. The Ministry of Education is planning to develop a crash course (15 hours) in digital skills and distance learning for all public sector teachers. [15]

France

Employers' surveys show that a lack of skills is the main barrier to hiring. According to the 2018 CEDEFOP Skills forecast, 54% of new job openings in France in 2016-2030 will require a high level of qualification, compared to 43% at EU level. Nevertheless, the share of science, technology, engineering, and mathematics (STEM) tertiary graduates slightly declined from 27.7% in 2010 to 25.4% in 2018. [16]

France government aim to boost localised production and technological development. In France, especially since the 2018 Villani Report on Artificial Intelligence57, a series of government initiatives are aimed at speeding up policies in this area. Technology sovereignty is at the core of recently launched policy measures. As part of the French 'Investing in the Future Programme' new calls are dedicated to companies developing 'sovereign future technologies'. The so-called 'French Tech Sovereignty Fund' launched in June 2020 will help French companies developing technologies of a sovereign nature that could potentially fall prey to large foreign players or be overtaken by competitors. [18]

Between 2018 and 2019, adult participation in learning increased from 18.6% to 19.5%, placing it well above the EU average of 10.8%. Moreover, 7.9% participation among low qualified adults compares favourably to the EU average of 4.1%. The individual learning account (CPF)7 that makes the individual responsible for her/his learning pathway is the main vehicle to provide training opportunities for (re)entry to the labour market or occupational mobility. CPF was digitalised, providing common online8 access for companies and beneficiaries to training opportunities including apprenticeships and distance learning. Within the 2018-2022 skills investment plan, distance learning is being developed (250 000 digital courses are planned) targeting especially those not in employment, education or training and low qualified job seekers (Cedefop ReferNet France, 2018a). However, the economic crisis caused by the COVID-19 pandemic puts renewed focus on helping people at risk through more direct measures beyond online training. Free professional guidance for job seekers is offered at regional level by institutions designated by law (including the public employment

service) and for employees by bodies following a call for project from the national institution for vocational training (France Compétences)

The public employment service (PES - Pôle Emploi) amended its strategy on training offers and improved guidance to jobseekers and support to companies. This happened in response to the 2019 European Semester country-specific recommendation (CSR) to France on skills shortages and mismatches. PES offers online services: an online platform of digital services and prototypes for project collaboration and design; Mon potentiel professionnel, offering personalised support to registered job seekers; and Focus compétences, providing online seminars in small groups on skills identification. The 2020 CSR repeated the importance of promoting skills. [17]

The cross-cutting “Industrie du Futur” (Industry of the Future (IdF)) programme was launched by the French government in April 2015. IdF consists of several objectives. It aims to modernise the French production base and production tools and support the use and integration of digital technologies to transform companies and business models. This in turn is expected to create new sources of growth and jobs. The IdFA platform’s objectives are to make France a leader in the world’s industrial renewal.

IdF’s is structured around five pillars: technological offerings, business transformation, training, international cooperation and IdF promotion. The first pillar focusses on developing cutting-edge technology. This activity supports companies with research funding, subsidies and loans and by developing a network of platforms for pooling and testing new technologies.

Secondly, IdF offers financial and personalised support for companies to invest in production and to engage in projects. It also seeks to identify 550 experts to help SMEs identify transformation projects. Its ambition is to support at least 2000 companies by 2016. The third pillar concentrates on upskilling the workforce. This is pursued by creating joint future visions with unions and developing training programmes and curricula. The fourth pillar targets international cooperation on standards and alliances. A bilateral approach is taken, in particular with Germany (Industrie 4.0) through cooperation on standardization and technology projects. [19]

Italy

A national strategic plan for adult competences was announced for 2020 to tackle the high rate of low-skilled people in Italy. The plan aims to improve coordination between the different players and processes involved in lifelong learning, to jointly establish national training strategies for 2020-2022 to ensure integration and return to the labour market. Italy ranks 25th of 28 EU Member States in the European Commission Digital Economy and Society Index 2020. The level of digital skills differs significantly among those employed in different economic activities. Digital skills are more widespread in the services sector, followed by public administration, and lowest in the industrial and primary sectors. This might hamper innovation and inclusion in society and the labour market. The National repository for regional vocational qualifications has been updated following an agreement in the State-Regions Conference. Covering qualifications from general education, higher education and VET, the framework fosters validation, permeability and guidance practices. [20]

Italy has adopted its first national strategy for digital skills, targeting the population at large. In 2019, 41.5% of Italians had at least basic digital skills (below the EU average of 58.3%) and only 22% had more advanced (i.e. above basic) digital skills (EU average 33.3%). The new strategy was adopted in July 2020 in the framework of the Digital Republic initiative. It covers education, the active workforce, ICT specialist skills and digital skills for active citizenship and democratic participation, under the co-ordination of the relevant ministries. The availability of distance learning courses is a positive development: there are 5 AGORÀ classrooms (online lectures) authorised by the Regional School Offices of Liguria, Apulia and Sicily. The Italian Ministry of Education is supporting experimentation in the Provincial Adult Education Centres with the PIAAC self-assessment tool developed by the OECD.

Unique labour endowment (Dote Unica Lavoro) – Italy, Lombardia - Regional programme providing free personalised learning and employment pathways. It provides an integrated approach to learning and employment pathways, grounded in lifelong learning, guidance and personalised approach. The objective is to support the employment/re-employment and upskilling/reskilling of individuals in the Lombardia region. In the target groups we can find: (a) Adults aged between 30 and 65 who reside in the region and are either unemployed or enrolled in a first/second level university master or employed in the armed forces (17). (b) Workers up to 65 years old employed in a company in the region affected by reduced working time or temporary suspension of work under a wage compensation scheme, such as wage guarantee fund, solidarity contract,

solidarity agreement, (18) if they are not already benefiting from other active policy measures. It is implemented at the regional level and its implementation is continuous since 2013. [21]

The Italian Ministry of Economic Development has launched the Industria 4.0 National Plan (I4.0), a strategy aiming at supporting industrial change through a series of conjunctional measures. The measures seek to promote investments in innovation, technology and skills development while taking into consideration principles set by the fourth industrial revolution. The Government intends to design a framework for effective and suitable operation.

The main objective is to support innovative investment and empowerment of skills related to the fourth industrial revolution by setting the framework for attracting private investment in technologies, support to research, development, and innovation and the promotion of investment in venture capital and start-ups. On the other hand, the initiative seeks to contribute to the empowerment of skills by promoting I4.0 education programmes, strengthening vocation training, skills development, Competence Centres, Digital Innovation Hubs and the financing of I4.0 Technology Clusters and Industrial PhDs. [22]

The Netherlands

Overall participation in adult learning is high and specifically encouraged among low-skilled people. 19.5% of adults have had a recent learning experience, compared with the EU average of 10.8%. However, low-skilled workers participate in learning activities much less frequently (at 9.9 %), increasing the risk that their skills will become outdated. To encourage adult learning, the government established the Work Position Incentive (Stimulans Arbeidsmarktpositie; STAP) budget. This offers a personal development budget of up to EUR 1 000 per year for individuals with or without a job as of 1 January 2022. Another large-scale initiative addresses adult illiteracy. In March 2019, the government earmarked EUR 425 million for the ‘Count with language’ programme for 2020-2024, an increase of EUR 35 million over 2015-2019. The aim is to reach out to illiterate Dutch native speakers and promote digital skills. The Language Accord for Employers, implemented by UWV/Leerwerkloketten, aims to support employers by improving the basic skills of their employees and to make basic skills part of their HR policy (STVDA, 2019). [23]

Language at work (Taal op de werkvloer) - National initiative whereby employers enter an agreement to improve the language skills of their employees and receive a subsidy to provide language courses at or outside the workplace. The objective is to encourage businesses to invest in the language skills of their employees. Employees with low and medium language skills in companies that want to address the issue of low language skills at the workplace are the target groups. It is implemented since 2016 at regional level. Regarding the funding structure it is considered a co-funding arrangement in which employers bear part of the training costs and, at the same time, can apply for a subsidy paid by national funding. [24]

The Smart Industry (SI) initiative was launched in November 2014 by the government and industry stakeholders. The objectives are to strengthen the Dutch manufacturing industry position and increase industrial productivity. SI is structured around three main action lines that seeks to capitalise on existing knowledge, accelerate and introduce ICT in companies and strengthen knowledge, skills and ICT conditions.

The core activities concentrate on agenda setting, building multi-actor eco-systems and executing support actions and research. SI is organised around three key lines of action, respectively capitalising on existing knowledge, accelerating in field labs and strengthening the foundations. The first action line concerns the use of existing knowledge and focusses on the gathering and dissemination of knowledge to businesses. This is carried out by providing companies with technological and market understanding, best practices and tools. Specific activities cover presentations, a website, online training modules and business team trainings. The second action line, acceleration through field labs, is assumingly the most visible part of SI. It seeks to create national and regional ecosystems and interrelated networks of companies and knowledge institutions with a basis in SI principles.

The field labs present practical environments for design, testing, experimentation and deployment of technology solutions. The labs work as operational environments where people can join for discussion, meetings etc. It is basically a location with a programme that is made up of multiple try-out innovation projects and planned training within projects. The third action line is of a more long-term nature and aims to improve knowledge, skills and ICT conditions. In terms of knowledge, it is focussed on strengthening R&D incentives in field labs and to develop a long-term SI research agenda together with top sectors and universities. Human capital conditions are sought upgraded through adapting relevant educational courses and programmes –

ranging from primary education to scientific education and dual education - to the needs of SI. It seeks to offer modular educational blocks and to organise courses on sustainable production. ICT conditions are targeted by a vision to develop an increasingly solid and secure ICT infrastructure and by a research programme for the development of software tools that cover chain collaboration, interoperability and standardisation. [25]

Slovakia

A comparatively small share of adults (8.6%) has not acquired at least an upper secondary qualification, compared to an EU-27 average of 21.6% (LFS, 2019). The likelihood that adults in Slovakia will frequently update their knowledge and skills through adult learning is low: only 3.6% of adults aged 25-64 have had a recent learning experience in the past 4 weeks (EU-27 10.8%) (LFS, 2019). Slovakia has launched upskilling initiatives, particularly in validation. The objective of the ESF project 'System of verifying qualifications' (2019) is to set up a comprehensive system by establishing structures and mandatory procedures for lifelong learning, with an emphasis on the validation and recognition of qualifications and piloting the validation system for non-formal and informal learning of approximately 300 qualifications, including validation of partial qualifications. This 4-year project also aims to complement the existing qualification standards of the National System of Qualifications by introducing assessment procedures. It is expected that these qualifications will be recognised by the Ministry of Education, certifying professional competences in line with Lifelong Learning Act (568/2009) (Cedefop ReferNet, 2020). [26]

Inspired by similar initiatives implemented in Germany and the Netherlands, the Ministry of Economy first presented the Smart Industry concept for Slovakia at a high-level conference in March 2016. The government adopted the strategic direction of the paper on the 29th of October 2016, and with the decision to pursue the development of local smart industry. The Smart Industry Platform was established to act as a central authority coordinating the various efforts and is comprised of a working group of multidisciplinary experts from industry, academic and government.

The Smart Industry Platform was formed as a first step in the implementation of the overall initiative, as a working group of experts designed to bring together representatives from key stakeholders. These included various ministries of the Slovak government, as well as industry associations (IT Association, National Union of Employers, Federation of Employers' Associations, Automotive Industry association, Klub 500), R&D agencies (Slovak Innovation and Energy Agency), academic and educational institutions (Slovak University of Technology, Technical University of Kosice, Slovak Academy of Sciences), businesses (Embraco, Siemens, SOVA Digital, Matador, Microsoft, Volkswagen), and industry clusters (Cluster for Automation Technologies and Robotics AT+R). [27]

Finland

Participation in adult learning in Finland is the second highest in Europe, yet some challenges exist. 29% of all adults aged 25-64 engaged in learning in 2019. However, there are still challenges, like improving learners' disposition towards learning and ensuring a comprehensive adult learning system with the right incentives and support services to all. According to the OECD (2020b), Finland has the largest gaps in learning participation between adults with low basic skills and those with higher skills, and there are considerable gaps in upskilling and reskilling opportunities.

New proposals were adopted regarding the validation of non-formal adult education. In December 2019, a working group coordinated by the Ministry of Education and Culture prepared a report with recommendations to include non-formal adult education provision in the national digital database of qualifications and certificates, Koski, by September 2021. This will also involve creating a more structured description of learning outcomes in different areas of non-formal adult education. The process will be coordinated by the National Board of Education, including funding for pilot projects, training of teachers and other staff and developing guidelines (MEC, 2019d).

A parliamentary working group on the development of the continuous learning concept continues its work, and it is on track to deliver its proposals by the end of 2020. The government asked the Ministry of Education and Culture to produce an educational policy report by the end of 2020. This snapshot of the current education system will serve as another tool for reshaping Finnish educational policy, including adult learning. [28], [29]

The Digital Finland Framework highlights the importance of intelligent and clean energy, climate neutral industrial processes and smart mobility services. Finland recognises the need for sustainable, resource-efficient solutions and the promotion of the circular economy. The policy strategy is to combine the material and process strengths in Finland with digital capabilities and support the circular economy through AI, the platform economy and digital design. With recent advances in smart energy, electricity costs for data centres remain relatively low and Finland allows the selling of recovered heat from data centres. Digitalisation is considered a cross-cutting topic and treated as such in particular in the domains of bioenergy, waste-to-value, smart grids, energy storage and smart buildings. [30]

Besides all the inputs from the European countries presented above, here are some highlights from outside Europe, related to best practices on Continuous Education. For example, in 2017 the Government of the Russian Federation officially announced an initiative towards a complete reformation of the state apparatus and a reorientation of the priority tasks of the country's development to the digital economy. [33]. The Russian Government initiated a couple of initiatives to foster specific Advanced Technologies as follow: Blockchain technology, Internet of Things (IoT), Artificial Intelligence, Augmented & Virtual Reality, Robotics and Connectivity (5G technology). [32]

In South Korea, was introduced in June 2014, the “Manufacturing Industry Innovation 3.0 strategy as part of Korea’s Creative Economy Strategy. Manufacturing 3.0 (broadly corresponding to the European definition of Industry 4.0) focuses on the concept of a smart factory collectively embracing automatization, data exchange and enhanced manufacturing technologies throughout the manufacturing process, incorporating both short and long-term technological plans. The strategy was revised in 2017, to keep pace with the fast progress of digitalisation and automation. The goal was increased from the development of 10 000 smart factories by 2020 to 30 000 smart factories by 2025, based on the agreement between the private and public stakeholders. [33]

The “Global Skills Strategy” was announced in the 2016 Fall Economic Statement with the scope to attract and get access to larger talent pools from foreign countries for high-skilled workers and retain the talents already within the Canadian borders. With Budget 2019, the Canadian government has moved this strategy into a permanent programme to foster the economy and strengthen businesses. Thanks to the Global Skills Strategy, Canada was able to increase the share of foreign skilled workers adding more than 30 000 people to their current workforce. [34], [35]

The United Kingdom published in March 2017, its last Digital Strategy Document under the name “UK Digital Strategy 2017”, following the previous Autumn Statement 2016. Among the long list provided in the action plan some items stand out as critical to achieve Scottish Digital Development: Launch a new Digital Growth Fund to fill the existing gaps in the availability of digital skills, Broaden the Digital Boost program to sustain and grow the digital maturity of businesses across Scotland and Test and ensure the Critical National Infrastructure is secured by cyber-attacks. Moreover, the Wales Region provides a Digital Plan that includes five main principles: inclusivity, enhancing skills, strengthen the economy, modernise public services and improve infrastructures. With an integrated though holistic approach, the Walsh government is working to create collaborations among a wide range of potential partners from business, to academia and society to achieve the expected Digital Modernization. [36]

The Japanese government has launched several initiatives to promote the emergence of an Ultra-Smart Society. In this vision, all things will be connected through IoT technology and all technologies will be integrated, thereby improving the quality of living: Blockchain, 5G Development Roadmap toward 2020, Robotics, Augmented & Virtual Reality, Government-led Cloud Computing Services and Industrial Biotechnology. [37]

United States of America reinforced STEM education. STEM education is one of the agreed priorities of the US government. In December 2020, the Office of Science and Technology Policy at the White House issued the Progress Report on the Implementation of The Federal Stem Education Strategic Plan. This progress report describes ongoing efforts and implementation practices across the Federal Government. The US Department of Education announced in November 2020 that during 2020, it invested ca. €470 m to support high-quality STEM education, including computer science, for students through its discretionary and research grants. The US National Nanotechnology Initiative (NNI) has put in place an infrastructure of more than 100 interdisciplinary research and education centres and user facilities across the United States. These centres provide specialised equipment and trained staff. [38]

Smart Manufacturing Development Plan was presented in 2016 and embodies the first general national policy on Smart Manufacturing. The plan aims at encouraging the industry to adopt information and communications

technology (ICT) and to enhance the manufacturing process. According to Chengji, the plan outlines four general tasks: [39]

- Development and technology know-how: the industry must be able to develop the necessary technologies.
- Capabilities: High relevance for cybersecurity, crosscutting standards, and the Industrial Internet of Things (IIoT).
- Adoption: Develop an ecosystem that provides system solutions and encourages companies to willingly adopt smart manufacturing (especially small and medium-sized enterprises (SMEs)).
- Workforce: Invest in education and training to prepare the workforce with the necessary knowledge and skills for smart manufacturing.

2.1.4. The European Energy Research Alliance and the Program on the Digitalization of the energy sector

The European Energy Research Alliance (EERA) [40] is an energy research community in Europe that brings together universities and public research centres in 30 countries. The ”Digitalisation of Energy” Joint Programme (JP), investment in digitalisation aims to integrate and coordinate efforts deriving from initiatives outside EERA that play a very significant role in digitalization and funding, both from the public and private sectors. Several EERA activities clearly demand Digital Services based on:

- **High Performance Computing** (Weather forecast or turbines in off-and on-shore wind energy, Molecular dynamics or ab initio calculi in the study of the interaction of the media on structural and functional materials, new advanced materials and processes, Integrated energy system analysis, energy mix and further distribution in the electricity grid, Design of new devices such as turbines, solar thermal plants, collectors, etc., CFD analysis of heat transfer between solar radiation, materials, and fluids, Multiscale simulations and Economic energy models)
- **Data Science (**Standardization of data and metadata within many JPs, Harvesting, curation, checking and exploitation of data, Data security, privacy and sovereignty requirements and algorithms, Artificial intelligence methodologies, Open Access and FAIR principles)
- **High Throughput Computing (HTC)** (Data assimilation (Internet of things, smart meters, and sensor deployment), Edge and Fog Computing (Smart Cities, major energy facilities), New actors in a distributed electricity market)
- **New paradigms and platforms** (Blockchain (energy market), Digital twins (NM, major energy facilities), Digital platforms)

The Joint Programme in Energy Systems Integration is designed to develop the technical and economic framework that governments and industries will need to build the future efficient and sustainable European energy system. It is fully aligned with the recently published SET Plan Integrated Roadmap and potential impact include increased reliability and performance, minimisation of cost and environmental impacts and, in particular, increased penetration of renewable energy sources.

The Smart Grids JP aims at addressing, in a medium to long term research perspective, one of the most critical areas directly relating to the effective acceleration of smart grid deployment: smart grids technology, its application and integration. In line with the context of the EU Industrial Strategy of May 2021, the general objectives of the Joint Programme Energy Efficiency in Industrial Processes consist in:

- Assess the existing industrial processes to contribute to the implementation of more efficient technologies and solutions (partially or entirely, depending on the case);
- Propose advanced concepts and designs to reduce energy consumption, operation, and maintenance costs, to improve the environmental footprint, as well as equal or improve the characteristics and the number of products manufactured.
- Verify the viability and affordability of the proposed solutions through concrete demonstration projects.

2.1.5. The European digital strategy and digital roadmap

The core of the European Digital strategy lies in the creation of the Digital Single Market, which was first proposed May 2015. It is one of the European Commission's 10 political priorities. It should enhance the benefits of scale given by the digitalisation on a European Level. All European costumers and businesses should be able to access and offer digital services in every member state. Complementary to the Digital Single Market, the EU aims to be the global driver of consumer and data protection mitigating the effects of big platforms. Therefore, the Digital Single Market is accompanied by the Digital Services and Digital Markets act, which curbs market power and ensures a level playing field for small businesses. Within the framework of the EDDIE Project, the focus on digital skills and jobs are in particular relevant. The Commissions is intendent to address the digital skill gap of many in the workforce by introducing the Digital Education Action Plan.

Digital Single Market

The Digital Single Market was proposed in 2015 and focuses on three core domains.

The Digital Single Market strategy aims to give consumers and businesses better access to online goods and services across Europe, for example by lifting barriers to cross-border e-commerce and access to online content, while improving consumer protection.

The improvement of networks and services by providing high-speed, secure and trustworthy infrastructures and services shall be given by the right regulatory conditions. The focus lies on cybersecurity, data protection/e-privacy, and the fairness and transparency of online platforms.

Maximizing the growth potential of the European digital economy so that every European can fully reap its benefits - in particular by improving the digital skills that are essential for an inclusive digital society.

Artificial Intelligence

The European Commission has proposed to invest €2.5 billion to the deployment of computing platforms and AI applications. The framework aims to mobilize resources to achieve an "ecosystem of excellence" and create a unique "ecosystem of trust." The Commission stresses several requirements for high-risk AI applications. There will be regulations on Training data, data and records, information to be provided, robustness and accuracy, human supervision. More narrow requirements for certain sensitive AI applications, such as remote biometric identification are discussed.

Competition Policy

The main drivers of the competition policy, which intends to create a level playing field are the Digital Services Act and the Digital Markets Act. Both will be covered in more detail in the next subchapter.

IT/Data security

A robust regulatory framework is already in place both in the field of data protection and cybersecurity. The former sees the General Data Protection Regulation (GDPR) and the Free Flow of non-personal Data Regulation in force. The EU is intended to monitor the development of technology and markets closely and adjust accordingly.

Role Model

The EU Commission aims to be a role model and has its own in-house strategy for its internal digitalisation. The goal is to have a common, cloud-based, platform for all EU institutions and agencies. This should improve the system security, the accessibility but also the transparency of the commission's work. Successful applications are intended to be shared the member states thereafter, pushing e-Governance on all levels. Furthermore, it is planning to co-create its IT solutions with private businesses and more importantly it should play an incubator role for new emerging technologies. By using its scale, this would foster innovation.

Digital Education

One cornerstone of the Digital strategy is the Digital Skills and Jobs Platform. It provides information and courses about Artificial Intelligence, Cybersecurity, High Performance and Quantum computing, programming and development as well as basic digital skills. Furthermore, its platform connects interested institutions and people i.e. by hosting a job platform.

Due to the COVID-19 pandemic, the digitalisation of daily life task increased in speed massively, therefore the Digital Education Action Plan (2021-2027) come into force. The Commission names two priorities:

1. Fostering the development of a high-performing digital education ecosystem
2. Enhancing digital skills and competences for the digital transformation

As far as lifelong learning is concerned, the Digital Education Action Plan is providing horizontal support, incorporating actions to develop a high performing digital education ecosystem. This is pursued mainly through Action 5: Digital transformation plans for education and training institutions, Action 6: Artificial intelligence and data usage in education and training, Action 7: Common guidelines for teachers and educators to foster digital literacy and tackle disinformation through education and training and Action 10: Council recommendation on improving the provision of digital skills in education and training.

2.1.6. The Digital Services Act and Digital Markets Act

The Digital Services Act (DSA)

Since 2000, the E- Commerce Directive has been the main legal framework for the provision of digital services in the EU. However, in 20 years the digital environment has changed and the rules need to be updated. Due to the nature of the platform economy, some very large platforms have become quasi-public spaces for information exchange and online commerce. On the one hand, they offer great benefits to consumers and constantly encourage innovation and commerce. On the other hand, they are also used to distribute illegal content or sell illegal goods or services online. They induce a particular risk to users' rights, the flow of information and public participation.

To counteract these developments, the Digital Services Act (DSA) regulates internet service providers, cloud services, messaging, marketplaces or social networks, which are considered intermediaries in their role as a link between consumers and goods, services and content. These digital services transmit or store content of third parties. Specific due diligence requirements apply to hosting services and in particular to online platforms, a sub-category of hosting services. Examples of online platforms include social networks, content sharing platforms, app stores, online marketplaces, online travel and accommodation platforms.

However, the main target group of this regulation are the few very large online platforms that have a significant social and economic impact with at least 45 million users (10% of the EU population). More and stricter rules apply to them.

The aim is to improve protection against hateful or illegal content and to create a harmonised and more powerful framework for transparency and accountability of online platforms, leading to fairer and more open digital markets. In general, the Digital Services Act mitigates current problems and can be seen as an ex-post regulation.

What are the major Changes due to the DSA?

The set of changes can roughly be divided into two sub-categories:

1. **Prevention of Illegal Content**
   - All hosting providers (including online platforms) are required to implement measures to counter illegal content online, including goods and services.
   - Among the obligations is a **“Notice and Take Down”** mechanism for users to flag such content, and for platforms to cooperate with “trusted flaggers”.
   - In addition, the draft regulation specifies what the content of such a notification must contain in order for the hosting provider to have positive knowledge of illegal content that triggers liability. Hosting providers must provide sufficient justification to the user for their decision to block or remove a

particular piece of content. The definition of what constitutes "illegal" content is governed by national law.
- Hosting providers are only liable for third-party content if they fail to remove illegal content after becoming aware of it.
- Rules for traceability of commercial users should improve finding sources of illegal goods.

2. **Enhance Transparency**
   - New rules on traceability of business users in online market places, to help identify sellers of illegal goods
   - Effective safeguards for users, including the possibility to challenge platforms' content moderation decisions
   - Transparency measures for online platforms that are wide-ranging, including on the algorithms used for recommendations
   - Obligations for very large online platforms to prevent abuse of their systems by taking risk-based action, including oversight through independent audits of their risk management measures.
   - The main parameters of recommendation systems on very large online platforms need to be explained in the respective Terms and Conditions. Additionally, all options to change or influence these parameters need to be announced. The users need to have the possibility to actively and directly influence the displayed content and at least one of the options should not be based on so-called profiling, i.e. automated processing of personal data. The operator must integrate such functions into the user interface of its website or app.
   - Researchers will have access to internal data of key platforms, which allows to audit how platforms work and how online risks evolve. The audit result can be published.
   - New oversight structure in Member States, supported by a new European Board for Digital Services. For the very large online platforms, the European Commission has an enhanced supervision and enforcement role.

What are the concrete implications?

The energy industry itself is not in the target group of this regulation. However, if an institution hosts a cloud service, that cloud service will be regulated by this framework. However, most of these services will have fewer than 45 million customers and therefore will only have to deal with the lighter regulatory package.

Moreover, most institutions are passively affected by the regulation passively. The large platforms must disclose who and how their commercial customers advertise. Since all common digital marketing channels are operated by large platforms, companies in the energy industry also use these channels. Therefore, their marketing history will be made publicly available so that competitors can see how they advertise.

Which Best Practice could emerge?

1. Implement new regulatory framework on all platforms
2. Learn from the best: Analysis of large datasets is possible since the platforms are required to make public who and how large costumer used them.

What is the Digital Markets Act (DMA)?

Since 2000, the E- Commerce Directive has been the main legal framework for the provision of digital services in the EU. However, in 20 years the digital environment has changed and the rules need to be updated. Due to the nature of the platform economy, some very large platforms have become quasi-public spaces for information exchange and online commerce. These large platforms have accumulated a great deal of market power, which reduces the business opportunities for new entrants and thus harms competition in the long-term.

The Digital Market Act is designed to regulate not the entire digital economy but these very large corporations in specific. It calls them “Gatekeeper”, which are offering either online search engines, online intermediation

services, online social networking services, video-sharing platforms, operating systems, interpersonal communication services, cloud computing or advertising.

The criteria to be defined as a Gatekeeper are:

1. has a strong economic position, significant impact on the internal market and is active in multiple EU countries;
2. has a strong intermediation position, meaning that it links a large user base to a large number of businesses;
3. has (or is about to have) an entrenched and durable position in the market, meaning that it is stable over time.

Moreover, the quantitative thresholds for the core platform service provider are 45 million monthly active end users in the EU (10% of EU population), more than 10,000 yearly active business users in the last three year and annual turnover within the European Economic Area of at least EUR 6.5 billion in the last three years (or an average market capitalisation of at least EUR 65 billion). If a Gatekeeper meets the quantitative thresholds, the first three criteria are presumed to be satisfied.

The intention of the Digital Markets Act is to addresses future market power problems and can be seen as an ex-ante regulation. The act went through the ordinary legislative procedure. It is directly applicable as a regulation throughout the EU. The aim here is apparently full harmonization, i.e. member states may not provide for a stricter or less stringent framework.

To characterise the spirit of the regulation, the DMA favours innovation by business users and new entrants over innovation by existing gatekeepers. This decision in turn leads to a preference for long-term competition over short-term efficiencies.

What are the major Changes due to the DMA

The regulations aim to prevent or mitigate market abusive behaviour of Gatekeeper. In general, the measures are divided into practices the gatekeepers are forced to do, which they would otherwise abstain from and practices they no longer allowed to carry out.

Practices Gatekeepers are required to carry out:

- Allow third parties to interoperate with the gatekeeper's own services in certain situations
- Allow their business users to access the data they generate when using the Gatekeeper platform
- Provide businesses that advertise on their platform with the tools and information necessary to allow advertisers and publishers to self-verify their ads run by the Gatekeeper
- Enable their business users to advertise their offerings and enter into contracts with their customers outside of the Gatekeeper's platform

Practices Gatekeepers are prohibited to carry out:

- Treat services and products offered by the gatekeeper itself more favourably in rank order than similar services or products offered by third parties on the gatekeeper's platform
- prevent consumers from engaging with businesses outside their platforms prevent users from uninstalling pre-installed software or apps if they wish to do so
- In particular the ban to self-promote own services is considered to harm the Gatekeepers market power.

If the European Commission detects wrongdoing it can fine of up to 10% of the gatekeeper's total turnover in the preceding fiscal year. For serious misbehaviour, under Article 27(1) of the DMA, the European Commission may impose daily penalty fines of up to 5% of the average daily turnover of the gatekeeper in the preceding fiscal year.

In the event of systematic and repeatedly violations by gatekeepers, additional remedies may be imposed on gatekeepers following a formal investigation. Such remedies shall be proportionate to the committed misbehaviour. As a last resort, non-financial measures such as the divestment of (parts of) a business may also be imposed.

What are the concrete implications?

Energy Institutions are most likely not defined as Gatekeepers, thus only affected indirect through the regulation. However, it improves the market chances for digital business models such as Smart Energy systems.

Which Best Practices could emerge?

Since there is no impact on Energy Institutions, there are no Best Practices to define.

2.1.7. Existing policies on Digitalization in Energy (and energy education)

In recent years, the digital evolution along with the new tools and technologies that have been developed all across the world, paved the way for a new era in which digitalization plays a major role in many aspects of our world, including the energy sector. The COVID-19 pandemic has accelerated this transition and made abundantly clear that with the good use of these technologies, set goals in societies and economies can be more easily achieved. In response to these challenges related to digital technologies, global organizations and research institutions have released documents with proposed guidelines and policies.

The International Energy Agency (IEA) has produced a document entitled 'Digitalization and Energy' covering a wide range of topics starting from the impact and the goals of digitalization in the energy sector to guidelines and policies for its effective use. It provides a valuable insight in the areas which can be significantly improved with the use of technological advancements and highlights the related risks:

- Energy access: In some developing countries in Africa, mobile phones are the most ubiquitous of consumer-electronic appliances while at the same time energy supply is limited. Some companies took this opportunity to develop new business models that will allow these people to access the energy services. More specifically, two services were offered to the citizens of rural areas: the rent-to-own service in which consumers pay a fee up-front and complete the payment in instalments and the solar-as-a-service in which the consumer never owns the device. Cloud services and software platforms as an alternative are also currently being investigated. It is important to note that lack of standards and policies along with lack of transparency may possibly discourage investors and stakeholders.
- Environmental sustainability: Digital tools can enhance the energy efficiency and minimize the carbon footprint which is detrimental to the environment. Although, these tools should be used wisely in order to prevent implications such as increased travel by self-driving vehicles, high energy consumption from smart devices and electronic waste.
- Energy security: Although cybersecurity risks pose a threat to energy security, the digitalization can possibly add to the system's resilience. For instance, mechanical failures can easily be prevented with the use of smart electronic devices and reduce outages.

It is evident that these risks can be prevented or mitigated, only by establishing effective, well informed, policy frameworks. The document presents policy recommendations that possible stakeholders should consider before releasing a policy.

More specifically one should:

- Build expertise and be updated in terms of new technology
- Facilitate easy and quick access to data
- Release flexible policies that can be adopted to technological changes
- Put the planned activities into action
- Be involved and take part in broad inter-agency discussions
- Take into account the benefits for the whole system and not only for its components
- Monitor and record the results produced from the digitalization of the system
- Take into account security risks in the design of the system
- Provide a common ground for different actors to compete in the development of new tools, platforms and models
- Learn from other stakeholders

A shining example that encompasses the aforementioned guidelines and can be used as a case study is Singapore's Smart Nation Vision, released in 2014, aiming to create “the world’s first smart nation”. The action plan focuses not only on the infrastructures but also on active research and development of new technology tools. More specifically, Singapore has fully invested in building concrete digital platforms and accumulating electronic resources such as high-speed broadband network to improve connectivity rates and sensors gathering data all across the island. To bridge the gap between different technologies and enhance the interoperability, it produces standards for network system architecture, communication and security protocols for sensors and the IoT that are tested outside the country. Furthermore, the government provides training seminars to 10 000 public servants in data science, in an attempt to expand the data analytics and cybersecurity skills of its employees. The country puts a strong focus on the research and development activities by investing approximately USD 14 billion in funds through to 2020. Finally, it strengthens the communication and data exchange between the public and private sector by releasing public data. For instance, the “Bus Uncle”, a Facebook Messenger chatbot tells the waiting time for the next bus in the distinct local creole Singlish. It is worth mentioning that this action plan cannot be easily applied to every country: each government has a different starting point and should adapt the guidelines accordingly taking into account elements such as existing digital and energy infrastructures.

Following the release of the document entitled “An EU strategy for Energy System Integration”, which stresses out the importance of building integrated, efficient, flexible power networks, the European Commission launched a roadmap in July 2021 in preparation for a new action plan regarding the digitalization of the energy sector. The action plan will focus on five axes: the creation of a common infrastructure for data sharing which will enable the exchange of information between different stakeholders, the active involvement of the citizens in this transition, the integration of digital technologies in the energy sector, the protection of the systems focusing on the cybersecurity and the incorporation of green technologies in the ICT sector. It is important to note that different policies have been published over the years regarding key elements of the digitization process: the ‘Electricity Directive - (EU) 2019/944’ for data exchange, the ‘Regulation on the internal market for electricity – (EU) 2019/943’ and the ‘Energy Efficiency Directive – (EU) 2018/2002’ for data protection with strong focus on the smart meters of the energy sector.

In September 2021, the European Commission published the ‘2030 Digital Compass: The European Way for the Digital Decade’, a document highlighting the key role that digitalization plays in our society and the challenges associated with vulnerabilities that have been revealed in different sectors such as limited access to digital technologies, interconnections with non-EU based companies and social divisions. As far as the energy sector is concerned, it is stated that digitalization can contribute greatly to the achievement of European Green Deal objectives. More specifically, digital tools and platforms along with the collected data can provide solutions and assist in building an independent, resilient and sustainable green economy. Limited transportations, virtual meetings and smart digital technology applications, will enhance the reduction of emissions contributing to Europe’s goal of reducing greenhouse gas emissions by at least 55% by 2030 and thus ensuring the protection of our planet. Continuous research efforts may also lead to the design and the implementation of more efficient digital tools. These tools may also be applied in the industrial energy sector and result in lower emissions and better outcomes in terms of production and efficiency. It is also mentioned that the transition to this new economy requires the collection, the processing and the distribution of all the product related data. For instance, the information about storage devices for electric vehicles and industrial applications will be distributed as part of the Sustainable Products Initiative in order to enhance the information exchange between the manufacturers, improve the resources efficiency and support the customers in the decision-making process.

It goes without saying that this transition requires digitally empowered citizens who will be perfectly capable to undertake these challenges. Strong focus will be given to digital skills which are vital to this aim and a prerequisite for the Digital Decade. The European Pillar of Social Rights Action Plan sets the target for adults with at least basic digital skills to 80% in 2030 with the launch of life-long learning programs in these areas of expertise. Citizens equipped with more specialized digital skills shall trust digital products and online services, identify possible threats, crossover the received information and rely on trustworthy sources. Finally, people should expand their advanced digital skills, in order to get quality jobs and move up the career ladder. As of 2019, the number of ICT specialists was 7.8 million, with a prior annual growth rate of 4.2% and thus it is expected that the EU will be far below the projected need of 20 million experts for key areas, such as cybersecurity and data analysis. Moreover, more than 70% of businesses claims that the staff has inadequate digital skills while also a significant severe gender imbalance is reported (only one in six ICT specialists and one in three STEM graduates are women). These challenges should be addressed with big investments in

training programs in these areas in order to bridge these gaps and equip the future generations with the essential skills, in order to shine in the Digital Decade.

In the same month, the European University Institute published the RSC Working Paper 2021/73 entitled “An energy system model to study the impact of combining renewable electricity and gas policies” authored by Martin Roach and Leonardo Meeus. In this work, it is stated that it is currently debated whether the policies that have been successful at bringing down the costs for renewable electricity can be replicated for renewable gas, i.e., hydrogen and biomethane. It is worth mentioning that the European Union (EU) aims for 40 GW of electrolysers domestically by 2030, there aren’t any support schemes for this. There are specific targets concerning biomethane, although many have support schemes. In the same working paper, it is mentioned that France aims for 10% of gas consumption to be supplied by biomethane in 2030. The support of biomethane may be limited by a link to its end-use consumption. Biomethane is supported in Germany when designated for electricity generation and in Italy for transport.

With the upcoming revision of the EU renewable energy directive, some stakeholders have advocated for a gas target to support low-carbon and or green gas technologies. If the recent experience in the electricity sector is regarded as largely successful in deploying renewable electricity generation technologies, then such a policy tool may have provided some inspiration for a gas target as is pointed out in the working paper. As one mechanism to promote decarbonized and renewable gases at the EU level there are proposals for guarantees of origin. The working paper advances an energy system model to help policy makers design renewable energy policies that combine support for renewable electricity with support for renewable gas. There is a so called by the authors “Stylized model” which includes demand for electricity, heating, and hydrogen in industry that is supplied by competing technologies where renewable gas policies can support the investment in electrolysers to produce green hydrogen as well as the investment in biomethane production which is subsequently injected into the gas network.

Usually, countries are considering introducing a renewable gas policy or increasing the ambition of the policy that is already in place. Such a policy typically consists of a target in combination with direct support to achieve the target. As the energy system is becoming increasingly integrated and the number of policy instruments is increasing, we expected to find significant interaction effects. This is confirmed by the working paper results. As further indicated, policy makers therefore need to be aware of these effects when they design their policies to avoid surprises regarding the costs of the policies and/or the effectiveness of these policies in supporting renewable gas technologies.

2.2. Existing skills offer and the future Energy labour market

Based on the results of the survey carried out in the context of WP 2, which led to the drafting of D.2.2, the consortium identified the skills gaps in the participating countries. The most important and highlighted lack of skills was identified to be “Analytical Methods” and “Programming development and technology related” skills set. Even though they are offered mainly for Engineers & Researchers and Technicians & Specialists staff categories, they are were not identified in other occupational categories which are strongly related to the energy sector.

Another finding of the research, demonstrated that the ET providers failed to offer skills related to Analytical Methods, Computing tools & Platforms, and Programming & Development.

What can be safely argued through the best practices research is that training programmes developed for VET level were the result of identified lacks in terms of:

- Effective digital upskilling of the professionals in energy related occupations;
- Upskilling professionals (especially the ones who have been in the field longer, since they are usually the ones away from any training activity for a longer period) to adhere to the new EU directives and policies introduced and are related to energy efficiency issues;
- Effective collaboration between the stakeholders (i.e., public authorities, business representatives and VET providers).

What the best practices identified and presented in this deliverable demonstrate is that the most effective and market ready skills are developed under the condition that work based learning is provided alongside the theoretical training and preferably in real life situations (see for example the practice “From Stump to Boiler” from Finland and LuxBuild2020 from Luxembourg).

Finally, it should be highlighted that as time goes by, energy efficiency interventions become a necessity, which can only be addressed through qualified professionals. Lifelong Learning Programmes need to be up to date with all the developments that happen in the sector, and ensure that it provides the appropriate high quality training options, to keep up with the developments and claim an active role in the change that needs to be undertaken.

3. Methodology for the design and development of Best Practices

This Chapter presents the concepts and methodology underlying the definition and development of the EDDIE Best Practices (BP), according to the vision and the objectives of the EDDIE Blueprint Strategy for the Digitalization of the Energy sector (BSDE). Conceptual definition and methodology will be used in the next

stages of the project, for the practical development and validation of the set of procedures that will form the BP.

3.1. Definition of Best Practice

The definition of a Best Practice (BP) is a highly debated topic of discussion; however, it refers to a set of methods, techniques or processes that have been proven to be effective and efficient in achieving desired outcomes. Within the context of LLP, a BP is a practice that stands out as a methodology, process or approach and should lead to the most positive contribution in terms of quality, learning opportunities and content, and alignment with the industry standards. All in all, a practice can be considered as best when it has been implemented and evaluated with positive results, and it is worth of wider dissemination.

In LLP, a BP is shown through its positive impact on the quality and effectiveness of the education and training provided. This may include ensuring the most positive contribution in terms of personal and professional development, providing flexible training opportunities, utilizing technology to enhance the learning experience, and ensuring that curricula align with industry standards. The overall scope and goals of a BP in LLP should be to provide students with the skills, knowledge, and competencies they need to adapt to a constantly changing world, and to keep the education and training provided in line with current digital transformation and industry standards and trends. LLP should allow for continuous growth and development throughout an individual's lifetime.

Overall, the BP defined in EDDIE is intended to be any *process* defined by a set of procedures (i.e., recommendations, lessons learnt, examples of existing good practices, new practices that advance them, practical tools) for the redesign and methodological validation of teaching and learning, directed to the Energy sector and the delivery of the skillset demanded by its digitalization and transformation.

3.2. Bottom-up approach for the development of a Best Practice

For the design and development of a BP, we propose and follow a bottom-up approach: the BP is the result of an analysis and evaluation of the current labour market, market and industry specifics as well as of the EU strategy set to achieve a digital transformation of the economic sector (including the Energy sector). In the context of the EDDIE ecosystem, the industry and/ or labour market are represented by the network of industrial stakeholders, which are presented in the project website. As for the current EU policies and strategies related to or affect energy efficiency in the Member States, these are:

- Climate change and energy transition
- EU digital strategy
- Social Europe for just transitions
- Digital education in Europe
- EU recovery plan

We look at and delve into inputs from market, stakeholders involved in the energy sector, public authorities (to define the demand, as it is seen in the EDDIE ecosystem), and we look at and delve into other inputs on the current offer from university. From this information, it can be defined WHAT has to been done in terms of BP (procedures) and HOW this should be achieved. Figure 3-1 provides a graphical representation of this methodology.

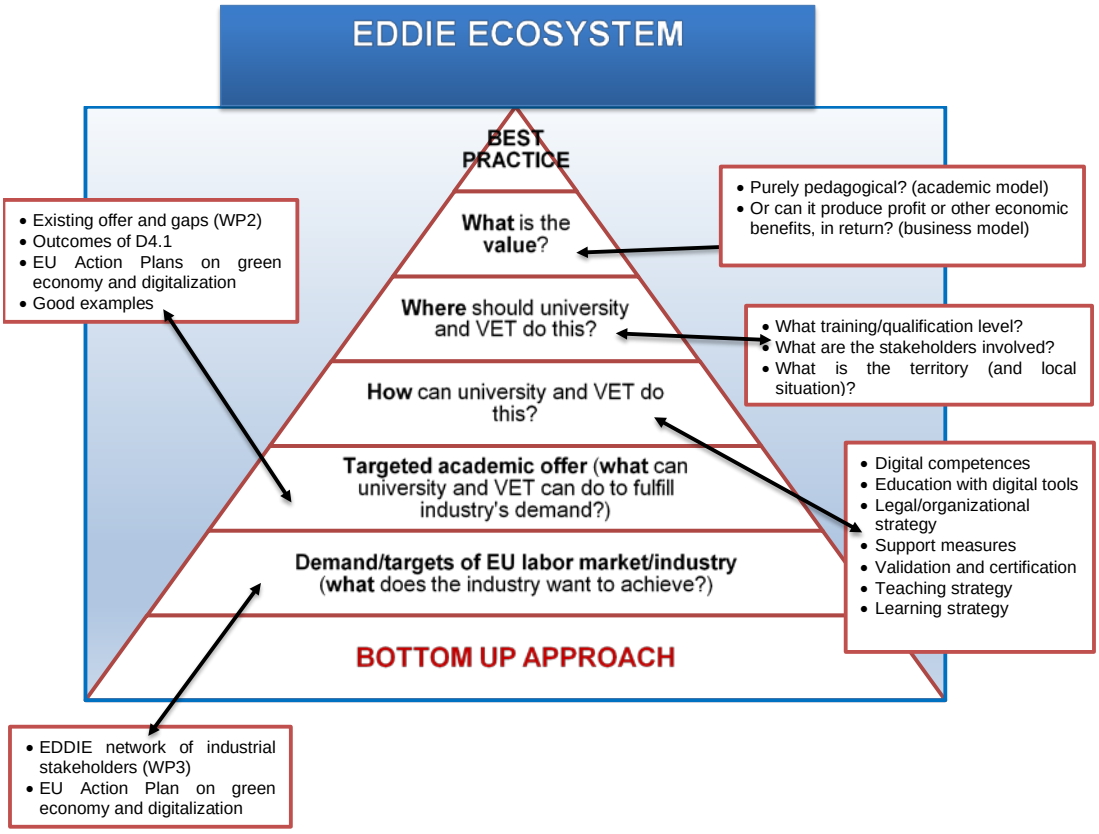


Figure 3-1: EDDIE approach on the identification and selection of best practices

The review, design and development of BP (for university but also for vocational education and lifelong learning) in WP4 is in part made to guide the works in WP5, where the Blueprint strategy is designed. For this reason, it is important that the methodology in WP4 bears in mind the structures that are being used in WP5 to analyze existing education programs, which stresses not only their academic suitability, but also their economic long-term sustainability. For this reason, we follow a list of items to be reviewed in additional to those already mentioned, in the design of best practices at the different stages of the academic and business models of new (or existing) education initiatives. Table 3-1 presents these items.

PHASE	BUSINESS MODEL	ACADEMIC MODEL
Specification	Methods of interaction with industry (energy and digital) for: technology trends, labor market, skill needs	Definition of target jobs, target skills. Taxonomies: skills, jobs, tools/systems.
	Methods for employees performance assessment	
	Methods for graduate-skill assessment, official education	
Design	Use of training-programs templates: business	Use of training-programs templates: academic

PHASE	BUSINESS MODEL	ACADEMIC MODEL
	Select facilities (virtual/physical) and resources	Definition of requirements/profiles for students
	Roles and functions of different stakeholders involved. Includes hiring mechanisms (if any)	Definition of skill-increments, target gaps. Contents and training goals.
	Financial structure: sponsorship, subsidies/grants, tuition, remuneration and costs	Develop detailed contents. Re-use of training modules. IPRs?
	Design of recruiting process: dissemination, marketing, recruiting procedures	Teaching and evaluation methods
	Digital tools licensing	Select digital tools
	Detailed operations' planning	Detailed academic planning
	Define certification entities and methods	Certification criteria
	Define feedback and validation methods	Validation criteria
Implementation success	Recruiting success (quantity)	Individual certification: results
	Financial success (profit, sustainability)	Programme certification: results
		Alumni feedback: results
		Employers feedback: results

Table 3-1: Items common to Best Practice model in WP4 and WP5

As for the focus of the BPs selected in this deliverable, they are targeted to:

The lifelong learning sector and focus on the development of a training offer based on an identified need regarding energy digitalization

In Industry 4.0 and the rapid advancements in digitalization, the lifelong learning sector should align with these digital and technological advancements, the economy, the labour market, and society. It should focus on the development of a training that addresses these identified needs and prepare learners both theoretically and practically for the new emerging occupations associated with the energy digitalization.

The introduction of digital tools and solutions to ensure high quality of training provision

To ensure high-quality personal and professional development in the era of digitalization, it is important for the lifelong learning to use digital tools and solutions. All in all, it is becoming essential for keeping up with the latest developments and ensuring that learners are equipped with the necessary skills to adapt in the digital age and the rapidly changing job market and advancements.

The effective collaboration of different stakeholders with LLP providers to offer a unique and targeted solution, both in terms of the needs of the professionals, as well as of those of the industry

Effective collaboration between different stakeholders and LLP providers is necessary to offer a unique and targeted solution that meets the needs of both professionals and the industry. This type of collaboration is essential for addressing the needs of a constantly evolving and digitalizing workforce and providing effective lifelong learning opportunities that are tailored to the needs of both individuals and the industry as a whole.

The increased impact of the intervention presented in terms of number of beneficiaries reached and/ or added value incurred at local/ national/ EU level

It is essential that the BP presented has a significant impact, both in terms of the number of beneficiaries reached and the added value created at local, national, and EU level. This will ensure that the training offered is reaching a large number of individuals and making a meaningful impact on the industry and society.

4. Presentation of Best Practices

In the sections that follow, the consortium presents a comprehensive examination of various interventions that have been implemented in the field of Lifelong Learning Programmes, specifically in relation to the energy transition and digitalization. As already described in the previous chapter, these interventions can be classified as best practices, good examples, and success stories, each providing valuable insights and information on effective strategies and methods in the field. More specifically:

Best practices (BP) are examples that meet the requirements previously described and are directly relevant to energy digitalization. These best practices provide an analysis of the most innovative and successful approaches that have been implemented in the field and can serve as a model for future interventions.

Good examples, on the other hand, may not be directly related to energy digitalization, but they focus on the energy transition and can provide valuable insights on methodology, structure, and organization. These examples can serve as a source of inspiration for creating new training programs and adapting existing ones to better serve the needs of the industry and the workforce.

Success stories are European projects that have had a positive contribution in providing training in the sector of energy transition. These projects have been successful in implementing new technologies, methods, and solutions in the field and have helped to improve the employability and skills of the workforce. These success stories can provide valuable insights on how to replicate their success on a larger scale.

4.1. Best practices

4.1.1. Predictive Maintenance (Multicountry)

General presentation of the practice

Maintenance Manager HQ runs one of the world's largest communities for maintenance professionals with thousands of global members from 500+ companies around the world.

Relevance/Importance

Maintenance Manager HQ is building the world's most trusted resource for maintenance management. This company also hosts the popular course taken by over a thousand students around the world: One Week Maintenance Manager, which teaches the core fundamentals of maintenance, how to launch side projects to better prep for interviews and the role, and how to land a maintenance job. The training is delivered for professionals with a specialized focus on predictive maintenance, which is in the heart of artificial intelligence applications in energy digitalization.

Aims and objectives

There are multiple objectives for this company such as:

- To provide all information about Maintenance in diverse sectors of activity, what are the necessary skills for Facilities Maintenance Manager, for Maintenance Manager, for Maintenance Engineer
- To provide courses on how to develop your own maintenance strategy, ace maintenance interviews, and set up effective hiring programs. Skills on how to lead a maintenance team, as well as technical maintenance management skills are also being taught
- Each course is awarded by the relevant maintenance management certificate
- It is also a platform for posting a job related to for maintenance managers exclusively
- A platform for finding maintenance jobs (such as a maintenance technician, maintenance manager, or maintenance supervisor in industrial maintenance)

Structure and organisation

Maintenance Manager HQ provides resource for maintenance management with a final certification that will build the skillset in maintenance management, build the maintenance network, craft a great maintenance resume and online presence and create a successful job search strategy. The program coursework consists of lectures, interviews, written content, and other instructional content that aims to build a solid human resources foundation in a candidate. Certified maintenance managers can take the knowledge they gain from the course and become more effective and successful maintenance professionals.

Scalability and Transferability

The website is very intuitive and has some feature that are relevant for the future EDDIE platform such as the job posting, job listings and the certification courses. The trainings are also offered online and it has a global network, thus the transferability potential is very high.

Impact and success factors

The Maintenance Manager Certification course does not have any prerequisites in regard to academic qualifications. This platform is ideal for anyone looking to gain some fundamental knowledge of maintenance management in a practical setting. The course will benefit everyone, from new professionals to maintenance to seasoned maintenance veterans looking for some new knowledge and unique insights about modern maintenance. The certification status is given by the e-certificate and digital badge that will be received upon completion of the course, and via the certification portal. Each online certificate comes with a verification link that redirects to Maintenance Manager HQ, where managers and/or potential employers can verify the certification status.

The most important critical success factor of this program is that all the instructors are real-world Maintenance leaders working at top companies, which combined with the huge global network of companies, creates a strong link between theoretical and practical knowledge. Students will also be assigned in real-world case studies and hands-on mentorship, which creates added value to the program.

4.1.2. Professional Certificate of Competency in Smart Grids Industrial Automation (Multicountry)

General presentation of the practice

A smart grid is an electricity network that uses digital and other advanced technologies in an integrated fashion to be able to monitor and intelligently and securely manage the transport of electricity. This online course covers smart grid infrastructure and the associated technologies such as smart metering, energy storage, SCADA, demand side management, artificial intelligence, cyber security etc. For a sustainable energy future, it is essential that engineers understand the role of smart grids and collaborate with each other to achieve the smart grid values. Due to the nature of the smart grid concept, the course is suitable for all engineers including electrical and electronic engineers, data communication engineers and industrial automation engineers etc.

Relevance/Importance

This Best Practice is highly linked to the digital solutions and concept of energy digitalization. Thus, in this practice several digital tools are used such as process control, instrumentation, control valves, process plant layout, piping design, SCADA, PLCs, advanced process control (APC), boiler control, industrial data communications, networking, industrial wireless radio telemetry systems, shielding/EMC/EMI, and noise reduction.

Aims and objectives

The main aim of this course is to introduce engineers to the principles of smart grids in power system application under various network conditions. According to that, the content includes smart electricity network and the role of communication in smart grid deployment, which will develop engineers' understanding of the overall smart grid components.

The course will discuss the basic components of smart grid systems and will look into topics of smart grid regulation and market economics, communication technologies and smart transmission/distribution grids. The application of various power electronic devices and the management of energy storage, electric vehicles, demand side management and AMI will also be covered. The computation tools for smart grid design, adaptive protection, Interoperability standards and software infrastructure will be highlighted. Furthermore, students will gain a fundamental understanding of big data and cyber security in smart grids.

After covering the necessary theory, the course will introduce practical studies involving the modelling and simulation of various system conditions using appropriate software tools. Students will also gain skills in interpreting simulation results.

Structure and organization

This course is designed for engineers and, it has a duration of three months and it is offered online, providing the flexibility of attending anytime from anywhere.

The expected weekly workload is approximately 5-8 hours, which includes a weekly pre-recorded webinar of 60 mins duration and a live webinar that runs for about 60 mins to facilitate class discussions and allow live Q&A.

Unit Content:

- Topic 1: Introduction to Smart Grids and Their Market Economics,
- Topic 2: Infrastructure of Smart Grids,
- Topic 3: Smart Transmission/Distribution Grids,
- Topic 4: Applications of Power Electronics and Energy Storage Systems,
- Topic 5: Demand Side Management and AMI,
- Topic 6: Electric Vehicles (EVs) Integration and Its Grid Impact,
- Topic 7: Measurement and Communication Technologies,
- Topic 8: Computation Tools for Smart Grid Design and Adaptive Protection,
- Topic 9: Interoperability Standards and Software Infrastructure ,
- Topic 10: Artificial Intelligence in Smart Grids,
- Topic 11: Cyber Security in Smart Grids,
- Topic 12: Project and Revision

To obtain a certificate of completion for EIT's Professional Certificate of Competency course, students must achieve a 65% attendance rate at the live, online weekly webinar, while detailed summaries or notes can be submitted in lieu of attendance. In addition, students must obtain a mark of 60% in the set assignments which could take the form of written assignments and practical assignments, but also obtain a mark of 100% in quizzes.

Scalability and transferability

Overall, it is a program industry oriented with a wide range of possibilities for career development. Combined with the flexibility of online training, the transferability potential is high.

Impact and success factors

This course is suitable for all engineers including electrical and electronic engineers, data communication engineers and industrial automation engineers etc. The most important success factor is that the content is

highly specialised in the sector of energy digitalization and, as expected, new emerging digital technologies are applied and taught. This enables professionals to stay informed, current and competitive in the industry, which is crucial for success in the field.

4.1.3. Digitalisation and smart technologies for the power sector (GE)

General presentation of the practice

The Renewables Academy AG (RENAC), based in Berlin, is one of the leading international providers for training and capacity building on renewable energy and energy efficiency. Since its founding in 2008, more than 25.000 participants from 163 countries have participated in its training programmes. The course "Digitalization and smart technologies for the power sector" is part of the RENAC Ready-Made Trainings, that also offers courses in online format. The course introduces the topic of energy digitization and explains why it is a key factor in building the sustainable energy systems of the future and how it can contribute to decarbonization.

Relevance/Importance

This course can be considered a best practice, since the topics analysed are extremely focused on the digitalization of energy. In particular it touches several topic of interest to the EDDIE project, such as cybersecurity, Internet of things, Big Data/ Data analytics, Blockchain, Advanced control system in the energy smart grid. Currently, the RENAC Ready-Made Trainings has no significant link with industry/research stakeholders.

Aims and objectives

Digitalisation is the key technology that makes it possible to organise decentralised networks and thus contribute to decarbonisation while maintaining a high level of security of supply; thus the objectives of the course are to:

- identify the areas of the power sector which are most affected by digitalisation;
- assess potential advantages for society, the economy and market participants arising from the digitalisation of the power sector;
- identify and explain the most important technologies which form the basis for the current digitalisation of the power sector;
- explain how these technologies can be applied in order to optimise generation, transmission, storage and consumption of electrical power;
- understand which aspects of digitalisation support decarbonisation and energy efficiency efforts, and which can put these objectives at risk;
- demonstrate how digital technologies shape existing markets and processes, and how they may create new ones;
- describe the risks arising from the increasing digitalisation of the power sector and create counter measures against potential attacks.

Structure and organization

The course is aimed for people involved in the energy sector who want to understand the link between digitalisation and energy and are willing to become well acquainted with current trends in smart grid development. The course is delivered online through a dedicated platform, it lasts for 1 month and the effort required for the students is about 13 hours of study. For participants who score 70% or higher on the exam a RENAC certificate is granted. The course is composed of 8 modules:

- Introduction (Learning objectives, Introduction to digitalisation in the power sector)
- Energy economics background of digitalisation of the power sector (Fundamentals of digitalisation of the power sector, Drivers and trends of digitalisation in the power sector)

- Opportunities and risks of digitalisation for sustainability and decarbonisation (Opportunity for decarbonisation through RES integration, Opportunities to expand decarbonisation into other sectors, Risk: higher power demand and emissions, Risk: higher emissions due to digital infrastructure)
- Key technologies (Computer algorithms, Connectivity and internet of things, Big data analytics, Machine learning, Smart metering, Blockchain)
- Smart generation, transmission, and consumption (Smart supply with virtual power plants, Smart storage, Smart grids, Smart demand)
- Smart markets and process (Smart markets, Smart contracts, Peer-to-peer trading, Algorithmic trading, Digital processes and process automation)
- Risks and cyber security (Tasks and goals of IT security, Cryptography and digital signatures, Attacks and countermeasures)
- Summary of the course (Summary, References, Further reading)

Scalability and Transferability

The course is delivered online, so it is fully scalable and transferable.

Impact and success factors

The course is aimed at a selected audience, but not just experts. Thus, the goal is to teach new perspectives, but also to raise awareness of how digitizing energy is the key step in evolving toward a more sustainable and less wasteful world. The strength of this course lies precisely in the fact that it is aimed at an industry audience that wants to approach new topics: they can do it easily online, at an affordable price. Most importantly, this practice has ensured that the training offered is reaching a large number of individuals and has made a meaningful impact on the industry and society. From these experiences can come an interest that leads to real change.

4.1.4. The Energy Training Centre (Multicountry)

General presentation of the practice

The Energy Training Centre offers Energy Industry Training Courses For Sustainable Energy Practitioners, where both technical and non-technical professionals within the energy industry are upskilled/trained.

Relevance/Importance

The Energy Training Centre delivers innovative and inspiring professional development training courses and workshops to support professionals from around the world to achieve the ever-growing global transition to cleaner energy production.

Aims and objectives

This centre is supporting clients within the conventional energy industry, such as those in oil gas adopt and implement effective strategies and systems to reduce their carbon footprint and emissions. They deliver training and run bespoke programs for clients who may be making a larger scale transition into the renewable energy market. For those organisations who are growing or are fully established in the renewable energy space, the objective is for training to further develop their knowledge and skills, and ensure they are up-to-date with industry standards and regulations.

Structure and organisation

All the training courses (online and in-person) are developed and delivered by leading experts in their field of expertise within the energy sector. The Consultants are chosen, not just for their high-level academic and industry related backgrounds, but also for their inspiring, innovative, and thought-provoking delivery and insight into the energy industry.

This training centre provides classroom training courses (Hands-on Learning Experience with Instructors In-Person), online training courses and in-house training on various topics such as Leadership and Strategy, Business Energy, energy finance, energy law and regulation, energy management, energy safety, smart energy etc.

Scalability and Transferability

The website features details about the courses and their format, a course finder, categories for courses (topics and sectors) and locations for the courses. All those features are relevant for the future EDDIE platform in terms of the Training Marketplace.

Impact and success factors

This Energy Training Centre targets the energy industry, around the world, while embracing various innovative approaches delivering training solutions that are not only relevant and convenient but also cost effective. So far, the training centre created partnerships with world-renowned institutions drawn from a vast range of sectors such as Oil & Gas, Electricity, Utilities, Power and Energy. The versatility of the training courses have provisioned and ushered hundreds of career-driven individuals from various competencies to their professional growth and development. Overall, it has created meaningful value in providing specialized training in the sector of energy digitalization with a strong link to the energy industry around the world.

4.1.5. Siemens Xcelerator Academy (Multicountry)

General presentation of the practice

Siemens Xcelerator is an open digital platform that was created to accelerate digital transformation and value creation for companies of all sizes. The platform allows users to request customized training paths and offers IoT hardware technologies, software and digital services from both Siemens and certified third parties, creating an ecosystem and marketplace to facilitate interactions and transactions between customers, partners, and developers.

Relevance/Importance

This program proposed by Siemens can be considered a best practice as it enables exchanges between various stakeholders in a single digital environment; it encourages the digitization of energy by providing software capable of managing this process; and it offers training to support professionals and businesses in acquiring the skills needed to manage the digital transition. In particular, it delves into several topics particularly important to the EDDIE project, including IoT and simulation and optimization.

Aims and objectives

Technology adoption is widely recognized as a major factor in the success of software projects. That's why the final aim of Xcelerator Academy is to provide specific trainings that enables companies to secure value realization from the investment in digital transformation.

Structure and organization

Siemens Xcelerator Academy is designed for companies who wants to accelerate their digital transformation.

It offers different packages, all aimed at acquiring, sustaining, and validating knowledge/skills to address business transformation through Xcelerator portfolio (a modular, cloud-connected, custom hardware and software portfolio built on programming interfaces similar to standard API applications). The program offers:

- On-demand training (composed by: on-demand videos explaining key concepts and demonstrate “how to”, practice labs built into virtual machines launched from desktop and knowledge checks to measure learning progress):
- Instructor-led training (provided virtually, in-person or on-site);
- Certification (composed by: self-paced learning that helps students preparing for the exam and a flexibly accessible and virtually-proctored certification exams);
- Customized learning program (the program is designed ad hoc by Siemens experts to meet the learning needs of the company).
- Xcelerator Academy offers training courses -linked to Siemens software- covering the following topics:
- IoT: “Internet of Things Analytics”
- Operations: “Digitalization of manufacturing operations management”
- Manufacturing: “Synchronize engineering, manufacturing and service” and “Digitally transform part production”
- Simulation: “A complete digital twin simulation solution”
- Electronics: “Smarter products, faster” and “A comprehensive E/E systems development solution”
- Mechanical: “The next generation of mechanical design, simulation, and manufacturing” and “Enable creative design, fast”
- Collaboration: “Connect people and processes across boundaries” and “Bring your software lifecycle under control”
- Applications: “Low-code app development drives digitalization”

Scalability and Transferability

Xcelerator Academy is extremely scalable because it is designed on a modular basis so that it can meet the needs of both small businesses and large corporations. The model is attractive and could be transferred to other players in energy transition software or tools who wish to expand their activities, including providing specific training and offering a platform for interconnection among the stakeholders involved.

Impact and success factors

The model proposed by Siemens with Xcelerator Academy can have a big impact in the energy digitization process as it allows not only to easily purchase the software and suites necessary for the transition of companies, but also offers customizable and scalable training to learn how to manage the process. Furthermore, the operation has given rise to partnerships with important players in the digital world (such as Nvidia): thus opening up a perspective of collaboration and knowledge transfer towards an increasingly integrated platform.

4.1.6. Energy Academy (NO)

General presentation of the practice

DNV's Energy Academy provides a wide range of courses for the electricity supply chain, bringing together courses from legacy DNV, GL, Garrad Hassan and KEMA. The courses draw on their extensive expertise in business & technical consultancy, testing, inspections & certification, risk management, and verification in the energy sector. Besides these standard courses, the Energy Academy can also create in-house trainings customized for addressing a company’s specific needs. These can be tailored versions of existing courses, or completely new.

Relevance/Importance

The selection of all courses could be a best practice, as they are tailored to energy transition and have been developed based on the professional know-how and deep expertise of DNV in the energy sector. All in all, the

Energy Academy offers a wide variety of training courses, with knowledge and skills relevant to the field of EDDIE, such as cybersecurity, IoT, data management, remote energy meter interrogation etc.

Aims and objectives

As a global group of energy experts, their main objective is to help industries and governments to navigate the many complex, interrelated transitions taking place globally and regionally in the energy industry. However, since in the ever-changing energy industry, knowledge management is the key to efficient, reliable and profitable operations, Energy Academy focuses on upskilling the workforce with the required knowledge and skills to support energy transition.

Structure and organisation

DNV (formerly DNV GL) is an international accredited registrar and classification society. The company currently has about 12,000 employees and 350 offices operating in more than 100 countries, and provides services for several industries including maritime, oil and gas, renewable energy, electrification, food and beverage and healthcare.

All of the courses are taught by experts with many years of professional experience in the field, who are still actively involved in real-life projects. There are the following two training options:

- open-enrolment courses (classroom and online), seminars, workshops and knowledge days
- Customized in-house training tailored to the needs of the company

Scalability and transferability

The strong network of both employees, experts and offices worldwide, showcase the successful transferability and meaningful impact in the energy industry. In addition, being fully integrated in the company's permanent structure, is a feature and service that is relevant for the future of the ENTITY and EDDIE.

Impact and success factors

The most important success factor of this initiative is the strong links and involvement of energy experts actively involved in real-life challenges in the energy sector, along with its global network of stakeholders. This has led to the provision of specialized training and professional know-how on the latest technologies and developments in the energy industry.

4.1.7. Intelligent and Integrated Energy Systems (Multicountry)

General presentation of the practice

This series of MOOCs, uploaded on the EdX platform, provides unique and multi-disciplinary insights on how to understand, design, plan and operate the intelligent and integrated energy systems in the rapidly evolving energy sector. The program focuses on four main aspects: technology, digitalization, policy and governance, and innovations for sustainable business, thereby providing the learner with a holistic view of the revolution in energy systems and power grids.

Relevance/Importance

This series of MOOCs is highly relevant to the field of energy digitalization, and it is aimed at professionals in the energy industry who want to broaden their perspective and discover alternative approaches to energy integration in an intelligent way. More specifically, it focuses on how to digitalize the 'conventional' grid and which digital technologies to use for this, including but not limited to, AI, machine learning, blockchain and computer simulations. Combined with the fact that it is endorsed by two leading worldwide companies in technology and energy, DNV and IBM, this intervention is considered a Best Practice.

Aims and objectives

The overall objective of this initiative is to enable professionals to deploy intelligent technology, strategy and business models to adapt to significant changes in the energy field. This knowledge and skills is relevant for all geographies in the world and can be applied for the transition of existing highly reliable energy eco-systems as well as for building new energy eco-systems in underserved areas.

Structure and organisation

This course discusses the energy system's physical, operational, digital, economic, policy, and business layers and their interrelation. On completion of the program, participants will be equipped with a certificate, while the content of the course is as follows:

- Digitalization of Intelligent and Integrated Energy Systems
- Policy and Management of Modern Energy Systems
- Technology of Intelligent and Integrated Energy Systems
- Business Implications of Intelligent and Integrated Energy Systems

Scalability and transferability

The program is offered completely online, so the transferability potential is high.

Impact and success factors

The most important success factor for this program is that it has been tailor-made by a team of professors from the Delft University of Technology and industry experts for specific job profiles, and has a strong link with key companies in the field. What makes this program unique is that professionals are presented with all relevant aspects of the energy transition, allowing them to understand and transform the energy system on all sides. This is crucial because the energy system cannot reach the required level of integration and intelligence without adapting the legislative and economic infrastructures as well.

4.1.8. Digital Transformation in Energy and Utilities Certification Course (Multicountry)

General presentation of the practice

This Certification Course allows a professional to become a Certified Digital Transformation Professional in Energy and Utilities.accredited by the US-based International Institute of Executive Careers (IIEC).

Relevance/Importance

This Best Practice is relevant to digitalization and energy: in its contents are included digitalization for Renewable Energy Companies, digitalization in Transmission & Distribution, digital Solutions for Retail & Energy Services among others. It is also closely linked with global industry or research stakeholders such as Deloitte and IBM.

Aims and objectives

This is a course for professionals and executives to get a Professional Certification in Digital Transformation in Energy and Utilities. The overall objectives are to focus on the Utilities Industry and the challenges of Utility Industry Firms and support the digitalization of conventional power generators and the renewable energy companies, giving solutions for retail and energy services.

Structure and organization

This is a 100% online program designed for professionals and executives who want to get a Professional Certification and accelerate their career. It is a self-paced of 10 lesson-course, and each lesson requires around 30-min to be completed.

The subjects included are:

- Digital Transformation: Focus on the Utilities Industry
- The Challenges of Utility Industry Firms
- Digital Transformation Across the Utilities Value Chain
- Digital for Conventional Power Generators
- Digital for Renewable Energy Companies
- Digital in Transmission & Distribution
- Digital Solutions for Retail & Energy Services
- Digital Commodities Trading
- Customer Experience and Commercial Models
- Final Certification Assignment

Scalability and transferability

This is an opportunity of growth and professional advancement, which is offered completely online and thus it has a high transferability potential.

Impact and success factors

This course is suitable for professionals and executives to get a Professional Certification in Digital Transformation in Energy and Utilities. At the end of this course professionals will be given a certificate of completion for Professional Certification in Digital Transformation in Energy and Utilities.

All in all, it is an industry-oriented initiative with new emerging technologies (digitalization) being used and taught in the field of energy digitalization. Combined with the links to global stakeholders, this course creates a meaningful impact in LLP.

4.2. Good examples

4.2.1. European Energy Manager-EUREMnext (Multicountry)

General presentation of the practice

The EUREM European EnergyManager Training is an ambitious standardised training programme and a worldwide network for European Energy Managers, provided in 29 countries worldwide.

In 1999 the Chamber of Commerce (CCI) Nuremberg for Central Franconia started the EUREM initiative with the first practical training “Energy Manager (CCI)” in Germany. EUREM was developed between 2003 and 2005 as part of an EU project of the Nuremberg Chamber of Commerce (lead), the German-Portuguese Chamber of Commerce in Lisbon (DUAL), the Energy Institute in London and the Economic Chamber Austria (WKÖ) in Vienna. With EUREM.NET – Training and Network of European Energy Managers – an EU follow-up project – this training and networking program has been implemented in nine other EU countries between 2006 and 2009.

Within the follow-up project EUREMnext, the EUREM training was introduced in six additional countries (Albania, Bosnia & Herzegovina, Estonia, Latvia, Serbia & Turkey). The actors from the new countries were supported by the established EUREM partners in Austria, Czech Republic, Finland, Germany, Greece and Spain. The EU-funded project “EUREMnext – Taking European Energy Managers to next efficiency levels by implementing energy audit recommendations”, started on 1st March 2018, headed by the Nuremberg Chamber of Commerce and Industry as the applicant and coordinator of the 13 partners from 12 countries. The 40-

month project was funded by the Horizon 2020 Research and Innovation Programme of the European Commission under Grant Agreement No. 785032.

Aims and objectives

Enriching the well-established EUREM-European EnergyManager training programme, making it available in new countries to allow more persons to become qualified/ accredited experts or upgrade their knowledge and skills, and adding ancillary implementation support activities, thereby contribute to increasing the quality of energy audit results, the probability of implementation of the recommendations, and ultimately the energy efficiency and competitiveness of the businesses.

Structure and organisation

Within the EUREMnext project, additional outputs were made available to the public:

- Provider Guides for 4 Implementation Support Actions
- 24 summaries of energy concepts
- 2 press releases per partner
- Policy Brief – What businesses need to implement more sustainable energy measures
- 6 good practice videos of participants' sustainable energy measures,
- 2 conferences to enable exchange of experience of energy managers and auditors, financial sector representatives, trainers, and other experts,
- 2 international EnergyManager Award competitions and national ones in new countries,
- Press releases, classical and social media, newsletters, personal contacts, events.

Within the EU-project “EUREMnext”, the EUREM training was enriched with new modules in e-learning format. Thanks to the new technologies that make e-learning functionalities easily accessible, it was possible to cover additional content without adding too much presence time to the current course format.

The four e-learning Modules provide an overview on:

- Module 1: Energy Audit Standards EN 16247 & ISO 50002
- Module 2: Mobility Management in Businesses
- Module 3: Employee Motivation & Communication of Energy Issues
- Module 4: Industry 4.0 & Energy Efficiency
- Module 5: Financial project appraisal
- Module 6: Practical module based on Energy Audit Support Tool for production processes

In addition to the e-learning Modules, podcasts were created to enhance the learning effect and to attract new external users. The podcasts are all available in English or with English subtitles, so that widespread usability is guaranteed.

Impact and evaluation

The e-learning modules are available in 12 different languages. The modules are also accessible to users not subscribed to a EUREM course. Interested parties only have to register themselves on the “Moodle” platform and will have freely access to them. Those, who are already registered on Moodle, can use their usual account to access the eLearning modules.

One of the overarching strategic objectives of the EUREMnext project is to transfer EUREM to six new countries (Albania, Bosnia-Herzegovina, Estonia, Latvia, Serbia and Turkey) and to allow more persons to become qualified/accredited experts or upgrade their knowledge and skills.

Since December 2019, all six new EUREM providers have started their pilot courses with 72 participants in total. All six countries have successfully finished their pilot courses. The next step was to achieve national accreditation/ recognition in order to enable a continuation of the training offer after the project duration.

Critical success factors

The EUREMnext project is considered a success, as it begun from an idea, which aimed at addressing the need for training of professionals, i.e., Energy Managers and managed in the course of a few years to become a pan-European training programme with significant impact.

Transferability

The idea of developing a training programme in line with the applicable International Standards and EU regulations applicable across the EU is highly transferable across any sector.

4.2.2. ingREeS -Scheme for Middle and Senior Level Construction Professionals on Energy Efficiency and Use of Renewable Energy Sources in Buildings (SK)

General presentation of the practice

In 2012 and 2013, Slovakia participated in the Build Up Skills Pillar I project managed by EACI (now EASME) to analyse a status quo in the level of competencies available in the sector of buildings, future needs and obstacles for improvement and investments in the skills and knowledge of human resource in the sector of buildings. Although the Pillar I project was aimed at craftsmen and on-site workers in the sector of buildings, Slovak teams used this opportunity to address also several middle and senior level professionals, as the needs in this area are of same urgency and need to be addressed should the objectives in the energy efficiency of buildings and in the use of renewable energy sources be delivered. Moreover, taking into account the specific situation in Slovakia, not addressing the needs in middle and senior level professions in the sector of buildings would undermine the effectiveness of achieving the expected impact of the action focused on craftsmen and on-site workers.

Aims and objectives

The project was dedicated to achieving two objectives. First, it analysed the construction industry's knowledge about energy efficiency and using renewable energy sources in buildings. Second, it reviewed the skills that were lacking and what needed to be done to deliver these skills to construction professionals.

"If our objectives were to be achieved, we realised that it wouldn't be enough to limit our focus to those who build the buildings," says project coordinator Frantisek Doktor from the project ingREeS (Setting up Qualification and Continuing Education and Training Scheme for Middle and Senior Level Professionals on Energy Efficiency and Use of Renewable Energy Sources in Buildings). "The objective of this project was to ensure that the designers, decisions makers and site managers who lead the construction efforts are equipped with the skills and knowledge needed to make energy efficiency and renewable energy use a part of their day-to-day procedures."

Structure and organisation

The project developed national qualification standards and training programmes on the use of renewable energy sources in buildings specifically geared towards Czech and Slovak middle and senior level construction professionals. By the end of the project, five qualification standards in total had been developed along with 16 training modules. The training is delivered via a combination of in-class lessons, distance learning and practical demonstrations. At the end of the programme, participants are assessed using online testing and, based on the results, receive an official certification.

Getting the managers to the training, however, was no simple task. For example, in Slovakia, partners had to overcome the country's missing culture of continuing education and training among civil engineers. In the Czech Republic, although the culture of continuing education was already developed, training on energy efficiency was notably lacking. "To succeed, we had to pay extra attention to the innovativeness of the programmes, ensure easy access to the training and focus on the quality and value of the content being

delivered," says Doktor. "As the information had to be up-to-date, we built the system so it can be easily updated and adapted to the latest news and developments."

Impact and evaluation

The project set up national qualification and further training schemes in Slovakia and the Czech Republic for middle and senior level construction professionals on energy efficiency and use of renewable energy sources in buildings.

Particularly the project led to:

- Development of 16 training modules that are building blocks of 5 education and training programmes;
- Setting up permanent network of trainers delivering the training programmes developed under the project;
- Training of trainers for delivery of the programmes;
- Creating a database of the offered training and awarded certificates to trainees;
- Proposal for policy and financial measures to be implemented to facilitate adequate demand response for intelligent energy solutions that would motivate middle and senior level professionals in participating to training programmes, boosting demand for highly qualified professionals and SMEs to invest into continuing education.

The efforts paid off. 51 trainers have been trained, alongside 739 trained and qualified trainees. 222 stakeholders have achieved improved capacity as a result of the project's focus on training. Furthermore, feedback from these participants shows that over 60 % of the information they learned was completely new, while the rest of the information provided a deeper understanding of concepts, they were already familiar with. "Participants will now use this information in their daily work as architects, site managers, supervisors and sustainability counsellors," adds Doktor. "This will not only lead to a marked improvement in the quality of their work, but also ensure that the buildings they are responsible for achieve their energy performance targets."

Even with the project now officially closed, the training goes on, given by organisations including the Slovak Chamber of Civil Engineers, the Czech Building Academy and the Czech Association of Construction Entrepreneurs. "Project partners not only continue to deliver the training, but also continue to improve its contents and expand its impact," adds Doktor. "For example, we are adding training on how construction professionals can implement building information modelling into a building's entire life-cycle."

Critical success factors

The project is a good practice in principle because it aimed at the upskilling of middle and senior construction professionals, who are usually left out from training activities. Secondly, the project triggered the flow of information on new technologies, materials, machinery and equipment, as well as on qualitative requirements, technology, work safety and protection of human health from construction companies, suppliers of materials, machinery, technology and equipment to education institutions to ensure continuous improvement of their training programmes.

Finally, it facilitated dialogue and cooperation between world of continuing education and training, world of work and policy makers in the area of continuing education and training, essential for triggering a qualitative and quantitative step-change in delivering continuing education and training on energy efficiency and use of renewables in buildings for middle and senior level professionals;

Transferability

This practice is highly transferable in other countries and professional groups which need to be retrained in the context of energy transition.

4.2.3. Fit-to-nZEB-Innovative training schemes for retrofitting to nZEB-levels (EL)

General presentation of the practice

Based on a thorough review of existing training programmes and an analysis of the training, researchers developed a compendium covering the knowledge, skills and competences required for deep energy retrofit. Using this compendium, researchers identified the key topics of relevance to the NZEB retrofit process and, based on these, developed a set of 17 high-quality practical training programmes to address them.

The project also established fully equipped training facilities, where building professionals could get hands-on experience with many of the skills and theories taught during the training programme.

“It’s very important to see how to correctly install a window or how to prevent mould and condensation in walls,” says Dimitris Pallantzas, a certified passive house designer and education officer at the Hellenic Passive House Institute, who participated in one of Fit-to-nZEB’s training facilities. “As a building physicist, this was all known in theory but new in practice, so it was very useful to gain the knowledge I need to go back and teach the technicians and construction workers of the future.”

Aims and objectives

Reaching of the 2020 and 2030 energy and climate objectives represents a major challenge to the construction sector, which needs to be ready to deliver high energy performing renovations and, in particular, nearly zero-energy buildings. This goal requires a major effort to increase the number of qualified construction specialists at all levels, which is directly related to the accessibility and quality of the training and educational programmes and the inclusion of training on intelligent energy efficiency and RES solutions in building renovation. Responding to these needs, the project is designed to:

(i) Elaborate a set of technological competences and learning outcomes on deep energy renovation;
(ii) Develop new large scale training schemes and programmes on deep energy renovation at all levels of the vocational education and training (VET) system;
(iii) Review the national educational plans and initiate the necessary changes;
(iv) Establish capacity for professional training of trainers and train a sufficient number of trainers;
(v) Support and monitor pilot courses on the new programmes on deep energy renovation at all levels.

The leading objective of the Fit-to-nZEB project proposal is to deliver all necessary requisites for the introduction of educational content on deep energy renovation of buildings in the curricula at all levels of the educational and training system in Southeastern Europe. This was accomplished done both through incorporation of new educational content in existing curricula and through the development of new specialized programs. This process will be guided by the understanding of the complex nature of building retrofit, combining various building disciplines and allowing integrated design and cross-craft understanding with special focus on practical exercises and demonstrations. An essential element of the project is the creation and deployment of certification schemes and accreditation procedures corresponding to the EQF.

Structure and organisation

The project has produced all necessary requisites for the introduction of educational content on deep energy retrofit in the curricula at all levels of the vocational training and education system, including:

- Module-based training programmes, available for use by any interested vocational training and education provider.
- Innovative training facilities: being strongly focused on practical training, the project has not only developed a set of practical exercises, but has designed and produced dedicated retrofit practical training and demonstration models

In order to meet its overarching goal to increase the number of qualified construction specialists at all levels, the project has set as its specific objectives:

- to develop a compendium of the knowledge, skills and competences required for deep energy information and, based on the compendium, to develop
- A design-focused training programmes on deep energy building renovation for higher education establishments (EQF level 6-7)
- A training programme on deep energy building renovation, to be included in the training plans and programmes for the tradesperson professions in “Construction” professional direction
- Training content, to be included in the training plans and programmes for the professions in “Mechanical engineering” professional direction
- Two training programmes for acquiring qualification on part of profession (specialization, or similar qualification according to each national qualification framework), to be used in the training plans of the VTCs (EQF level 3-4)
- A comprehensive scheme for validating of knowledge, skills and competences acquired at the workplace (EQF level 3-4).
- To disseminate the educational content on deep energy building renovation at nation-scale level
- To develop the design of demonstration and practical training models, to build one such model for the use of the training centres providing the trainings, and to specify the equipment and building materials necessary for practical training and demonstrations
- To conduct a train-the-trainer course for selected trainers from the supporting educational and training institutions and to organize
- To conduct a systematic large-scale communication campaign promoting the new training courses.

Impact and evaluation

In total, the project has trained over 180 educators, who are now delivering the Fit-to-nZEB training programmes at the project’s training facilities. Furthermore, 26 pilot courses have been conducted at universities, professional high schools and vocational training centres; and more than 10 Memoranda of Understanding have been signed with education and training providers to use the project’s training materials. To date, this has resulted in 350 workers, 100 university students and 120 school students being trained.

Critical success factors

The success of the project lies within the fact that it became one of the most recognised NZEB training programmes in Europe, offering world-class upskilling courses customised to local needs and in collaboration with the construction industry. What contributed was the combination of the knowledge to the creation of training facilities to support the training provision. Finally, through the project, 26 pilot courses were carried out in Universities, as a means to enrich HEI curriculum with hands-on knowledge and skills.

Transferability

The practice is highly transferable, under the condition that common efforts by policy makers, industrial and market actors, and the civil society are made towards its successful transfer.

4.2.4. QualitEE-Quality certification frameworks for Energy Efficiency services to scale up responsible investment in the building sector (EL & SK)

General presentation of the practice

Ever heard of energy efficiency services providers? Some companies looking into new technologies and measures to make more efficient use of the energy they consume definitely have. But the fact is, most of them have a hard time trusting these providers, and this may partially be due to a lack of information.

QualitEE aims provide reliable tools for quality assessment and procurement. These comprise guidelines for quality assessment, financial assessment, and a procurement handbook. The toolkit builds trust between consumers, suppliers and financiers. It offers information related to best practices as well as a framework to establish consensus on the definition of good quality services. The toolkit can be used for self-assessment, from project development to procurement and delivery. It has been developed in close cooperation with stakeholders and tested through 28 pilot projects in 11 European countries. So far, these pilots have led to 33 GWh of energy savings and over 9 200 tonnes of CO2 savings each year.

Aims and objectives

The QualitEE-project aims to scale up investment in building energy efficiency by establishing quality certification frameworks for energy efficiency services across Europe, which do not exist currently. Quality certification frameworks from other sectors are comprised of the following elements; specification of standardised quality criteria, institutionalisation of the quality assurance process, and active promotion schemes.

Quality certification frameworks go beyond the presentation of model contracts, directly addressing the main challenges for energy efficiency markets (EEFIG, 2015):

i) Market heterogeneity and lack of standardisation makes it costly for clients to differ between “good quality” and “bad quality” services and lead to customers’ lack of trust;
ii) Financial Institutions perceive the “technical risk” of energy efficiency services as opaque and are thus hesitant in making financing decisions;
iii) Heterogeneity of services and service providers and lack of standardised project assessment tools restrict bundling of small investments in individual energy services into tradeable bonds, preventing access to secondary capital markets.

Structure and organisation

One of the first things the team identified through their research is the diversity was scope of energy efficiency services projects. QualitEE pilot projects reflected on this reality, with investments ranging from EUR 20,000 spent on lighting replacements to EUR 8.5 million invested in deep building retrofits.

Likewise, there were various local nuances in markets across Member States. This called for a flexible approach, which included the definition of quality assessment criteria that could be applied in the assessment of energy efficiency of any size or scope or based on any approach. They revealed whether the critical components for success have been addressed in the development of the service rather than forcing a particular approach or standard contract. Besides, the project defined a master set of quality assessment criteria at the European level. It sets a common framework for national adaptations that accommodate local market nuances.”

Thanks to surveys in 15 European countries, the project could also build an extensive database of energy efficiency services markets – covering both energy performance contracting (EPC) and energy supply contracting (ESC) – that can be explored on its official website. The team compared results collected in 2017 and 2019 with earlier surveys from 2013 and 2015. It notably found that EPC markets are growing, that the EPC concept was generally perceived as too complex, and that pressure to cut energy costs drives the entire market.

Impact and evaluation

In terms of the investments provided, the criteria have been applied to existing projects with a total project value of over 13.5 Mio. €, ranging from project values of 20,000 to 6.6 Mio € to test their applicability for quality assurance and gain information of the quality assuring processes.

Critical success factors

The success of the project lies on the real-life implementation of quality assurance schemes for energy efficiency services based on a stakeholder process. The national stakeholder process consists of the establishment of national promotion teams, which preselect adequate business models, and the National Discussion Platforms where approaches are discussed in a wider target group. This process assures acceptance and backing from the market actors for the implementation of national quality assurance schemes. The national quality assurance schemes build on a common background and are adapted to the specific requirements of the individual national markets.

Transferability

The transferability potential of the practice is high, provided that commitment is secured on behalf of the stakeholders.

4.2.5. ENERGISE-European Network for Research, Good Practice and Innovation for Sustainable Energy (FI)

General presentation of the practice

We are living in a rapidly changing world, where complex societal challenges such as climate change, inequalities, and unsustainable resource use are putting unprecedented pressures on our social and environmental systems. Addressing these urgent challenges requires radical changes in patterns of production and consumption at a pace and scale beyond what has been previously achieved. More than ever, robust scientific research and practice on transformational change is necessary to promote a societal shift toward sustainable practices. It is now widely acknowledged that technological advancement by itself is not going to deliver the reductions in carbon emissions required. Social and cultural change is and will be a key component in promoting a sustainable future.

The ENERGISE project makes an important contribution to understanding what role households can play in transformations towards using energy more sustainably in domestic spaces. ENERGISE develops a Living Labs approach to directly observe existing practices related to energy consumption in a real-world setting and to test both household and community-level initiatives to reduce energy use. Data collection before, during and after the implementation of 16 Living Labs in 8 partner countries is instrumental in contributing to the design and assessment of future energy consumption initiatives across Europe.

Aims and objectives

ENERGISE responds directly to these challenges by engaging in frontier energy consumption scholarship. Recognising the persistence of diverse energy cultures, both within and between countries, ENERGISE offers an ambitious social science programme to enhance understanding of changes in energy consumption practices across 30 European countries. Moving beyond state-of-the-art research, ENERGISE theoretically frames and empirically investigates socio-economic, cultural, political and gender aspects of the energy transition. It also examines how routines and ruptures (re)shape household energy consumption practices. Adopting a cutting-edge Living Labs approach, designed specifically to facilitate cross-cultural comparisons, ENERGISE fuses tools for changing individual- and community-level energy consumption with a novel method for energy sustainability assessment. ENERGISE will open new research horizons and greatly enhance Europe's capacity for high-impact, gender-sensitive consumption research. It also offers timely support for public- and private-sector decision-makers who grapple with the design and implementation of measures to effectively reduce household energy consumption.

Structure and organisation

Working directly with academics, householders, practitioners, businesses and policy-makers, the project has been instrumental in developing a greater understanding of the social dimension of energy use. Throughout the ENERGISE project, attention was drawn on cutting-edge social scientific methods and techniques to help us develop a better understanding of how and in what way people use energy, with specific focus on thermal comfort (heating homes) and cleanliness (washing laundry). The work carried out was underpinned by a novel

theoretical framework developed for the project as well as future work that considers social practices and cultural change as key ingredients in a successful energy transition.

Guided by the ENERGISE conceptual framework, the consortium began by analysing over 1000 existing sustainable energy consumption initiatives focusing on households across 30 European countries, toward developing innovative typologies and informing the empirical component of our project. They then adopted a 'Living Lab' approach working directly with over 300 households across 8 European countries.

Through the ENERGISE Living Labs, the project engaged households in participatory research and deliberations in order to challenge and contest social norms and habitual practices tied up with energy usage, with the overall aim of adopting more sustainable practices and documenting how change comes about in different social and cultural contexts. Overall, it was demonstrated that through the ELLs, and for most of the households across Europe who participated in the study, reducing indoor temperatures by 1°C in the heating season and reducing laundry by one cycle per week is possible, without compromising convenience and comfort.

Impact and evaluation

Socio-economic impacts of the project include:

- Improved understanding of a range of factors impacting on household energy practices.
- Enhanced understanding of reductions in energy use through individual-level and community-based interventions and their connections with wider energy cultures.
- Contribution to knowledge of what kinds of energy initiatives 'work', where, with what degree of success, and why.
- Improved exploitation of social-scientific evidence to address challenges to energy transition related to social acceptability.

Critical success factors

The ENERGISE project is considered a successful one is because of the development and delivery of 1) a new theoretical framework, which also underpins typologies of innovative energy initiatives; 2) novel approaches to Living Labs, which includes a multi-scalar approach to empirical research, covering local, regional, national and EU levels; 3) understanding routines and ruptures in shifting energy use, and; 4) advancing the Energy Union through knowledge exchange, including the identification of new opportunities for local energy transitions and their upscaling potential.

Moreover, the project demonstrated that addressing the energy efficiency problem is not solely a collective issue. In particular, it Identifies and demonstrates that individual and collective practices and approaches can reduce dependency on imported energy and diversify supply.

Transferability

The transferability of the practice is high, under the condition that people are placed in the epicentre of the efforts for sustainable energy, in alignment and cooperation between governments, businesses, communities and households

4.2.6. eTEACHER-end-users Tools to Empower and raise Awareness of Behavioural CHange towards EneRgy efficiency (FI)

General presentation of the practice

eTEACHER concept consists of encouraging and enabling energy behaviour change of building users by means of continuous interventions displayed through a set of empowerment tools to drive informed decisions

in order to save energy and optimise indoor environment quality. These empower tools are a set of ICT solutions that ensures friendly connection in between end-users and building systems, implement continuous behavioural change interventions and provide tailored advice.

Aims and objectives

Buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions in Europe. Building users have the potential to reduce energy consumption about 6-10% and improve indoor environmental conditions and comfort through behavioural changes. However, motivating behavioural change requires specific methods and strategies to convince people and be effective over the time. It is demonstrated that solutions to address this issue must be appealing, pedagogic and user-friendly, otherwise, rebound effects could provoke even higher energy consumption levels than before the application of these methods. In addition, people are energy users of multiple buildings that they usually visit, live or work on it and thus, the energy behaviour change should be motivated in different contexts (building users, facilities, energy systems…) and roles or profiles (visitors, facility managers, householders, owner, student, teachers…). These issues make the challenge more complex and require solutions that must be focused on social, technical and commercial aspects. Other issues related and addressed by eTEACHER project are:

- People are not connected or aware about building facilities and energy issues are not visible.
- There are not comprehensive solutions that connect BEMS and building occupants (interoperability).
- Buildings has in general low automation and monitoring level.
- There are not prediction tools and tools focused on comfort and users' feedback.

Structure and organisation

The project included the development of the following results:

- BACS add-ons. Definition of technical requirements for eTEACHER ICT solutions, set in overall requirements and use cases according to energy conservation measures, indoor environmental quality and building performance. First steps for the development of the What-if analysis service, Pulse/Metrix service and UBCI/database (universal interface to link with buildings' BEMS/BACS).
- eTEACHER app. First steps to select the most suitable gamification techniques and development of the web services relating to the mobile app (energy/comfort advisor, user feedback, gamification, dashboarding). Development of central database, containers and REST API to run project mobile app.
- Design of the monitoring and evaluation methodology that establishes the methodology to carry out the demonstration and impact indicators. Research on available sensors for building pilots. Test of reliability and connectivity of sensors. Design of monitoring systems for building pilots. Deployment of sensors (on-going) and integration with database.
- Three exploitation workshops to define the preliminary exploitation strategies for project results.
- Data management plan validated by ethic experts of the EC.
- Several dissemination events organised or participated by partners.

Impact and evaluation

The eTEACHER's project approach is demonstrated in schools, office buildings, healthcare centres and residential buildings. The total number of building users summing up all the pilot buildings is 5204 people. According to the different types of people involved in the pilots, the project will use several methods to achieve a change in energy behaviour.

Critical success factors

The project eTEACHER aims at developing an Information and Communication Technology (ICT) toolbox to motivate energy behavioural change of energy end-users in buildings, providing tailored interventions that result in significant energy savings and better productivity, health and comfort levels. This is exactly the factor that makes this project stand out.

Transferability

The transferability possibilities of the project are very high across different countries.

4.3.7. Digital Energy and Optimization (Multicountry)

General presentation of the practice

The Digital Energy and Optimization training course is designed for professionals and companies that want to utilize predictive and prescriptive analytics and software for energy production, storage, distribution and overall optimization of the energy system as a whole. The course is provided by GLOMACS, a Training and Consultancy company, operating since 2003 internationally. It operates in Europe, Asia, North America, and Africa and is recognized as an ISO 9001:2015 and ISO 29993:2017 Certified Training and Consultancy Company.

Relevance/Importance

This course can be considered a good example of using online tools for teaching, while the subject matter covered is also in line with those of interest to the EDDIE project. It delves into topics related to artificial intelligence and machine learning to simulation and optimization.

Aims and objectives

The objective of the training course is to prepare the professionals for the digital world and the requirements of Industry 4.0 as it is becoming present in all the sectors and shows special opportunities in the area of energy preservation and optimization. At the end of the training course, the students will learn to:

- Apply the data mining methodology for energy usage patterns.
- Effectively utilize Artificial Intelligence algorithms for real-time optimization.
- Identify key areas where the Data Mining and Artificial Intelligence can be utilized.
- Understand the benefits through the example cases.
- Use Data Mining and Artificial Intelligence methods for optimization of spinning reserves.
- Structure and organization (Target group, Program type, Certification, schedule, evaluation and teaching method, …).

Structure and organization

The target of the course are professionals who wants to learn techniques of data mining and Artificial Intelligence, team leaders, supervisors, section heads and managers, professionals who have an interest in data science, technical professionals including those in maintenance, engineering & production and project managers. The training course uses proven adult learning techniques, including "learning by doing": students will be asked to design a new product for the digital world. Teaching will take place through presentations, group exercises, electronic training manual, and group discussion on the results of the exercises. Upon completion of the training course, students receive a GLOMACS certificate. In accordance with the standards of the National CPE Sponsor Registry, one CPE credit is granted for every 50 minutes of participation. The course is spread over 5 days, each day will cover some specific topics:

- Day 1 - Data Mining and Pattern Recognition (data mining process, data preparation, association and pattern recognition, data mining in energy industry, data mining-clusters and outliers)
- Day 2 - Artificial Intelligence Algorithms (artificial intelligence development, linear regression, logistic regression, decision tree, support vector machine, other algorithms applied in artificial intelligence)
- Day 3 - Energy Distribution Planning and Optimization (energy storage planning, managing incidents and instrument failures, energy grid management, energy consumption forecasting)

- Day 4 - Developing Digital Twins (digitization of industry and energy, optimal power flow problem formulation, neural network application to optimal power flow, particle swarm optimization for optimal power flow, total transfer capability enhancement by evolutionary algorithm)
- Day 5 - Simulation, Machine Learning and Smart Contracts (dynamic simulation of industry systems, simulation of unit commitment problem, machine learning for renewable energy, forecasting renewable energy generation, smart contracts within the energy industry)

Scalability and Transferability

The course is delivered online, so it is fully scalable and transferable.

Impact and success factors

This course can have a great impact at the corporate level, as energy conservation and the art of optimization are critical to both the success of any industry, organization, or business, and most importantly it helps train and raise awareness of the digital transition with consequent optimization of production and reduction of energy waste.

4.3. Success stories

4.3.1. Open training and qualification platform on nZEB construction and renovation-PROF/TRAC (multi-country including Slovenia)

General presentation of the practice

PROF / TRAC offers an Open Training and Qualification Platform for professionals dealing with nearly Zero Energy Buildings (nZEB).

Aims and objectives

The PROF/TRAC European Qualification Scheme on nZEB skills aims at overcoming market barriers towards a successful design and construction process of nearly Zero Energy Buildings. It targets professionals with a higher education degree in the construction sector, the so-called white-collars.

The qualification scheme is the outcome of an intensive consultation among national experts in PROF/TRAC partner countries. This work resulted in the definition of:

- harmonized work fields,
- nZEB skills,
- nZEB skills levels,
- description of qualifications across Europe.

This framework constitutes a solid basis to compare the nZEB skills requested to different professions and to the same profession from one country to the other.

Structure and organisation

PROF/TRAC made up a comprehensive list of technologies and interdisciplinary skills related to nZEBs. These technologies and skills represent the “highest common denominator” for the qualification of the targeted building professionals, meaning that any construction sector white-collar involved in nZEB design and construction will necessarily have at least one of these skills. The more skilled the professionals, the more successful the nZEB design. Four areas of expertise were identified:

1. Energy Management (EM)
2. Energy Production (EP)
3. Energy Reduction (ER)
4. Interdisciplinary Skills (IS)

For each of them, PROF/TRAC listed the essential technologies and skills required for professionals dealing with nZEB. Of course, not all professions are expected to have the same skills and qualifications levels for all the identified nZEB technologies. Thus, PROF/TRAC has:

- established skills levels, with assigned scores from 0 (min.) to 5 (max.);
- set up recommendations about the minimum skills level for each work field per skills and qualifications.

The description of nZEB skills levels and PROF/TRAC recommendations is detailed in the Qualification Scheme and in the nZEB skills recommendations.

Impact and evaluation

The PROF-TRAC project has trained and certified 128 trainers from 23 countries in Nearly-Zero Energy Buildings (NZEB). These people then went on to train over 1,300 architects, engineers and building managers in pilot courses. PROF/TRAC courses will roll on after the end of the project. At least 50 courses are foreseen in the next five years with 1,700 more professionals to be trained, using the open-source training material repository that was developed by the project.

Critical success factors

The element that distinguishes this particular practice relates to the fact that it developed skills that professionals should possess in terms of nZEB constructions, and assigned scores, depending on their level of qualifications. It also includes the design and implementation of a certification scheme, a quite important factor for the transparency of all enhanced knowledge and skills.

Transferability

The transferability potential of the practice is high and has also been provisioned by the implementing consortium. As stated above, to date 23 countries have already benefited from the course and within the upcoming five years, they plan to train 1,700 professionals through the training material repository.

4.3.2. KeepWarm: Improving the performance of district heating systems in Central and Eastern Europe (multi-country)

General presentation of the practice

KeepWarm is an EU-funded project whose objective is to accelerate cost-effective investments in the modernisation of District Heating Systems (DHS). It brings together eleven project partners from a variety of relevant sectors (energy agencies, national DHS associations, agricultural chambers, research institutes, consultancies on energy efficiency and NGOs) from seven countries across Central and Eastern Europe. Within this region, DHS are frequently still inefficient and for the most part keep overly relying on fossil fuels (oil, gas or coal).

Aims and objectives

The aim of this initiative, launched in April 2018, was to modernise DHS around the whole region and reduce greenhouse gas emissions by improving system operations and promoting a switch to less-polluting sources, like renewables. The project partners ensured that best practices for environmental-friendlier heating and cooling will be taken up across Europe, replicating KeepWarm's approach in other countries and regions, even beyond the end of the project.

As a response to the current state of play of DHS in the region, the project focused its efforts on the following improvements, as listed below, in order of importance:

- Retrofitting of the existing distribution system, particularly grid efficiency
- Increasing the use of renewable energy sources, including waste-to-energy
- Re-use of excess-heat from industry
- Introduction of ICT technologies for heat distribution management.

Structure and organisation

To overcome barriers to district energy deployment in Central and Eastern Europe, KeepWarm will conduct the following activities:

- Training and capacity building in technical topics, RES and EE topics, Organisation, Financing, and Management.
- Business model development: it has been created as a means of helping beneficiaries creating new and sustainable business models for their district heating system. It covers 11 different aspects of the business model to consider. For each aspect questions were developed to facilitate the optimisation of the business model.
- Attracting funding for uptake: collection of resources of main funding sources for district heating systems, including public and private sector funding, EU funds and international financial institutions support.
- Policy integration: a repository of ongoing EU energy and climate policies and their effect on district heating sector, some of which are looking at additional regulations at national level related to specific renewable energy sources used for district heating.
- Demonstration case

Impact and evaluation

In seven partner countries, 746 hours of training were held divided into 68 training sessions, and the goal of 700 hours of training was exceeded by 46 hours. Since DHS operators provided inputs that training in technical topics was a priority, 213.5 hours of capacity building in technical topics were delivered, and the number of individuals benefiting from the training peaked at 565 persons. On the other hand, training in organisational topics lasted 105 hours since DHS operators showed weaker interest in topics from this group.

Critical success factors

The KeepWarm project provided significant added value for DHSs, cities, regions and other stakeholders through a variety of resources and services offered. The consortium provided support through the whole spectrum of services available, including assistance in matters that related to the legal framework, guidance in navigating potential subsidies, permits and standards relevant to you, exploiting district heating data in meaningful feasibility studies of market-ready scenarios, etc.

Transferability

The transferability potential of the practice is very high, under the condition that all relevant stakeholders involved are mobilised and engaged in its implementation. In addition, some of the project results, such as the business model can be applied directly in the organisations without any changes, rendering the practice even more applicable in other countries.

4.3.3. SMART-UP (multi-country)

General presentation of the practice

Smart-Up is an EU funded project that aimed at the encouragement of vulnerable customers in those Member States that have embarked on the rollout of Smart Meters to actively use their Smart Meters and In-House Displays to achieve energy savings. Previous studies have shown that Smart Meters do not lead to energy savings in the residential sector unless households actively use them and modify their energy-use behaviour and the project was developed to address exactly this gap.

Aims and objectives

The SMART-UP project aims to encourage the active use of smart meters and in-house displays by vulnerable consumers, engaging 5,000 vulnerable households in five countries. There is a strong engagement strategy in the training of specific stakeholders that are in close contact with vulnerable households. As advisors, social workers and other frontline staff empower vulnerable households to make small changes to their energy related behaviour in order to improve their living conditions and help them to reduce their energy bill.

Structure and organisation

The SMART-UP pilot was a complex piloting activity to verify the impact of different ways of assisting vulnerable consumers. Within the large-scale pilot enhanced training and advice was delivered to 1,000 vulnerable households in each country and within the small-scale pilot 60 – 65 vulnerable households per country were divided into experimental groups and specific interventions are delivered to them according to the experimental group SMART-UP large pilot– to deliver enhanced training and advice to 1,000 vulnerable consumers in each country, SMART-UP small scale pilot– to assist 60/65 (according to the country)vulnerable consumers with different interventions.

The SMART-UP pilot aims to determine the most efficient interventions to support vulnerable consumers facing energy poverty. The impact of the interventions was determined through the comparison of baseline data collected before and after the intervention. As reported in the evaluation reports, an ex-ante questionnaire was built to collect the baseline during the delivery of the enhanced training and advice and an ex-post questionnaire was built to collect the baseline data after a significant period from the delivery of| the interventions.

Impact and evaluation

Through SMART-UP more than 400 social workers have been trained and more than 4,400 vulnerable households have received their advice engaging a total of 5,000 vulnerable. In Spain the SMART-UP project inspired a social programme funded by the Municipality of Barcelona to combat energy poverty. As a result, 100 unemployed people have been trained and more than 1,800 vulnerable households have been advised on how to use energy more efficiently, on how to read and understand electricity and gas meters, and on how to reduce their energy bills. An additional positive outcome has been that 32% of these trained formerly unemployed people are now working in Barcelona's Fuel Poverty Points of Information.

Critical success factors

The success of the project relies on the fact that addressed the issue of energy consumption and efficiency from a grass roots level. The consortium focused on how energy efficiency could be achieved by raising awareness in and educating vulnerable households, which eventually created a multiplier effect by not only achieving the overarching objective, but also offered the possibility to unemployed people to enter the labour market, as indicated above. Visits and advice made households aware that they could implement simple, easy, inexpensive or free actions to save energy in their homes. In consequence some have implemented them and continue to save money and others, even if they have not incorporated them into their daily routine, they have at least tried them.

Transferability

The transferability potential of the practice is high, but also depends on whether a country implements and fosters Smart Meters roll out. Moreover, the engagement of relevant stakeholders is of high value, being that their role is vital both for the support of the smart meters rollout and the relevant communication of their use.

4.4. Lessons learnt and recommendations

To identify the good practices presented above, the consortium focused on a set of pre-agreed criteria, which were:

- The contribution to the upskilling/ reskilling of the workforce
- The alignment with EC policies related to energy efficiency
- The collaboration of stakeholders in the implementation of the initiative and
- The incorporation of digital tools in training programmes related to energy efficiency.

From the review of the practices identified, it was established that overall, the initiatives in lifelong learning programs focusing on energy digitalization are commendable steps towards upskilling the workforce. These programs have the potential to equip individuals with the necessary skills and knowledge to stay relevant in the rapidly changing energy sector. However, it can easily be demonstrated that digital tools, apart from the online provision of the courses, were not incorporated in the practices, which renders the necessity of the EDDIE results still in valid and up to date.

In addition, it can be seen that priority has been placed on raising awareness on both the reskilling of professionals, starting from management level and reaching out to front-line staff that works with vulnerable households on the poverty margin. In addition, the provision of holistic approaches to build the capacities of the relevant stakeholders was also a priority for the practices presented, highlighting the importance of establishing efficient cooperation structures among companies, local authorities and energy companies and line ministries.

In the table that follows, the partners present the practices identified to demonstrate the basic elements which relate to their design and implementation.

Practices identified	Objectives	Target groups	Topics
Predictive Maintenance	Provide training in maintenance management, including predictive maintenance	The general public	• Reskilling workforce in real-world case studies and mentorship • Huge global network of companies
Professional Certificate of Competency in Smart Grids Industrial Automation	Introduce engineers to the principles of smart grids in power system application under various network conditions	Engineers	• Highly specialised in the sector of energy digitalization and • New emerging digital technologies are applied and taught.
Digitalisation and smart technologies for the power sector	Contribute to decarbonisation while maintaining a high level of digital solutions	People involved in the energy sector	• Aimed at an industry audience that wants to approach new topics: they can do it easily online, at an affordable price
The Energy Training Centre	Provide training for clients who are undertaking a transition in the energy sector	Technical and non-technical professionals	• Partnerships with world-renowned institutions • Specialized training in energy digitalization
Siemens Xcelerator Academy	Provide specific trainings that enables companies to secure value realization from the investment in digital transformation	Professionals and companies in the energy sector	• Customizable and scalable training to digital tools
Energy Academy	Provide a wide range of courses for the electricity supply chain	The general public	• Upskilling the workforce • Support industries in energy transition

Practices identified	Objectives	Target groups	Topics
Intelligent and Integrated Energy Systems	Enable professionals to deploy intelligent technology, strategy and business models to adapt to significant changes in the energy field	Professionals in the energy sector	• Tailor-made by professors and industry experts
Digital Transformation in Energy and Utilities Certification Course	Focus on the Utilities Industry and support the digitalization of conventional power generators	Professionals and executives in the energy sector	• Industry-oriented • Use if digital tools
European Energy Manager-EUREMnext (Multicountry)	Train and certify energy managers, while creating a network of certified professionals worldwide	Professionals in the energy sector	• Reskilling of the workforce in the field of renewable energy sources • Provision of training in alignment with the needs of the sector
ingREeS -Scheme for Middle and Senior Level Construction Professionals on Energy Efficiency and Use of Renewable Energy Sources in Buildings (SK)	Analysis of the construction industry's knowledge about energy efficiency and using renewable energy sources in buildings. Revision of the skills that were lacking and what needed to be done to deliver these skills to construction professionals	Middle and senior level construction professionals	• Development of qualification standards • Development of certification mechanism • Upskilling of the workforce
Fit-to-nZEB-Innovative training schemes for retrofitting to nZEB-levels (EL)	Develop large scale training schemes and programmes on deep energy renovation	Trainers in the field of deep energy	• Capacity building of trainers • Improvement of training provision in the deep energy sector
QualitEE-Quality certification frameworks for Energy Efficiency services to scale up responsible investment in the building sector (EL & SK)	Develop tools for quality assessment, financial assessment and procurement	Companies that undertake energy efficiency services projects	• Establishment of mechanisms to implement quality assurance schemes for energy efficiency services • Establishment of cooperation structures among the different stakeholders in the energy efficiency sector
ENERGISE-European Network for Research, Good Practice and Innovation for Sustainable Energy (FI)	Develop a social science programme to enhance understanding of changes in energy consumption in the households	The general public	• Establishment of mechanisms to mainstream energy consumption • Fostering individual and community initiatives to achieve energy efficiency
eTEACHER-end-users Tools to Empower and raise Awareness of Behavioural CHange towards EneRgy efficiency (FI)	Encourage and enable energy behaviour change of building users by means of continuous interventions displayed through a set of empowerment tools to drive informed decisions in order to	Schools, office buildings, healthcare centres and residential buildings	• Digital tools for energy behavioural change • Fostering individual and community initiatives to achieve energy efficiency

Practices identified	Objectives	Target groups	Topics
	save energy and optimise indoor environment quality		
PROF/TRAC (multi-country including Slovenia)	Development of a training programme aimed at overcoming market barriers towards a successful design and construction process of nearly Zero Energy Buildings	Professionals with a higher education degree in the construction sector	• Upskilling of the workforce • Development of a certification mechanism
KeepWarm: Improving the performance of district heating systems in Central and Eastern Europe (multi-country)	Modernise DHS around the whole region and reduce greenhouse gas emissions by improving system operations and promoting a switch to less-polluting sources, like renewables	Cities, regions and other stakeholders	• Provision of capacity building activities to promote change • Establishment of mechanisms to accelerate energy efficiency
SMART-UP (multi-country)	Encouragement of vulnerable customers to actively use their Smart Meters and In-House Displays to achieve energy savings	Advisors, social workers and other frontline staff	• Reskilling of the workforce in the field of energy consumption • Establishment of cooperation structures to promote energy efficiency
Digital Energy and Optimization	Prepare professionals for the digital world and Industry 4.0	Professionals and companies in the energy sector	• Upskilling of workforce related to energy digitalization

Table 4-1: list of good practices of lifelong learning programmes in the field of energy efficiency

Although in the sector of energy digitalization in LLP some interesting initiatives have been implemented, it requires further development in term of incorporating emerging digital tools. From the research and analysis of the previous chapter, some key findings and commonly used methodologies that have positive contribution to LLP programs were identified. Overall, these are the key takeaway from these examples regarding the success of the LLP programs in the field of energy digitalization:

- Practical training from real-world professionals and experts is crucial for success
- Specialized training in emerging digital technologies is important to stay current and competitive in the industry
- Reaching a large audience and raising awareness is key to making a meaningful impact on the industry and society
- Relevant and cost-effective training solutions are important for professionals to grow and develop
- Strong partnerships with industry experts and global stakeholders provide specialized training and effective knowledge transfer
- Tailor-made courses and a link to key companies in the field are important for a complete understanding and training
- Industry-oriented initiatives with links to global stakeholders and the use of new emerging technologies create meaningful impact

5. Conclusions and next steps

The desk research that was carried out to identify best practices in lifelong learning programmes designed and implemented to address energy digitalization and transition, demonstrated the following elements:

- Lifelong learning provision focused on the development and/ or enhancement of knowledge and skills in the energy sector, a need which arose mainly due to the EC policy documents and strategies and the need to adopt these changes on a practical level.
- There is a pronounced need to enhance the capacities of the trainers and contribute to their upskilling as a means to drive the overall change towards energy efficiency through training provision across the different target groups (from managers, to government representatives, to households).
- The establishment of cooperation mechanisms among the stakeholders involved, should be considered as a priority, given that energy digitalization is not a matter that concerns a single professional group or just the industry.
- The urgency to ensure that the tools, mechanisms and content is available for the professional development of all related categories, even if it's undertaken through informal learning structures, given the importance of the overall matter at hand.

It is a fact that green and digital skills in general have been integrated as a horizontal priority across the Erasmus plus programme, especially for the new Programming period (2021-2027). In this context, energy efficiency, recycling, renewable resources, etc. are topics that are regarded as horizontal and should be addressed across all sectors and not limited to the evident ones. Promoting the enhancement of green skills to young people and adults is the only way to a sustainable future, including the profound understanding of the necessary actions to achieve the objectives set.

It should also be highlighted that the incorporation of digital tools in lifelong learning provision on energy digitalization is not yet as promoted. This could be attributed to the fact that lifelong learning, based on the mapping carried out, has not focused on this aspect yet, putting in the epicentre workforce upskilling and stakeholders' engagement and awareness raising of the general public. Ensuring that all target groups involved are aware and possess the necessary skills is very important towards achieving the energy transition objectives, however, it should also be considered that in the general context of digital transformation, digitalisation can be the catalyst towards further growth and can positively impact the alignment of actual needs with the requirements of the labour market. Therefore, lifelong learning should also become more market oriented, to increase its attractiveness, among others.

The identified best practices consist of eight initiatives targeting mainly professionals working in the field. The practices prioritize training and upskilling to meet the dynamic demands of the energy sector, offering specialized programs tailored to industry requirements, such as integrating smart grids and promoting digitalization. Collaboration with partners and networks ensures comprehensive learning experiences and gathers data on skills needs, providing flexible, often online, and customizable training accessible to a wide audience, including engineers and professionals. The emphasis on personalized learning experiences, driven by AI tools, underscores a common focus on applying new and emerging technologies across these practices.

Beside the Best Practices some other success stories were identified. They target professionals, but also students and the public. These success stories continue to prioritize skill development, industry orientation, application of emerging technologies, and collaboration. Additionally, practices emphasize deep energy renovation, quality certification, and assurance in energy efficiency services. These efforts align with broader initiatives promoting energy-efficient behaviours and digital transformation in the energy sector.

When it comes to recommendations for the future based on the findings in this deliverable and the identified best practices, the consortium agrees that:

- Given the rapidly evolving nature of digital technologies, there is a continuous requirement to update knowledge and skills to stay relevant.
- More focus should be placed on the engagement of the local communities, especially vulnerable groups, through the design and implementation of initiatives which aim at their awareness, education and engagement in actions targeting energy efficiency.
- Lifelong learning should become more relevant to the needs of the labour market, instead of following developments, to improve the qualifications of professional categories, following the understanding of skills mismatches.

- The engagement and mobilisation of different stakeholder categories is a parameter of utmost importance to be fostered through different types of actions, including lifelong learning programmes. Tackling energy digitalization is not a challenge that affects only policy level, or the industry. It is an endeavour which requires the involvement of everyone, let alone one requiring significant investments.
- The digital tools that are at the disposal of the lifelong learning providers should be taken advantage of, to secure on one hand the increased effectiveness of the programmes developed, as well as keeping up with the requirements in the context of digital transformation.
- The curricula that will be developed need to be current in emerging digital technologies in the industry, embrace industry-oriented initiatives with practical training and utilize the relevant digital tools and solutions.
- It is important to develop certification mechanisms, demonstrating that validation and recognition of digital skills in the energy sector. This is particularly true for professionals willing to demonstrate their expertise, and for companies wanting to hire staff with specific competencies.

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