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Education for Digitalization of Energy

Deliverable 4.2

Report on Best Practice for Vocational Education & Training (VET)

Author(s): Claudia Battistelli, Berna Balci, Martin Molnar, Anupama Vashishtha, Amila Kaharevic (RWTH) – Alvaro Lopez Lopez (COMILLAS) - Daniela Casiraghi, Susanna Sancassani, Bianca Santolini (POLIMI) - Andreas Stavrou (FOSS) – Johanna Bocklet, Hendrik Drier (EWI) – Konstantinos Michos, Alexandros Chronis, Georgia Saridaki, Maria Valliou (NTUA) - Genoveva Ponce Buenestado, Sonia Reventun Alegre (PADRE PIQUER) - Marta Sturzeanu, Carina Zidaru and Radu Plamanescu (CRE) – Katerina Tasidou, Marina Zotaki (Novel)

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Abstract:

This report aims at the presentation of good practices developed and implemented in VET provision in the field of energy efficiency and transition. The desk research focused on recent projects and takes 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 environmental sustainability. Moreover, most of the practices presented take well into consideration the context of digital transformation, even before it became a necessity following the pandemic outbreak. Finally, the solutions that are presented are very well designed and implemented as efforts to address the skills mismatches in the energy sector.

Keywords:

Best practices, VET design, VET provision, Skills, Competencies, Occupations, CEDEFOP, Digitalization, Energy, Education, Training

DISCLAIMER

	Participant organisation name	Short	Country
01	UNIVERSIDAD PONTIFICIA COMILLAS	COMILLAS	Spain
02	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	NTUA	Greece
03	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE	RWTH	Germany
04	FOSS Research Centre for Sustainable Energy – U. of Cyprus	FOSS	Cyprus
05	Politecnico di Milano – METID	POLIMI	Italy
06	Kungliga Tekniska Högskolan	KTH	Sweden
07	Fundación Obra Social y Monte de Piedad de Madrid – Escuelas Profesionales Padre Piquer	PIQUER	Spain
08	Centrul Roman al Energiei	CRE	Romania
09	REPSOL SA	REPSOL	Spain
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14	NTT Data Italia SPA	NTT	Italy
15	NOVEL Group	NOVEL	Luxembourg
16	University of Cologne Business School	UCBS	Germany
17	Institute of Energy Economics at the University of Cologne	EWI	Germany

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Document Reviewers

Date	Reviewer's name	Affiliation
24.12.2021	George Papadakis	Professor of Energy Technology, Department of Natural Resources and Agricultural Engineering, Agricultural University of Athens
27.12.2021	Simos Retalis	Professor of Design Models for Technology-Enhanced Lifelong Learning Environments, Department of Digital Systems, University of Piraeus

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Definitions, Acronyms and Abbreviations

AI	Artificial Intelligence
ATI	Advanced Technologies for Industry
BIM	Building Innovation Modelling
BMBF	Federal Ministry of Education and Research
BMBWI	Federal Ministry of Economic Affairs and Energy
BSDE	Blueprint Strategy for the digitalisation of the Energy Value Chain
CCS	Carbon Capture and Storage
CEDEFOP	European Centre for the Development of Vocational Training
CFA	Centres for Apprenticeship
CIC	Construction Industry Council
CIFPA	Centre for Innovation for Vocational Training
CNCD	Conseil national pour la construction durable
CVET	Continuing VET
CY	Cyprus
DfE	Department for Education
DSA	Digital Services Act
EC	European Commission
ECTS	European Credit Transfer System
ECVET	European Credit System for Vocational Education and Training
EDSC	European Digital Skills Certificate
EERA	European Energy Research Alliance
EL	Greece
EPBD	Energy Performance for Buildings Directive
EQAVET	European Quality Assurance Reference Framework
EQF	European Qualifications Framework
ESF	European Structural Fund
ETF	European Training Foundation
ETIP	European Technology and Innovation Platform
EU	European Union
FI	Finland
GDP	Gross Domestic Product
GDPR	General Data for Protection Regulation
GSS	Geothermal Solar Skills
HVAC	Heating, ventilation, and air conditioning
ICILS	International Computer and Information Literacy Study
ICT	Information and Communication Technologies
IEA	International Energy Agency
IEE	Intelligent Energy Europe
ISO	International Standards Organisation
IT	Information Technology

I-VET	Initial VET
JP	Joint Programme
KSC	Knowledge Skills Competencies
LEC	Low Energy Construction
LU	Luxembourg
MEFP	Ministry of Education and Vocational Training
NAS	National Advisory Services
NITRD	Networking and Information Technology Research and Development
NL	the Netherlands
NSF	New Skills Fund
NWS	National Further Education Strategy
nZEB	near Zero Energy Buildings
OECD	Organisation for Economic Cooperation & Development
OP	Operational Programme
PIA	Programme d'Investissement d'Avenir
PISA	Programme for International Student Assessment
P-VET	Permanent VET
SALTO	Support Advanced Learning & Training Opportunities
SE	Sweden
SET	Strategic Energy Technology
SETIS	SET Information System
SI	Smart Industry
SK	Slovakia
SME	Small-medium enterprise
STEM	Science Technology Engineering Mathematics
TEI	Technological Educational Institute
UK	United Kingdom
US	United States
UWV	Employee Insurance Agency
VET	Vocational Education & 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 good practices designed and implemented for Vocational Education and Training provision in relation to energy efficiency and sustainability.

For the compilation of the report, the research team of the EDDIE project focused on the identification of practices on the following principles:

- VET programmes that were effectively combined with work-based learning
- VET programmes which were ICT facilitated and in the context of digital transformation challenge
- VET programmes that effectively addressed skills mismatches and led to certification schemes and/ or concrete occupational profiles
- VET programmes, which successfully engaged the local stakeholders in order to provide a holistic training approach for the beneficiaries.

It can safely be concluded that up to this date, the effective combination of digital tools with VET provision in the field of energy transition is not quite developed yet. 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.

Finally, it becomes evident that VET provision should continue to work towards strengthening its links to the labour market, to ensure its consistency with the changing requirements and enhance its attractiveness in the economic environment of the EU Member States.

1. Introduction

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

In addition, today the world is suffering an 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 employment status. As a result of the pandemic, digitalisation expands in most sections of our society and has also a major effect on the energy sector.

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

The purpose of 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 programmes responding to industry changes and to increase the attractiveness of the energy sector as a career choice. It will take into consideration in an interdisciplinary way green and soft skills, social sciences and humanities economics and gender dimension.

This project, therefore, 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 VET 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.

This document presents the practices that were identified as successful following desk research carried out by the research team of the project. The partners involved took into consideration the skills need, as identified in D.2.2, along with a bottom up approach, developed for the purposes of the EDDIE project. The objective was to map and select the most successful VET training programmes, which were created and delivered as a result of a need identified on behalf of the industry.

What can be safely argued is that the effective collaboration between the industry, the public sector and the VET providers always leads to stellar results with a high sustainability and transferability potential. Another

important factor to consider are the investments that need to be made, in order to create a highly skilled workforce, and to build strong links among the stakeholders involved.

1.1. Structure of the document

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

The third section of the document describes the logic and methodology 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 VET provision for energy transition or efficiency, as well as the digitalisation of VET provision 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. Finally, the fifth section presents the conclusions related to the lessons learnt from the practices identified.

To conclude, 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 principal 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 VET Policy and the needs it aspires to cover. The Digital Education Plan is then presented to highlight the need for incorporating emerging technologies in VET 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 the skills mismatches as described in D.2.2 is offered, in combination with the needs that the practices identified came to address.

2.1.1. EU VET Policy

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.

Starting from the EU VET POLICIES, 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 at VET level thus fostering the advancement of education and training, while defining a long-term vision for European digital education.

It takes into consideration two main Actions delivered by the EU Commission and described in the European Education Area[1] that seem relevant to the EDDIE project as best practices in terms of policies and recommendations at VET educational level:

- the digital Education Action Plan
- council recommendations on promoting mutual recognition of qualifications and learning periods abroad

EU VET Policy – an overview

Vocational education and training (VET) aims to provide all citizens with the **knowledge, skills and competences needed to enter the job market.** VET responds primarily to **economic need**s, but also plays a key role in supporting **research, innovation, social and employment policies**.

The European Community differentiates between two types of VET:

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

- **Initial vocational education and training (I-VET)** delivered at upper secondary and post-secondary education level. It takes place in a school setting or in training centres and enterprises, but always before entering the working life.
- **Permanent vocational education and training (P-VET)** is intended for people who are already employed or for those who have already completed secondary education or I-VET. It aims to improve the skills of employed citizens or to allow them to re-skill for new career paths. This type of VET takes place mainly in the workplace.

The process of European cooperation in vocational education and training was launched in 2002. Since then, two institutions have been supporting it:

- the European Centre for the Development of Vocational Training (CEDEFOP)
- the European Training Foundation (ETF)

Cooperation on VET has facilitated progress towards **common goals** across the EU and helped address **common challenges.**

Cooperation has continued over the years and the 'deliverables' introduced in the Bruges Communiqué (2010) and the Riga conclusions (2015) have made the common challenges and priorities for VET more concrete and achievable.

Cedefop and ETF have monitored and analysed what EU countries have done in 2015-19 to follow up on the agreements made in Riga 2015. Based on these analyses, **new objectives for the post-2020 period** were defined.

EU VET Policy – recent developments

Recent developments in VET have been strongly influenced by the **outbreak of the COVID-19 emergency**.

During the COVID-19 pandemic, indeed, **teleworking and distance learning** have become regular tools. This on the one hand has **accelerated the digital transition**, while on the other hand it has **raised new inequalities**, as many people do not possess the necessary digital skills or are in insufficiently digitized workplaces or schools. In addition, the pandemic has also had a significant **impact on career opportunities** for many people in the EU.

To tackle this crisis, on 20 July 2020 the European Commission presented the **"European Skills Agenda for sustainable, competitiveness, social fairness and resilience"**.

The document proposes **12 actions** to support partnerships for **skills development** and to help people to **build their skill throughout life**, in an environment that sustains adult education.

Action **4** is entirely dedicated to VET and presents a **"Proposal for a Council Recommendation on vocational education and training for sustainable competitiveness, social equity and resilience"**. This Action proposes a set of actions to be implemented at EU level to **modernize** the VET European environment.

In this historical moment, it is essential that young people and adults are **equipped with the necessary skills to enter the job market** and **support green and digital transitions**. The document therefore proposes to strengthen the **dialogue between the different education sectors** and to foster **learning and work mobility** in close cooperation with employers. It then stresses the importance of improving the **digital literacy of VET teachers** and ensuring that VET institutions are properly equipped from a technological point of view.

One of the Agenda's main achievements is the signing of the **Pact for Skill** (November 2020). Through the creation of new partnerships, dialogue between all the actors who help shape the job market will be facilitated. The aim of these **large-scale partnerships** is to define the **key principles for up-skilling and reskilling the workforce** and to ensure that young people and adults receive **effective training** to cope with the **green and digital transitions.**

At the end of 2020 (24 November), the Council of the European Union adopted a set of VET **Recommendations** to ensure **sustainable competitiveness, social equity and resilience**.

Among the key inputs provided by the document are to:

- promote **agile programs and frameworks** that can quickly **adapt to a changing job market**. The curricula, programs and qualifications of vocational education and training must be **regularly updated** on the basis of an analysis of competence needs.
- ensure **flexible pathways** and offer true **career progression opportunities.** The offer must be **learner-centred**: it must offer face-to-face, digital and blended learning pathways to ensure access to the widest possible audience. VET pathways should be based on a **modular structure**, allowing for the accumulation of learning outcomes, their transfer and recognition towards a qualification.
- train for **digital and green transitions** and for the most **in-demand occupations.** VET should be adapted and/or broadened, to promote the acquisition of **entrepreneurial, digital and green skills** in line with European economic, industrial and innovation strategies.
- ensure **digitized delivery of training/skills**. VET trainers need to promote **technical and digital competences** and **innovative training methods**. It is important that these learning paths are supported by state-of-the-art vocational and digital pedagogy, which integrates digital learning tools in diverse and multicultural contexts.
- promote **equality of opportunities**. Inclusive and accessible pathways for **vulnerable groups** need to be ensured. This also means making training **accessible through digital learning platforms**, supported by tools, devices and internet connection, especially for vulnerable groups and people in rural or remote areas.
- **quality assurance system**. VET pathways must fit into the **European Quality Assurance Reference Framework (EQAVET framework)** which is based on a set of indicative **descriptors** and common reference indicators for quality assurance in VET (applied at both system and provider level, according to the national context).

All these recommendations are crucial for the EDDIE project, since they indicate what the EU expects from the VET programmes to be developed from 2021 ahead.

2.1.2. Digital Education Action Plan (2021-2027)

The Digital Education Action Plan (2021-2027) has been designed based 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
- improving education through better data analysis and foresight

This first Digital Education Action Plan (2018-2020) focused on the importance of the Digital transformation on education and training, but only during the pandemic, it became clear that having an education and training system 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, some of them specifically addressing VET. The actions that seem particularly interesting for Vocational Education & Training (VET) are the ones addressing secondary education in terms of development of teachers and students' skills or the strengthening of infrastructures and equipment. They propose:

- the creation of guidelines on online and distance learning,
- the creation of digital education content frameworks and platforms to exchange certified contents
- the support of teachers and trainers in fostering the development of digital skills (with recommendations, guidelines, and monitoring activities)
- the extension of traineeship to support the development of student's digital skills

The Commission will establish a European Digital Education Hub by 2022 to support the process.

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 2: Propose a **Council Recommendation** on **online and distance learning for primary and secondary education** by the end of 2021.

In particular, the main objective is to support Member States in using different pedagogical methods and tools, meeting the needs of different students in all the circumstances and at the same time increasing the inclusiveness and flexibility of primary and secondary education.

This Action will strengthen the digitalisation of education at primary and secondary level in Europe thus indirectly supporting the activities of the EDDIE project which specifically address the VET education

ACTION 3: Develop a **European Digital Education Content Framework** by 2023 and launch a feasibility study on the creation of a **European exchange platform** by the end of 2021.

Specifically, in 2022 a dialogue will be launched which will address issues such as **digital innovation and technological transformation,** as well as the impact that the COVID-19 pandemic has had and is having on education, taking into account the needs of all parties involved in education.

Thanks to this dialogue, it will be possible to create a **European Framework for Digital Education Content and a European Exchange platform** focused on certified online education resources and platforms. This Action will produce two outputs particularly relevant for the EDDIE project.

- The European Framework for Digital Education Content could support the EDDIE project in evaluating its outputs in terms of contents, and in setting new goals and processes to produce digital contents.
- The European Exchange Platform could be used by the entity to share the education resources and platforms produced by the project itself

ACTION 4: Improve **connectivity and digital equipment** for education.

Schools, in order to have a variety of online resources, need a high-speed internet connection; however, during the emergency caused by the COVID-19 pandemic it emerged that many European countries do not have high digital capacity or a fast internet connection.

In order to solve these issues, the European Commission has decided to support gigabit and 5G connectivity for socio-economic drivers.

This Action will encourage the Member States to use the support provided by the EU through various funding programmes aimed at improving access to the Internet and e-learning tools.

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**

ACTION 7: Develop **common guidelines for teachers and educational staff** to foster digital literacy and tackle disinformation through education and training by 2022.

As we live in an increasingly digitised world, it is vital that European citizens are digitally literate in order to be able to distinguish real news from fake news, to manage the huge amount of information that we receive every day, and especially to safely navigate online. They must therefore be educated by teachers and educators who in turn receive support to best carry out digital literacy.

This Action is particularly important as by 2022 it will produce common final guidelines for teachers and educators to promote digital literacy and address disinformation through education and training.

ACTION 10: Propose a **Council recommendation** on improving the p**rovision of digital skills in education and training** by the end of 2022.

This action is necessary because in 2019, only 56% of people based 16-76 had digital skills. The goal is to provide young European students with computational skills, for example by introducing computing science in primary education, by creating a shared IT guide and finally by sharing best practices and discussing possible limitations.
In particular, this ACTION will produce two important outputs for the EDDIE project:

- the creation of Council Recommendations on improving the provision of digital skills in education and training;
- the contribution to the objectives of the Strategy for Shaping Europe's Digital Future to ensure 65% of Europeans have at least basic digital skills by 2025.

ACTION 11: Improve monitoring and support the cross-national collection of data on student digital skills through participation in the International Computer and Information Literacy Study.

Currently, data show that young people do not develop advanced digital skills simply through the use of devices, but more accurate data at transnational level indicating the level of digital skills of young people in the European Union are lacking.

One of the main objectives is to reduce the number of 13 and 14-year-olds with poor IT skills to less than 15% by 2030.

In order to do so, the progress towards this goal will be monitored through ICILS data; the participation of countries in the Erasmus+ programme will be funded; and will be carried out an annual report on digital skills in the Education and Training Monitor.

The most relevant outputs of this ACTION for EDDIE are the following:

- the ICILS 2023 data collection by the end of 2022;
- the publication of the international results from ICILS 2023 by the end of 2024;
- the release of the ICILS 2023 international database by 2025.

This input will be particularly relevant for VET training and will support a better comprehension on the digital skills of the target involved in the EDDIE training activities**.**

ACTION 12: Incentivise advanced digital skills development through targeted measures including scaling up the Digital Opportunity traineeships by extending them to VET learners and apprentices, and offering professional development opportunities for teachers, trainers and other educational staff in school, VET, adult and higher education.

This Action will increase and develop the digital skills not only of students and teachers, but also of recent higher education and VET graduates under an annual call until 2027. It will thus indirectly benefit the EDDIE project.

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.

Mutual recognition of diplomas

Mutual recognition of diplomas and qualifications in EU Member States is one of the milestones to achieve a **European Education Area** by 2025.

In November 2018, the Commission published a “**Proposal for a Council Recommendation** on promoting automatic mutual recognition of **higher education and upper secondary education diplomas** and the outcomes of **learning periods abroad”**.

At secondary level, the solution is still difficult to find: recognition of upper secondary qualifications and outcomes of learning periods abroad varies from country to country. This context is often characterised by lack of information and certainty about the recognition of qualifications and competences. The Council

Recommendation declares that EU Member States commit to introduce **automatic recognition by 2025,** also through actions that are finalized to build trust in each other's education systems.

At upper secondary level, the Recommendation is focused on supporting recognition processes for qualifications required to access higher education, including VET qualifications. It promotes the recognition of the outcomes of learning periods abroad at this level, too.

At higher education level, the Recommendation recalls the **Bologna Process** and the **Lisbon Recognition Convention**, and different specific multilateral agreements defined between groups of EU Member States.

It also promotes the use of existing tools, which already support the recognition of qualifications and the outcomes of learning periods abroad, such as:

- **Europass**
- **European Qualifications Framework** (EFQ),
- **European Credit Transfer and Accumulation System** (ECTS)
- **Diploma Supplement**

This recommendation is relevant for the EDDIE project: all the training opportunities promoted by the project should meet all the possible characteristics and be described with useful metadata to support the mutual recognition of different course in the EU Member States.

2.1.3. 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 Utilization (CCU)
- Nuclear safety

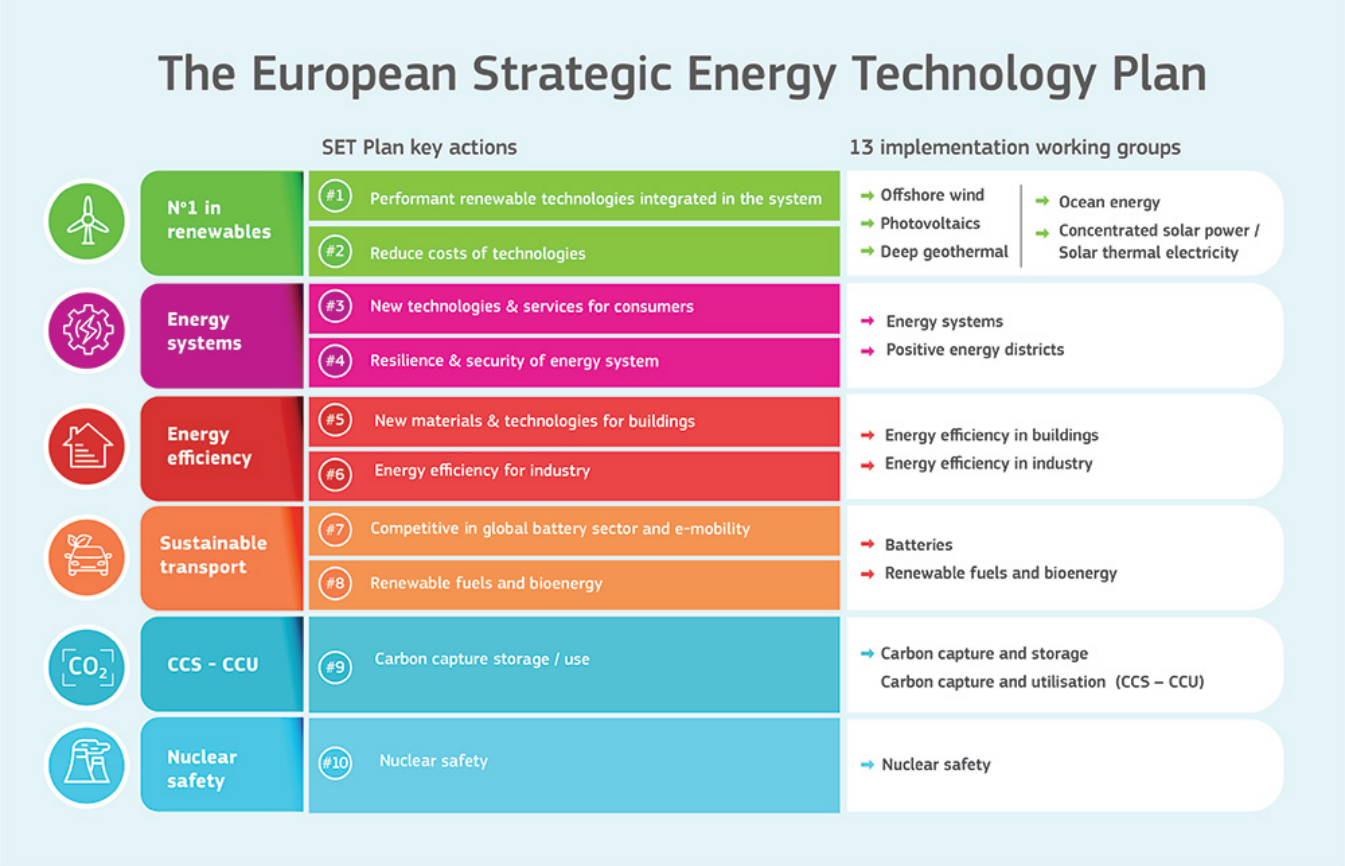

Figure 2-1: SET Plan infographic.

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, aforementioned.

Considerations in the perspective of VET

The energy transition will thoroughly affect the VET system. The swift appearance of new and changing technologies will require VET centres to be highly flexible to keep educating young EQF 3-5 profiles, who are key actors in the sector. In addition, they will play an important role in reskilling and upskilling the existing workforce, in what we could call an intersection between VET and lifelong learning. In this point, an efficient action of the VET system can help smoothing the employment displacement effect on European workers. Indeed, adapting the current workforce to new tasks may be fundamental in reducing the total number of employees who are sent out of the working system to be replaced by new profiles.

For the VET system to efficiently achieve these goals, it is also recommended to create networks that not only have to promote rational and standardized curricula across Europe, but also interrelate with University networks, research centres and industry in order to response in a fast way to the needs of the sector.

2.1.4. 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"*). Based on the selected sectors, the Electronics and Automotive industry employed the highest share of advanced technology skilled professionals. The type of technologies most prominent include Advanced manufacturing technologies and the Internet of Things. Key skills which are highly demanded across these sectors also include Artificial Intelligence and Big data. The results indicate that advanced digital skills are the most common in professional support and engineering related occupations. A lower share of people working in management positions have such skills and production workers and technicians have the lowest overall share. We find diverse patterns across sectors. To build a solid workforce with knowledge in advanced technologies, it is essential for the EU and its Member States to retain and to attract talents with the corresponding skills. The performance of EU Member States in terms of talent mobility varies a lot. In general, European countries manage to retain and attract talents with skills in advanced technologies to a satisfactory extent. Indeed, most of countries display a ratio above 1, indicating a net gain of talents. However, four countries suffer from a net loss of talents:

Romania, Greece, Croatia, and Latvia. The larger share of these countries' highly-skilled nationals emigrate to the United Kingdom and Germany. [4].

If we take a closer look for the technological trends and policies at EU level, we can see that the ones related to the energy sector are internet of things, artificial intelligence, big data, and cybersecurity. [6]. Following examples will provide an overview about the performance of the EU27 member states in Advanced Technologies (in terms of digitalization of the energy sector such as IoT, e-mobility, Security, big data) and will give a snapshot of the policy landscape supporting the production and uptake of Advanced Technologies at EU, national and regional levels. The examples outline the strengths and weaknesses of the EU27 in terms of technology generation and uptake across the sixteen Advanced Technologies. A summary of the latest policy priorities and main policy initiatives in the EU27 with examples from the national and regional level in support of Advanced Technologies will also follow.

In the field of Artificial Intelligence, the availability of professionals with skills in AI is growing very fast and it outpaced the US in the period 2018-2019, as the results of the analysis of LinkedIn data suggest. The EU market is expected to grow faster than the global market. On the contrary, Big Data is a European weakness compared to the US and China, although it plays a crucial role in the future development of a digital-based economy and is highly relevant in enabling the deployment of Artificial Intelligence. According to the ATI Survey, 24% of European organizations are currently adopting AI and another 24% are planning or evaluating whether to adopt AI systems in the near term.

The European Union has a strong research base in Cybersecurity both in terms of academic and industrial research, as well as product development-related activities. The EU is among the world leaders in quantum technologies and has unique expertise and a strong research community in post-quantum cryptography, leading in secure implementations of cryptographic algorithms in both hardware and software.

Europe is in an excellent position to become a global leader in IoT. Within the sixteen advanced technologies the EU27 holds the second highest share of worldwide patent applications in the Internet of Things. The Internet of Things represents the glue between the manufacturing and the digital world. Well-targeted investment in IoT will be crucial not just to revive the dynamics of Advanced Manufacturing, but also to fuel Artificial Intelligence applications. According to a survey conducted by the International Data Corporation, the most common challenges faced by European organizations were costs, complexity, security, privacy limitations of current infrastructure, unclear return of investment, management Buy-In, skills availability and lack of holistic offers. [7]

A complementary are is for energy harvesting as the process in which a small amount of energy that would otherwise be lost such as heat, light, sound, vibration, wind magnetic force or movement, is transformed into electricity and stored for later usage. It is well known for its applications in solar cells and electro dynamo, but it knows numerous new innovative uses, as for the Internet of Things (IoT). Energy harvesting is also a great tool to address the issue of the climate change and global warming because it reuses ambient energy which is otherwise wasted. The most common energy sources used for energy harvesting are mechanical, thermal energy and solar radiations. [17]

By tacking a peak to other trending technologies at EU level concerning the energy sector and the digitalization one concept is for smart Building that could be defined as a set of communication technologies enabling different objects, sensors and functions within a building to communicate and interact with each other and also to be managed, controlled and automated in a remote way. Also, technologies help to connect a variety of subsystems that originally operated independently. The main objective of the Smart Building is Energy Optimization. The scope of Smart Building is very wide covering various objects within the household from windows or elevators to vehicle charging. The Energy Efficiency is expected to mainly come from Smart Lighting and Smart HVAC Systems. [16].

Additionally, the European Commission (EC) aims to ensure Data Accessibility and Re-Usability to Support Data Sharing in Europe. [18] The European Union (EU) and its Member States face important challenges on their way to translating data into business opportunities, such as legal issues and technical barriers to the reuse of data. [19] To address these challenges, the European Commission's "European Data Strategy" commits to investing in Innovative Tools and Infrastructures to store and process data and giving users rights, tools and skills to retain control over their data. [20] The EC considers data to be a building block for economic growth, competitiveness, innovation, job creation and societal development and expresses its importance in the latest EU Digital strategies. [21], [22].

Germany

Although the number of VET learners rose by 0.9%, the number of new apprenticeship contracts dropped by 1.2% in 2019. In terms of supply and demand, bottlenecks remain for apprenticeships, notably due to occupational imbalances (late September 2019: 53 100 vacancies and 24 500 applicants without apprenticeships). Several new pieces of legislation came into force in 2020. In January 2020, a new law was adopted to align dual VET with future requirements in five areas, by introducing a minimum training wage for apprentices, emphasizing equivalence to academic qualifications by introducing new terms for advanced vocational training programmes, expanding part-time vocational training to new target groups such as people with learning disabilities or people needing to work alongside their training, facilitating recognition of prior VET learning and reducing administrative burdens. A Law to reform the care and nursing occupations) came into force in early 2020 with measures to increase quality and attractiveness of occupations in the sector. As part of the 'skilled workers strategy', the Skilled Immigration Act came into force in March 2020 granting applicants with a recognized full vocational or higher general education qualification the possibility to live and work in Germany. The new version of the law on advanced training programmes to become a master craftsman or technician, aiming to increase outreach, was approved. [1]

There are currently around 330 occupations requiring formal training in Germany. Employer organizations and trade unions are the drivers when it comes to updating and creating new training regulations and occupational profiles or modernizing further training regulations. As a result, training, testing and certificates are standardised in all industries throughout the country. This ensures that all apprentices receive the same training regardless of region and company. Moreover, employers have trust in these certificates as they provide evidence of what an individual knows and is able to do. The shared responsibility between government, employers and trade unions also helps in responding to emerging new challenges such as digital innovations like the Internet of Things, which will have an increasing impact on manufacturing and the way work is organized. [2]

Through INVITE innovation competition, The Federal Ministry of Education and Research facilitates the search for suitable further training offers, strengthens the user orientation of further training platforms, and increases the range of AI-supported further training offers. The Federal Ministry of Education and Research (BMBF) is therefore promoting innovative developments as a measure of the National Further Education Strategy (NWS) in a total of 35 winning projects (including meta projects) that enable everyone to digitally find the further education that suits them and theirs as quickly and easily as possible Life situation fits. The coherence of the digital training space is to be increased, more digital offers for individualized learning and individual learning paths in job-related training are to be available, and training platforms are to be more user-oriented. [5]

National education and training policies provide a further framework for advanced technology skills promotion. An example is the Federal Ministry of Education and Research of Germany that is implementing a policy to foster continuing training and lifelong learning at the national level: The National Training Strategy. The main focus of the policy is to improve transparency on the training offer and to offer personalized advice for interested individuals and companies. A measure to address these challenges is the implementation of digital education rooms that connect people with precise education offer thanks to an algorithm which allow an individual and adaptive learning in the digital space. The programme also aims at better recognising the acquired skills, as well as the informal competences, and at issuing education certificates digitally. [5]

The Education Worldwide programme (AusbildungWeltweit) of the Federal Ministry of Education and Research (BMBF) has been promoting international experience in vocational training beyond Europe since 2017. It supports stays abroad for trainees and company trainers in countries that are not covered by the EU's Erasmus+ programme. Since 2017, more than 1,000 stays in over 40 countries have been approved. The stays abroad must be operational or practice-oriented. The new funding guidelines for the period until 2024 significantly expand the spectrum of training worldwide. For example, in addition to training companies and chambers, vocational schools can now also apply for funding.

In Germany's federal Digital Agenda, several initiatives have been launched under the umbrella of 'VET 4.0'; [6] e.g. in the area of digitalisation in inter-company vocational training centers and competence centers.

In Germany, higher VET is usually completed after in-company vocational training and/or several years of employment and the majority of higher vocational training qualifications are assigned to level 6 on the German

qualifications framework. A recently revised VET law includes the introduction of 'certified professional', 'bachelor professional' or 'master professional' degrees which provides for parity of esteem between VET and higher education, internationally understandable degrees and career mobility. At the same time, between 2000 and 2017, whilst the number of people achieving academic qualifications enjoyed a major increase, achievements of higher VET qualifications remained largely unchanged, pointing to the need to raise the attractiveness of higher VET. This provides a good example of some of the challenges facing higher VET's development. [7]

"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. [8].

Spain

Low enrolment in VET persists and the employment rate of VET graduates decreased. In 2018, the share of upper secondary Spanish students in VET (35.8%) remained below the EU average (48.4%). The employment rate of recent upper secondary VET graduates dropped from 70.0% in 2018 to 66.0% in 2019, well below the EU average of 79.1%. VET graduate tracking has been launched. The creation of an integrated information and monitoring system, coordinated by the State Public Employment Service (SEPE), is ongoing to increase transparency and coordination of the VET system for employment. This will include a state registry of all VET providers and a catalogue of all formal and non-formal training programmes and the respective delivery requirements (Cedefop ReferNet Spain, 2019). In July 2020, the Ministry of Education and Vocational Training released two reports: one about VET graduate transition into the labour market (MEFP, 2020b), and another about the education paths followed by VET students after graduation (MEFP, 2020c).

From January 2020, the whole VET regulation is under the responsibility of the Ministry of Education and Vocational Training, including both initial and continuous VET (for education and employment respectively). Nevertheless, the Ministry of Labour will keep some VET initiatives to address short and specific workplace training needs.

In accordance with the roadmap for the implementation of the Digital Agenda in Spain, the Ministry of Education is currently mapping new occupational standards to respond to the increasing digital skills and professional profiles requested by the labour market.

One inspiring example of innovation and digitalisation in VET is Tknika, a centre promoted by the Deputy Ministry of Vocational Education and Training of the Education Department of the Basque Government. Through networking and direct involvement by the Basque Vocational Training teaching staff, the Centre develops innovative projects in the areas of technology, education and management. [23]

Aragón's regional Centre for Innovation for Vocational Training (CIFPA) is another example for VET where the objective is to promote the processes of technological and methodological innovation in the Professional Training system of the Autonomous Community of Aragon. [24]

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 inter-enterprise 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. [25].

Romania

The attractiveness of vocational education and training (VET) has increased but ensuring quality and labour market relevance remains a challenge. Compared to the 2011/2012 school year, the number of students enrolled in professional schools increased sevenfold. Of the 85 000 students pursuing this study field in 2019, 15% were enrolled in dual education. The number of new entrants to dual VET was almost three times higher than in 2017/2018, revealing strongly increasing interest among students and companies in this training path. In 2019, new six-month apprenticeship programmes became available for low-qualified people and for those who left school without any qualification. These programmes support integration in the labour market and do not require prior formal qualifications, while employers receive an incentive of about EUR 340 per month for each apprenticeship contract. However, the overall employment rate of recent vocational graduates suggests that the adequacy and quality of the training is insufficiently aligned to labour market needs (67.7% compared to the EU average of 79.1%). Furthermore, the PISA test showed a large performance gap between students in general and those in the VET strand (108 score-points).

Steps have been taken to continue VET remotely. A consistent part of the training component of VET programmes was taught online in partnership with companies, with a focus on development of skills and professional competences. Where needed, remedial practical activities were expected at the beginning of the school year. For students in final years who had not completed a practical period of their studies, online activities will be carried out to allow them to complete their training properly. Graduation exams for European Qualifications Framework (EQF) 3 and 4 training programmes were replaced by a student project in the field of study that was submitted for examination. For graduates from EQF 5, the written and practical part were equated with the final grades for the specialty modules obtained throughout the years of study and with the presentation of a report, which took place either online or face-to-face. [26]

There are no skills forecasting system to feed into the planning of VET and higher education programmes, although one is expected to be developed as a pre-condition for using European Structural and Investment Funds (2021-2027).

INNOVET is an Erasmus+ project involving three European partners, the Technological Educational Institute (TEI) of Eastern Macedonia and Thrace, Greece, Forschungsinstitut Betriebliche Bildung GmbH from Germany and the Association for Education and Sustainable Development in Romania as well as education and business representatives. INNOVET aims to design, implement and adopt an innovative modular VET IT tool. This modular VET IT tool includes modelling and simulations of business processes and real enterprises in the training programmes of VET schools.

Greece

To increase the attractiveness of VET, links to the labour market need to be strengthened. The employment rate for VET graduates remained stable at around 50.9% but is still far below the EU average of 79.1%. High-quality training programmes will be key for a robust post-crisis recovery. The continuous development of the optional fourth apprenticeship year for upper secondary VET graduates with a strong work-based component is expected to strengthen the link between education and the labour market. Four thousand secondary VET teachers have been trained on apprenticeship issues and certification of career guidance counsellors is under way. VET graduates' skills certification will facilitate their integration into the labour market. Thorough monitoring of all VET initiatives and projects will strengthen the sector. [27]

The Interreg-funded project INNOVENTER aims to create a VET learning framework to promote social entrepreneurs' competences and skills. The core idea is to establish VET-oriented social entrepreneurship training for SME entrepreneurs so that they innovate themselves, while engaging disadvantaged people as employees at the same time. The main project outputs include ECVET-compliant training courses on social entrepreneurship tailored to the relevant national contexts, including curricula, learning modules and handbooks. The project also aims to produce online and mobile training platforms with interactive tools for SMEs. The project brings together three EU Member States (Bulgaria, Cyprus and Greece) and two candidate countries, Albania and the Republic of North Macedonia, across the Balkan-Mediterranean regions.

So VET consists of a project team of seven organisations from the UK, North Macedonia, Greece, Turkey, Italy and Sweden, collaborating to enhance the development of social entrepreneurship to combat youth unemployment. The main objective of the SO VET programme is to upgrade vocational training systems in

order to provide effective courses in the subject of social entrepreneurship, through developing a number of outputs.

France

In 2018, 39.3% of learners were engaged in vocational pathways, against the 48.4% EU average. The employment rate of VET graduates fell from 72.2% in 2018 to 68.8% in 2019, significantly below the 79.1% EU average.

The 2018 reform continues to steer developments across VET. The reformed upper secondary VET path started in September 2019 with new schedules, new pedagogical organisations focusing more on progressivity of learning and on a better link between vocational and general subjects, with more career guidance in the last year and new classes (prépa-métiers) to give learners an insight into different economic sectors. The Training Centres for Apprentices (CFA) became training organisations whose financing will depend on numbers of signed apprenticeship contracts. Creation of private, employer-led CFAs is now possible. In 2020, 1 800 CFAs compared to 965 previously, report that they are delivering or planning to deliver apprenticeships; however, the COVID-19 crisis may have affected recruitment of new apprentices. The government introduced measures to support apprenticeship, including financial incentives for firms to hire apprentices. Regions have stepped up their leading role in informing schools and universities about occupations and training programmes (including apprenticeships). Starting in 2017, 3-year pilots were run in metropolitan France to encourage transition from upper secondary VET to higher technician programmes. Classes to facilitate the transition from vocational baccalaureate pupils into higher education, and career guidance scheme for baccalaureate holders run by VET schools, have been in place since 2018 (MEN, 2018) (Cedefop Refernet, 2020). Excellence in VET is being promoted through the launching of new 'Trades and qualifications campuses' that encourage international cooperation. The first 23 excellence campuses in key sectors of the economy were announced in 2020 (MEN, 2020f). By 2022 'excellence' campuses will be set up in each region (Cedefop ReferNet, 2019, 2020). The European Commission's Structural Reform Support Programme currently supports the launch of new campuses and the upgrading of existing ones. The Investment Plan for the Future (Programme d'investissement d'Avenir- PIA) will fund 20 to 30 projects in 2020 (EUR 80 million).

France's programme "Industrie du Futur" was launched in 2015 with the ambition to support the use of digital technologies, modernise production tools and transform business models. "Industrie du Futur" is based on 5 pillars including one that focuses specifically on the upskilling of the workforce. The upskilling objective is pursued by working closely with labour unions to develop a common vision that encompasses them and by developing training programmes designed to train the industry's employees in order to create a workforce that is apt to cope with Industry 4.0. Tackling the skill shortage allows to facilitate the diffusion of new technologies in the industry and to foster France's competitiveness. [28]

EdTech France is a reflection of the diversity of the entrepreneurial ecosystem it represents: its members are very young start-ups as well as companies that have reached a certain maturity, send out offers for school education, higher education or vocational training, are publishers of digital resources or designers of technological solutions (platforms, applications, etc.), digitize training courses, train in code, etc. EdTech France constitutes an association of French companies that aim to federate and structure the ecosystem of French EdTech in order to maximise the impact of innovation and technology in education and professional training. To this end, EdTech operates with a mandate to make private sector solutions visible and legible and to facilitate exchanges and meetings with the various providers and seekers of EdTech solutions. To promote innovation among those involved in VET, EdTech France is also partnering with Center Inffo, an association under the supervision of the French Ministry of Labour with a public service mission to provide stakeholders in vocational training and apprenticeships with guidance (e.g. through legal expertise, training and specialised information). In this context, the role of EdTech France includes participation directly or through its members in the Center Info working and reflection groups and advancing actions and projects likely to promote the use of innovative solutions in vocational training. [29]

France is harnessing the potential of AI for education. A partnership with the private sector will develop pedagogical resources based on AI to support teachers with differentiated and personalised learning of French and mathematics in grades 1-3 of primary education. A voice assistant to learn English in primary education will be tested in 2020 as part of the modern languages plan (MEN, 2019a). A working group of AI researchers in the National Education Council will also support educational innovation. Four multidisciplinary

Artificial Intelligence Institutes (Instituts Interdisciplinaires d'Intelligence Artificielle (3IA)) are developing research, training and innovation clusters in specific fields, involving the creation of 150 Chairs in AI (MESRI, 2019a). [30]

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 personalized 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. [31].

Italy

The educational content of VET has been redefined by the State-Regions Conference. The resulting agreement updated the national classification (repertory) of professional profiles (Repertorio nazionale di figure professionali) and is expected to improve the labour market relevance of VET provision, especially at local level.

The government revised the work-based learning pathways (Alternanza Scuola-Lavoro) and renamed them 'Pathways for transversal competences and guidance'. The objective is to facilitate the acquisition of skills for personal and professional development, allowing learners to put into practice the competences acquired at school and to develop transversal competences through real tasks in operational contexts. Additional funding has been allocated to the establishment of new Higher Technical Institutes. During the COVID-19 crisis, many regional VET providers moved their learning towards distance mode and strongly developed digital competences of teachers, trainers and learners. Project work online and simulations were introduced to replace the practical training that could not take place in laboratories and companies. The "Rilancio" Law Decree of 19 May 2020, converted into Law 77 of 17 July 2020, created the "New Skills Fund" (NSF) focused on active labour market policies. The NSF combines the need to reduce the consequences on employment of the Covid-19 emergency with training of workers. As for its budget, an initial amount of EUR 230 million by the OP SPAO has been increased by EUR 500 million by the "Agosto" Law Decree, and it will allow companies to be compensated for reduction in working time under condition that the worker attends continuing vocational training. [32]

INDIRE has a rich resource bank for professional development related to the use of ICT in schools, including over 1,400 text or multimedia resources (including over 10 hours of video tutorials), many of which introduce subject-specific uses of ICT. Training is often blended, combining face-to-face sessions with online activities and materials. Among other resources, INDIRE hosts a platform for best practices, tools and resources for schools known as D.I share. [33]

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. [34].

The Netherlands

Graduates from vocational education and training (VET) fare well on the labour market. 90.4% of recent VET graduates had a job in 2019, one of the highest rates in the EU, where the average is 79.1%. According to an employers' survey, demand for professionals with a secondary VET qualification even surpassed that for tertiary graduates (UWV, 2019). More than half of the vacancies required professionals with a secondary vocational training qualification while one third required high-skilled people. The share of VET pupils from the total upper secondary school population is high, at 67.5% in 2018 (EU average 48.4%).

The 2019-2022 quality agreements aim to further improve the quality of VET provision. The Macro-effectiveness Act adopted in 2015 aimed to improve the match between VET programmes and labour market needs (OECD, 2018). The law encourages schools to cooperate instead of competing, to prevent multiple schools in the same area from offering similar tracks. Before launching new educational programmes, schools are required to coordinate their plans. The 2018 quality agreements allow each vocational secondary school (mbo) to frame their own strategy and priorities for 2019-2022, in consultation with regional partners (OCW, 2018b). Funding of approximately EUR 400 million a year was earmarked for quality agreements, of which 25% is performance-based. As of 2019, vocational and general secondary schools can apply jointly for a subsidy to tackle shortages of teachers in their region (Government, 2019c). Subsidies may reach EUR 250 000 per region and can be increased by up to EUR 75 000 if one or more VET schools are involved. New measures aim to improve the legal situation of VET students. In a new bill the term 'participant' is replaced by 'student', giving VET students similar rights as for tertiary students. The proposal also introduces a 'VET declaration' (mbo verklaring) for early school leavers, to validate the competences acquired before leaving the programme. This should help them find a job. Another novelty of the bill is the 'VET student funds', a pool created by each VET school from their central financing to support disadvantaged students at risk of dropping out. A subsidy scheme was introduced to support the joint development of flexible VET programmes in 2019. This aims to stimulate public and private secondary VET institutions to jointly develop flexible vocational programmes for the 'third learning pathway', corresponding to the needs of employees and job seekers. Such programmes are tailored to the target group in terms of duration and the number of training hours. EUR 20 million is available over 4 years for the development of innovative programmes, working methods and materials addressing regional skills needs that can also be used in other VET programmes. [35]

Competences related to new technologies are especially significant to consider since, along with entrepreneurial, social and civic competences, they are identified in the Council Recommendation as being of increasing significance. It has been found that within VET programmes transversal skills increasingly encompass digital skills in an effort to prepare people for a fast-changing technological environment. In Netherlands, the balance between providing technical, occupation-specific skills and more transversal, generic skills within individual qualifications has shifted, which will feed through into curricula. For example, the introduction of 21st century skills into the VET curriculum includes entrepreneurial and digital skills.

Recent innovations to support teachers and trainers in innovation and digitalisation include the use of i-coaches in VET schools and the introduction of 'hybrid' professionals; and teaching alongside collaborative robots (cobots) is already on the horizon. I-coaches support teachers to build a bridge between ICT and education, fostering the improvement of digital skills and the creation of a learning community (see box below). The other recent development, the emergence of 'hybrid' professionals, involves teachers and trainers combining roles in both VET institutions and companies, for example by having two part-time contracts. Helping to bridge the gap between VET institutions and companies, hybrid professional examples include Brainport Eindhoven in the Netherlands. [36]

Kennisnet and saMBO-ICT have reviewed i-coaches in 12 secondary vocational institutions in the Netherlands (MBOs). They show that i-coaches assume a wide range of roles. Some were given a lot of room for innovation but few resources by their boards and hence acted as enthusiastic drivers of ICT. Others helped institutions' departments ensure ICT standards when designing courses and deciding on the necessary infrastructure. [37]

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. [38]

Slovakia

Slovakia aims to improve employees' adaptability to new labour market requirements. In 2019, the ESF project 'Sector-driven innovations for an efficient labour market in the Slovak Republic' was launched, focusing on both initial and continuing vocational education and training. In addition to supporting employees, it aims to contribute to the identification of skill needs by monitoring the demand of enterprises for skilled labour. With a budget of approximately EUR 20 million, project activities cover i) helping Sectoral Councils update job profiles and occupational standards included in the National System of Occupation, ii) creating a sector-driven lifelong learning system focusing on VET for both young people and adults and iii) providing comprehensive sources of information regarding skill needs (Cedefop ReferNet, 2020). A new upper secondary programme 'Intelligent and digital systems' was launched during 2019/2020. Graduates will be able to offer services related to internet of things and in support of smart factories, smart homes and smart cities (Vantuch, J.; Jelínková, D., 2019).

In 2018, total enrolment in upper secondary VET remained stable at 67.8%, well above the EU-27 average of 47.8% (UOE, 2018). Students enrolled in VET had some exposure to work-based learning (12% in 2017 compared to 11% in 2016). Most educational programmes provide some practical elements in the curriculum (UOE, 2017). In 2019, the employment rate of recent VET graduates at 84.6% continued to be well above the EU-27 average of 79.1% (LFS, 2019).

Due to COVID-19, the school calendar for VET has been extended. Also, flexibility has been allowed regarding practical experience in the workplace, and work-based learning modules will be exceptionally integrated with a project module so that the work environment-related objectives can be addressed. During practical exams, the evaluation of practical experience uses different instruments flexibly to show that the students have reached the objectives included in the evaluation criteria. The proposed flexibility enables regional educational authorities and teachers to find the most appropriate means for each case and situation. Entrance exams to access intermediate or higher vocational training for those who do not have the academic requirements were postponed until the first half of July and later. [39]

In some countries, VET providers are able to trade and to make profits, which can act as a stimulus to innovate by being able to obtain income from innovations. In Estonia, the Netherlands and Slovakia, profits must be re-invested back into education and training. In Slovakia about one third of schools make profits in this way.

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). [40]

Finland

VET is a popular study path. In 2018, 71.6% of all learners at upper secondary level were enrolled in VET. VET offers good job opportunities for young students entering labour market and for adult students seeking new career opportunities. The employment rate of recent graduates aged 20-34 is 80.4%.

The COVID-19 lockdown led to a shift to distance learning. The flexibility of the VET system, based on a modular qualification structure and individual learning pathways, enabled an easy adaptation. Nevertheless, guidance, validation and entry exams were affected. The government introduced financial support packages to aid education providers affected by the shutdown.

Ensuring that all learners receive digital competence development according to their individual needs is a challenge for VET. Before COVID-19, 15% of the students used the online learning apps related to their vocational field regularly, but 28% only occasionally according to a report on the level of digitalisation (MEC, 2018b). Remote studies were completed in an electronic environment regularly by 12% and occasionally by one quarter of the respondents. The Trade Union of Education reported that a lack of teacher/trainer capacity and motivation to use new pedagogical solutions among VET teachers were challenges (Finnish National Agency for Education, forthcoming)

The 2019-2023 government programme aims to increase the number of students completing upper secondary education, including VET. It provides more investments: EUR 235 million have been earmarked until 2023 for hiring new teachers and trainers (Cedefop ReferNet Finland, 2019a). In November 2019, VET and general education matters were brought under one department at the Ministry of Education and Culture. This arrangement aims to strengthen the cooperation between the two strands (Cedefop ReferNet Finland, 2019b). In June 2020, the Ministry of Education and Culture launched a three-year programme (2020 – 2022) for quality and equity in VET. [41]

One of the most innovative regions in the EU is Helsinki-Uusimaa, Finland, one of the fastest growing regions in Europe showing strong cooperation in VET at local and regional level.

Omnia's Edutech Bootcamp in Finland is an intensive blended learning experience for VET students who are challenged to ask questions, try things out and learn through a mix of collaborative, hands-on and online learning. VET teachers collaborate through social media and cloud-based services to support learning, as well as create and share content.

A VET quality strategy until 2030 is being prepared. It replaces the 2011 strategy and aims to ensure comprehensive quality management in VET institutions by applying customer-oriented approaches and clear targets, including for system efficiency (Cedefop ReferNet, 2020).

To enhance skills matching, at the end of 2019 a big data project developed automatic collection and analysis of qualification requirements for adults (Finnish National Agency for Education, forthcoming). Furthermore, in 2020 the Finnish National Agency for Education started work on including optional competence modules in sustainable development, financial literacy and economic know-how in the upper secondary VET curricula. [42]

A trend towards more individualized learning pathways is seen in a number of structural developments such as reforms to national qualifications frameworks and qualification and curriculum modularization. In Finland, it is at the heart of current reforms, which aim to achieve an innovative lifelong learning VET system organised around personal study paths, broad-based competences and close cooperation with working life. Under the new system, IVET and CVET are merged and there are no fixed VET paths for anyone: rather, individual competence needs are addressed by offering learners the opportunity to acquire qualifications flexibly, attending programmes in education institutions, workplaces, or digital learning environments. National digital solutions are a central part of implementing such individualized learning, including Arvo, a digital education management information service, and ehooks, an online service to support individual study paths.

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 crosscutting topic and treated as such in particular in the domains of bioenergy, waste-to-value, smart grids, energy storage and smart buildings.

International analysis

Besides all the inputs from the European countries presented above, here are some highlights from outside Europe, related to best practices on VET Education. For example, in **Russia**, ”The National Digital Economy Programme of the Russian Federation” [2] has the objective to create a safe and powerful infrastructure for highspeed data transfer, processing, and storage which is made available for all organisations and households of Russia International best practices in the field of digital transformation have been used when setting up this initiative. The programme also addresses digital government, digital business, digital innovation and skills development among others. One of the focus areas of the programme is to develop up-to date legal regulation, which is expected to create favourable competitive conditions for digital transformation and to introduce uniform requirements for electronic operations. Another important area is cybersecurity. Russia is developing standards in order to protect the interests of individuals, companies and the state from cyber threats. [43]

Another example is The Presidential Decree ”Executive Order on National Goals and Strategic Objectives of the Russian Federation by 2024” which was issued on 7 May 2018 and the main goals of this long-term strategy are to accelerate technological development and support high-productivity export-oriented businesses in the basic sectors of the economy. A further objective is to improve the availability of the necessary skills and form highly qualified employees. [44]

During the Covid Pandemic, **South Korea** stood out through its swift and effective use of Advanced Digital Tools without shutting down the economy. The Advanced Technology that has been used was the Artificial Intelligence (AI) to enable fast testing, mobile apps to provide real-time information on locations visited by patients diagnosed with COVID-19 and supported the diffusion of (contactless) lifestyle in order to limit the spread of the virus [45]. South Korea is investing in Research and Development (R&D) and is among the highest in the world: according to OECD [46], Gross Domestic Research spending was 4.64% of GDP in 2019 (against 2.1% in the EU27), with the lion’s share generated by private research investment (3.73% of GDP in 2019, against 1.39% in the EU27). South Korea has a strong ICT industry located in the region around the capital Seoul, dominated by multinational conglomerates such as Samsung. This is coherent with the high level of specialisation of the country in Advanced Technologies such as Big Data, Microelectronics and Artificial Intelligence shown by our patents’ analysis. [47]

Canada is working on the creation of a wide Innovation Program. Most of the current Research Funding is under two big umbrella projects, which spans broader than simple investments in Emerging Technologies, Smart Materials, etc. In terms of Government policies towards technology development and adoption, the Ministry of Innovation, Science and Industry is responsible for the economic development and corporate affairs department. The Ministry works in parallel to develop different objectives, from investments in Innovation and Science, to commercialisation of Research and Ideas, and to support both small and medium enterprises and Canadian citizens with the appropriate Digital Skill Set. In this context, Canada released the Canada Innovation and Skill Plan and the Innovation for a Better Canada. The Canada Innovation and Skills

Plan envisions support to entrepreneurs and companies through specific programs, such as Innovation SuperClusters Initiative, Strategic Innovation Fund, Innovative Solutions Canada and Venture Capital Catalyst Initiative. [48] This plan aims to implement the Innovation and Skills Plan around four main themes:

- People, skills, and communities: equip Canadians with the right skills to have the chance to be further involved and grow in the new Digital Economy.
- Research, technology and commercialization
- Investment and scale: support in developing start-up and scale-up ecosystem and attract further investments.
- Program simplification

For example, **Scotland** was relying on what was called “Scotland's Digital Future: A Strategy for Scotland”, published in 2011. With this strategy the Scottish government was aiming at extending the connectivity, promoting the digital economy, and sustaining active digital participation, and plans to digitise the public sector and the services provided. In the context of Government initiatives to foster specific advanced technologies, the Digital Training and Support Framework [49] was initiated in 2016 to be carried out until 2021. Was created to provide the communities with “assisted digital and digital inclusion services” [50] as part of the Government Digital Inclusion Strategy. Within the digital inclusion services, noteworthy are the ones dedicated to research and analysis and digital training courses to improve skills and understanding of the digital world by users with different backgrounds and within different communities. [51]

Japan is the world’s third largest economy and a leading industrial and technology power, particularly in the automotive and consumer electronics industries. Japan is a world leader for Digital Infrastructures, with a high level of adoption of Advanced Technologies. For example, Japan leads the Organisation for Economic Co-operation and Development (OECD) on mobile broadband connectivity and has the second highest share of fibre connections in fixed broadband (77%). According to the Smart Japan ICT Strategy which was launched in 2014 by the Ministry of Internal Affairs and Communication and is based on two main pillars, a national strategy to create innovation through pervasive ICT-based connectivity and an international strategy to promote Japan’s global competitiveness and outreach in ICT. Both pillars aim at promoting economic growth and the Japanese contribution to international society through innovation by ICT. The strategy includes investments in ICT infrastructures and skills, as well as multiple initiatives such as priority projects addressing sectors such as smart cities and smart agriculture. [52]

The United States has since doubled down on its initial comparative advantage in digital technologies and is now confirming its leadership in Artificial Intelligence. The initial comparative advantage of the US in digital technology did not only provide the skills, talent and technology, but also the venture capital needed for AI expansion. PayPal is the prime example of employees and founders who have used their private capital to build another layer of the ecosystem with the developments of Tesla, Inc., LinkedIn, Palantir Technologies, SpaceX and Affirm. The funding of the Networking and Information Technology Research and Development (NITRD) [14] Programme has been also reinforced. The NITDR is the Nation’s primary source of federally funded work on advanced information technologies in computing, networking, and software. The programme provides research and development foundations for ensuring technological leadership. In addition, the Biden's plan contains a $100 bn broadband investment plan with Cybersecurity spending among others to protect the Energy Grid. [53], [54]

In 2016, the **Chinese** government published the “Three-Year Guidance for the Development of the Internet Plus AI”. [55]. According to this plan, China aims to develop new AI industries, for example in core technology research. In addition, the statement emphasises that projects relevant to AI innovations (e.g. smart vehicles or houses) will be promoted, and the development and application of smart wearable devices as well as robots will be pushed. The plan focuses on four aspects:

- AI-hardware skills
- Powerful platform-ecosystems
- AI-applications in major socio-economic fields
- Societal impact of AI

2.1.5. The European Energy Research Alliance and the Programme on the Digitalisation of the energy sector

The European Energy Research Alliance (EERA) [56] is an energy research community in Europe that brings together universities and public research centres in 30 countries. One of the Joint Programme (JP) of the EERA is the "Digitalisation of Energy". The main objectives of this JP are the following:

- Set priorities for research in energy and technology
- Digital solutions for the energy sector
- Promote computational, storage and advanced IT services for the energy sector
- Promote open data and development of community standards for FAIR
- Reinforcement of the EERA position in Europe in topics related to DfE
- Performing of cross-cutting research activities that can be only achieved by close collaboration of scientists and researchers from the energy and digitalization sectors
- Coordination and collaboration with external initiatives focused on developing digitalization activities in order to put the energy sector on board as 'major use case'

The Joint Programme in Energy Systems Integration seeks to bring together research strengths across Europe to optimize our Energy System, in particular by benefiting from the synergies between Heating, Cooling, Electricity, Renewable Energy and Fuel Pathways at all scales. The energy elements of the water and transport system are also included, as well as the data and control network that enables the optimization.

The Smart Grids JP means of an extended cross-disciplinary cooperation involving many Research and Development (R&D) participants with different and complementary expertise.

Energy efficiency in industry is rising towards the top of the EU and the Member States/Associated Countries agendas for several compelling reasons. Among others are economic reasons, such as unstable energy prices and reliability of supply; environmental reasons, i.e., the need to reduce greenhouse gas emissions; and intergovernmental reasons, as the industrial sector is becoming a frequent target of recommendations for international action.

2.1.6. 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 costumer 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, 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 filed 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 corner stone 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 VET provision 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.

2.1.7. 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 abused 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.

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.

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.

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 DSA 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.

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 wrong doing 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.

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.

2.1.8. Existing policies on Digitalisation 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 digitalisation 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 digitalisation 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 Chabot 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
- 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 decarbonised 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 education & training 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. VET provision needs 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 VET, 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 VET, a BP is shown through its positive impact on the quality and effectiveness of the education and training provided. This may include ensuring that curricula align with industry standards, providing hands-on training opportunities, and utilizing technology to enhance the learning experience. The overall scope and goals of a BP in VET should be to provide students with the skills and knowledge needed to succeed in their chosen field, and to keep the education and training provided in line with the industry needs.

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.

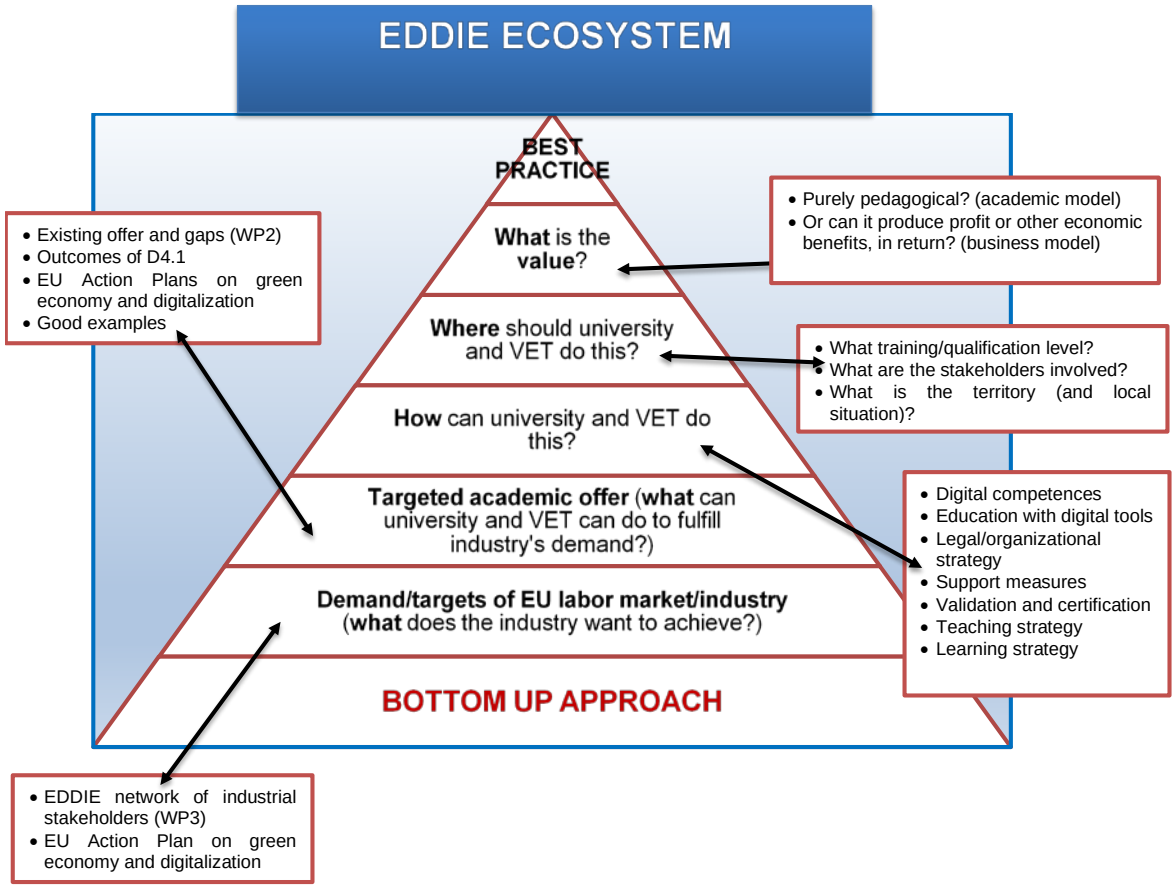

Figure 3-1: EDDIE approach on the identification and selection of best practices

The review, design and development of BP (for universities 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 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, this is based on the findings of *D4.1 – Identification and assessment of VET systems for delivery of skills and professional knowledge to address digitalization*. Thus, the Best Practices selected are targeted to:

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

All in all, D4.1 highlights the need for improvements in the European vocational education and training (VET) system in relation to the knowledge and skills demanded by the ongoing digital transformation of the energy sector. Thus, the VET system must align with the technological advancements, the economy, the labour market, and the society to prepare learners both theoretically and practically and to deliver technical, green, and soft skills that can be directly used in new occupations associated with the energy transition and digitalization. Based on these findings, it is clear that the VET sector must focus on the development of a training offer that addresses the identified needs regarding energy transition.

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

The introduction of digital tools and solutions is also crucial to ensure high-quality training provision. This is especially important in today's economy, in the context of Industry 4.0 and the ongoing trend of digitalization. In the rapidly advancing field of digitalization, the use of digital tools and solutions in training provision is becoming essential for keeping up with the latest developments and ensuring that learners are equipped with the necessary skills to succeed in the digital age. It also allows for a more flexible and adaptable approach to learning and ensures that the future workforce is well-prepared for the rapidly changing job market and advancements.

The effective collaboration of different stakeholders with VET 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

Currently, as identified in D4.1, the European VET system still fails to provide effective and equitable employability to learners in relation to the knowledge and skills demanded by the ongoing digital transformation of the Energy sector. Thus, the effective collaboration of different stakeholders with VET providers is necessary to offer a unique and targeted solution, both in terms of the needs of the professionals and those of the industry. This collaboration will help to ensure that the training offered is relevant and meets the needs of the industry and professionals.

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.

3.3. Requirements for Best Practice

Based on the findings of *D4.1: Identification and assessment of VET systems for delivery of skills and professional knowledge to address digitalization*, the EC has set a defined Action Plan for the digitalization of education, and several significant initiatives related to energy and digital transition have been set by the EU member States. Both the EC Action Plan and the national initiatives aim at fostering a coherent integration of the VET curricula in order to include specialized training and professional education also in the areas of IT and Modern Energy systems. Nevertheless, the process of transformation of the education has just started and meaningful results are yet to be seen. Thus, although the content of energy digitalization is still raw in the VET sector, the following review of existing training programs aims to identify the most relevant Best Practices with a particular focus to the energy sector's transition.

The consortium has established the following requirements for the Best Practices in VET sector:

1. Relevant to digitalisation and energy
2. Use of digital tools and solutions
3. Links with industry/research stakeholders
4. On-the-job training and practical skills

In order to specify the relevance of the Best Practice to digitalisation and energy, and based on the preliminary research for WP5 – Job Profiles analysis, the digital skills that were found most important for the development and implementation of new technologies and systems in energy digitalization are:

- **Artificial Intelligence and Machine Learning:** used for a wide range of applications, such as optimizing the operation of power plants, predictive maintenance for equipment failures, and analysing energy usage data to improve efficiency.
- **Cybersecurity:** used for protecting control systems, networks, and data while ensuring the integrity and availability of energy systems.
- **Internet of Things (IoT):** used to monitor and control energy systems, track equipment performance, and optimize energy usage.
- **Robotics:** used to automate tasks such as drones for inspecting power lines and solar panels, and robots for cleaning and maintenance.
- **Big Data/Data Analysis:** analyse big data and extract insights to improve energy systems.
- **Blockchain:** used for a wide range of applications, such as monitoring transactions, managing energy trades, controlling energy and storage flows and tracking renewable energy credits.
- **Augmented reality:** used to improve the efficiency of the design, training, and maintenance of the systems,
- **Energy modelling:** used mainly for optimizing the performance of energy systems.
- **Simulation and optimization:** used to simulate the performance of energy systems and optimize their operation.

- **Cloud services:** used mainly to access resources, store, and analyse large amounts of data.
- **Advanced control systems in the energy grid:** used to optimize the performance of the grid, improve system stability, and manage the integration of renewables.
- **Measurement techniques:** used to measure, monitor and control the energy systems in real-time.

Apart from the Best Practices, during our research, some other examples that support the analysis of the VET sector were identified, while not directly related to energy digitalization. To expand our research and provide a more comprehensive view, these are also presented and analysed in the next section as good examples and success stories. Due to the limited number of references on the exact subject of energy digitalization, these examples complement both our research and the identified Best Practices. They provide valuable insights on methodology and important lessons learnt that can be applied in the VET sector. To clarify how relevant those examples are to energy digitalization, their focus is mainly on the broader concept of energy transition and take well into consideration the context of digital transformation.

3.4. Analysis of Best Practices and Good Examples

Best practices are identified considering the requirements set by the consortium, which are explained in detail in the section above. In order to identify and examine the successful and effective methods that have been implemented in VET, each practice and example will be analysed through the following steps:

- **General presentation of the practice:** a general description of the best practice/good example
- **Relevance/Importance:** why the best practice/good example is chosen and what is its relevance/importance.
- **Aims and objectives:** a description of the aims and objectives of the best practice/good example.
- **Structure and organisation:** a description of the target group, program type, certification, duration of the program, evaluation, teaching method etc.
- **Scalability and Transferability:** a description of the best practice's ability to increase/decrease in performance and to be replicated from one organisation or country to another.
- **Impact and success factors:** a description of provided knowledge and skills, outcomes and results, and lessons learnt from the best practice/good example.

These steps will be used to describe and analyse the best practices/good examples in order to identify key elements that have led to their success and to determine how these elements can be replicated and adapted in other countries and organisations.

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 VET provision, 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. The electricity and energy programme (SW)

General presentation of the practice

The electricity and energy programme (EE) is one of the 12 vocational programmes that the Swedish National Agency for Education has established in order to address the needs of the industry and strengthen cooperation between education and industry. The vocational programme is 3 years in duration, and its main goal is to prepare students for working life or higher vocational education.

All in all, the programme contains at least 15 weeks of on-the-job learning where the education takes place at a workplace, while it can also be carried out as an upper-secondary apprentice programme, where at least half of the programme takes place at a workplace.

Relevance/Importance

The Electricity and Energy Programme has a strong focus on energy digitalization, as it provides students with the knowledge and skills needed to work with automated production systems, systems for energy and environmental technologies, or computers and communication systems. The program also utilizes digital tools and solutions to provide students with hands-on experience in the use of technology in the energy sector, as well as demonstrates strong links with industry. It provides on-the-job training and practical skills through apprenticeships, allowing students to apply their knowledge in real-world scenarios and be well-prepared for a career in the energy digitalization sector.

Aims and objectives

The Electricity and Energy Programme (EE) aims to develop students' knowledge of supplying and assisting basic societal functions such as the production, installation and distribution of electricity, energy and water systems. With a diploma from the programme, students should have the knowledge needed to work with automated production systems, systems for energy- environmental- and water technologies, or computers and communication systems, or as electricians in the distribution or installation of electricity.

This education programme develops the required knowledge for supporting and assisting basic important functions in society such as the production, installation and distribution of electricity, energy and water

systems. It should thus provide knowledge about electricity, energy technology and automation, and skills in carrying out tasks in these working areas.

Structure and organisation

This course is taught at EQF1-4 levels according to the European Qualifications Framework, as it refers to an upper-secondary education.

The Electricity and Energy Programme provides training in several key areas, including automation, computers and ICT, electrical technology, and energy technology.

- The **automation orientation** covers instrumentation, process and control technology, and practical electricity. It provides a foundation for vocational outcomes in the sectors of property automation, industry automation, and process automation.
- The **computers and ICT orientation** covers computers and computer systems, electronic components and units with microcomputers, and network technologies and units. It is particularly useful for professions in computer technology, electronics and network and communications technologies.
- The **electrical technology orientation** covers electrical installations, practical electricity, and installations of communication networks. It includes 500 credits and is particularly useful for railway education in electricity and signals technology.
- The **energy technology orientation** covers operations and maintenance in energy facilities, practical electricity, water and environmental technologies, renewable sources of energy, and energy plants. It provides a foundation for careers in the energy industry.

Apart from that, students also have the opportunity to study entrepreneurship, which may cover areas such as starting and running a company, being creative, taking initiatives, seeing opportunities and solving problems.

Scalability and Transferability

The transferability potential of this initiative is very high, under the condition that local VET and industry stakeholders are incorporated both in the training content. Given the applicability of the results, in regards to the needs identified in D4.1 across the EU, it could be easily transferred to other countries. Overall, it could prepare and equip the future workforce with the appropriate knowledge and tools to support energy digitalization.

Impact and success factors

EE has been successfully implemented in preparing students for careers in the energy industry for more than 12 years. This knowledge and skill set is in high demand in many industries and sectors across EU, making it a valuable asset for students as they enter the workforce. Apart from that, its strong links with the industry and the mandatory on-the-job training and apprenticeships ensure that students have the practical skills to follow the ongoing digitalization and are aware of the latest developments and advancements in the field.

4.1.2. VET program for Automation Technicians (SW)

General presentation of the practice

Burckhardt Compression AG in Switzerland offers a two-year training course (at the libs training centre in Oerlikon) plus a two-year internship (at Burckhardt Compression AG) for automation technicians. This course will give students the opportunity to train in the construction of control and automation systems as well as in the optimisation of these control systems.

Relevance/Importance

The emphasis of the training programme is on digitalisation through system automation and energy, as it aims to train students to learn how to build, programme, analyse and optimise control and automation systems in the Chemical/Petrochemical, Gas Transport and Storage, Mobility and Hydrogen Energy and Industrial Gas sectors, as well as for applications in Refinery and Gas Capture and Processing.

Another important factor, is that the training is closely related to industry and real-life challenges. The students do their training and internship in a company that is a leader in creating compression solutions with the aim of making these solutions energetically sustainable for the future.

Aims and objectives

Overall, the aim of this programme is the training for the construction of control and automation systems. More specifically:

- Learning how to optimize these control systems
- Installing and wiring control cabinets
- Commissioning automation and control systems
- Performing system maintenance
- Programming and analysing control systems
- Detecting and eliminating possible problems that may arise.

Structure and organization

This course is taught at EQF5 level according to the European Qualifications Framework. The course is aimed at students who have a good knowledge of technical products and processes, and are also interested in technology and know-how. In addition, a good knowledge of basic mathematical principles, especially algebra, is important, as you will have to perform many calculations as an automation technician. The training emphasizes the importance of a good command of English and skills such as teamwork. After the first two years of training there will be a further two years of work experience in the company.

Scalability and Transferability

The initiative has a high replication potential to address the issue of building the necessary technical competences for the automation of machinery related to energy compression systems in a real-life environment, thus optimising this technology with the aim of making these solutions energy sustainable for the future.

Impact and success factors

What makes the VET Automation Technician Training Programme at Burckhardt Compression such an impactful programme is the fact that it combines an interesting training in digitisation of the system compression industry with a long internship in a company that presents itself as an international leader in the sector. The VET programme for automation technicians covers everything from planning to final execution and final inspection of automation systems.

4.1.3. Vilnius Vocational Training Centre of Technologies (LT)

General presentation of the practice

Vilnius Vocational Training Centre of Technologies (VTMC) is a vocational training institute, located in Vilnius, Lithuania, that has been created from the reorganization of 4 different vocational schools. Its main target is the preparation of specialists for the national and international markets, regarding engineering, IT and Computer, business administration and visual technology sectors. VTMC includes 2 sectoral practical training

centres and is licensed to provide 49 formal vocational education programs in secondary education, continues vocational education and initial vocational education.

Relevance/Importance

VTMC is actively modernizing practical training opportunities in the offered training programs. It ensures the connection of the offered training with companies, both in the training courses and the practice opportunities for the students. The IT and computing program offered through VTMC, addresses qualifications that could be a base for addressing various of the skills identified through EDDIE project.

Aims and objectives

The main target of VTMC is to develop a vocational training, ensuring public interest, through:

- providing basic, secondary, formal initial and continues non-formal vocational training
- providing conditions for qualification improvement and retraining
- meeting students' cognitive, educational and self-expression needs
- enabling students to develop key competences and qualifications
- developing cooperation with employers and social partners

Structure and organisation

The centre offers 4 vocational education and training programs:

1. IT and Computing (*Java developer; Web developer; Software tester; Computer hardware adjuster; Computer design operator; Computer network coordinator; .NET developer*)
2. Engineering (*Electrician; Energy system electronics technician; Automatic systems operation mechatronic; Metalworking machinist; Welder; Mechatronics automation systems operation technician*)
3. Visual technologies (*Visual service provider; Visual advertising producer*)
4. Business administration (*Accountant/cashier; Secretary; Finance service specialist*)

The training programs are carried out in the 3 departments of the centre, the Energy & Mechatronics, the Transport & Business, and the Information & Visual Technology. Since 2014, the institution has also developed 2 sector-based practical training centres (labs), the engineering industry centre and the energy sector practical training centre.

As from 2022, VTMC and Vilnius Jerusalem Labor Market Training Center, were reorganized, forming Vilnius Technology and Engineering Training Center (TECHIN). All in all, the school has a long-lasting and active cooperation with local companies, other VET and universities. This cooperation ensures that companies professionals' share their knowledge with students, as well as accepting them for practice.

Scalability and Transferability

The program demonstrates a high transferability potential, indicated by the cooperation of the centre with companies and other VET providers, as well as its participation in international projects.

Impact and evaluation

VTMC accepts more than 700 students per year, guided by 54 vocational teachers and 22 subject teachers. From 2022, as TECHIN, it plans to approach 1.000 per year, ensuring lectures from IT companies professionals. The large number of both students and teachers, is a clear indication of the positive contribution of VTMC in VET sector. It has also developed various project activities in Erasmus+, Nordplus and other international programs and has created valuable impact in the 4 sectors it is involved with. The strong network it has created between other VET providers, companies and universities is a clear indicator of how important knowledge transfer and collaboration is in addressing real-life challenges, such as energy digitalization.

Critical success factors

The success of the project relies on the active cooperation between the centre and industry, developing the form of apprenticeship training, developing IT specialist training initiatives. The centre has ensured for more than a decade that students, alumni, teachers and other staff have been gaining professional experience and developing social skills in foreign training centres and companies. Another critical parameter, that leads to the success of this program, is the connection between theoretical and practical knowledge, ensured through the development and operation of the 2 sector-based practical training centres.

4.1.4. Dual VET training system (GE)

General presentation of the practice

The dual VET training system in Germany allows for a practical employment at a company and at the same time customized learning of the theoretical and managerial basis of the career chosen. Apprenticeships are available in very specific fields and therefore, also in combinations of energy and digitalization, like “Electronical technician for building systems integration” or “Assistant for regenerative energy technology”.

Relevance/Importance

The dual VET training program is highly relevant because it provides the possibility to start a career and continue a subject-specific education in the intersection of energy and digitalization. Above all it imparts practical skills focused on digitalization that are directly put into practice and on-the-job training in the energy industry. The links to the industry are very tight since the stakeholders are already employed. However, the link to research stakeholders is a bit limited.

Aims and objectives

The program aims to provide young professionals with theoretical knowledge, on-the-job training, and additional skills through in-class learning that is customized to the career choice. Therefore, young professionals are more likely to succeed in their career and possible gaps in general knowledge or necessary skills can be resolved.

Structure and organization

The dual VET training program allows stakeholders to start an apprenticeship/career at a company and receive on-the-job training while at the same time receive in-class training one or two days a week about the theoretical basics of their jobs and further skills by a vocational school. The targeted groups for this program are graduates of secondary school up to graduates with A-levels that are interested in directly starting a career at a company while at the same time finishing a vocational training.

There are around 325 officially recognised training programmes in Germany, and some indicative examples for programs that target energy and digitalization are “Electronical technician for building systems integration” and “Assistant for regenerative energy technology”. Participants learn to implement the technology and tools for smart building, smart home, energy management systems, implementation of renewable energy in private households, and electromobility.

Scalability and Transferability

The knowledge obtained in the dual VET program is highly specific to the career chosen and its requirements. Since energy digitalization is a really demanding sector that requires cross sectoral knowledge, tailored to the needs of the industry, this best practice has a high transferability potential. There is also a possibility of scaling up programs that focus on the interrelation of energy and digitalisation since programs in this field are not very popular yet but will be in high demand in the near future.

Impact and success factors

The dual VET programs focused on digitalization and energy are highly significant and directly impact on the shortage of specialists in the energy sector. Nevertheless, their success is highly dependent on the company chosen and individual engagement of stakeholders.

4.1.5. Schneider Electric

General presentation of the practice

Schneider Electric SE is a European multinational company that specializes in digital automation and energy management. It addresses homes, buildings, data centers, infrastructure and industries, by combining energy technologies, real-time automation, software, and services. offers flexible and cost-effective technical training and courses for many products and solutions, mainly focusing on professionals with practical face-to-face session, digital programs and electrical installation simulators. Overall, they offer the following training to interested companies and industries:

Face-to-face sessions level

- Practical exercises on real size equipment in their training center or on the company's site
- Training solutions fully customized to the company's electrical distribution system
- Digital simulators and full immersion in virtual scenario to experiment and test the company's ability to manage their system and apply safety procedure to their system
- On-the-shelf ready to use e-Learning programs, accessible 24/7, in many languages

The company provides more than 1400 courses from 91 training centers worldwide with practical face-to-face sessions, digital programs and electrical installation simulators. These are categorized in the following sectors (number in brackets indicates number of courses in the category):

- Automation and control (458)
- Building management and security (60)
- Critical power and cooling services (68)
- Electrical distribution and energy automation (481)
- Electrical safety (42)
- Energy efficiency (48)

The courses are delivered through the following training types:

- Certification (9)
- E-learning (22)
- Led by instructor (1112)
- Webinars

Aims and objectives

One indicative example of a training program is the Industrial Automation Training, which offers a large curriculum of courses covering a wide range of products and concerns relevant to energy digitalization, including training on:

- Industrial Software - SCADA
- PAC and PLCs and Networking
- Speed Drives
- Distributed Control System
- Process automation
- Variable speed drives, human machine interface, machine control

Relevance/Importance

The selection of all 1400 courses can be considered as best practice as many courses from the selection are relevant to digitalisation and energy, many of them use digital tools and solutions. As they are developed by

Schneider Electric, they are all related to the company's industry strategy and the context is relevant to many of the skills of interest like Energy modelling, Simulations, Advanced control systems in the energy grid, Measurement techniques Artificial Intelligence and Machine Learning.

Aims and objectives

At the completion of this course the trainee will be able to Identify main motor starting methods, recognize the frequency converter principle and its advantages, realize substantial energy savings using speed control, reduce harmonic distortion generated by frequency converters, calculate the payback of an investment in a variable speed drive etc.

Structure and organization

Schneider Electric offers both on demand training on organised specialised software and hardware training and onsite training in more than 90 training centers around the world. In addition to a select list of 'How-to Videos' provided, the local training centres can provide e-learning, virtual and hands-on courses, some of which can be conducted at the facilities of the professionals being trained.

Scalability and Transferability

The program is flexible and offered all over the world in many languages through many different ways, which highly indicates the successful scalability and transferability of this initiative.

Impact and success factors

Schneider Electric Training provides all the components to efficiently construct the bridge between where a company is today in technical performance and where it wants to be in the future. It is a hands-on example of industry being highly active in training and education, which offers practical and on-the-job skills to professionals and companies that are active in the field of energy and digitalisation through its deep know-how and professional expertise in the field.

4.1.6. EnerTracks (GE)

General presentation of the practice

To foster international expertise and knowledge transfer, Agora Energiewende and its partners at the Renewables Academy (RENAC) offer the following training programmes, which can be combined or taken individually:

- The EnerTracks Fellowship Programme (in-person)
- The EnerTracks Study Tour Programmes (virtual or in-person)
- The EnerTracks Online Modules

The Renewables Academy (RENAC) AG, based in Berlin, Germany, is one of the leading international providers for training and capacity building on renewable energy and energy efficiency. Agora Energiewende is a think tank that develops evidence-based and politically viable strategies to advance the goal of climate neutrality in Germany, Europe, and the rest of the world.

Aims and objectives

The trainings are particularly aimed at energy transition policy experts employed by an organisation working in the energy transition field. Experts from civil society organisations and/or an academic bodies researching energy policy or another relevant field fall into the wider target group.

Structure and organisation

The EnerTracks Fellowship Programme

A small group of eight participants is invited to go to the Agora Energiewende office in Berlin, Germany. They continue working part-time for their home institution while participating in training sessions that are prepared and facilitated by Agora Energiewende energy experts. These multi-disciplinary sessions cover a variety of topics such as energy markets, power system flexibility, and research methodologies, among others. Supplemental online and reading material, as well as group discussions, complement each of these sessions. With the support of their Agora Energiewende mentors, each participants tackles one specific transformation topic of their choice. The topic should be relevant from the perspective of the participant's own organisation, with the intention of transferring the learnings into their work.

The EnerTracks Study Tour Programmes

The virtual and in-person Study Tour programmes are designed for early-career individuals. Over the course of 5.5 weeks (virtual Study Tour over Zoom and Mural) and 2 weeks (in-person study tour on site in Berlin, Germany), a select group of 12-16 energy transition professionals are provided with immersive training: either in Berlin or from the comfort of their own home. During the tour, participants receive intensive training in stakeholder engagement, electricity modelling, and design thinking. Under the guidance of RENAC and Agora Energiewende experts, participants work together in small groups and learn how to develop a comprehensive decarbonisation roadmap.

The EnerTracks Online Modules

The Online Learning Modules are designed for individuals who are working in the energy sector and are willing to work on de-carbonisation and increased flexibility of power systems. The online learning modules developed by the Renewables Academy AG (RENAC) offer participants the opportunity to uncover important topics about energy transformation at their own pace. These courses are designed for all levels, providing an introduction to more advanced courses around the political, economic, and technical aspects related to the transformation of energy systems. The four Modules can be taken as a consecutive programme or individually:

- Module 1: Introduction to power systems – Fundamentals of electricity, generation technology, flexibility options in power systems, fundamentals of power systems and power markets
- Module 2: Policies supporting energy transformation – Political support mechanisms for renewable energy, carbon markets, balancing power market design and operation
- Module 3: Technical aspects of energy transformation – Aspects of grid integration of renewable energy systems, application and technical aspects of the four classic flexibility options (grid, storage,
- generation, demand-side e-mobility)
- Module 4: Future trends in the power sector – Energy sector coupling, digitisation in the energy sector, an introduction to Hydrogen applications and more

Scalability and Transferability

The transferability potential of this practice mostly relies on the effective collaboration between the training center and the organization involved, in order to create a curriculum with both theoretical and practical skills.

Impact and success factors

Upon successful completion of the programme, alumni of the Fellowships and Study Tours are invited to join the EnerTracks Alumni Network. The alumni programme offers former participants the opportunity to deepen contacts, exchange ideas, and continue their EnerTracks experience through further events and training opportunities. Since the launch of the network in March 2021, over 90 participants have joined the alumni network, and the EnerTracks team continues to collaborate closely with alumni to develop the network further.

This enables the continuation of knowledge transfer even after the completion of the trainings, which helps to ensure the long-term impact of the program and the sustainability of it.

The program has a clear focus on digitalization in the energy sector, and an on-the-job training which gives participants the practical skills to apply the knowledge directly to their job positions. It also uses digital tools and technologies throughout the training process, which allows for greater flexibility and accessibility for participants. Finally, the multi-disciplinary and interactive training methods, such as group discussions and project work, helps to ensure that participants are able to apply the knowledge in real-world settings.

4.2. Good examples

4.2.1. From Stump to Boiler (FI)

General presentation of the practice

From Stump to Boiler is a bioenergy educational environment developed by REDU, the largest VET provider in Lapland. It is owned and funded by six municipalities, while also benefiting from state subsidies. The aim of this project is to address labour market needs in terms of knowledge and skills of the workforce and in particular in the bioenergy production sector.

Within the context of this endeavour, REDU is operating the educational district heating plan, with the objective to provide training for professionals across all stages of the production bioenergy production chain, i.e. from harvesting to refining biomass. What makes this practice stand out is the fact that REDU provides an educational framework for students who otherwise would not have the possibility participating in full-fledged apprenticeships at energy production facilities, due to legal restrictions.

Aims and objectives

The programme, which is attended by both youth and adult VET students with different skillsets and experience levels, includes the familiarisation with all different stages of the process, focusing on the enhancement of different skills and competencies, from the operation of harvesters, to timber transport, biomass combustion and new forest fertilisation. The training cycles are short term, while also interchanging with workplace environment, with the intention of combining theoretical knowledge with hands-on applications, from gathering biomass, to logistics, to energy production.

Structure and organisation

The programme, while it is run by two staff members, a full-time teacher and a field expert, it is student run, with the objective to provide the students with a unique holistic learning experience addressing all processes of biomass energy production. This provides the possibility to students to get familiar with the entire cycle of energy production, enabling them to develop and use the newly acquired skills and competencies effectively as soon as they graduate. It should also be highlighted that, scheduled tasks per training cycle vary depending on the season: during wintertime, training is related to the heating season, while summertime focuses on maintenance work.

Impact and evaluation

The REDU learning environment is unique, considering that it accomplishes directly the fulfilment of skills necessary in the sector of biomass production, since its graduates are ready for achieving full employment status. Therefore, in terms of impact, it can be safely assumed that the endeavour is of significant added value both for the students, as well as the labour market: REDU has achieved the development of an efficient educational environment, while the students possess the appropriate skillset to work directly in heating plants.

Critical success factors

What makes the REDU educational environment successful is the offer of a training cycle, which leads to market ready skills for VET students. Combining training with workplace practice in short-term cycles enables the development of skills and competencies which are not limited to theoretical level. Assisting in the familiarisation of students with the entire cycle of biomass energy production, from gathering biomass, to logistics, to energy production, creates a valuable benefit, both for the students as well as the energy production sector.

Transferability

The transferability potential of this practice relies mostly on the effective coordination and collaboration of the REDUS VET provider with the local authorities, which are committed to participating in the creation of a learning environment which makes a difference not just in the workforce of the region, but also the energy production sector. In addition, the organisation of the programme, which offers the possibility to students to run their practice, under the supervision of the dedicated personnel, enhances the sense of responsibility and effectiveness of the training programme.

Therefore, it can be argued that the practice demonstrates high transferability potential, under the condition of commitment and engagement of all actors involved in its implementation.

4.2.2. Towards near Zero-Energy Buildings (nZEB) Training in the Southern EU countries (EL)

General presentation of the practice

The SouthZEB project was funded by the Intelligent Energy Europe Programme. It was implemented by a consortium of nine partners in four EU MS: Greece, Cyprus, Southern Italy and Portugal. The SouthZEB project developed ten training modules and assessment schemes for professionals involved in nZEB building process. Eight modules specifically directed towards architects, engineers and municipal employees, while the remaining two were devoted to managerial nZEB project skills.

Aims and objectives

The objective of the SouthZEB project was to design and develop training and assessment programmes for professionals, especially on the transfer of and knowledge from selected front runner countries (i.e., UK, Austria, Germany, and France) to the southern EU countries (Greece, Portugal, and Cyprus). The target groups of the training programme were:

- Building Professionals/ developer companies, including all intermediate and senior professionals (engineers, architects, municipality employees) in the Southern European countries. They facilitate the construction of new buildings towards the nZEB targets;
- Authorities/ decision makers to support the use of appropriate funding schemes and other incentives for the promotion of nZEB.
- Property owners who benefit from the project outcomes as energy efficient buildings are less costly for the users.
- Vocational training/ Certification bodies.

Structure and organisation

The SouthZEB project was created to fill the gap identified in the field of know-how regarding nZEB buildings, following the implementation of the Directive on Energy Performance of Buildings (EPBD, 2010/31 / EU), according to which all new buildings from 01/01/2021 and all new buildings that house the services of the public and wider public sector from 01/01/2019 must be Buildings of Zero Energy Consumption Plans.

The training modules were developed by the programme partners, with extensive experience and knowledge on the subject, gathering and combining the theoretical background with practical exercises. It should also be noted that the modules were developed in accordance with the current legislation and existing standards, providing an up-to-date and complete knowledge on the subject.

The modules included the presentation and analysis of all parts of a building for it to become an nZEB building. Specifically, they addressed elements from the building shell, the various technologies and materials that exist today, the common problems that were presented and ways to resolve them, techniques to exploit solar energy passively and actively, as well as thermal bridges and how to address their installation. The technical equipment of Heating - Cooling - Air Conditioning was also analysed, its characteristics and the combinations that could lead to low energy consumption of the building. Moreover, the modules targeted the local legislation of each country and its particularities (for example the traditional settlements) and how it would be possible to develop nZEB buildings, while at the same time undertaking renovations of existing buildings and interventions necessary to make them nZEB buildings. It is also noted that through the training, the professionals come into direct practical contact with programmes for the simulation of the energy consumption of the building, issues of particular importance such as thermal comfort inside the space, indoor air quality and how these can be achieved through procedures, construction and operation tests of the systems upon delivery of the project to the owner.

Impact and evaluation

Within the SouthZEB project, the partners developed 10 training modules focused on the needs of nZEB specific professionals that were delivered in the target countries, in a first phase, to trainers and, in a second phase, to trainees. The main outputs from the project were:

- Ten training modules: eight (8) modules for architects, engineers and municipality employees in the South EU countries, which were based on recognized and successful professional development courses. Special emphasis was put on the building traditions of the participating countries. Two (2) special modules were developed for construction management and field supervision of nZEB, as well as for training decision makers in the preparation of appropriate funding schemes and other incentives for promoting nZEB;
- A portal and an e-learning platform for trainers and trainees in the target countries with the aim of achieving the “nZEB designer” and “nZEB trainer” certificate, but also remote participants (from any other country) that wanted to attend the course (without obtaining the certification);
- Train the trainer workshops on nZEB in each target country;
- Training sessions on nZEB in each target country during which the trained trainers acted as multipliers and transferred their knowledge to target end-users;
- Ten assessment exams, one for each of the training modules aforementioned.

By the end of the project, the following results were achieved:

- 150 trainers trained
- 1,500 professionals trained
- 3,000 user registrations in the e-learning platform

Critical success factors

Apart from the innovative character of the approach and the content development, the success factors of the project are summarised under two axes:

1. This project addressed the need of developing training and certification schemes for professionals involved in the nZEB building process (engineers, architects, municipality employees, decision makers) focusing on transferring successful practices from front runners to EU countries less advanced in this area. The SouthZEB project was one of the first projects which had incorporated the certification scheme in the design of the VET courses developed and which had provisioned the

organisation of assessment exams for the course participants. Some attempts had been made to develop training & certification schemes for nZEB professionals, all of them by NGOs, however none was official.

2. The training modules developed took into consideration the building traditions of each participating country. This way, the workforce trained in the context of the project and the subsequent interventions promoted, would ensure that the architectural identity of the local buildings would be respected and maintained, both for the construction of new buildings, as well as existing ones in need of rehabilitation.

These two parameters rendered the project result unique and a good practice for the design of new nZEB buildings or in the rehabilitation of existing buildings towards nZEB concept.

Transferability

The transferability potential of the SouthZEB project is very high, considering that it was in essence a VET training programme for professionals in the nZEB building process, combining on one hand the expertise from front runner countries, to the architectural identities of the Southern European Countries that participated in the project. This way, the consortium ensured that both new buildings that would be constructed and new ones, would both be in accordance with the EU Directive on Energy Performance of Buildings, as well as in line with the building traditions of each country. Bearing this in mind, the training programmes developed could be applicable in any country, with the necessary adaptations in terms of the building traditions and the local legislations.

4.2.3. Geothermal and Solar Skills-GSS-VET (EL)

General presentation of the practice

The EU's strategy for sustainable growth, Europe 2020, puts innovation and green growth at the heart of its blueprint for competitiveness, leading to a completely new demand for environmental skills in the construction sector. However, training providers have not yet caught up with this new skills demand, creating an important skills gap in the current labour market, as highlighted in the "Green skills and environmental awareness in vocational education and training" report from CEDEFOP. Green skills and environmental awareness in vocational education and training, state that most learning providers do not yet include green skills in their learning strategy.

GSS–VET (Geothermal and Solar skills – Vocational education and training) project aims to design and deliver a demand-driven Vocational and education training in response of the targets set up by the EU Directive 2010/31/EU on the Energy Performance Buildings: all new buildings by 2020 to be nearly zero energy buildings.

Aims and objectives

The aims of the project included:

- Enhancing creativity and innovation incl. entrepreneurship at all level of VET
- Promoting work-based learning incl. traineeships, apprenticeships and dual learning models to help transition from learning to work
- Promoting partnership between public and private institutions
- Reaching the objective of 15% of adults to participate in lifelong learning
- Making lifelong learning and mobility a reality.

GSS-VET objectives were to:

- Design 3 EU core curricula (EQ levels 4-5) for Geothermal, Photovoltaics and Solar Thermal energy systems installers, divided in sets of learning outcomes.
- Implement, deliver and evaluate the aforementioned training curricula

- Certify, after developing a technical scheme according to ECVET recommendations and ISO 17024 norm, participants developed skills.

Structure and organisation

The partners created an innovative VET training programme, which included work-based learning, ubiquitous learning and flipped classroom for geothermal and for solar energy system installers (EQF level 4-5). The training content focused on technical skills, but also on important horizontal ones: entrepreneurship, ICT, interdisciplinary skills and ability to work effectively with people from other disciplines.

In the context of the project, the following activities were carried out:

- Definition of skills and creation of the European Curricula for plumbers and electricians, as well as specialists with technical background aged 16+ years willing to work as geothermal & solar systems' installers.
- Mapping of existing training programmes in geothermal & solar installations
- Development of innovative teaching methods
- Description and guidelines for implementation for innovative teaching methods & Systemic definition of the innovative teaching methodology
- Development of training content, qualification standards and certification
- Pilot testing of the programme developed
- Mobilisation of stakeholders to create internship as well as ToT opportunities

Impact and evaluation

During the project implementation, the impact reached was:

- 40 trainers and 200 workers having benefited from the trainings delivered.
- 2,500 adults in the created training curricula and the innovative methodology,
- 1,000 trainers in targeted trainings thanks to the involvement of VET providers, sectoral organisations (including an EU umbrella), regional authorities and other associated partners.
- The creation of a roadmap for the official recognition of the training by 2025.
- The development of a network of VET providers implementing the GSS – VET training in 8 EU countries.

Critical success factors

The success of the project lies within the fact that a targeted VET programme for Geothermal, Photovoltaics and Solar Thermal Energy system installers, which included much more than just technical knowledge in a traditional classroom setting. The partners investigated the necessary skills for this particular occupation, in addition to the appropriate horizontal ones, i.e., ICT & entrepreneurship and developed a valuable holistic programme, which would address on one hand the labour market needs along with the EU Directive on the Energy Performance of buildings and would be of increased added value to the participants.

Another important parameter, which makes this project stand out, is the mobilisation of a very big network of stakeholders, which was engaged during the project lifetime, to provide apprenticeships and for the students and training opportunities for the trainers.

Transferability

The project results demonstrate a very high transferability potential, both in the context of the need for the adoption of the EU Directive 2010/31/EU on the Energy Performance Buildings across all Member States, and in the context of equipping VET learners with more skills than just technical ones. Under the condition of adaptation to the country specific particularities related to construction legislation and directives, this project can be applied in any country.

4.2.4. NE(W)AVE-Renewable e-VET Learning (EL)

General presentation of the practice

Renewable Energies is a growing and profitable industrial sector in Europe. However, in spite of its importance and great expectations of continuing growth, there is still a lack of skilled employees. Very often installation and maintenance services are in the hands of young people without a specific training. The NE(W)AVE project aimed to create, test and implement a comprehensive learning model for the future professionals in the renewable energies. The project developed an online training programme for young VET graduates or about to graduate focusing on the enhancement of their skills related to renewable energy, without being limited to technical ones, but above all practical. Through their participation in the course, the learners also had the opportunity to complete a period of mobility in Spain and Italy hosted by two companies.

Aims and objectives

The objectives of the NE(W)AVE project were:

- To contribute to increasing the employability and inclusion of NEETs and VET learners developing VET business partnerships in the renewable energy field based on work-based learning
- To promote innovative learning opportunities in VET developing an Open Online Course on renewable energy
- To support VET trainers & mentors' professional development offering an E-toolkit based on new training material and scheme.
- To increase employment chances of the above-mentioned targets in the renewable energy sector
- To promote the professional development of VET trainers through the acquisition of new and/or increase competences in terms of teaching/learning methods, tutoring and intercultural skills
- To promote close cooperation between stakeholders from the education and business field.

Structure and organisation

The project included the following activities:

- Research on skills needed for jobs related to renewable energy
- Development of an e-toolkit for education professionals and training to help VET trainers modernise and diversify their educational offer related to the renewable energy sector.
- Development of a Mini Course on Mobility Management for Mentors for the organisation of international placements for their own learners at companies and can increase their awareness of the competence upgrading methods in VET and increase their interest in using e-learning approaches in mobility opportunities for their learners.
- From VET learning to jobs in the field of renewable energy: Opportunities and recommendations, as a means to enhance a close and concrete collaboration among different stakeholders.

Impact and evaluation

In the context of the project implementation, the impact achieved can be summarised as follows:

- Over 24 VET learners who attended and successfully completed the course
- Over 25 VET institutions, which piloted the programme
- Over 20 learners who participated in the scheduled mobility
- Over 50 registered VET trainers in the platform.

Critical success factors

The success of the project relates to the development of a course for VET trainers and mentors on how they could modernise and diversify their training delivery in the renewable energy sector. The project offered a

professional development opportunity for teachers and mentors in VET, rendering the project innovative, since it did not only focus on the development of an updated course for learners, but it ensured that the target group (i.e. VET trainers and mentors) would be equipped with the appropriate methodologies to make a difference in VET provision in the field of renewable energy.

Transferability

The project results can be easily transferred to other countries, given the applicability of the results developed across the EU, taking into consideration the need for provision of updated, accurate and attractive VET training programmes related to the renewable energy sector.

4.2.5. CraftEdu (SK)

General presentation of the practice

Understanding the existence of a significant gap between the skills of the construction workers and the market demand, CraftEdu develops innovative qualification and VET schemes for craftsmen and on-site workers in the field of energy efficiency and use of renewable energy sources in buildings. CraftEdu supports the EU policies for introduction of nearly zero-energy buildings and deep energy building renovation within a vision for a decarbonized building stock in 2050.

Aims and objectives

The CraftEdu project aims to address the following challenges:

- Low quality of construction works on-site directly influencing energy efficiency in buildings.
- Structural changes in construction industry and technological changes related to energy efficiency and development of renewables;
- Decreasing number of VET learners at construction professional schools and low interest of youth to the construction industry.

The CraftEdu project will develop and expand the voluntary initiative “Building Future” aimed at supporting energy efficiency and use of renewable energy sources in buildings, including support to training of construction professionals by employers.

Structure and organisation

The CraftEdu system brings together suppliers of construction technologies and materials, construction companies involved in the construction of public buildings, family houses and housing units, as well as their renovation in order to increase energy efficiency and the use of renewable energy sources in buildings from a life cycle perspective.

In the Slovak Republic, the project further develops the VET training courses available, through the introduction of 5 innovative new ones, which correspond to the occupational profiles of installer of fittings into construction openings–windows, Hydro-insulator, Low-voltage electrician, High-voltage electrician, Carpenter.

Impact and evaluation

Throughout the project duration, the partners achieved:

- 12 VET programmes, 5 of which in Slovakia
- 4,280 learners successfully attended the VET programmes
- 650 investments initiated
- 20 policy instruments were influenced.

Critical success factors

What makes the CraftEdu project successful is the tailored approach to address the training needs of the country in terms of the craftsmen and on-site workers in the field of energy efficiency and use of renewable energy sources in buildings. Through the programme, structural changes were addressed, VET programmes were updated and additional courses introduced. The project also developed occupational profiles as a means to directly address the mismatches of workforce supply to the labour market demands. Finally, the creation of incentives for investments is another parameter that contributes to the success of the project.

Transferability

The transferability potential of the practice is very high, under the condition that local particularities and regulations are incorporated both in the training content, as well as the occupational profiles developed.

4.2.6. Education close to zero energy constructions: “Energy lift” (SE)

General presentation of the practice

The Agency's competence enhancing efforts are aimed at clients, engineers, architects, construction project managers, consultants and technical managers. Energy Offices coordinate the education to disseminate knowledge about energy-efficient construction and renovation.

Aims and objectives

This is an effort from the Swedish Energy Agency to prepare the construction sector for future requirements for near-zero energy buildings (NNE standard). In order to achieve Sweden's energy and climate goals, major efforts are made on energy efficiency and increased use of renewable energy. All new buildings must have very low energy consumption. At the same time, energy use in existing buildings must be drastically reduced. In order to promote low energy building, all actors in the construction industry are aware of the energy goals and understand how their work affects the performance of the building's energy performance.

Structure and organisation

The education intends to provide a holistic view of the construction process linked to low energy building in terms of new production and renovation. The education explains what differences it involves building and renovating low energy buildings in comparison with conventional buildings. The Energy Agency's knowledge-enhancing efforts are seen as an increase in knowledge based on the fact that each occupational group in the target group has basic knowledge in property management, construction processes, installation technology and more.

Impact and evaluation

People through all stages of the construction process have participated. Information and working methods are spreading. The total number of participants in the Energy Charter against near zero energy houses were:

- 1643 people are registered on the web course.
- 749 people have attended a seminar
- 352 people have completed their course certificate.

Critical success factors

The initiative was successful in principle because it aimed at proactively preparing the workforce to be able to contribute in meeting the national energy objectives. In addition, it effectively combined all professional categories related to low energy building, providing in this way a holistic approach. Finally, another important factor for its success has also been to collaborate with the well-organised regional energy agencies in the country.

Transferability

Potential for transmission is good, under the condition that regional actors who can market the concept for the target group are also involved in its implementation. Another important element that needs to be taken into consideration is the need for increasing awareness on the programme, to ensure that as many professionals are involved for their development.

4.2.7. Improve Skills and Qualifications in the Building Workforce-WE-Qualify (CY)

General presentation of the practice

The WE-Qualify project «Improve Skills and Qualifications in the Building Workforce in Cyprus» is an EU co-funded project through the «Intelligent Energy Europe» programme under the European initiative «Build Up Skills». According to the current National status quo and the «Roadmap» that has been developed within the Build Up Skills Pillar I (www.buildupskills.org.cy), a lack of a sufficient number of skilled workforce for the implementation of measures relating to the construction of energy efficient buildings has been identified. Additionally, a lack of appropriate training programs for the training of the workforce has been identified.

The WE-Qualify project has emerged between the three nominations for the most successful European Projects for the year 2016, in the Public Domain category, for the promotion of clean, safe and efficient energy in Europe.

Aims and objectives

The initiative aimed to promote the continuing vocational education and training of workers in technical occupations in the Construction sector, as well as other relevant sectors related with the installation and maintenance of energy saving and renewable energy systems.

Structure and organisation

The project WE-Qualify has responded to the needs of the Cyprus construction sector for qualified trained installers and has given the opportunity to the participants to attend specialized and high-quality training programmes.

The training programmes were organized by the WEQualify consortium and took place at the facilities of the Cyprus Productivity Centre.

The participants who successfully completed the training programmes, have significantly improved their skills and knowledge on the subject. In addition, with the WE-Qualify certification, they have achieved a wide recognition of their professional competence and skills, competitive advantage and increased career advancement prospects, recognition and enhanced reputation in their field of work. The names of the certified installers who have acquired the certification mark WE-Qualify, were published in a publicly accessible directory on the project's website.

Impact and evaluation

Educational training programmes for the development of the following skills were organized:

- Skill 1: Installation of thermal insulation

- Skill 2: Installation of thermopanels and exterior sunshades
- Skill 3: Installation and maintenance of biomass boilers and stoves

By the end of the project implementation, 92 installers were trained, 76 of which were also certified.

Critical success factors

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Transferability

The initiative presents high replication potential to address the issue of creating the necessary skills in order to meet the demand for more efficient and better buildings.

4.2.8. VET4LEC- Inclusive Vocational Education and Training for Low Energy Construction (Multi-Country, including Finland, Slovenia and Spain)

General presentation of the practice

The Energy Performance of Buildings Directive (EPBD) requires all new buildings to be nearly zero energy buildings (N) by 2020, with major implications for vocational education and training (VET) in construction. Low energy construction (LEC) calls for a different set of knowledge, skills and competences (KSC) to be deployed, as revealed in the Build Up Skills (BUS) investigation, which found that existing VET needs upgrading to incorporate a deeper knowledge and understanding of energy efficiency, higher technical skills, and a holistic approach to the building process. The cross-occupational co-ordination demanded implies inter-disciplinarity, broad occupational profiles and transversal abilities, including problem solving and communication.

Aims and objectives

The main aim of the VET4LEC project is to determine the expertise required for NZEB and contribute to developing a trans-European framework for VET for LEC. The objectives are:

- To evaluate different approaches to developing and delivering VET for LEC;
- To provide criteria for curricula development and outline components of a core energy literacy curriculum compatible with the European policy tools;
- To develop guidelines and recommendations on how to address the weaknesses identified.

Ten EU countries participated, representing different VET systems and industrial relations models: Belgium, Bulgaria, Finland, Germany, Hungary, Ireland, Italy, Poland, Slovenia and Spain. The first stage involved scoping each national VET system, including the extent of VET for LEC provision; the construction labour market and workforce; and NZEB implementation. In the second stage, initial VET (IVET) and continuing VET (CVET) examples were assessed, particularly for building envelope occupations, to identify core KSCs required, aided by a conceptual framework developed to increase the transparency of construction VET and by visits to seven countries to interview VET for LEC providers, social partners, LEC contractors and LEC site personnel. Guidelines were then drawn up for VET providers and recommendations proposed for addressing weaknesses identified.

Structure and organisation

The guidelines enable construction IVET and CVET providers to ensure programmes prepare workers to meet EPBD requirements. Whilst more detailed work is required in each country, it is important to draw out core KSCs common for all, establish elements of effective systems for providing VET for LEC, and develop a framework applicable across the EU though flexible enough for adaptation to different contexts. Examples have been identified from partner and other countries of distinctive approaches to VET for LEC, suiting different contexts but also possible in combination:

1. Common syllabus (Germany): A prescriptive framework detailing the IVET curriculum, covering transversal abilities, and useful for developing specific training programmes.
2. Common curriculum (Ireland): Based on an introductory course for building operatives, specifying areas to be covered in the curriculum, and potentially forming a basic LEC IVET and/or CVET curriculum.
3. Specific modules (Finland and Slovakia): Based on standalone training modules developed for supervisory and managerial grades and useful for training at higher levels.
4. Sector framework (Poland): Setting out LEC requirements across construction occupations, based on EQF but with more detailed KSC, and valuable for developing occupational profiles and potentially identifying occupational overlaps.
5. Occupational profiles (Belgium): Developed into curricula by VET providers, with some content discretion, facilitating incorporation of transversal abilities.
6. Content guidance (UK): Setting out indicative content and learning outcomes by occupational area, emphasising different occupational roles and addressing occupational overlaps.

Through the VET4LEC project, a construction VET transparency tool has also been developed for building envelope occupations, facilitating curriculum designers in setting out core KSCs applicable to new build and retrofitting.

Impact and evaluation

Approaches to VET for LEC vary considerably, though countries face similar challenges and all need to ensure that VET is effective for meeting NZEB requirements, incorporates LEC-related KSC, and is sufficiently broad to cover transversal abilities and cross-occupational understanding.

Deep integration of energy literacy into existing occupational profiles, curricula or syllabuses at all levels is preferable to just adding LEC-related topics onto IVET programmes. CVET for LEC presents a challenge, particularly in the short term, as short courses and a range of delivery methods are needed, catering to different existing training and qualifications levels. Course content must be carefully considered, where possible specific modules should be part of a comprehensive and longer CVET programme, and funding is essential for providing an upgraded, comprehensive and accessible VET programme. Factors hindering VET for LEC development and undermining efforts to achieve an integrated construction process need addressing, including limited work-based learning opportunities, low VET participation by the self-employed and small firms, low construction VET currency, often weak labour market regulation, and fragmented organisation of work on site.

Critical success factors

The most important element of the project was the development of the guidelines based on the strong elements each country could bring into the consortium. In particular, the guidelines were developed through assessment of examples of IVET and CVET for LEC identified in collaboration with project partners, including:

- Occupational profiles from Belgium (IVET)
- Curricula from Germany (IVET and CVET)
- A sectoral framework from Poland (IVET)
- Specific modules from Finland (CVET)

These were supplemented with ‘good’ examples from two EU countries not partner to the project, which were also investigated:

- A module-based training programme relating to higher level VET for construction professionals from Slovakia, developed as part of a Horizon 2020 project and
- Course content guidance from Britain, developed by Leeds College of Building for the Construction Industry Council (CIC 2017).

Transferability

The potential for transferability is high, given that the consortium partners worked on the development phase, combining knowledge and data from all countries involved.

4.3. Success stories

4.3.1. LuxBuild2020 (LU)

General presentation of the practice

LuxBuild2020 implemented the national project of Luxemburg in the context of the European initiative “Build up skills, energy training for builders”, which was supported by Intelligent Energy Europe (IEE). The European Union had set ambitious targets in terms of climate and energy policy – the so-called 20-20-20-targets. By the year 2020, CO2 - emissions were to be reduced by 20 percent, energy consumption is expected to decline by 20 percent and renewable energy were expected to rise to 20 percent of electricity consumption. For all these targets, a sufficient number of qualified craftsmen and blue-collar workers is needed, to realise these visions on the buildings-sites. LuxBuild2020 focused on the training of the blue-collar workers.

Aims and objectives

The objectives intended by the LuxBuild2020 project were:

- Make the 20-20-20 targets in terms of climate and energy policy possible
- Prepare the building sector for the challenges of the 20-20-20 targets
- Strengthen the economy through the promotion and revaluations of the skilled crafts VET in Luxemburg, increased integration by better vocational training of immigrants and increased competitiveness of the small and medium sized business (SME).

Structure and organisation

The BUS project from Luxembourg, LuxBuild 2020, used didactic materials as its main training tool. The project set up a demonstrative object, namely a didactic building for its training activities. This didactic building is a demo model of an actual building site, which contained both real size, and small-scale models for various construction tasks as well as construction material samples. Training was based on introducing expertise through practical hands-on exercises.

The main activities were (1) Structural work; (2) Wood construction; (3) Exterior carpentry; (4) Special techniques; (5) Electricians; (6) Façade specialists.

Impact and evaluation

The “LuxBuild2020” initiative made it possible to improve the professional skills in the field of energy efficient constructions, and to develop and promote a broad offer of related training programmes. This training and education offer was divided into theoretical and practical on-site courses (within a “test house”). The organisation of the offer was a continuous work-in-progress, which was monitored by the “Conseil national pour la construction durable” (CNCD) to constantly adapt and improve the available structures.

The main results of the project were:

- Creation of centres of excellence for craftsmen based on a competency framework

- Innovative training concept: practical training, internal and external coaches, pedagogical tool
- Innovative learning material: toolbox for AAA-houses
- Gateway “LuxBuild2020”: support services and tools

Critical success factors

The practice is considered a success due to the following reasons:

- It was adapted to the needs of different crafts.
- Training integrates the impact of passive house construction for different workers, such as bricklayers, carpenters, façade specialists, etc.
- Provided trainees with practical training.
- Provided trainees with a diversity of learning situations.
- Simulated actual on-site working conditions.
- Enabled live demonstrations of various tasks.
- Allowed for immediate interaction between trainers and trainees

Transferability

The degree of transferability of the practice relies mostly on the maturity of each country to create the conditions for the provision of VET training real time. It requires the design and planning of a long-term state-of the art construction project, along with different training sites for each professional category. It is not a practice, which can be easily transferred, however it does set an shining example of collaboration between VET provision and the world of work.

4.3.2. BUStoB (NL)

General presentation of the practice

The BUStoB consortium foresaw the development of 76 modules for construction professionals. During the BUStoB project, various new techniques became available that were sufficiently developed to be used in sustainability, some techniques were combined and the division into clusters was optimised.

Aims and objectives

The main aim of the BUStoB project was to develop and test the missing training materials on EQF levels 2-4. This is based on the future descriptive qualification schemes as developed in BUS_N@W. This makes it possible to offer professionals in the construction and installation sector basic VET courses in the field of sustainable techniques and additional interdisciplinary skills.

The second goal of BUStoB was to put together short knowledge tests that prevent unwittingly incompetent professionals from making construction and/or installation errors. In order to detect missing skills and to offer relevant further training advice.

The third goal was to organise regional pilots in which the partners could focus on the implementation and further development of materials and on building regional training capacity. Regional partnerships were supported with train the trainer sessions, regional labour market information and the implementation of the developed training courses.

Structure and organisation

The BUStoB project developed regional partnerships with regional training centres and regional trainers. To achieve this, the consortium established links between existing and new regional partnerships in which regional VET providers, educators and companies work together to train professionals who work in the built

environment. BUStoB supported these regional partnerships with train the trainer sessions, regional labour market information and the practical implementation of the training and knowledge tests in regional construction and/or renovation projects.

The development of the VET training programme included the following activities per module:

- Developing documents with the learning objectives of the course and an assessment by market actors
- Assessing existing course material for possibilities for reuse;
- Developing training modules and knowledge tests;
- Assessment and testing of the training and knowledge tests by the target groups. The modules have been evaluated on process, quality and quantity by the consortium and a selected group of market players;
- Improving and adapting the training modules and the knowledge tests.

Impact and evaluation

The regional training projects were evaluated with the tools developed in the previous BUSN@W project, to assess the impact of the training actions. The monitoring results were used to determine the positive effects of the training and to determine our performance indicators.

The results of the pilots demonstrated that the difficulty level of the modules fits well with the average knowledge level of the target group. E-learning appears to be an effective and convenient way of learning if used in the right way. To deploy effectively the BUILD UP Skills e-learning modules, collaboration with VET providers is essential, in order to integrate the modules in their regular courses. The modules can as a knowledge test or as part of the introduction of the training. The pilots provided several recommendations and tips that helped improve not only the modules but also the BUILD UP Skills advisor app.

To promote the participation of professionals and to appeal to women in the construction and installation industry, the partners created an inventory of projects that focus on gender diversity in both sectors. Desk research was also carried out into existing research on the participation of women in the construction and installation sector, in collaboration with VHTO, the Dutch expert organisation for women in technical professions. The result of this was a presentation of the opportunities for gender diversity in the construction and installation sectors.

The BUStoB project has developed two different forms of digital knowledge testing. The developed e-learning modules include knowledge tests with which users can test themselves. The BUILD UP Skills advisor app has been enhanced with a new 'learn from' interaction to check whether professionals understand fundamental issues that can arise and construction errors. Preliminary information was collected related to construction errors, which can arise during the implementation of sustainable techniques. Subsequently, an investigation was carried out into forms of knowledge testing. Based on the lessons learnt, the partners further enhanced the Advisor app.

Critical success factors

This endeavour is a success in the sector, given that it has incorporated two very important features at its development phase: the first one is the possibility for construction workers to test their current knowledge on sustainable construction techniques, in order to follow the appropriate learning path, and the second was the collection and systematisation of construction issues and errors in the BUILD UP Skills advisor app, to transfer knowledge and lessons learnt in an effective way.

Transferability

This project demonstrates a very high transferability potential. The VET modules developed, can also be transferred to other countries and further enriched to align with the new EC regulations and the legislative/ regulatory particularities of each country.

4.3.3. BIM-based EU-wide standardized qualification framework for achieving energy efficiency training-(LU)

General presentation of the practice

The European Construction sector is facing unprecedented challenges to achieve ambitious energy efficiency objectives, in a context dominated by reduced investments, search for cost effectiveness and high productivity. Moreover, the industry is experiencing its digital revolution, with Building Information Modelling (BIM) approach gaining significant interest across Europe. Member states implement very different approaches through regulations and maturity targets, which always face the traditional low-tech and informal practices of construction businesses (a sector dominated by SMEs).

The BIMEET project leverages the take-up of ICT and Building Information Modelling (BIM) through a significant upgrade of the skills and capacities of the EU construction workforce. This project is built around a strong consortium relying on educational and research & technology expertise, robust experience of accrediting bodies, training supply chain and a wide engagement of industry led best practice.

Aims and objectives

BIMEET aims to broaden the BIM training agenda to support the European Union building energy efficiency agenda. This requires broad awareness and expertise in BIM practice across different asset types and across different roles in the industry. The aim of BIMEET-project is many-fold:

- pave the way to a fundamental step change in delivering systematic, measurable and effective energy efficient buildings through BIM training with a view to effectively address European energy and carbon reduction targets;
- promote a well-trained world leading generation of decision makers, practitioners, and blue collars in BIM for energy efficiency;
- establish a world-leading platform for BIM for energy efficiency training nurtured by an established community of interest.

Structure and organisation

BIMEET general aims translate into the following objectives:

- O1: Screen and synthesize past and ongoing European, as well as national, initiatives and projects with a focus on assembling evidence-based quantitative / measurable scenarios and use cases that demonstrate the role of BIM in achieving energy efficiency in buildings across the whole value chain.
- O2: Benchmark existing Europe-wide BIM trainings across the building value chain (including lifecycle and supply chain), highlighting energy efficiency linkages, as well as qualification targets, delivery channels, skills, accreditation mechanisms, while highlighting training gaps and enhancement potential
- O3: Harmonize energy related BIM qualification and skills frameworks available across Europe with a view of reaching a global consensus through our BIM for energy efficiency expert panel.
- O4: Map identified skills, qualifications, and accreditation into a BIM for energy efficiency overlay with a total lifecycle and supply chain (including blue collar) perspective.
- O5: Adapt the BIM4VET platform to provide a robust computer-based online and open-access environment for BIMEET.
- O6: Establish a governance, policy, and regulatory framework as well as adapted business models to ensure the long-term sustainability of the proposed BIMEET training agenda.
- O7: Disseminate within and beyond Europe the resulting BIMEET platform and training programme

Impact and evaluation

Throughout the project implementation, the following results were achieved:

- Altogether 19 piloting VET training courses were held with 293 participants.
- E-Learning courses 2: self-studies and webinars with 754 participants.
- National workshops 270
- Conferences 750
- Expert panel meetings 75
- Final workshops 70

Critical success factors

What makes the BIMEET project successful is the fact that it harmonised BIM qualification and skills framework across Europe, aiming at achieving consensus in terms of the qualifications for the selected roles in design, building and maintenance processes in order to effectively utilise building information modelling for energy-efficient buildings. After having identified the knowledge skills and competencies, the partners developed an online training programme, combined with work-based training for increasing the added value of the training programme.

Transferability

Based on the validation results, the participants corroborated that the qualifications they acquired through their involvement in the BIMEET training programme could be applicable across any other country of the EU, with the necessary modifications related to country specific regulatory and legislative provisions. Another finding of the validation process was that the BIMEET VET programme could also be adapted/ enriched to be incorporated at EQF level 7, increasing even more its added value.

4.4. Lessons learnt and recommendations

To identify the good practices presented above, the project team 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 digitalization
- The collaboration of stakeholders in the implementation of the initiative and
- The incorporation of digital tools in VET provision.

From the review of the practices identified, it was established that overall, priority has been placed on the upskilling and reskilling of the workforce in the context of the introduced EC policies concerning energy efficiency and sustainability and the objectives set for the upcoming reference period, the involvement of stakeholders, to ensure the effective preparation and/ or upskilling of the workforce and, finally, on the promotion of work-based learning in the field of VET. To date, as it was also identified in D4.1, there are not many projects/ initiatives/ practices which focus on the energy digitalisation in the sector of VET, which practically leads to the validation of the originally need for the implementation of the EDDIE project.

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
The electricity and energy programme	Upskilling workforce related to energy digitalization in order to improve employability in the sector	Young people	Provision of VET education in alignment with the needs of the sector Reskilling of workforce

Practices identified	Objectives	Target groups	Topics
VET program for Automation Technicians	Workforce upskilling with on-the-job training in energy digitalization	Young people & VET learners	Upskilling of workforce in the sector Enhance employability of VET learners in the field of energy digitalization
Vilnius Vocational Training Centre of Technologies	Knowledge transfer between industry and academia in energy digitalization	Young people & VET learners	Upskilling of workforce in the sector Enhance employability of VET learners in the field of energy digitalization
Dual VET training system (GE)	Practical workforce upskilling of professionals	Young professionals	Dedicated structure for collaboration between industry and education Provision of VET education in alignment with the needs of the sector
Schneider Electric	Promote the continuing vocational education and training of workers in technical occupations	Professionals in energy sector	Dedicated structure for collaboration between industry and education Provision of VET education in alignment with the needs of the sector
EnerTracks	Foster knowledge transfer in energy digitalization	Professionals in energy sector	Dedicated structure for collaboration between industry and education Provision of VET education in alignment with the needs of the sector
From Stump to Boiler (FI)	Workforce upskilling in the bioenergy sector	Young people & VET learners	Provision of VET education in alignment with the needs of the sector Dedicated structure for combination of traditional training with work-based learning
Towards near Zero-Energy Buildings (nZEB) Training in the Southern EU countries (EL)	Professional upskilling of construction professionals to align with the updated EU Directives on nZEB buildings	Building Professionals/ developer companies, including all intermediate and senior professionals (engineers, architects, municipality employees) in the Southern European countries.	Provision of VET education in alignment with the needs of the sector Job growth stimulation Upskilling and reskilling of the workforce in the construction sector
Geothermal and Solar Skills-GSS-VET (EL)	Design and deliver a demand-driven Vocational and education training for Geothermal, Photovoltaics	Plumbers and electricians, as well as specialists with technical	Provision of VET education in alignment with the needs of the sector

Practices identified	Objectives	Target groups	Topics
	and Solar Thermal energy systems installers	background aged 16+ years willing to work as geothermal & solar systems' installers	
NE(W)AVE-Renewable e-VET Learning (EL)	Test and implement a comprehensive learning model for the future professionals in the renewable energies Contribute to increasing the employability and inclusion of NEETs and VET learners developing VET business partnerships in the renewable energy field based on work-based learning	• VET learners • VET trainers and providers	Enhance employability of VET learners in the field of renewable energy Professional development of VET trainers
CraftEdu (SK)	Development of innovative qualification and VET schemes for craftsmen and on-site workers in the field of energy efficiency and use of renewable energy sources in buildings	VET learners, craftsmen and on-site workers	Reskilling of the workforce in the field of renewable energy sources Provision of VET in alignment with the needs of the sector
Education close to zero energy constructions: "Energy lift" (SE)	Preparation of the construction sector for future requirements for near-zero energy buildings (NNE standard)	VET learners, construction workers	Reskilling of the workforce in the field of renewable energy sources Provision of VET in alignment with the needs of the sector
Improve Skills and Qualifications in the Building Workforce-WE-Qualify (CY)	Promote the continuing vocational education and training of workers in technical occupations in the Construction sector, as well as other relevant sectors related with the installation and maintenance of energy saving and renewable energy systems	Workers in technical occupations related to energy saving and renewable energy systems	Provision of VET education in alignment with the needs of the sector Job growth stimulation
VET4LEC-Inclusive Vocational Education and Training for Low Energy Construction (Multi-Country, including Finland, Slovenia and Spain)	Development of a trans-European network for VET in low energy construction	• VET learners • Professionals in the construction sector	Upskilling and reskilling schemes applicable across the EU Integration of the curriculum into VET provision
LuxBuild2020 (LU)	Make the 20-20-20 targets in terms of climate and energy policy possible	Professionals in the construction sector	Alignment and cooperation of all stakeholders involved in the construction field Set-up a structure for training purposes

Practices identified	Objectives	Target groups	Topics
	Prepare the building sector for the challenges of the 20-20-20 targets		Combine effectively VET provision with work-based learning
BUStoB (NL)	Offer professionals in the construction and installation sector basic VET courses in the field of sustainable techniques and additional interdisciplinary skills	Professionals in the construction sector	Alignment and cooperation of all stakeholders involved (VET providers, educators and companies) Training and certification schemes
BIM-based EU-wide standardized qualification framework for achieving energy efficiency training-(LU)	Leverage the take-up of ICT and Building Information Modelling (BIM) through a significant upgrade of the skills and capacities of the EU construction workforce	Professionals in the construction sector	Integration of ICT in energy efficiency VET provision Upskill and reskilling schemes applicable across the EU

Table 4-1: list of good practices of VET provision in the field of energy efficiency

Although the sector of energy digitalization in VET is yet to be developed, some key findings and commonly used methodologies that have positive contribution to VET programs were identified from the research and analysis of the previous chapter. Overall, the key takeaway from these examples is that the success of VET programs in the field of energy digitalization is highly dependent on the alignment of curricula and training programs with the current industry trends and needs. The vast majority of all the interventions identified, showed strong links with industry partners, and had incorporated in their curricula hands-on training opportunities and apprenticeships, with a focus on using emerging digital tools and software.

Some future recommendations and methodologies that the VET sector could adopt while developing training programs relevant to energy digitalization are:

Curriculum alignment with industry standards

As we are talking about an industry sector with rather specific needs and skills in the emerging era of digital transformation, the curricula of the programmes should align with the current industry standards and needs, so that students and professionals are trained in the skills that are most in demand. This includes addressing skills gaps in the field of energy digitalization and could be achieved through regular consultation with industry experts, involvement of professionals and experts in trainings and through the incorporation of industry-relevant case studies and projects into the curriculum.

On-the-job training opportunities

Professionals in the sector of energy digitalization, are required to show practical knowledge and approach of digital skills in order to be competitive in the field. Thus, it is important for these training programmes to offer the opportunity to students and professionals to gain hands-on experience and practical skills through on-the-job trainings and apprenticeships. This not only helps to ensure that students are well-prepared for careers in the industry, but also helps to keep the VET sector relevant and responsive to changing industry needs.

Strong network and collaboration

In order to ensure that the VET programme is aligned with the industry needs and trends, the establishment of strong links with industry partners is really important. This can help bridge the gap between theoretical and

practical knowledge and align the program with the technological advancements and changes in the energy sector. This could be achieved by actively engaging industry experts and professionals in the training and development of curriculum, as well as by involving students in real-life case studies and challenges faced in the industry. Another strategy could be to develop a network of all stakeholders and participants, in order to enable knowledge transfer and collaboration between the knowledge triangle.

5. Conclusions and next steps

As already presented in the previous chapters, the Joint Programme of the European Energy Research Alliance aims (among others) at the introduction of digital solutions in the energy sector, the promotion of computational, storage and advanced IT services, as well as the promotion of open data.

In addition to that and based on the findings of the EDDIE *Deliverable 2.1: Current challenges in the energy sector and state of the art in education/ training*, green skills have become a horizontal priority due to the global concern of climate change, in order for the various organisations to achieve energy efficiency, limit produced pollution and environmentally-damaging emissions, comply with increasingly strict regulatory requirements and present an overall environmentally friendly image.

The main findings of the research on Best Practices (BPs) in the Vocational Education and Training (VET) sector for energy digitalization indicate that a strong emphasis on practical training and hands-on experience, coupled with customized learning and strong industry partnerships, are the crucial to success. The identified six Best Practices include relevant and up-to-date curriculums covering automated production systems, energy and environmental technologies, and fostering strong industry partnerships. Additionally, modernizing practical training opportunities to meet industry demands and customizing programs to address current challenges in the energy transition field are recommended. Collaboration with industry and research stakeholders, utilization of digital simulators and virtual scenarios for practical skill development, and incorporation of interactive and multidisciplinary training methods such as group discussions and project work are also suggested.

Due to the limited number of references on the subject of energy digitalisation, additional research was conducted to provide a more comprehensive perspective. These findings offer valuable insights on methodology and important lessons learned applicable to the VET sector, aligning with the main findings on Best Practices. The examples mainly focus on the broader concept of the energy transition within the context of digital transformation. The majority of examples emphasize the importance of aligning VET education with sector needs and providing practical, on-the-job training. Some examples, such as structures for combining traditional training with work-based learning and EU-wide upskilling and reskilling schemes, aim to enhance VET learners' employability and stimulate job growth. Additionally, emphasis is placed on VET trainer professional development and curriculum integration into VET provision as crucial factors for delivering high-quality education aligned with industry needs.

What can be concluded from reviewing the collected practices and findings is:

- It is imperative to take all the necessary steps to redesign VET training programmes in order to be aligned with the new EC Directives published. As per the commission recommendation of 28.09 2021 on Energy Efficiency First: from principles to practice, provisions to treat energy efficiency as the “first fuel”, that is a source of energy in its own right, in which the public and the private sectors can invest ahead of other more complex or costly energy sources (“save before you build”). This presupposes that the VET providers should play an active role in the preparation of the workforce to achieve the principles set, instead of following developments.
- VET provision only focuses on the needs of the learners, based on somewhat outdated curricula, which do not cater for the incorporation of work-based learning and/ or the actual needs of the sectors addressed. However, the need for VET programmes which are in line with the needs of the labour market becomes more and more imperative. VET providers should contribute to and implement mechanisms to respond to the fast-paced changes of the labour market needs, the expectations of individuals, as well as those changes which come as a result of EC policy and strategy documents.
- In this context, reskilling professionals of the sector is of equal importance to ensure that there are no knowledge gaps and all professionals possess the necessary knowledge and skills to work together in the achievement of a greater objective. The “shelf-life” of skills is becoming increasingly short and in order to address it VET providers need to develop flexibility and responsiveness to the changing circumstances.
- The digitalisation of VET provision is an aspect that has been somewhat neglected, but needs to be revisited, better planned and be conceived outside of the strict context of online or blended teaching approaches. The changes brought about as a result of fast paced digitalisation in companies, professionals and sectors need to also be reflected in how VET is designed and provided in order to meet the needs in terms of digital skills. These needs are different depending on the sector and the

occupational profile at hand; it is however very important for VET to monitor the changes and the way they occur, through the creation of better linkages with to improve its attractiveness and quality.

- The effective and consistent collaboration of all stakeholders in the energy efficiency sector is imperative, not just for the enhancement of work-based learning (which prepares market-ready workforce), but most importantly because the work that needs to be undertaken towards energy sustainability should be undertaken by all stakeholders involved. It does not solely reflect on the design of targeted strategies, but also includes demanding investments, in terms of resources, incentives and ownership on behalf of the individuals to reach long-term results. VET can play a determining role in this, through the provision of targeted and relevant programmes, which do not follow developments, but lead them.

This demonstrates that VET provision in the MS needs to be well in line not just with all the EC policies and strategies that relate to the energy sector, but also with all the policy documents that foster the incorporation of digital tools in the field of energy efficiency. This has also been corroborated through the conclusions of the EDDIE *Deliverable 2.2: Current and future skills in the energy sector*, following a survey which has been carried out. In particular, the consortium has already established that the energy sector is in need of high level expertise in terms of the digital and soft skills that the workforce possesses. A combination of hard and soft skills is important for the growth of the employees and company achievements, which to date the VET programmes offered do not cover.

The EDDIE project can bring about the needed change, given that its main objective is the promotion of sustainable cooperation among all stakeholders involved in those fields. The practices presented in this report, apart from the gaps of VET provision in terms of practical skills and competencies that the workforce has, also demonstrates that it lags behind in introducing the appropriate digital tools in the sector. The consortium believes that the change that needs to be brought about can be achieved through the implementation of this project in an effective and sustainable way, while taking into consideration all the successful methodologies and strategies that have been identified and analysed in this report. The methodologies identified from Best Practices and Good examples offer valuable insights into successful strategies. Implementation in the VET sector could better prepare trainees for the challenges and opportunities in the energy transition and digitalization sectors.

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