
# WP3 – Making VET relevant and addressing sustainable development

## D3.1 – Trends on technological changes and their impact on qualifications

**May 2023**

Authors: Chapter 1: Dr O. Hudec (TUKE)
Chapter 2: E. Mavrou (CRES)
Chapter 3.1: D. Káposztásová, Z. Vranayova (TUKE)
Chapter 3.2: E. Currà, M. Morganti, A. D'Amico, M. Russo (UNIROMA)
Chapter 3.3: C. Murillo, J. Mitxelena (GAIA)
Chapter 3.4: C. Inácio, J. Encarnação (ENERGAIA)
Chapter 3.5: Dr Ch. Malamatenios, E. Mavrou (CRES)
Chapter 4: E. Mavrou (CRES)

Editors: Dr Kleanthis Kaldellis (UNIWA), Dr Oto Hudec (TUKE), Dr Charalambos Malamatenios (CRES)

Contact: Centre for Renewable Energy Sources and Saving (CRES)
Georgia Veziryianni
Email: gvezir@cres.gr
Tel: +30 210 6603 267
19th km Marathonos Avenue
19009 Pikermi-Attiki, Greece
www.cres.gr

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

SECOVE website: secove-project.eu

# Contents

# 1 Introduction

This study provides a comprehensive insight into technological change and its impact on the need for future professional qualifications in the domain of sustainable energy. It aims to provide insights into the dynamic relationship between emerging technologies in the sustainable energy and climate change context and the evolving demands of the future demands of the modern skilled workforce.

The aim of the study is to provide in-depth insights on the broader sustainability in energy sector, considering hydropower, solar energy (including photovoltaics and concentrated solar power for power generation, and solar thermal systems for domestic hot water preparation, but also for assisting space heating, solar cooling, etc.), wind energy (including onshore and offshore wind) and other renewable energy components. However, there are sectors that intersect with sustainable energy, including green building, construction, cybersecurity, local government and other renewable energy sectors. The awareness of these interdependencies will provide insights into the broader sustainable energy domain and help to determine better the focus of centres of vocational excellence in the five countries involved in the SECOVE project.

**Challenges** facing the Sustainability in Energy Sector can be divided into three main groups of questions:
Financing: The cost of investing in sustainable energy can be high.
Technology: Sustainable energy technologies are not always well developed or mature.
Political: Political uncertainty can be a major factor in discouraging investors.

In the context of sustainable energy, it is important to mention the influential role of the European Commission in shaping policies and initiatives that promote renewable energy and environmental sustainability. Policies such as the Renewable Energy Directive, the Energy Efficiency Directive and the Sustainable Energy for All initiative are already in place. This has a positive impact on supporting the growth of sustainable energy initiatives and the actors in the sector - companies, public administrations, the education system and citizens. There are still urgent challenges to ensure funding and raise public awareness.

**The main research question** that aligns with the task of analysing the sustainability in energy sector and related industries, as well as identifying the impact of technological trends and changes on the future labour market and vocational education and training is:

*"What are the current and emerging trends in sustainable energy and related industries, and how do they impact the qualifications needed for the future labour market and the relevance of vocational education and training in meeting these needs?"*

**Partial research questions** corresponding to the main research question and align with the task outlined in the study:

I. *What are the primary technologies and systems being used in sustainable energy (and five related industries)?*

II. *How are these technologies and systems expected to evolve and develop in the future?*

III. *What are the current and projected workforce needs and skills gaps in sustainable energy and related industries?*

IV. *How are vocational education and training programs currently addressing these workforce needs and skills gaps?*

V. *What strategies and policies can be implemented to modernize vocational education and training programs to better align with the evolving needs of sustainable energy and related industries?*

VI. *How can vocational education and training providers, industry, and policy makers collaborate to create more effective workforce development programs and address the anticipated skills gaps in sustainable energy and related industries?*

The SECOVE project is a collaborative effort by partners from five European countries (Greece, Portugal, Spain, Italy and Slovakia). The aim of the SECOVE project is to develop a comprehensive understanding of sustainable energy and to identify opportunities for further development in the field of vocational education and training (VET). Thus, this study is focusing on the current state of the industry, the challenges facing it, and the potential opportunities for the future. It will consider the economic, social, and environmental aspects of the SES, as well as the role of policy and other stakeholders.

The project will also investigate the need for VET courses and qualifications in sustainable energy, and the potential for further development of VET. The project partners will work together to develop a set of recommendations for the future development of VET in sustainable energy.

The findings of the research will be used to inform the development of VET courses and qualifications in the sustainable energy, and to help ensure that VET is tailored to the needs of the SES and five related industries. In the end, it will be used to inform the development of Centres of Vocational Excellence (COVEs) in the five countries involved in the project. The COVEs will be dedicated to the development of skills and knowledge related to sustainable energy, and will provide a platform for collaboration between industry, education and research.

The development of the COVEs will contribute to the growth of sustainable energy by providing trained personnel, and by encouraging innovation and collaboration. It will also provide an opportunity for students and professionals to gain hands-on experience in sustainable energy. The study will consider the economic, social, and environmental aspects of the industry, as well as the role of policy and other stakeholders.

# 2 Sustainability in the energy sector

In this chapter the path towards climate neutrality (until 2050) will be highlighted. EU strategies and policies towards the sustainability of the energy sector for 2030 (and eventually 2050) will be presented. The contribution of SECOVE's project to this goal will be underlined.

A. **Definition of sustainability in energy sector:** A definition of the (rather complicated and complex) sector is needed, its evolution and composition, leading to a justification of the five sectors chosen in the study. So, as the term "Sustainable Energy Sector" is, indeed, a bit confusing and misleading, the most accurate term that should be used herein is "Sustainable Energy Sources Sector", which in the end leads to the "Sustainability in Energy Sector" (together with all technologies / techniques / activities aimed to improve the energy performance of systems, which lead to energy savings and the rational use of energy, i.e. to "Energy Efficiency").

   This term refers to the portion of the economy that encompasses all activities related to the production, distribution, and utilization of energy from renewable and environmentally friendly sources. It involves the development and deployment of technologies, systems, and practices that minimize negative impacts on the environment and promote long-term sustainability.
   Sustainable (renewable) energy sources include but are not limited to solar power, wind power, hydropower, geothermal energy, and biomass. These sources are considered sustainable because they are naturally replenished and have significantly lower greenhouse gas emissions compared to fossil fuels such as coal, oil, and natural gas and are commonly known as Renewable Energy Sources (RES).

i. **Types of Sustainable – Renewable Energy Sources:**

   a. **Hydropower**: Hydropower is a renewable energy technology that harnesses the energy of flowing or falling water to generate electricity. It is one of the oldest and most widely used forms of renewable energy, dating back thousands of years. Hydropower plants, also known as hydroelectric power plants, convert the kinetic energy of moving water into electrical energy through the use of turbines and generators.
   b. **Solar Energy**: Solar energy refers to the energy derived from the sun's radiation. It is harnessed through the use of solar photovoltaic (PV) panels or solar thermal systems. Furthermore, concentrated solar power is also exploited.
      i. **Photovoltaic**: Solar PV systems convert sunlight directly into electricity using photovoltaic cells. These cells are made of semiconducting materials, such as silicon, which generate an electric current when exposed to sunlight. PV panels consist of multiple interconnected solar cells and are commonly installed on rooftops, open fields, or solar farms. The generated electricity can be used on-site or fed into the electrical grid.
      ii. **Concentrated Solar Power**: Concentrated Solar Power (CSP) is a form of solar energy technology that harnesses the sun's radiation by concentrating it onto a smaller area to generate heat, which is then used to produce electricity. CSP systems use mirrors or lenses to concentrate sunlight onto a receiver, typically located at the top of a tower or within a parabolic trough.
      iii. **Solar Thermal Systems**: Solar thermal systems capture the sun's heat and use it for various applications, such as water heating, space heating, or electricity generation. These systems typically use mirrors or lenses to concentrate sunlight onto a receiver, which transfers the heat to a fluid (usually water or oil). The heated fluid is then used to

generate steam, which drives a turbine connected to a generator to produce electricity. Solar thermal systems can also directly heat water for residential or commercial use.

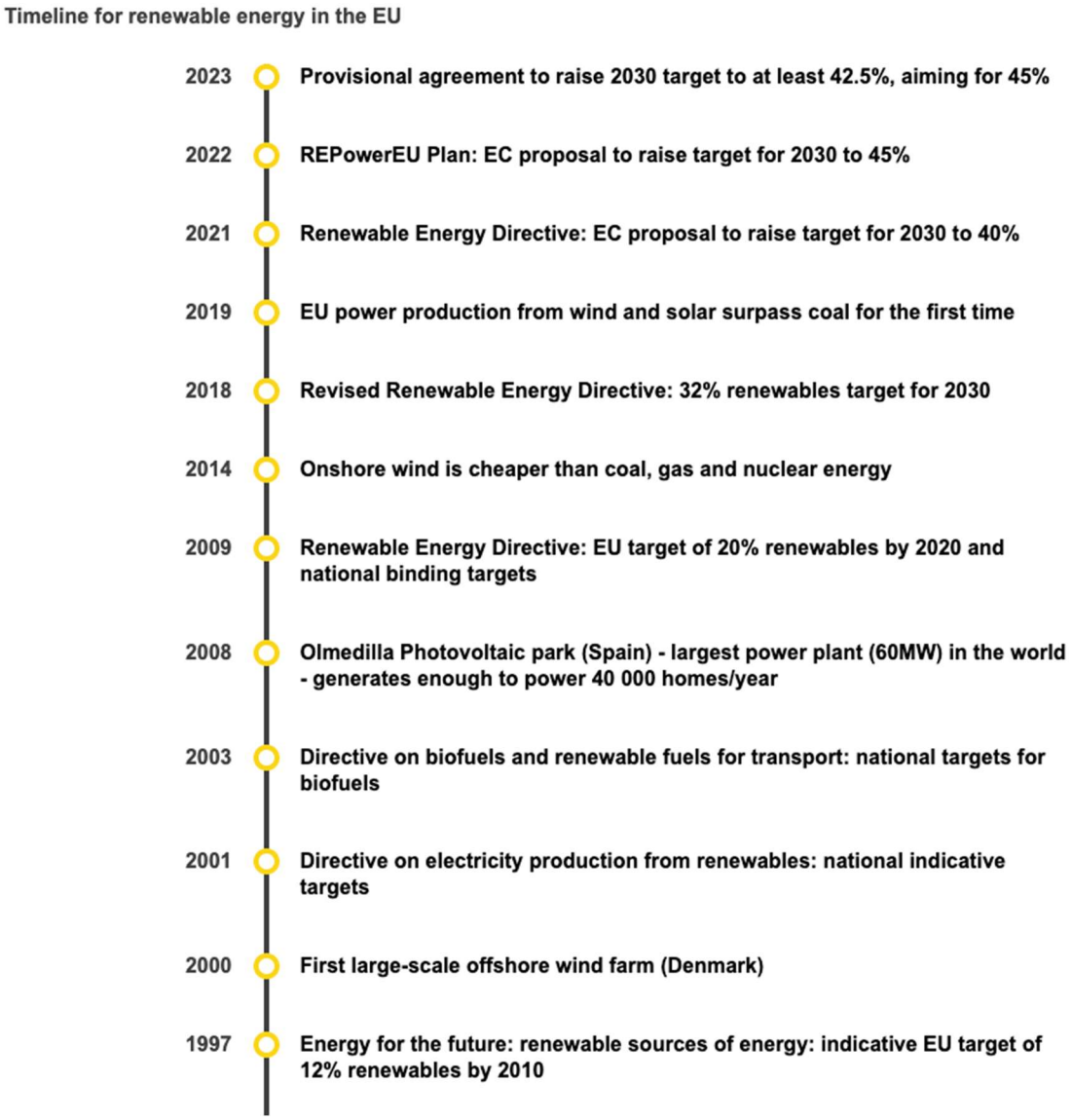
c. **Wind Energy**: Wind energy (onshore) refers to the power generated by harnessing the kinetic energy of moving air. It is a renewable and clean energy source that converts wind into electricity through the use of wind turbines. Wind energy has gained significant traction worldwide as a key component of the transition towards sustainable energy systems.
d. **Offshore Wind**: It refers to the generation of electricity from wind turbines located in bodies of water, typically in coastal areas or offshore. Compared to onshore wind farms, offshore wind farms harness the stronger and more consistent winds found at sea, offering unique advantages and challenges. Offshore wind energy has seen significant growth in recent years and is considered a crucial component of the renewable energy transition. Continued advancements in technology, cost reductions, and regulatory support are driving the expansion of offshore wind farms, contributing to the decarbonization of the energy sector and reducing reliance on fossil fuels.
e. **Geothermal**: it is a renewable energy source that harnesses the heat stored beneath the Earth's surface. It utilizes the natural heat generated by the Earth's core and the heat trapped in rocks and fluids in the subsurface to generate electricity or provide direct heating and cooling.
f. **Biomass**: Biomass energy refers to the energy derived from organic matter, such as plants, agricultural residues, forestry waste, and dedicated energy crops. It is a renewable energy source that can be used for heating, electricity generation, and transportation fuel.
g. **Ocean energy**: it refers to the energy that can be harnessed from the ocean's vast resources, including waves, tides, currents, and temperature gradients. It is a form of renewable energy that has the potential to contribute significantly to the global sustainable energy mix. However, there are challenges associated with ocean energy, including high upfront costs, potential environmental impacts, and technological limitations.
h. **Hydrogen energy**: it refers to the utilization of hydrogen as a fuel source for various energy applications. It is considered a versatile and potentially clean form of energy that can be produced from a variety of sources and used in multiple sectors, including transportation, industry, and power generation. Efforts are underway worldwide to advance hydrogen technologies, improve efficiency, reduce costs, and establish a hydrogen infrastructure.

ii. **Related sectors to SES:** Sustainability in Energy Sector encompasses various industries and subsectors, including renewable energy generation (e.g., solar and wind farms), energy storage technologies (e.g., batteries), energy-efficient buildings, sustainable transportation (e.g., electric vehicles), and energy management systems. It also involves research and development efforts to improve the efficiency, affordability, and scalability of sustainable energy technologies.
The growth of SES is driven by the increasing recognition of the need to mitigate climate change, reduce dependence on finite fossil fuel resources, and enhance energy security. Governments, businesses, and individuals are increasingly investing in and transitioning towards sustainable energy solutions to achieve a more sustainable and resilient energy future.

## B. European Union and sustainable energy targets

The European Union has experienced consistent growth in renewable capacity over the past five years compared to 2010-2015. However, it is expected that the pace of expansion will more than double from 2022 to 2027 [1]. Since the introduction of the Renewable Energy Directive in 2009, the share of renewable

energy sources in energy consumption has increased from 12.5% in 2010 to 21.8% in 2021. Sweden had the highest share of renewables in consumption (62.6%), ahead of Finland (43.1%) and Latvia (42.1%), as reported to Eurostat [2]. The European Union has proposed even more aggressive goals under the REPowerEU package, aiming to eliminate Russian fossil fuel imports by 2027 [1]. In the following picture the Timeline for renewable energy in the EU is presented starting from 1997 until 2023 [2].




On March 2023, the European Parliament and the Council reached a provisional agreement [3] to reinforce the EU Renewable Energy Directive 2018/2001/EU [4]. This agreement enhances the implementation of the "Fit for 55" [5] legislation, which aims to fulfill the objectives of the European Green Deal [6] and the REPowerEU [7] initiative. This provisional agreement currently requires formal adoption by the European Parliament and the Council. Once this process is completed, the new legislation will be published in the Official Journal of the Union and enter into force [3]. A detailed description of its context is described in the Box:

**European Green Deal: EU agrees stronger legislation to accelerate the rollout of renewable energy [3]**

One of the key outcomes of the agreement is the increasing of the EU's binding renewable energy target for 2030 to a minimum of 42.5%, surpassing the current target of 32% and nearly doubling the existing share of renewable energy in the EU. Additionally, the target for the EU is to achieve 45% of renewables by 2030.
The agreement raises the EU's binding renewable target for 2030 to a minimum of 42.5%, up from the current 32% target and almost doubling the existing share of renewable energy in the EU. Negotiators also agreed that the EU would aim to reach 45% of renewables by 2030.

The agreement reaffirms the EU's determination to gain its energy independence through a faster deployment of home-grown renewable energy, and to meet the EU's 55% greenhouse gas emissions reduction target for 2030. A massive scaling-up and speeding-up of renewable energy across power generation, industry, buildings and transport will reduce energy prices over time and decrease the EU's dependence on imported fossil fuels.

**A larger share of renewables to achieve a decarbonised economy**

Permitting procedures will be easier and faster under the new law. Renewable energy will be recognized as an overriding public interest, while preserving a high level of environmental protection. In areas with high renewables potential and low environmental risks, Member States will put in place dedicated acceleration areas for renewables, with particularly short and simple permitting processes. The provisional agreement also enhances cross-border cooperation on renewables.

The agreement includes targets and measures to support the uptake of renewables across various sectors of the economy. The revised Directive strengthens annual renewables targets for the heating and cooling sector and for renewable energy used in district heating systems. It introduces a specific renewable energy benchmark of 49% for energy consumption in buildings by 2030 to complement EU buildings legislation and guide Member States' efforts.

As a key energy-consuming sector, industry is included for the first time in the Renewable Energy Directive. The agreement establishes indicative targets (1.6% of annual increase in renewable energy use) as well as a binding target to reach 42% of renewable hydrogen in total hydrogen consumption in industry by 2030. The agreement also reinforces the regulatory framework for renewable energy use in transport (14.5% greenhouse gas intensity reduction or 29% share of renewable energy in final energy consumption), including a combined sub-target of 5.5% for advanced biofuels and renewable fuels of non-biological origin, including a minimum level of 1% for renewable fuels of non-biological origin. These targets support the EU's ambitions on renewable hydrogen roll-out.

The agreement also contains provisions to support energy system integration via electrification and waste heat uptake as well an enhanced system of guarantees of origin to improve consumers' information.

**A more sustainable use of bioenergy in line with ambitious climate goals**

The agreement strengthens the bioenergy sustainability criteria, in line with the increased climate and biodiversity ambition of the European Green Deal. In the future, these criteria will apply to smaller installations (equal or above 7.5 MW) rather than the 20 MW threshold under the current directive. The agreement includes provisions to ensure that forest biomass is not sourced from certain areas with a particular importance from a biodiversity and carbon stock perspective. In addition, the agreed rules establish that woody biomass will have to be used according to its highest economic and environmental added value (so-called cascading use). Financial support will be banned for energy produced through the use of saw logs, veneer logs, industrial grade roundwood, and stumps and roots.

## C. Contribution of SECOVE project

The project SECOVE aims to contribute to the above targets of EU decarbonization, by creating a well-trained labor force in sustainable energy and by establishing a network of cooperation among Centres of Vocational Excellence (CoVEs) in the partner's countries. This document contributes to this target by indicating the way VET qualifications in Europe can relate more to the current and future needs of sustainable energy market. For more relevant results for the partner's Regions, this study focuses at bridging the RIS3 Smart Specialization Strategies with VET education in the respective Regions (Košice-Slovakia, Lazio-Italy, Basque Country-Spain, Porto Metropolitan Area-Portugal, Attica-Greece), in order to promote employability, innovation, education, social inclusion and sustainable energy.

### a. Research and Innovation Strategies for Smart Specialisation (RIS3)

European national and regional authorities are encouraged to develop smart specialization strategies through an entrepreneurial discovery process. This approach aims to enhance the effectiveness of the European Structural Investment Funds (ESIF) and foster greater synergies among various EU, national, and regional policies, as well as public and private investments. The goal is to promote more efficient utilization of the ESIF and maximize the impact of investments in support of innovation and economic growth.

National/regional research and innovation strategies for smart specialisation (RIS3) are integrated, place-based economic transformation agendas that do five important things [8]

1. They focus policy support and investments on key national/regional priorities, challenges and needs for knowledge-based development, including ICT-related measures;
2. They build on each country's/region's strengths, competitive advantages and potential for excellence;
3. They support technological as well as practice-based innovation and aim to stimulate private sector investment;
4. They get stakeholders fully involved and encourage innovation and experimentation;
5. They are evidence-based and include sound monitoring and evaluation systems.

Each region is welcome to design its RIS3 in order to benefit from this initiative by following a specific procedure [8]:

- Analysis of the regional context and potential for innovation,
- Set up of a sound and inclusive governance structure,
- Production of a shared vision about the future of the region,
- Selection of a limited number of priorities for regional development,
- Establishment of suitable policy mixes,

- Integration of monitoring and evaluation mechanisms.

The entrepreneurial discovery process uses the business knowledge existing in a country/region adopting an entrepreneurial approach in the sense of focusing on market opportunities, diversification with respect to other countries/regions, risk taking (and management) and seeking alliances for optimizing access to resources and their use (natural, financial and intellectual resources, market knowledge, etc.). This means that the policy making bodies will have to engage all stakeholders in the area of innovation (businesses, technology and competence centers, Universities and public bodies, scientific and technological parks etc.) in an entrepreneurial process for designing the smart specialization strategy [9].

SECOVE's partners have taken under consideration the RIS3 of their Region when deciding which sector needed to be further studied and analyzed in this document (see also below).

### b. VET and Centres of Vocational Excellence in Europe

European Union has been a supporter of education and training since the beginning of its establishment, by creating respective policy documents and conducting reports. Kew policy landmarks are indicated in the following Box, as also mentioned in the JRC Science for Policy Report "The role of Vocational Education and Training in Smart Specialisation Strategies" [10].

**Selected Key EU Documents [10]**

1990: *Memorandum on Vocational Training in the European Community* in the 1990s
2002: Launch of *Copenhagen Process* and *The Copenhagen Declaration* for enhanced European cooperation in vocational education and training.
2004: *Maastricht Communiqué*
2010: *Bruges Communiqué* - VET providers to collaborate with enterprises, design centres, cultural sector, and HE in forming "knowledge partnerships"
2012: *Rethinking Education Communication* called on Member States to promote "highquality dual VET systems, aligning VET policies with regional/local economic development strategies namely for smart specialisation"
2015: *Riga Communique* set out the deliverables for European cooperation on vocational education and training for the period 2015-2020
2016: *New Skills Agenda for Europe*
2017: *Strengthening Innovation in Europe's Regions*: Towards resilient, inclusive and sustainable growth at territorial level was the first document dedicated to Smart Specialisation that strongly promoted the role of VET
2018: *Platforms of Centres of Vocational Excellence*: Networks of VET institutions will be tasked to link their activities with S3 and cooperate at European level with the support of the Erasmus+ programme.

Furthermore, on 2020 The European Commission has published its *European Skills Agenda* [11] for sustainable competitiveness, social fairness and resilience. COVID-19 pandemic accelerated the digital transformation [12] to the training and education systems. In addition to this acceleration, the EU recognizes the need for reskilling and upskilling of workers due to various changes such as the commitment to green and digital transitions, the transition to a climate-neutral economy, the advancement of AI,

demographic changes. The European Skills Agenda is meant to help up- and re-skill workers through partnering Member States, companies and social partners to work together for change, by empowering people to embark on lifelong learning, and by using the EU budget as a catalyst to unlock public and private investment in people's skills [12].

To enhance this goal, the EU initiated the 2023 as the *European Year of Skills* in order to help people get the right skills for quality jobs. Furthermore, this initiative targets to help companies, in particular small and medium enterprises, address skills shortages in the EU [14] mainly in the green and digital transition. The overall objective of this initiative and the related activities is to enhance and reassure the social fair and just transition to the new era.

In a similar context and to reinforce this objective, a link between the Vocational Training and Regional market/economy and stakeholders is strongly supported by the EU. The Centres of Vocational Excellence initiative (2018) aims to establish trans-national collaborative platforms of VET providers, together with relevant stakeholders responsible for economic development, innovation and competitiveness policies [10]. The goal is to encourage regional VET institutions or a cluster of regional entities to work in collaboration with local/regional stakeholders. The exploitation of the RIS3 priorities in combination with the CoVE's training support targets the creation of a local labor force well-trained in the innovations which shall be effective for the Region's development. The strategy in order to achieve that is to integrate technological and process innovations, skills and work organization practices, and innovation in low-tech sectors which account for the large share of employment in Europe. Policymakers are urged to "integrate the VET offer into comprehensive skills and knowledge-based economic development strategies, particularly at regional and local level…to attract investments, to clusters, innovation, Smart Specialisation strategies and sustainable growth strategies" [10].

SECOVE project aims to contribute to the above-mentioned initiatives, being in line with EU policies and targets. The goal is to provide the CoVEs thorough analysis of the needs in qualifications and skills in the specific Regions, enhancing the implementation of the RIS3 by supporting the training of the local labor force. Additionally, this target is strengthened by creating networks/hubs/liaisons with the industry, research institutes, policy makers, stakeholders and businesses in order to work effectively for the fair transition to a sustainable energy system.

## D. Contribution of this document

n this study, the Consortium's partners chose to analyze one sector that is related to the Research and Innovation Strategies (RIS3) in each Region. In this way, each Region would exploit SECOVE project, by integrating the results of this study into the CoVEs and offering training courses that shall cover the current and future Qualifications and Skills of the most relevant SES workforce for each region. The selected sectors are presented in the following Table.

| Partner | General sector |
|---|---|
| TUKE | Green building |
| UNIROMA | Building and construction industry |
| GAIA | Cybersecurity, Artificial Intelligence and IT |
| ENERGAIA | Local administration (municipalities) |
| CRES | RES Systems |

The purpose of this document is:

a) to analyze the current status of each sector
b) to identify the gaps in the existing Qualifications and Skills provided by VET – or gained by the labor force from experience
c) to synthesis the results providing recommendations and suggestions to CoVES, policy makers and Stakeholders.

The methodology used to achieve this purpose is described in the following paragraphs. Each section is common for all the analyzed sectors. The general guidelines described below are documenting the methodology (gathering the data, analysis and synthesis), which has been the foundation for the detailly presented procedure.

### a. State of the art and future trends

This section provides an overview of existing research on technological trends in sustainability in energy sector (SES) and their impact on the labor market. It examines the state of the industry of sustainable energy and related sectors, the nature of changes and trends that are expected, and the current understanding of the impact of these trends on job qualifications.

i. **Key data need to be introduced** (each partner selected what is important for their case and region). The proposed research methods are Literature review and Desk research.

1. Economic and market data - macroeconomic indicators to provide context for understanding the industry's performance and potential, market size, growth, trends, and segmentation, as well as data on industry players.
2. Technical - technology data - new technologies, innovations, products and services.
3. Social data - social trends, consumer preferences, and other demographic information that can provide insight into industry's impact.
4. Environmental data - environmental regulations, sustainability trends, and data on the industry's impact on the environment.
5. Labour data - employment trends, wages, job titles, and educational requirements for industry positions.
6. Government and policy data (EU, countries, regions) - government policies, regulations, subsidies.

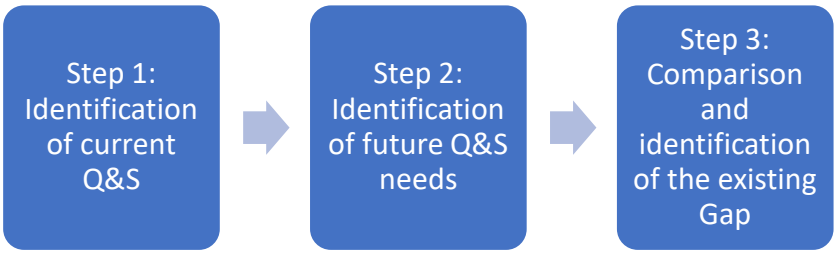
ii. **Technology foresight of the SES**

The goal of this section is to identify the technological innovations which are expected to grow in the future years. The procedure to achieve this goal involves collecting data and information on the current state of the sector, analysing trends and anticipating future changes. The proposed research methods are Desk research and/ or Focus Groups/Interviews. In SECOVE, the technology foresight intents to be used to anticipate changes especially related to skills and VET, to identify opportunities for collaboration between industry, education, and research.

### b. Qualifications and skills

In this section, the analysis is focusing in the qualifications of the labour force and is tending to relate the outcomes with the VET system. The methodology used, as shown in the following scheme, is consisted by three steps/ procedures:

1. List the existing Qualifications and Skills (Q&S) of the labour force related to SE and the respective Industry;
2. List the required Q&S of the labour force that are needed in order to meet the demands of the market / industry by 2030;
3. Compare and synthesize the two lists and identify the present gaps.




**Methodology for the identification of training needs.**

### c. Synthesis- recommendations

The analysis made in the subchapters of this study has resulted to the outcomes, which are synthesized to the final chapter in order to provide recommendations for policy makers for the modernization of VET. Each partner presents the suggestions and following steps which are necessary in order to achieve the initiated target. All the outcomes are gathered and further analyzed to the final chapter of this document "Conclusions- recommendations- outcomes" which combines the propositions into a core strategy for the VET system and its stakeholders which could enhance the fair transition to the EU's clean energy targets.

**REFERENCES**

[1] International Energy Agency, 2023. Renewables 2022 Analysis and forecast to 2027. Available at: https://iea.blob.core.windows.net/assets/ada7af90-e280-46c4-a577-df2e4fb44254/Renewables2022.pdf

[2] European Commission' site. Topic: "Renewable Energy Directive" https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en

[3] European Commission, Press release, 2023. “European Green Deal: EU agrees stronger legislation to accelerate the rollout of renewable energy”. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_23_2061

[4] Directive (EU) 2018/2001. The promotion of the use of energy from renewable sources. Available at: (recast) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC

[5] European Council, Policies, European Green Deal, Fit for 55. Available at: https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/

[6] European Commission’s Priorities. European Green Deal, Striving to be the first climate-neutral continent. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[7] European Commission, COM(2022). REPowerEU Plan. Available at:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483

[8] European Union Regional Policy, Smart Specialisation Platform, 2012. Guide to Research and Innovation Strategies for Smart Specialisation (RIS 3). Available at: https://gsri.gov.gr/wp-content/uploads/2021/07/RIS3-Guide-March-2012final_0204_en.pdf

[9] ESPA’ site- Hellenic Republic- Ministry of Development and Investements, Cohesion Policy. Research and Innovation Strategies for Smart Specialisation (RIS3). https://www.espa.gr/en/Pages/staticRIS3.aspx

[10] Hazelkorn, E and Edwards, J (2019). Skills and Smart Specialisation: The role of Vocational Education and Training in Smart Specialisation Strategies, Luxembourg: Publications Office of the European Union. Available at: https://s3platform.jrc.ec.europa.eu/documents/20125/247601/Skills+for+Smart+Specilisation+The+role+of+VET+in+S3.pdf/e514e042-96e6-2740-2463-ddb2dec79d3c?t=1621268542950

[11] European Commission, Press release, 2020. Commission presents European Skills Agenda for sustainable competitiveness, social fairness and resilience. Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1196

[12] CEDEPOF, Annual report, 2022. The future of work is Learning. Available at: https://www.cedefop.europa.eu/files/9182_en.pdf

[13] European Commission, European Website on Integration, 2020. European Skills Agenda for sustainable competitiveness, social fairness and resilience. Available at: https://ec.europa.eu/migrant-integration/library-document/european-skills-agenda-sustainable-competitiveness-social-fairness-and-resilience_en

[14] European Union’s site. European Year of Skills. https://year-of-skills.europa.eu/index_en

# 3 Analysis of selected industry sectors in five EU countries

## 3.1 Green buildings industry, Košice Region, Slovakia

### 3.1.1 The Green Buildings industry

The **green building industry** (GBI) refers to the practice of creating environmentally responsible and resource-efficient structures and using processes throughout a building's lifecycle. It is a holistic concept that starts with the understanding that the built environment can have profound effects, both positive and negative, on the natural environment, as well as on people's health and well-being. Green construction is a philosophy and process that makes the creation and usage of the built environment friendly to the natural environment. Therefore, **the green building industry** [1] encompasses various practices aimed at reducing environmental impact while promoting sustainability. Green Industry means economies striving for a more sustainable pathway of growth, by undertaking green public investments and implementing public policy initiatives. The **energy sector** has responded to the shift towards **green buildings** by recognizing the critical role that buildings can play in meeting climate change ambitions. The implementation of energy efficiency improvements in the building sector requires developing innovative, reliable and high-quality technologies and infrastructure.

According to EPA (epa.gov, [18]) we can define impacts of the built environment as presented in Box 1:

BOX 1

| **Built life cycle Environment:** | **Consumption:** | **Environmental Effects:** | **Final Effects:** |
|---|---|---|---|
| Siting | Energy | Waste | Harm to Human Health |
| Design | Water | Air pollution | Environment Degradation |
| Construction | Materials | Water pollution | Loss of Resources |
| Operation | Natural Resources | Indoor pollution | |
| Maintenance | | Heat islands | |
| Renovation | | Stormwater runoff | |
| Deconstruction | | Noise | |

Commonly used definitions of the **sustainability in energy sector** include increasing the production of renewable energy, making safe energy universally available, and practicing energy conservation. Contribution between the *green building industry and sustainable energy* is essential for achieving sustainable goals in green building projects.

Green buildings are responsible for around 33-35% of greenhouse gas emissions, making them a major contributor to climate change. To reduce this impact, green buildings must incorporate measures that are environmentally friendly and resource-efficient across the building lifecycle [2].

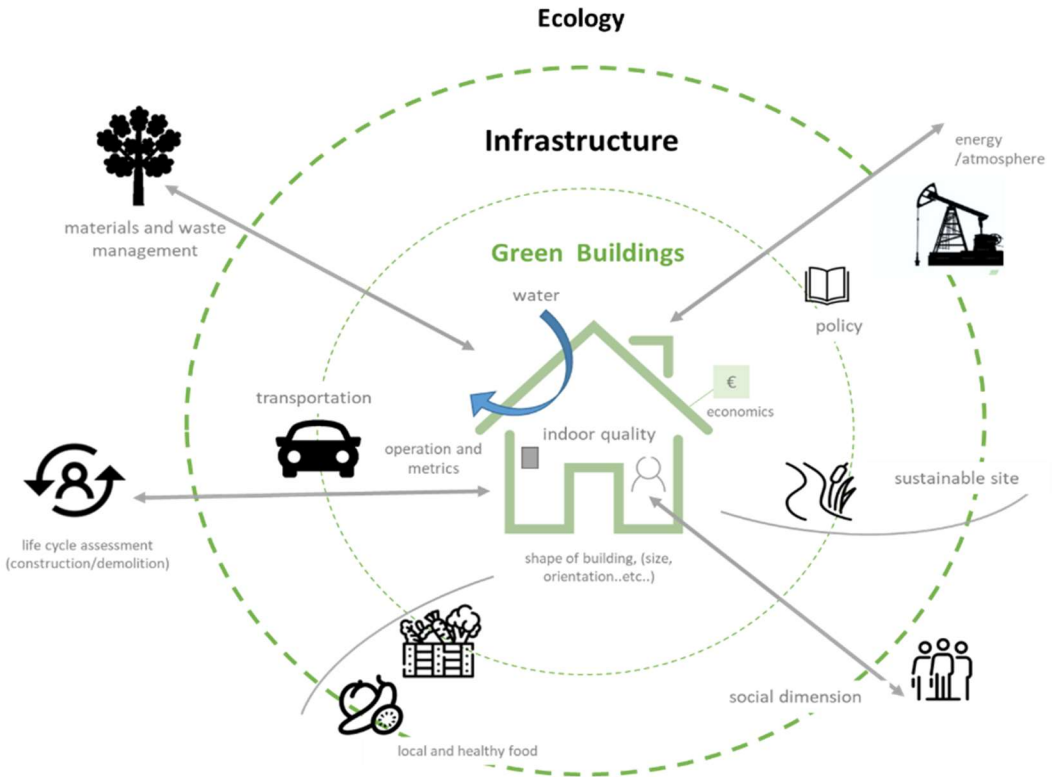



*Figure 1 Green building and its impact on other spheres*

*(Source: [3])*

To deal with the various problems the construction industry is facing, the concept of green buildings (GBs) has been gradually shaped and put forward and green building rating systems (GBRSs) have been developed. The concept of GBs covers a wide range of elements, and its definition is constantly updated depending on country origin and as the construction industry develops (Table 1.).

Table 1 Example of GB definition in the world [4]

| Country | Definition |
|---|---|
| **USA** | A GB is a building that, in its design, construction, or operation reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment |
| | Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle, from siting to design, construction, operation, maintenance, renovation, and deconstruction |
| | The planning, design, construction, and operations of buildings with several central, foremost considerations: energy use, water use, indoor environmental quality, material use, and the building's effects on its site |
| **UK** | The GB Certification BREEAM could represent the concept of GBs that are more sustainable environments that enhance the well-being of the people who live and work in them, help protect natural resources, and make more attractive property investments |
| **EU** | A Sustainable Building contributes in some way to preserving the environment, also increasingly extends to the idea of the well-being of the occupants, both in terms of space usage and air quality |

| | |
|---|---|
| **Germany** | Sustainable building means using and introducing available resources consciously, minimizing energy consumption and preserving the environment |
| **France** | Certificated sustainable building endorse the overall performance of a building and that of the four areas considered by the certification scheme: energy, environment, health and comfort |
| **Australia** | Green Building incorporates principles of sustainable development, meeting the needs of the present without compromising the future |
| **Japan** | A sustainable building (green building) is one which is designed: (1) to save energy and resources, recycle materials, and minimize the emission of toxic substances throughout its life cycle; (2) to harmonize with the local climate, traditions, culture, and surrounding environment; and (3) to be able to sustain and improve the quality of human life while maintaining the capacity of the ecosystem at the local and global levels |
| **China** | Green building refers to a building that saves resources to the extent within the whole life cycle of the building, including saving energy, land, water, and materials while protecting the environment and reducing pollution so it provides people with a healthy, comfortable, efficient use space, and works in harmony with nature |
| **Singapore** | Green building is energy and water efficient, with a high quality and healthy indoor environment, integrated with green spaces and constructed from eco-friendly materials |

BOX 2

**Slovak Republic (SR)**

We can define the **green building** as an energy-efficient building that has a high-quality indoor environment, uses water management methods, circular economy principles and sustainable materials, and at the same time has a positive impact on the surrounding environment. It is an environmentally sustainable building, designed, constructed and operated to minimise the total environmental impacts.

**Goals**

- economy-wide energy savings of 30.3% by 2030
- from 2021 all new buildings are required to be 'nearly zero-energy buildings' (NZEB)
- national target for greenhouse gas emissions in non-ETS sectors is -20% compared to the 2002 level
- planned total share of renewable energy sources (RES) for 2030 is 19.2%, (lower than the EU's goal of 32%.)
- achievement of economy-wide energy savings and reduce greenhouse gas emissions while promoting renewable energy sources and nearly zero-energy buildings
- defining policies

The interrelations between the green building industry with RIS3 can be inferred that RIS3 SR aims to promote research and innovation in sustainable construction.

However, even green buildings have their advantages and disadvantages. On the one hand, they can bring long-term economic benefits to owners and create a healthy and pleasant indoor environment for occupants. On the other hand, the initial costs of building and implementing green technologies can be high, the availability of certain materials or technologies may be limited, and the savings and returns may prove to be poorly estimated. In addition, the effectiveness of green building strategies may depend on factors such as climate, location and building. Green Building Pros & Cons are presented in BOX 3.

BOX 3
**Green Building Pros & Cons Summary List**

| Green Building Pros | Green Building Cons |
|---|---|
| Energy-efficiency improvements | High construction costs |
| Water preservation | Technology relatively new and immature |
| Less waste | Hard to find qualified workers |
| Better recycling | Maintenance issues |
| Protection of our natural resources | Technology issues |
| Less particle pollution | Unclear long-term effects and risks |
| Less air pollution | Indoor air temperature may vary |
| Overall health improvements | Financing may be an issue |
| Higher property value | Design of green buildings can be exotic |
| Sustainable construction practice | Lack of availability of green materials |

*Source: [5]*

In addition to contribution between the green building industry and sustainable energy sector, it is also important to ensure that formal policies, standards, and incentives are in place to support green buildings. This will help to reduce energy consumption and environmental impact while continuing to refine mechanisms for implementing green buildings in the future. Also, deficiencies in the supply of skills and training for green building can function as an important barrier to progress. EU is implementing strategies towards green transition.

#### *3.1.1.1 Status Quo of the Green Buildings industry*

The EU is implementing various policies and targets, legislative measures and initiatives on green buildings, such as the Green Deal and the Circular Economy Action Plan. Targets are being set, the feasibility of which can be debated. European countries are nowadays embarking on a transition towards climate neutrality, digital leadership and net-zero technologies. Driven by the combined energy and climate crises, the European Union is becoming more and more aware of the need to switch to a green economy.

The EU has set three key targets for 2030 on greenhouse gas emissions reduction, renewable energy share, and energy efficiency. The EU wants to accelerate the take-up of renewables to contribute to reducing net greenhouse gas emissions by at least 55% by 2030 [6], while the 2030 Climate and Energy Framework maintains the target structure of the EU's 2020 Package, which aims to cut greenhouse gas emissions by 20 percent, increase renewable energy share, and improve energy efficiency [7]. The European Union's 2030 climate and energy package introduced fundamental changes compared to its 2020 predecessor.

EU has implemented a number of legislative measures to promote the green industry sector. This includes repurposing existing EU funds, faster approval of green projects, and drives to boost skills and secure supplies of critical raw materials [8]. The EU Climate Law requires that all EU policies contribute to achieving the EU Green Deal objective. The EU Green Deal also includes actions to strengthen the decarbonisation efforts in industry, such as product sustainability and the supply of raw materials. The adopted Circular Economy Action Plan presents opportunities for SMEs which are already producing food and textiles in conformance with sustainability standards [9]. Additionally, the EU Biodiversity strategy will work in tandem with the Farm to Fork strategy by focusing on restoring forests, soils and wetlands and creating green spaces in cities. To address legislative gaps that hinder improving biodiversity standards across the EU, the EU will implement a new Nature Restoration Act.

In order to incentivize investments necessary for climate action while maintaining protection against carbon-leakage risk, the European Commission outlined several industry-focused proposals in its Fit for 55 package. These include tighter regulations on emissions trading schemes and effort sharing regulations, complemented by a carbon border adjustment mechanism (CBAM) [10].

The green building industry has seen rapid growth in recent years, with the global buildings construction market projected to reach $11,121.90 billion by 2030. This growth is being driven by a growing global focus on green construction methods to fulfil sustainability goals [9]. This is part of the EU's plan to reduce net greenhouse gas emissions by at least 55% by 2030. To achieve this goal, the European Commission has proposed amending the Renewable Energy Directive, which seeks to increase the current target to at least 40% renewable energy sources in the EU's overall energy mix by 2030 [6].

Buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions in the EU. The efficiency of energy use for heating, cooling, lighting, etc., the thermal insulation and other characteristics of private and public buildings, which result from their construction and/or their use, determine the level of energy consumption and CO2 emissions that a building is responsible for. Improved building materials with enhanced insulation properties, energy saving systems and devices, even renewable energy generation capacity, have been introduced to reduce the carbon footprint of buildings with the end goal of a decarbonised building stock by 2050.

The EU has established a legislative framework to facilitate this transition. It includes the Energy Performance of Buildings Directive (EPBD) and the Energy Efficiency Directive, which have been recently amended as part of the Clean Energy for All Europeans packages. While making sure that the carbon footprint of buildings is reduced, it is equally important to ensure the building sector's resilience vis-à-vis future climatic conditions and extreme weather events.

Building codes increasingly foresee measures in that regard, as part of a broader effort to minimise the adverse effects of climate change on core human infrastructure. Several measures are actually of dual use, for example reducing the energy needed to heat buildings, while also insulating the buildings from the higher external temperatures on warm days. Improving the energy performance of Europe's building stock is crucial, not only to achieve the EU's 2020 and 2030 targets but also to meet the longer-term climate objectives as laid down in the low carbon economy roadmap 2050 [11].

BOX 4

**The average performance of green buildings to non-green buildings comparison:**

- 13% lower maintenance costs;
- 24-50% lower energy consumption;
- 33-39% lower CO2 emissions;
- 40% less water consumption;
- 70% less solid waste in landfills;
- 27% higher user satisfaction

*Source: [12]*

Another very important from the economical point of view is the payback period for the investment in green buildings. This issue is crucial for many investors. Payback period is particularly essential for certain commercial

markets such as office, multi-residential housing or hotels, in which properties regularly change ownership. According to several studies focus on problematics of green buildings, e.g., the median payback period is 8 years. Payback period for cost of a green retrofit or renovation projects is a median 6 years [13].

Additionally, Slovakia's 'Integrated National Energy and Climate Plan for 2021 to 2030' (will be updated in June 2023) framework aims to increase the share of renewables in the energy mix to at least 32% by 2030. These initiatives demonstrate a commitment to transitioning to a circular, sustainable, and low-carbon economy by 2040.

Buildings are a global scale mainly measured on the basis of certification systems. **Certification of green buildings** is an indicator of quality and also a guarantee of comprehensive embodiment of buildings. They demonstrate that buildings are made from quality materials, they are environmentally friendly and users have created a suitable environment for their daily activities. At present widespread use of certification systems is in the construction industry all around the world. Box 5 shows advantages and disadvantages of rating systems.

BOX 5

**The main benefits of using rating systems are competitive:**

| advantage | disadvantage |
|---|---|
| • marketing; provides ability to create better design and realization of buildings | • additional costs and time during the planning and realization |
| • buildings are more environmentally friendly | • difficulties with rating systems |
| • opportunity to obtain financial support from government or municipality | • difficulties with documentation processes |

According to experts from Yale University, the four most common green building certifications include LEED (Leadership in Energy and Environmental Design), WELL, the Living Building Challenge, and Energy Star. LEED certification is the most common certification found around the world. A study conducted in 2016 compared the energy use of large green office buildings with similar non-green buildings. The results showed that, on average, LEED certified buildings used 18-39% less energy per square foot than their conventional counterparts [14]. Another study found that LEED office buildings used 10-15% less site energy than comparable conventional buildings [15].

In conclusion, green buildings are designed to be more energy-efficient than non-green buildings. Studies have shown that LEED-certified office buildings use less site energy than comparable conventional buildings. Green building strategies can include passive design, green roofs, energy-efficient lighting, HVAC systems, and renewable energy production on-site via solar panels. Ensuring energy efficiency in green buildings means integrating smart technologies during construction and strategically using them in everyday life.

#### *3.1.1.2 Major technological changes in the Green Buildings industry (GBI)*

The clean energy and sustainability economy continues to be a large and growing source of jobs all over the world. Technological progress is one of the drivers to finding lasting solutions to both economic and environmental challenges, such as providing new jobs and promoting energy efficiency. Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development. A wide range of existing occupations are affected, but in some cases new occupations are in five occupational clusters for green buildings BOX 6:

BOX 6

**Five different occupational clusters for green buildings:**

1.Site and design

2.Construction

3.Operation and maintenance, controlling

4.Renovation and deconstruction

5. Education and policy, promotion

*Source:[16]*

The sustainable energy sector has created many new jobs in recent years. According to a report by the International Labor Organization (ILO), worldwide employment in the renewable energy sector reached 12.7 million last year, a jump of 700,000 new jobs in just 12 months. The report also highlighted the need for skills development and inclusivity for clean energy transitions to ensure that workers have access to jobs related to clean energy technologies.

Therefore, **technological change** has major impact on professions and specializations related to the **sustainable energy sector.**

BOX 7

**Drivers of skills change**

- Change in the natural or build environment
- Policy or regulation
- New technologies
- Markets for green industries (competitive advantage)
- Consumer habits
- People with the right skills can act as drivers of change in the green building sector

**Green structural change**

- Need of additional jobs/specialisation
- Substituted jobs
- Certain jobs may be eliminated without direct replacement
- Many existing jobs will be redefined
- New jobs created will offset those lost
- But those who will get green jobs are not necessarily those who will have lost their jobs

*Source: [16]*

On February 24th, 2023 the panel discussion of Focus group consisted directly of stakeholders, civil engineering chamber representatives, university representatives, designers and energy auditor, experts took interesting and high-quality discussions that identified the trends on technological changes in GBs and their impact on qualifications and skills in our country. In SR there is still the huge potential in applying a green concept in the sector of existing residential buildings and the public buildings sector and related education at universities and creation of vocational centers of excellence as well. The conclusions of experts, literature review (based on outputs of ILO report: [16]) and current state of art is presented in the following table 2:

Table 2 Technological change

<table>
<tr><td colspan="6">Green Architecture<br>(in general)<br>design of buildings with the lowest possible negative impact on the surrounding environment by using sustainable materials and energy sources in construction</td></tr>
<tr><td>Technological change</td><td colspan="5">Affected professions / specializations</td></tr>
<tr><td rowspan="4">1. Bioclimatic design and Biomimicry<br><br>(both approaches aim to create high-performing buildings that are energy-efficient and environmentally friendly)<br><br>Technology<br>The bioclimatic design focuses on designing buildings based on local climate conditions and human comfort requirements, biomimicry focuses on emulating nature's</td><td rowspan="2">Siting and Design</td><td>Conception<br><br>Planning<br>Designing<br>Advising</td><td colspan="3">Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br><br>Architectural Technicians / Technical Drawing Specialists<br><br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists</td></tr>
<tr><td rowspan="3">Construction</td><td rowspan="3">Installation</td><td colspan="3">Building Site Supervisors, Site Engineers and Site Architects,<br>Environmental health and safety specialist</td></tr>
<tr><td rowspan="4">Conservation</td><td>Insulation</td><td>Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers; Technician Painters/Decorators, as well as semiskilled<br>occupations that assist</td></tr>
<tr><td>Efficient Heating & Cooling</td><td>Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians</td></tr>
<tr><td>Conservation of Electric Power</td><td>Electricians and Installers of Energy Management<br>(energy efficient appliances and lighting technologies)<br>Storage and Distribution Managers</td></tr>
<tr><td>Water</td><td>Plumbers, Green plumbers<br>Installers<br>Electricians and IT Technicians</td></tr>
<tr><td rowspan="2">Building Level RE</td><td>Heating / Cooling</td><td>Installers of Solar Thermal Systems<br>Installers of Wood Pellet<br>Installers other Biomass Heating systems<br>Installers of Mass Heating</td></tr>
<tr><td>Electricity</td><td>Installers of Small-Scale Wind Energy Systems<br>Heat Pump Installers<br>Remote Sensing Scientists and Technologists</td></tr>
</table>

| | | | | | |
|---|---|---|---|---|---|
| designs to create more sustainable structures. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** Biomimicry includes biomimicry specialists, researchers, designers, engineers, and educators. Developing skills in bioclimatic design requires a multidisciplinary approach that combines knowledge of climate science, materials science as well as energy efficiency and sustainable building practices. | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Roofers, Builders<br>Weatherization Installers and Technicians |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors,<br>Quality Controllers, Energy efficiency analyst<br>Inspectors, Certifiers, Diagnostics, Facility Manager, Intelligent green building manager | | |
| | Renovation and | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable design specialist<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors | | |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing, Financial Quantitative Analysts<br>Educators and Information Providers, Researchers | | |
| | | Manufac. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians | | |
| | | Green building clients | Developers<br>Energy Managers<br>Householders<br>Facilities Managers<br>Building Managers | | |

| Technological change | Affected professions / specializations | | | | |
|---|---|---|---|---|---|
| ***2. Green insulation*** (is insulation that is made from natural, recyclable, non-toxic, and eco-friendly materials)<br><br>**Technology**<br>Green insulation not only helps reduce energy consumption but also helps lower carbon footprints and also improve the health and comfort of building occupants | Siting and Design | Conception<br>Planning<br>Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects<br>Environmental health and safety specialist | | |
| | | | Conservation | Insulation | Bricklayers, Carpenters, Roofers, Plasterers |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power (not electric heating & cooling) | Electricians and Installers of Energy Management Systems (energy efficient appliances and lighting technologies)<br>Storage and Distribution Managers |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating<br>Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

<table>
<tr><td rowspan="11">Required Specializations: Professionals need to be trained on how to properly install green roofs, walls, and facades and maintenance workers need to be trained on how to properly maintain these systems in order to ensure their effectiveness over time. The implementation of green walls involves designing supporting structures that are purposely designed for climbing plants or cascading ground covers. Therefore developing skills requires a multidisciplinary approach that combines knowledge of horticulture, materials</td><td rowspan="5">Operation and Maintenance</td><td rowspan="4">Maintenance</td><td rowspan="3">Conservation</td><td>Insulation/Weatherization</td><td>Roofer, Builder,<br>Weatherization Installers and Technicians</td></tr>
<tr><td>Efficient Heating & Cooling</td><td>Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians</td></tr>
<tr><td>Conservation of Electric Power</td><td>Electricians and Maintainers of Energy Management Systems</td></tr>
<tr><td>Building Level RE</td><td>Heating / Cooling</td><td>Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating Large Building or Heat Pump Maintainers</td></tr>
<tr><td>Controlling</td><td colspan="3">Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics</td></tr>
<tr><td rowspan="2">Renovation and</td><td>Designing Advising</td><td colspan="3">Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors</td></tr>
<tr><td rowspan="5">Education and Policy, Promotion</td><td>Education Research Financing</td><td colspan="3">Policy Makers, Urban Planners<br>Financing, Financial Quantitative Analysts<br>Educators and Information Providers, Researchers</td></tr>
<tr><td>Manufact. Distribut.</td><td colspan="3">Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians</td></tr>
<tr><td>Green building clients</td><td colspan="3">Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers</td></tr>
</table>

| | | | |
|---|---|---|---|
| science as well as energy efficiency and sustainable building practices | | | |

| Technological change | Affected professions / specializations | | | | |
|---|---|---|---|---|---|
| ***3. Zero-Energy Buildings***<br><br>(designed and built to consume as little energy as possible, and when a renewable source of energy is added to these buildings, they can produce as much energy as they consume)<br><br>**Technology**<br>Construction of net-zero energy buildings requires smart design, solar tempering, energy modeling, super- | Siting and Design | Conception<br>Planning<br>Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects<br>Environmental health and safety specialist | | |
| | | | Conservation | Insulation | Bricklayers; Carpenters;<br>Plasterers; Glaziers; Masons; Roofers;<br>Plasterers; Painters/Decorators, as well as semiskilled<br>occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems<br>Storage and Distribution Managers |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems<br>Heat Pump Installers |
| | | | | Electricity | Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| sealing the building envelope, and other features. They use renewable technologies to produce energy while reducing the overall use of energy with highly efficient HVAC systems, insulation, and lighting. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** Specialized knowledge in sustainable building practices is required, renewable energy technologies, materials science, and engineering principles. Professionals need to be trained on how to properly implement zero-energy design principles | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Weatherization Maintainers and Technicians<br>Semiskilled occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation and | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors | | |
| | Ed | Education | Policy Makers, Urban Planners | | |

| | | | | | |
|---|---|---|---|---|---|
| and maintenance workers may need to be trained on how to properly maintain zero-energy systems in order to ensure their effectiveness over time. | | Research Financing | | | Financing<br>Educators and Information Providers, Researchers |
| | | Manufact. Distribut. | | | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians |
| | | Green building clients | | | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers |

| **Technological change** | **Affected professions / specializations** | | | | |
|---|---|---|---|---|---|
| ***4. Cool-roof systems***<br><br>*(reflect sunlight and absorb less heat than traditional roofs, reducing the need for air conditioning during hot weather)*<br><br>**Technology**<br>They are designed to reflect more sunlight than conventional roofs, | Siting and Design | Conception | | | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists |
| | | Planning<br>Designing | | | Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers |
| | | Advising | | | Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists |
| | Construction | Installation | | | Building Site Supervisors, Site Engineers and Site Architects<br>Environmental health and safety specialist |
| | | | Conservation | Insulation | Bricklayers; Carpenters;<br>Plasterers; Glaziers; Masons; Roofers;<br>Decorators, as well as semiskilled occupations that assist<br>Weatherization Installers and Technicians |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers, Green plumbers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems<br>Storage and Distribution Managers |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |

| | | | | | |
|---|---|---|---|---|---|
| which helps to lower the temperature of the building and reduce energy consumption for cooling. | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** Professionals need to be trained on how to properly install cool-roof systems and maintenance workers need to be trained on how to properly maintain cool-roof systems in order to ensure their effectiveness over time. The use of cool-roof | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Weatherization Maintainers and Technicians |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or<br>District) and Combined Heat and Power (CHP) Systems<br>Heat Pump Maintainers |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation and Deconstruction | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management<br>Analysts, Consultants and Advisors, Sustainable Design specialist | | |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers | | |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians | | |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers | | |

| | | | |
|---|---|---|---|
| systems may also require specialized knowledge of energy efficiency and sustainable building practices. | | | |

**Green Infrastructure for GBs**
(in general)
refers to any practice that uses or replicates natural systems to achieve a desired outcome. It includes green roofs etc., sustainable water management systems. It can reduce energy use and the urban heat island effect, which lowers carbon dioxide emissions from regional electricity generation

| **Technological change** | **Affected professions / specializations** | | | | |
|---|---|---|---|---|---|
| ***1. Sustainable water management***<br><br>*(*the energy sector can benefit from sustainable water management practices by reducing water consumption, improving energy efficiency, and minimizing the environmental impact of power generation*)*<br><br>**Technology**<br>Various | Siting and Design | Conception<br><br>Planning<br>Designing<br><br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br><br>Architectural Technicians / Technical Drawing Specialists<br><br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br><br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects<br>Environmental health and safety specialist | | |
| | | | Conservation | Insulation | Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers;<br>Plasterers; Painters/Decorators, as well as semiskilled<br>occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems<br>Storage and Distribution Managers |
| | | | | Water | Plumbers, Installers, Electricians and IT Technicians<br>Water resources specialist |

| | | | | | |
|---|---|---|---|---|---|
| techniques for sustainable water management such as metering, measuring, and managing water use, optimizing cooling towers, replacing restroom fixtures, eliminating single-pass cooling, using rainwater harvesting systems, grey water systems, stormwater management,...etc. | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** SWM requires specialized knowledge in hydrology, ecology, engineering principles as well as energy efficiency and sustaina | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers;<br>Plasterers; Painters/Decorators, as well as semiskilled<br>occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or<br>District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers |
| | | Controlling | Energy Auditors<br>Quality Controllers | | |

| | | | |
|---|---|---|---|
| ble building practices. Professionals involved in building design and construction need to be trained on how to properly implement sustainable water management principles. and maintenance workers need to be trained on how to properly maintain sustainable water management systems in order to ensure their | | | Inspectors, Certifiers, Diagnostics |
| | Renovation and Deconstruction | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management<br>Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers |

| | | | | | |
|---|---|---|---|---|---|
| effectiveness over time | | | | | |

| Technological change | Affected professions / specializations | | | | |
|---|---|---|---|---|---|
| ***2. Green roofs, walls and facades (incorporate vegetation into building design to provide environmental benefits)***<br><br>**Technology**<br>Green roofs, walls, and facades can mitigate environmental problems such as urban heat islands, air pollution, stormwater runoff, and loss of biodiversity, provide aesthetic benefits by adding greenery to urban areas. | Siting and Design | Conception<br>Planning<br>Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects | | |
| | | | Conservation | Insulation | Bricklayers; Carpenters;<br>Plasterers; Glaziers; Masons; Roofers;<br>Painters/Decorators, as well as semiskilled occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems<br>Storage and Distribution Managers |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** Professionals need to be trained on how to properly install green roofs, walls, and facades and maintenance workers need to be trained on how to properly maintain these systems in order to ensure their effectiveness over time. The implementation of green walls involves designing supporting structures that | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers; Painters/Decorators, as well as semiskilled occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation and Deconstruction | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management<br>Analysts, Consultants and Advisors, Sustainable Design specialist | | |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers | | |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians | | |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br><br>Building Managers | | |

| | | | |
|---|---|---|---|
| are purposely designed for climbing plants or cascading ground covers. Therefore developing skills requires a multidisciplinary approach that combines knowledge of horticulture, materials science as well as energy efficiency and sustainable building practices. | | | |

| Technological change | | | Affected professions / specializations |
|---|---|---|---|
| ***3. Vertical farming systems (VfS)*** (the energy consumption | Siting and Design | Conception | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists |
| | | Planning | Architectural Technicians / Technical Drawing Specialists |

| | | | | | |
|---|---|---|---|---|---|
| of vertical farming systems is a significant concern for their sustainability)<br><br>**Technology**<br>Energy consumption sources in vertical farming include lighting, heating, cooling, ventilation, and water management practices. | | Designing<br>Advising | HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects<br>Environmental health and safety specialist | | |
| | | | Conservation | Insulation | Semiskilled occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power (not electric heating & cooling) | Electricians and Installers of Energy Management Systems<br>(energy efficient appliances and lighting technologies) |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:**<br>VfS required skills in sustainable energy management and multidisciplinary approach that combines knowledge of materials science, engineering | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | -- |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers |

| | | | |
|---|---|---|---|
| principles as well as energy efficiency and sustainable building practices. Professionals involved in building design and construction need to be trained on how to properly implement sustainable energy management principles and maintenance workers need to be trained on how to properly maintain sustainable energy management systems. | | | Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics |
| | Renovation and | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers |

| **Renewable energy sources in GBs**<br>(in general)<br>used in green buildings to reduce negative environmental impacts and promote sustainability | | | |
|---|---|---|---|
| **Technological change** | **Affected professions / specializations** | | |
| **1. Solar energy (SE) and use of photovoltaic panels**<br><br>(is a clean, renewable source of energy that | Siting and design | Conception | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists |
| | | Planning Designing | Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers |
| | | Advising | Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists |
| | Co | | Building Site Supervisors, Site Engineers and Site Architects |

| | | | | | |
|---|---|---|---|---|---|
| can be used to power up buildings with green energy)<br><br>**Technology**<br>Solar power is generated from sunlight, which is converted into electricity through solar photovoltaic panels. | | Installation | Environmental health and safety specialist | | |
| | | | Conservation | Insulation | Roofers, Builders, |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems (at domestic level - energy efficient appliances and lighting technologies |
| | | | | Water | Plumbers, Installers, Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |
| **Required Specializations:**<br>SE requires a multidisciplinary approach that combines knowledge of materials science, engineering principles as well as energy efficiency and sustainable building practices. Profesionals need to be trained on | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Roofers, Builders, |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers | | |

| | | | |
|---|---|---|---|
| how to properly implement solar energy management principles and maintenance workers need to be trained on how to properly maintain solar energy systems in order to ensure their effectiveness over time. | | | Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | Education<br>Research<br>Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers |
| | | Manufact.<br>Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers |

| Technological change | Affected professions / specializations | | | |
|---|---|---|---|---|
| ***2. Geothermal, biomass energy source and use of the heat pumps***<br><br>*(*significantly reduce the negative environmental impacts of building operations while promoting sustainable development) | Siting and Design | Conception<br>Planning Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects<br>Environmental health and safety specialist | |
| | | | Conservation | Insulation — Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers |
| | | | | Efficient Heating & Cooling — Plumbers and Heating Installers; HVAC Installers; Electricians and IT Technicians |
| | | | | Conservation of Electric Power (not electric heating & cooling) — Electricians and Installers of Energy Management Systems (energy efficient appliances and lighting technologies) |
| | | | | Water — Plumbers, Installers, Electricians and IT Technicians |
| | | | | Heating / Cooling — Installers of Solar Thermal Systems |

| | | | | | |
|---|---|---|---|---|---|
| **Technology** Geothermal energy can be used for heating and cooling applications through geothermal heat pump systems that exchange heat from the earth. Biomass energy can be generated by burning organic material or converting it into liquid fuels. Heat pumps, including geothermal heat pumps, use electricity to move heat from one place to another. | | | Building Level RE | | Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** It requires multidisciplinary approach that combines knowledge of | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers;<br>Painters/Decorators, as well as semiskilled occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | | Heating / Cooling | Maintainers of Solar Thermal Systems |

| | | | | | |
|---|---|---|---|---|---|
| materials science, engineering principles as well as energy efficiency and sustainable building practices. Professionals need to be trained on how to properly implement geothermal and biomass energy management principles and install the heat pump and maintenance workers need to be trained on how to properly maintain geothermal, biomass energy and heat pumps. | | | Building Level RE | | Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation and Deconstruction | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | | |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers | | |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians | | |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers | | |

| **Technological change** | **Affected professions / specializations** |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| ***3. Seasonal energy storage***<br><br>*(is the process of storing energy for extended periods of time, such as over the course of a season)*<br><br>**Technology**<br>Thermal energy storage systems are used to store heat in a fluid such as water or molten salt, or other material. It can be as simple as hot-water tanks, but more advanced technologies can store energy more densely. Water sorption-based thermochemical storage materials are also being developed to store energy for short-term and extended periods. | Siting and Design | Conception<br>Planning<br>Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects | | |
| | | | Conservation | Insulation | Bricklayers; Carpenters;<br>Plasterers; Glaziers; Masons; Roofers;<br>Plasterers; Painters/Decorators, as well as semiskilled occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power (not electric heating & cooling) | Electricians and Installers of Energy Management Systems<br>(at domestic level, mostly responsibility of individual householders to choose energy efficient appliances and lighting technologies) |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

<table>
<tr><td rowspan="11">Required Specializations:<br>It requires multidisciplinary approach that combines knowledge of materials science, engineering principles as well as energy efficiency and sustainable building practices. Professionals need to be trained on how to properly implement thermal energy storage principles and maintenance workers need to be trained on how to properly maintain energy storage systems in order to ensure their effectiveness over time.</td><td rowspan="6">Operation and Maintenance</td><td rowspan="5">Maintenance</td><td rowspan="4">Conservation</td><td>Insulation/Weatherization</td><td>Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers;<br>Plasterers; Painters/Decorators, as well as semiskilled<br>occupations that assist</td></tr>
<tr><td>Efficient Heating & Cooling</td><td>Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians</td></tr>
<tr><td>Conservation of Electric Power</td><td>Electricians and Maintainers of Energy Management Systems</td></tr>
<tr><td>Water</td><td>Maintainers Electricians and IT Technicians</td></tr>
<tr><td rowspan="2">Building Level RE</td><td rowspan="2">Heating / Cooling</td><td>Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems</td></tr>
<tr><td>Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems</td></tr>
<tr><td>Controlling</td><td colspan="3">Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics</td></tr>
<tr><td rowspan="2">Renovation and</td><td>Designing Advising</td><td colspan="3">Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management<br>Analysts, Consultants and Advisors, Sustainable Design specialist</td></tr>
<tr><td rowspan="3">Education and Policy, Promotion</td><td>Education Research Financing</td><td colspan="3">Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers</td></tr>
<tr><td>Manufact. Distribut.</td><td colspan="3">Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians</td></tr>
<tr><td>Green building clients</td><td colspan="3">Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br><br>Building Managers</td></tr>
</table>

| Technological change | Affected professions / specializations |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| ***4. Green hydrogen and fuel cells***<br><br>*(is a type of hydrogen produced by splitting water into hydrogen and oxygen using renewable electricity such as solar or wind power)*<br><br>**Technology**<br>It can be produced from a variety of domestic resources, including natural gas, nuclear power, biomass, and renewable power sources. Green hydrogen is considered a clean energy source because it does not produce greenhouse gas emissions during production or use. Fuel cells are devices | Siting and Design | Conception<br>Planning<br>Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects | | |
| | | | Conservation | Insulation | Bricklayers; Carpenters;<br>Plasterers; Glaziers; Masons; Roofers; |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power (not electric heating & cooling) | Electricians and Installers of Energy Management Systems<br>(at domestic level, mostly responsibility of individual householders to choose energy efficient appliances and lighting technologies) |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| that convert the chemical energy of hydrogen into electrical energy without combustion. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** It requires multidisciplinary approach that combines knowledge of materials science, engineering principles as well as energy efficiency and sustainable building practices. Professionals need to be trained on how to properly implement green hydrogen and fuel cell technology principles and maintenance workers need to be trained on how to properly maintain green hydrogen | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers;<br>Plasterers; Painters/Decorators, as well as semiskilled<br>occupations that assist |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation and | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management<br>Analysts, Consultants and Advisors, Sustainable Design specialist | | |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers | | |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians | | |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers | | |

| | | | |
|---|---|---|---|
| and fuel cell systems in order to ensure their effectiveness over time. | | | Building Managers |

| **Smart systems for GBs**<br>(in general)<br>AI, intelligent energy management systems based on multiple renewable energy sources can be used to optimize energy consumption and reduce negative environmental impacts | | | | | |
|---|---|---|---|---|---|
| **Technological change** | **Affected professions / specializations** | | | | |
| ***1. Use of smart appliances*** *(can be used in green buildings to promote energy efficiency and responsible energy use)*<br><br>**Technology**<br>Smart, green buildings have digital control systems that automate building operations and smart appliances can work together for improved reliability. Smart appliances are | Siting and Design | Conception<br><br>Planning Designing<br><br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br><br>Architectural Technicians / Technical Drawing Specialists<br><br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br><br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects | | |
| | | | Conservation | Insulation | Roofers, Builders |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems energy efficient appliances and lighting technologies |
| | | | | Water | Plumbers, Installers<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br><br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| designed to optimize energy consumption by using sensors and automation to adjust their operation based on usage patterns and environmental conditions (smart thermostats, smart lighting systems, and smart power strips) | | | | | |
| **Required Specializations:** Professionals need to be trained on how to properly implement smart appliance installation principles and maintenance workers may | Operation and Maintenance | Maintenance | Conservation | Insulation/Weatherization | Roofers, Builders |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics | | |
| | Renovation and | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br><br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers | | |

| | | | |
|---|---|---|---|
| need to be trained on how to properly maintain smart appliance systems. | | | Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable design specialist |
| | Education and Policy, Promotion | Education<br>Research<br>Financing | Policy Makers, Urban Planners<br>Financing<br><br>Educators and Information Providers, Researchers |
| | | Manufact.<br>Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers |

| Technological change | Affected professions / specializations | | | |
|---|---|---|---|---|
| ***2. Green Artificial intelligent (AI) assistants*** *(sustainable AI shows intelligent solutions from predictive and prescriptive energy consumption insights to intelligent energy generation and distribution )*<br><br>**Technology** The goal of Green AI is to integrate technology and sustainability into a | Siting and Design | Conception<br>Planning<br>Designing<br>Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers, Sustainable Design Specialists<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | |
| | Construction | Installation | Building Site Supervisors, Site Engineers and Site Architects | |
| | | | Conservation | Insulation | Bricklayers; Carpenters;<br>Glaziers; Masons; Roofers |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Installers<br>HVAC Installers<br>Electricians and IT Technicians |
| | | | | Conservation of Electric Power | Electricians and Installers of Energy Management Systems (at domestic level, mostly responsibility of individual householders to choose energy efficient appliances and lighting technologies) |
| | | | | Water | Plumbers, Installers,<br>Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Installers of Solar Thermal Systems<br>Installers of Wood Pellet and other Biomass Heating systems<br>Installers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Installers |
| | | | | Electricity | Installers of Small-Scale Wind Energy Systems<br>Remote Sensing Scientists and Technologists |

| | | | | | |
|---|---|---|---|---|---|
| unified ecosystem, reducing the negative environmental impacts of AI development and use. AI has great potential in cutting down on energy waste, lowering costs, accelerating clean renewable energy use, designing efficient district heat pump systems for buildings, equipping building managers with occupancy data for timely heating/ cooling decisions. . | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Required Specializations:** Multidisciplinary | Operation and | Maintenance | Conservation | Insulation/Weatherization | Bricklayers; Carpenters; Plasterers; Glaziers; Masons; Roofers; |
| | | | | Efficient Heating & Cooling | Plumbers and Heating Maintainers<br>HVAC Maintainers<br>Electricians and IT Technicians |

| | | | | | |
|---|---|---|---|---|---|
| specialization of computer scientists and mathematicians but also from cognitive science, cognitive psychology, materials science, engineering principles as well as energy efficiency and sustainable building practices. Profesionals need to be trained on how to properly implement Green AI principles and maintenance workers may need to be trained on how to properly maintain Green AI systems to avoid to improve accuracy. | | | | Conservation of Electric Power | Electricians and Maintainers of Energy Management Systems |
| | | | | Water | Maintainers Electricians and IT Technicians |
| | | | Building Level RE | Heating / Cooling | Maintainers of Solar Thermal Systems<br>Maintainers of Wood Pellet and other Biomass Heating systems<br>Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | | | | | Heat Pump Maintainers<br>Maintainers of Small-Scale Wind Energy Systems |
| | | Controlling | Energy Auditors<br>Quality Controllers<br>Inspectors, Certifiers, Diagnostics, Remote Sensing Scientists and Technologists | | |
| | Renovation and | Designing Advising | Construction Company Managers and Business Functions<br>Architects and Civil/Structural/ Environmental Engineers<br>Architectural Technicians / Technical Drawing Specialists<br>HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>Surveyors, Renovators, Energy and Water Efficiency and Waste Management<br>Analysts, Consultants and Advisors, Sustainable Design specialist | | |
| | Education and Policy, Promotion | Education Research Financing | Policy Makers, Urban Planners<br>Financing<br>Educators and Information Providers, Researchers | | |
| | | Manufact. Distribut. | Manufacturers and Distributors of Green Building Materials and Products<br>IT & System Technicians | | |
| | | Green building clients | Developers<br>Energy Managers<br>Public Servants Working in Procurement and Management of Buildings<br>Householders and Tenants<br>Facilities Managers<br>Building Managers | | |

### 3.1.2 Qualifications and Skills (Q&S)

The ILO emphasizes the importance of developing skills for green jobs to ensure a just transition to a low-carbon economy [16]. There will be a need for people whose jobs are not considered green to receive training in skills to enable changes that will improve sustainability. For example, a change to building regulations designed to improve energy efficiency creates a one-off change in skills requirements across a range of occupations in the construction sector, and a consequential requirement for training to meet these skills need. Researching these occupations, skills and training and education needs means looking beyond the core green industries. Table 3 present Current, Future Q&S needs and present gaps.

Table 3: *Current Q&S, Future Q&S needs and present gaps*

| **1.Green architecture** *technology* | ***Q&S*** | **Technical skills/soft skills** |
|---|---|---|
| ➢ Zero-Energy Buildings<br>➢ Cool – roofs systems | *Current Q&S* | Current technical skills for zero energy building and cool-roofs systems include design for an energy-efficient building/system, utilization of green construction technology, super-insulation and super-sealing of the building envelope, optimization of HVAC systems, and implementation of renewable energy, SWM methods etc.<br>*Soft skills include*: interpersonal and communication skills as well as professionalism, environmental awareness, innovation and leadership, interdisciplinary and team work, risk management, understanding market needs, analytical skills. |
| | *Future Q&S needs* | • need to address both the ecological and social impact of green architecture<br>• need for changes in the certification, which is currently only at the energy level, the certificate should be defined in a different way in the future (certification not only energy)<br>• use of Bioclimatic design in terms of thermal comfort and energy savings thanks to the peculiarities of its design and construction.<br>• connection of construction with spatial planning and geographical conditions<br>• use of programs that allow simulation, the design phase is crucial<br>• participation of designer in whole project - its operation and optimization - the entire life cycle of the building |
| | *Present gaps* | • financial, technical and legal aspects of green architecture are still unknown by construction company managers<br>• requirement of a general knowledge of green architecture and its benefits to be able to convince potential buyers for managers<br>• need to set priorities, what a green building should contain. There is currently an effort to get many different systems into the building, and the initial decision to include them is irreversible<br>• improvement in legislation, set standards<br>• Influence and promote green trends already during the preparation of the study<br>• risk of loss of employment by construction workers who fail to learn new green |
| **2. Green infrastructure** *technology* | ***Q&S*** | **Technical skills/soft skills** |
| ➢ Sustainable water management methods | *Current Q&S* | Skills and expertise needed to build green infrastructure include civil, mechanical and electrical engineering, data analysis, machine learning, skilled tradespeople, asset owners and operators, project delivery ecosystem knowledge, digital, data and cyber capabilities.etc. |
| | *Future Q&S needs* | • the need to address both the ecological and social impact of green infrastructure<br>• new skill related to water management and renewable energies<br>• focusing on other types of energies, e.g. water, use gray water, waste water<br>• need for microturbines and better use of existing resources<br>• need to find a compromise between comfort and service of the entire system |

| | | |
|---|---|---|
| ➢ Green roofs, facades and walls | *Present gaps* | • the need to set priorities, what a green building should contain. There is currently an effort to get many different systems into the building, and the initial decision to include them is irreversible<br>• improvement in legislation, set standards, risk analysis<br>• need to improve communication between all team members in the preparation of green buildings from the very beginning, to dimension the building structures together<br>• risk of loss of employment by construction workers who fail to learn new green |
| **3. Renewable energy sources for GBs** *technology* | ***Q&S*** | **Technical skills/soft skills** |
| ➢ Solar energy (SE) and use of photovoltaic panels<br>➢ Geothermal, biomass energy source and use of the heat pumps<br>➢ Seasonal energy storage | *Current Q&S* | Current capabilities and skills are high include strong analytical, math, and engineering skills, technical skills, energy efficiency skills, analysis skills, using mathematics and scientific rules to solve problems, Bachelor's degree in engineering, environmental science, or related field. |
| | *Future Q&S needs* | • need to address both the ecological and social impact of RES in GBs<br>• requirement for cooling than for heating buildings as a result of good recovery of buildings<br>• need for energy storage systems using hydrogen transformation and its multi-use for other purposes<br>• to design user-friendly solution so that the costs do not exceed the benefits<br>• need to find a compromise between comfort and service of the entire system |
| | *Present gaps* | • the need to set priorities, what a green building should contain. There is currently an effort to get many different systems into the building, and the initial decision to include them is irreversible<br>• new skill related to energy efficiency and renewable energies<br>• non-existent sharing networks for produced energy<br>• improvement in legislation, set standards<br>• need to train architects, changing their work to green solution<br>• need to improve communication between all team members in the preparation of green buildings from the very beginning, to dimension the building structures together<br>• risk of loss of employment by construction workers who fail to learn new green |
| **3. Smart systems for GBs** *technology* | ***Q&S*** | **Technical skills/soft skills** |
| ➢ Use of smart appliances<br>➢ Artificial Intelligence (AI) assistants | *Current Q&S* | One of the main ways that AI is being used in smart home systems is through the use of virtual assistants. These assistants, such as Amazon's Alexa and Google's Assistant, are able to understand and respond to voice commands, allowing users to control their smart home devices simply by speaking to them. |
| | *Future Q&S needs* | • the need to address both the ecological and social impact of smart systems for GBs<br>• to design energy independent buildings from other sources and that will be able to produce the necessary energy by itself - it will be autonomous and managed through IT<br>• use of automated building assessment processes independent of the human factor<br>• Use of BIM - digital model of the future building to optimize the project and construction and subsequent acquisition of data from operations<br>• training in the field of BIM by the Chamber of Civil Engineers as well as in the field of trends<br>• the need to consider the human factor and the end user – to have easy control over IoT and think about people<br>• need for remote connection to solve service problems (not exit) - as a side effect of automation |
| | *Present gaps* | • needs for more qualifications and skills of AI in GBs<br>• improvement in legislation, set standards<br>• need to improve communication between all team members in the preparation of green buildings from the very beginning, to dimension the building structures together<br>• green building monitoring system that is necessary and necessary as it helps improve buildings |

| | | |
|---|---|---|
| | | • risk of loss of employment by workers who fail to learn new green in GBs |

The activities of preparing green building projects, planning them, designing them and advising on them are all closely connected and share much in the skills they require. They can be carried with the same people: construction company manager, architect or energy efficiency consultant may work with a client to work out conceptually what will be involved in retrofitting their home or business premises.

The boundaries between the occupational groups are not strict. Advice may, for example, also come from people who install a technology or from people in controlling occupations. Construction company managers who are classified as being in the controlling/planning/advising/controlling cluster will often also be involved in project delivery.

New skill needs are related to **energy efficiency**, **water management** and **renewable energies in buildings**.

### *3.1.2.1 Current Q&S of the Green Buildings professionals*

Many education and training systems have well-established processes in place to enable them to be responsive to new and changing skills needs. Table 4 shows the review of current Q&S for green building professions related to green buildings:

Table 4 Current Qualifications and Skills related to GBs.

| Professions / specializations related to Green Buildings | Short description of the profession focusing on SE | Current Qualifications and Skills |
|---|---|---|
| Construction Company Managers and Business Functions | • responsible for planning, coordinating, budgeting, and supervising construction projects from start to finish | Specialised knowledge:<br>they need to know in general about the whole life cycle of construction<br>university degrees<br>Knowledge of:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Architects and Civil/Structural/ Environmental Engineers<br>Sustainable design specialist | • are responsible for design and planning of structures<br>• to design, and construct major facilities such as highways, bridges, dams, airports, water supply systems, | Specialised knowledge:<br>• university degrees<br>• building design principles that maximize efficiency<br>• sustainable development<br>Knowledge in general:<br>• renewable energy technologies,<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |

| | | |
|---|---|---|
| | and waste disposal systems<br>• to design of buildings and other structures to ensure they are safe and stable<br>• to improve the environment by reducing pollution and waste | |
| Architectural Technicians / Technical Drawing Specialists | • responsible for detailed drawings of architectural and structural features of buildings<br>• building technologists, provide technical building design services and are trained in architectural technology | Specialised knowledge:<br>• practical skills in CAD, BIM systems<br>• technical skills<br>• technical and vocational education and training courses<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers | • are responsible for the designed systems in Gbs<br>• an important role in ensuring energy efficiency in buildings | Specialised knowledge:<br>• University degree<br>• about clean energy resources<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• water/heat conservation strategies<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Renovators | • professionals who specialize in the modification of any existing structure or portion of a structure that results in the disturbance of painted surfaces | Specialised knowledge:<br>• university degrees<br>• retrofit, renovation skills<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Building Site Supervisors, Site | • are professionals who oversee the | Specialised knowledge:<br>• university degrees |

| | | |
|---|---|---|
| Engineers and Site Architects | construction of projects and monitor activities at worksites<br>• to manage crews, ensure health and safety codes are followed, and oversee the delivery of materials and erection of the project on-site | • they need to know in general about the whole life cycle of construction<br>• management, economics<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Green Builders, Installers, Technicians, Plumbers, | • are responsible for the installation and maintenance of services that provide a comfortable space for building occupants | Specialised knowledge:<br>• technical and vocational education and training courses<br>• installation techniques<br>• construction or electrical engineering<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Maintainers, Technicians, Facilities manager | • are responsible for the installation and maintenance of services that provide a comfortable space for building occupants | Specialised knowledge:<br>• technical and vocational education and training courses<br>• maintenance techniques<br>• construction or electrical engineering<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Energy Auditors, Energy Managers | • they review utility bills, perform tests to evaluate energy efficiency levels, and make recommendations for improvements, focus on making assessments | Specialised knowledge:<br>• university degrees<br>• specialised masters and other forms of continuing training in energy efficiency<br>• renewable energy technologies<br>• energy, its distribution, conservation<br>• certification strategies<br>Knowledge in general:<br>• sustainable development<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>environmental regulation |
| Quality Controllers, Inspectors | • are responsible for ensuring that | Specialised knowledge:<br>• university degrees |

| | | |
|---|---|---|
| | the construction of green buildings meets the required standards<br>• to identify construction deficiencies that can turn into potential complaints or demand warranty repairs<br>• to produce high-quality, technical inspection reports that capture on-site conditions and review and verify the technical merits of energy efficiency | • training offered by professional associations<br>• quality control strategies<br>• Inspection principles and codes<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Certifiers, Diagnostics | • provide independent, third-party verification that a home, building, or land development is designed and built to achieve high environmental standards | Specialised knowledge:<br>• university degrees<br>• diagnostics, verification systems<br>• certification strategies<br>• training offered by professional associations<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>environmental regulation |
| Policy Makers | • to present an overview of green building economics and policies through a survey of theoretical and empirical evidence concerning green building initiatives<br>• to evaluate alternatives for green building policies according to their potential social, environmental, | Knowledge in Environmental Science, Renewable Energy Technologies, Environmental Regulation, International Politics, Economics, Law<br>• training offered by professional associations |

| | | |
|---|---|---|
| | and economic impacts | |
| Urban Planners | • develop land use plans and programs that help create communities, accommodate population growth, and revitalize physical facilities in towns, cities, counties, and metropolitan area | Specialised knowledge:<br>• urban planning, country, sustainable design principles<br>• revitalization strategies<br>• training offered by professional associations<br>• university degrees<br>Knowledge in general:<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, as well as global governance frameworks<br>• environmental engineering<br>• environmental regulation |
| Researchers | • to conduct studies and research related to the design, construction, and overall operation of green buildings<br>• to discuss the relevant benefits and challenges of green building through a critical review of existing research knowledge | Specialised knowledge:<br>• university degrees<br>Knowledge in Environmental Science, Renewable Energy Technologies, Environmental Regulation, International Politics, Continuing professional development |
| Manufacturers and Distributors of Green Building Materials and Products | • to specialize and provide solutions for exterior and interior finishes that contribute to energy saving and sustainability | Knowledge in Environmental Science, Construction, Renewable Energy Technologies, Environmental Regulation, International Politics, Economics, Manufacture sector |
| IT & System Technicians | • are responsible for a variety of key IT functions, including providing technical assistance to customers, diagnosing and troubleshooting IT issues | Specialised knowledge:<br>• university degrees<br>Computer engineering degree<br>Knowledge in AI systems,<br>Environmental Science, Renewable Energy Technologies, Environmental Regulation, International Politics<br>Continuing professional development |
| Developers | • provide real estate development and home construction services | Knowledge in Environmental Science, Construction, Renewable Energy Technologies, Environmental Regulation, International Politics, Economics |

| | | |
|---|---|---|
| Building Managers | • provide complete construction management, general contracting, design+build and base services | Knowledge in Environmental Science, Renewable Energy Technologies, Environmental Regulation, Economics<br>Courses in green procurement |

By analysing the skill gaps and needs of selected priority occupations, the research identified so-called "green competences" to transform these occupations into green jobs. Based on a review of the international experience we can sup up specific green building construction skills BOX 8:

BOX 8

**Specific green building construction skills include:**

- knowledge of green building construction
- technical and vocational education and training specific to green solutions
- green entrepreneurship and private sector development along the green building
- classroom learning and hands-on practice in lab

**New skills requirements in building include:**

- knowledge of new materials, technologies and energy efficiency adapted technical
- solutions;
- cross-cutting knowledge of energy issues;
- understanding of other occupations related to building renovation;
- client counselling/advice to meet new market demands; and
- building techniques adapted to risks of natural disasters
- combining knowledge in the field of construction and with IT and architecture

### *3.1.2.2 Q&S needed to address the technological changes*

The trends in Centre of Vocational Education for green buildings include the development of green building standards and certification systems, the use of green building techniques, and environmental education.

| Green building techniques categories | Specializations | | Required Qualifications and Skills |
|---|---|---|---|
| | Technological change | Affected profession | |
| 1. Structure's location | • Zero-energy buildings<br>• SW management methods<br>• Use of smart appliances<br>• AI assistants | • Managers and Business Functions<br>• Architects and Civil/ Structural/ Environmental Engineers<br>• Architectural Technicians / Technical | • Knowledge of sustainable site development, environmental regulations, and compliance strategies<br>• Design passive techniques: orientation and layout of the building, 3D modeling, BIM usage<br>• Design space allocation to enhance the inflow of daylight<br>• Design the roof to provide overhangs<br>• Understand heating, ventilation, and air conditioning systems |

| | | | |
|---|---|---|---|
| | | Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Renovators<br>• Building Site Supervisors<br>• Building botanist/ Vegetation expert<br>• Urban Planners | • Applying advanced technologies such as new insulation products, green roofs, or roof structures capable of carrying solar panels<br>• Knowledge of energy efficiency standards for equipment and green building standards is valuable<br>• Identifying a suitable location for solar photovoltaic panels, installing them at the place chosen, and making the necessary indoor connections<br>• knowledge renewable energy technologies, water conservation strategies, green building standards<br>• Estimate the economics of renewable energy projects, including calculating major financial indicators, such as return periods<br>• communication skills to work effectively with clients, contractors, architects, and other stakeholders. |
| 2. Energy efficiency | • Cool – roofs systems<br>• Zero-Energy Buildings<br>• Green roofs, facades and walls<br>• Solar energy (SE) and use of photovoltaic panels<br>• Geothermal, biomass energy source and use of the heat pumps<br>• Seasonal energy storage<br>• Use of smart appliances<br>• AI assistants | • Intelligent green building manager<br>• Risk management specialist<br>• Facilities Managers<br>• Energy Auditors,<br>• Energy Managers<br>• Quality Controllers<br>• Inspectors<br>• Green remote controller<br>• Certifiers, Diagnostics<br>• Weatherization Installers and Technicians<br>• Builders, Installers, Technicians,<br>• (Green) Plumbers<br>• Plumbers, Maintainers, Technicians<br>• Architectural Technicians / Technical | • Identify and reduce the absorption of heat from the sun<br>• Design systems and facilities of high energy efficiency and renewable energy systems for thermal conditioning and lighting<br>• Understand heating, ventilation, and air conditioning systems<br>• Knowledge of installation and maintenance of solar thermal/photovoltaic settings<br>• Understand energy efficiency of facilities and materials; and energy control systems, among others<br>• Install/ maintain efficient heating systems, making existing heating systems more efficient, using water more efficiently and installing solar water heating systems<br>• Understanding of environmental parameters (temperature and humidity), and the ability to make relevant measurements<br>• Calculate the load calculations, measure airflow, and do full commissioning and maintenance work following installation<br>• Knowledge of energy efficiency standards for equipment and green building standards is valuable<br>• Install the electrical parts of plumbing systems /electric water heating, heat pumps, small-scale CHP (combined heat and power) systems, including controls<br>• Understanding of what is required to connect to it, even if the final connection may be made by someone else<br>• Knowledge of thermodynamics and heating installations |

| | | | |
|---|---|---|---|
| | | Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Researchers, Remote Sensing Scientists and Technologists<br>• IT & System Technicians,<br>• AI specialist | • Knowledge of sustainable design principles, renewable energy technologies, green building standards and certification systems<br>• Estimate the economics of renewable energy projects, including calculating major financial indicators, such as return periods<br>• Communication skills to work effectively with clients, contractors, architects, and other stakeholders. |
| 3. Water conservation | • Zero-energy buildings<br>• SW management methods<br>• Green roofs, facades and walls<br>• Solar energy (SE) and use of photovoltaic panels<br>• Seasonal energy storage<br>• Use of smart appliances<br>• AI assistants | • Environmental health and safety /Water conservation/ Sustainable design specialist<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Researchers, Remote Sensing Scientists and Technologists<br>• IT & System Technicians,<br>• AI specialist | • Design of efficient water management systems (including water harvesting, grey water)<br>• Knowledge of installation and maintenance of solar thermal/photovoltaic settings<br>• Capability of overseeing workers in undertaking green building works such as installing greywater systems, installing efficient HVAC systems, installing RES<br>• Install/ maintain water systems more efficiently and installing solar water heating systems<br>• Install/ maintain rainwater harvesting, the use of grey water, heat pumps,<br>• Understanding of environmental parameters (temperature and humidity), and the ability to make relevant measurements<br>• Calculate the load calculations, measure airflow, and do full commissioning and maintenance work following installation<br>• Install the electrical parts of plumbing systems water heating<br>• Understanding of what is required to connect to it, even if the final connection may be made by someone else<br>• Knowledge of thermodynamics and heating installations<br>• Knowledge of water conservation strategies, green building standards and certification systems<br>• Estimate the economics of water conservation projects, including calculating major financial indicators, such as return periods. |

| | | | |
|---|---|---|---|
| 4. Indoor air quality | • Zero-energy buildings<br>• SW management methods<br>• Use of smart appliances<br>• AI assistants | • Architects and Civil/ Structural/ Environmental Engineers<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Intelligent green building manager<br>• Risk management specialist<br>• Facilities Managers<br>• Energy Auditors<br>• Installers, Technicians, (Green) Plumbers<br>• Maintainers<br>• Researchers, Remote Sensing Scientists and Technologists<br>• IT & System Technicians,<br>• AI specialist | • Understand heating, ventilation, and air conditioning systems<br>• Capability of overseeing workers in undertaking green building works such as installation of insulation, installing greywater systems, installing efficient HVAC systems, installing RES and the management and recycling of waste materials<br>• Knowledge in electrics, in plumbing, and in installation of ducting (HVAC)<br>• Calculate the load calculations, measure airflow, and do full commissioning and maintenance work following installation<br>• Identifying a suitable location for solar photovoltaic panels, installing them at the place chosen, and making the necessary indoor connections<br>• Understanding of what is required to connect to it, even if the final connection may be made by someone else<br>• Knowledge of sustainable design principles, green building standards and certification systems<br>• Estimate the economics of indoor air quality, including calculating major financial indicators, such as return periods<br>• Estimate the economics of renewable energy projects, including calculating major financial indicators, such as return periods<br>• Communication skills to work effectively with clients, contractors, architects, and other stakeholders. |
| 5. Materials selection | • Cool – roofs systems<br>• Zero-Energy Buildings<br>• Green roofs, facades and walls<br>• Solar energy (SE) and use of photovoltaic panels<br>• Geothermal, biomass energy source and use of the heat pumps<br>• Seasonal energy storage<br>• Use of smart appliances<br>• AI assistants | • Policy Makers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• Developers<br>• Building Managers<br>• Plumbers, Maintainers, Technicians | • Advise on window choice, and be skilled in installing energy efficient glazing solutions<br>• Choose materials and building systems based on their environmental and energy life cycle of the building<br>• Require good practical knowledge of products and processes in the construction phase<br>• Capability of overseeing workers in undertaking green building works such as installation of insulation recycling of waste materials<br>• Applying advanced technologies such as new insulation products, green roofs, or roof structures capable of carrying solar panels. |

| | | | |
|---|---|---|---|
| | | | • Knowledge of sustainable design principles, renewable energy technologies, water conservation strategies, green building standards and certification systems<br>• Economics of green material, including calculating major Financial indicators, such as return periods<br>• Communication skills to work effectively with clients, contractors, architects, and other stakeholders. |

Green building techniques require a range of skills, including knowledge of sustainable design principles, renewable energy technologies, environmental regulations and compliance strategies. Professionals working in the construction industry need to have expertise in areas such as energy-efficient lighting, water conservation, eco-friendly materials selection, and sustainable site development.

They also need to be familiar with green building standards and certification systems such as LEED and WELL Building Standard. In addition to technical skills, professionals working in green building also need communication skills to work effectively with clients, contractors, architects, and other stakeholders involved in the construction process. Therefore, the skills needed for green building techniques are diverse and require a combination of technical expertise and communication skills.

BOX 9

**Green building techniques can be grouped into five major categories:**

1. structure's location
2. energy efficiency
3. water conservation
4. indoor air quality
5. materials selection

Designing green building requires a multidisciplinary team of professionals who have expertise in sustainable design principles, environmental regulations, compliance strategies, and communication skills. In table 5 we summarized technological change impact on professions in GBs according **five major green building techniques categories** related to required qualifications and skills:

Table 5 Technological change impact on professions in GBs according five major green building techniques categories

### 3.1.3 Synthesis- Recommendations

#### *3.1.3.1 Future impact on Q&S- Most interesting trends for CoVEs*

As green construction becomes more widespread new market focused on sustainable construction techniques should build job prospects for many more future workers. Many of the occupations in green building design, such as architects and civil engineers, require at least a bachelor's degree, while many of the construction and trade occupations can be learned through on-the-job training or an apprenticeship.

CoVEs provide training and education to professionals in the construction industry on sustainable design principles, renewable energy technologies, and green building practices. The goal of CoVEs is to develop a skilled workforce that can meet the growing demand for sustainable building practices.

Therefore, CoVEs are an important part of the effort to reduce environmental impact and improve energy efficiency in the construction industry by providing training and education to professionals working in this field. Table 6 shows the structural needs for CoVEs depending on profession, required Q&S, and available training in GBs:

Table 6: Structural needs for CoVEs

| Affected Profession/ specializations | Required Q&S | Existing Q&S/ Available Training | Structural needs for CoVEs |
|---|---|---|---|
| Managers and Business Functions | Specialised knowledge:<br>• university degrees - management, economics, CE<br>• continuing professional development<br>• in the entire life cycle of green buildings from design to implementation of green buildings<br>Knowledge of:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | Yes, partially.<br>• University degrees<br>• Training offered by professional associations | Training or reskilling managers for sustainable building design, green technologies and solution, smart design and digitalization. |
| Architects and Civil/ Structural/ Environmental Engineers | Specialised knowledge:<br>• university degrees<br>• continuing professional development<br>• building design principles that maximize efficiency<br>• sustainable development<br>• design complete areas of residential | Yes, insufficient.<br>Skills and competencies, detailed information in sustainable design and energy efficiency, new green methods and technologies are missing. Need to prepare new study programs on green architecture. | Training or reskilling building professionals, architects for sustainable building design, green technologies and solution, smart design and digitalization. |

| | | | |
|---|---|---|---|
| | buildings (spatial planning)<br>• to support green buildings in the countryside and in the city<br>Knowledge in general:<br>• renewable energy technologies<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | | |
| Architectural Technicians / Technical Drawing Specialists | Specialised knowledge:<br>• university degrees in CE<br>• practical skills in CAD, BIM systems<br>• technical and vocational education and training courses<br>• technical skills<br>• digitization of the territory - how green the territory will look after construction<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, governance frameworks<br>• environmental engineering and regulation | Yes, insufficient.<br>Skills and competencies, detailed information in sustainable design and energy efficiency, new green methods and technologies are missing. Need to prepare new study programs on green architecture and digital design. | Training or reskilling Architectural Technicians / Technical Drawing Specialists for sustainable building design, green technologies and solution, smart design and digitalization 3D.<br>BIM, CAD systems training courses |
| HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers | Specialised knowledge:<br>• university degrees<br>• building design principles that maximize efficiency<br>• clean energy resources<br>• renewable energy technologies<br>• water/ heat conservation strategies | Yes, partially.<br>Skills and competencies, detailed information in sustainable design and energy efficiency, new green methods and technologies are missing. Need to prepare new study programs on green architecture. | Specialized masters and other forms of continuing training in energy efficiency, building codes and energy certification |

| | | | |
|---|---|---|---|
| | Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | | |
| Renovators | Specialised knowledge:<br>• university degrees<br>• retrofit, renovation skills<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | Yes, insufficient.<br>Skills and competencies, detailed information in sustainable design and energy efficiency, new green methods and technologies are missing. Need to prepare new study programs on green architecture. | Specialized masters and other forms of continuing training in<br>reconstruction with an orientation towards green buildings |
| Building Site Supervisors | Specialised knowledge:<br>• university degrees<br>• management, economics<br>• the whole life cycle of construction<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | Yes, insufficient.<br>Skills and competencies, detailed information in sustainable design and energy efficiency, new green methods and technologies are missing. Need to prepare new study programs on green architecture. | Specialized masters and other forms of continuing training in energy efficiency, building codes and sustainable building design. |

| | | | |
|---|---|---|---|
| Building botanist/ Vegetation expert | Specialised knowledge:<br>• university degree in Botanic, Vegetation<br>• combining knowledge of design and botany to design vegetated roofs/walls.<br>• constructions.<br>Knowledge in general:<br>• sustainable development<br>• green principles<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks | Yes, but separated you need to study 2 university degrees. | Training or reskilling Building botanist/Vegetation expert<br>for sustainable building design, green systems, smart design. |
| Intelligent green building manager | Specialised knowledge:<br>• university degrees – CE, management, economics<br>• the operation of construction and systems HVAC<br>Knowledge of:<br>• sustainable development<br>• renewable energy technologies<br>• building and systems design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | No, only as a part of Facility management. Need to prepare new study programs on digital green building maintenance. | Adaptation of technical and vocational education and training courses/ new courses |
| Risk management specialist | Specialised knowledge:<br>• university degrees<br>• connections of systems and building surfaces and how to maintain them<br>• identification of risks/ methods/ codes<br>Knowledge of: | Yes, partially,<br>Need to prepare new study subject on this. | Adaptation of technical and vocational education and training courses/ new courses |

| | | | |
|---|---|---|---|
| | • sustainable development<br>• renewable energy technologies<br>• local codes and requirements, global governance frameworks<br>• health and environmental engineering and regulation | | |
| Facilities Managers | Specialised knowledge:<br>• university degree<br>• maintenance techniques<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, as global governance frameworks<br>• environmental engineering and regulation | Yes, insufficient.<br>Need to prepare new study programs on digital green building maintenance. | Adaptation of technical and vocational education and training courses/ new courses |
| Energy Auditors, Energy Managers | Specialised knowledge:<br>• university degrees<br>• specialised forms of continuing training in energy efficiency<br>• renewable energy technologies<br>• energy, its distribution and conservation<br>• certification strategies<br>Knowledge in general:<br>• sustainable development<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | Yes | Specialized masters and other forms of continuing training in energy efficiency, building codes and sustainable building design.<br>Technical education complemented by certified working experience.<br>Training and examination related to certification |

| | | | |
|---|---|---|---|
| Quality Controllers, Inspectors/ Green remote controller | Specialised knowledge:<br>• university degrees<br>• training offered by professional associations<br>• quality control strategies<br>• Inspection principles and codes<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies,<br>• local codes and requirements, as global governance frameworks<br>• safety and environmental engineering and regulation | Yes, partially.<br>University courses (degrees and continuing training) | Technical education complemented by certified working experience.<br>Training and examination related to certification |
| Certifiers, Diagnostics | Specialised knowledge:<br>• university degrees<br>• diagnostics, verification systems<br>• certification strategies<br>• training offered by professional associations<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | Yes, partially.<br>Part of University courses (degrees and continuing training) | Technical education complemented by certified working experience.<br>Training and examination related to certification. |
| Urban Planners | Specialised knowledge:<br>• university degrees<br>• training offered by professional associations<br>• urban planning, country, sustainable design principles<br>• revitalization strategies | Yes, but deeper green education for urban planners needed. | Training or reskilling for sustainable building design, green technologies and solution, smart design and digitalization. |

| | | | |
|---|---|---|---|
| | Knowledge in general:<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | | |
| Researchers, Remote Sensing Scientists and Technologists | Specialised knowledge:<br>• university degrees<br>Knowledge in:<br>• Environmental Science, Renewable Energy Technologies, Environmental Regulation, International Politics, Continuing professional development, | Yes,<br>continuing professional development required | Training for teachers, researchers..etc. |
| IT & System Technicians,<br>AI specialist | Specialised knowledge:<br>• university degrees/ computer engineering degree<br>• continuing professional development<br>• combining knowledge in the field of construction with IT and architecture<br>Knowledge in:<br>• Basic Renewable Energy Technologies and systems | Yes, partially.<br>Training offered by professional associations | Training or reskilling IT & System Technicians, AI specialist for sustainable building design, green technologies and solution, smart design and digitalization for GBs. |
| Weatherization Installers and Technicians | Specialised knowledge:<br>• technical and vocational education and training courses<br>• maintenance techniques<br>• construction /electrical engineering<br>Knowledge in general:<br>• sustainable development | Yes, insufficient. | Technical courses in related to Weatherization Installers and Technicians needs as maintenance / Green techniques and technologies and their connections on other parts of building design. |

| | | | |
|---|---|---|---|
| | • renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | | |
| Builders, Installers, Technicians, (Green) Plumbers | Specialised knowledge:<br>• technical and vocational education and training courses<br>• maintenance techniques<br>• construction or electrical engineering<br>Knowledge in general:<br>• renewable energy technologies<br>• system principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental regulation | Yes, partially | Technical courses in related Builders, Installers, Technicians, (Green) Plumbers needs as installation / green techniques and technologies and their connections on other parts of building design. |
| Environmental health and safety /Water conservation/ Sustainable design specialist | Specialised knowledge:<br>• technical and vocational education and training courses<br>• maintenance techniques<br>• of the impact of green buildings on people and outwardly on the climate<br>• to support green buildings in the countryside and in the city<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency | No, new study program needed. It is a part of Environmental engineering or Buildings services study programs. Education should be ahead of the times and think about future necessary skills and knowledge Devote part of the teaching at secondary schools to the issue of green roofs and green construction | Training or reskilling Environmental health and safety /Water conservation/Sustainable design specialist for sustainable building design, green technologies and solution, smart design and digitalization, water conservation methods. |

| | | | |
|---|---|---|---|
| | • local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | | |
| Plumbers, Maintainers, Technicians | Specialised knowledge:<br>• technical and vocational education and training courses<br>• maintenance techniques<br>• construction or electrical engineering<br>Knowledge in general:<br>• sustainable development<br>• renewable energy technologies<br>• building design principles that maximize efficiency<br>• local codes and requirements, global governance frameworks<br>• environmental engineering and regulation | Yes, but new study branch needed. Education should be ahead of the times and think about future necessary skills and knowledge<br>Devote part of the teaching at secondary schools to the issue of green roofs and green construction maintenance | Adaptation of technical and vocational education and training courses/ new courses |
| Policy Makers | Specialised knowledge:<br>• training offered by professional associations<br>Knowledge in:<br>Environmental Science, Renewable Energy Technologies, Environmental Regulation, International Politics, Economics, Law | Yes, training offered by professional associations | Training for policy makers and finance professional. Development of green building standards and certification systems, the use of green building techniques, and environmental education. |
| Manufacturers and Distributors of Green Building Materials and Products | Specialised knowledge:<br>• training offered by professional associations<br>Knowledge in:<br>in Environmental Science, Construction, Renewable Energy Technologies, Environmental Regulation, International Politics, Economics, Manufacture sector | Yes | Technical education complemented by certified working experience.<br>Training and examination related to certification |
| Developers | Knowledge | Partially, not sufficient. | Courses in green procurement. |

| | | | |
|---|---|---|---|
| Building Managers | in Environmental Science, Renewable Energy Technologies, Environmental Regulation, Economics Courses in green procurement | | Promoting green design. |

*Note: Grey – university degree requirement, Blue – High school/ technical and vocational education and training courses requirement*

The focus group for skills (February 24th, 2023) and competencies discussed this issue and stands that skills and qualifications will be most important in creation a new job profiles in green building industry. Personal characteristics such as desire to work, motivation, flexibility, professional knowledge, manual skill, evaluation of green building project proposals, critical thinking. There is a need of combining knowledge in the field of construction with IT and architecture - also for lower qualification jobs (e.g. maintenance worker) a very important is combining knowledge of design and botany to design vegetated roofs and green structures. Digitization of the territory - how green the territory will look after construction can help developers or building managers to see the design in 2D, 3D.

Specific knowledge in various phases of the cycle of design and implementation of green buildings as well as during the entire life cycle of green buildings helps managers to see the impact of green buildings on people and outwardly on the climate and how vegetation technologies/systems contribute to sustainability in energy sector.

### *3.1.3.2 Recommendations for policy makers for the modernisation of VET*

Preparing the labor force for future market expectations and needs in green buildings requires workforce forecasting, which involves predicting future labor needs and identify a skill gap problem. Vocational education and training programs prepare people for work and develop worker's skills to remain employable and respond to the needs of the green transition. VET programs offer accessible short-term training, certificates, and degrees that can benefit many workers by providing in-demand skills [17]. In Europe, the Council of the EU adopted a Recommendation on vocational education and training for sustainable competitiveness, social fairness, and resilience in 2020. The Recommendation defines key principles for ensuring that vocational education and training is agile in that it adapts swiftly to changing labor market needs. Learning green building construction skills is a smart career investment because it plays an important role in the construction industry, energy sector, and economy. It is expected to grow further, leading to more jobs and better jobs for green building construction workers all over the word. Therefore, investing in training programs that teach these skills can help individuals prepare for a career in this growing field.

BOX 10

**Several drivers of skills change in green buildings have been identified:**

1. emphasis on soft skills, such as communication and collaboration
2. shortage of skilled workers in the green building sector
3. investing in leadership development for career progression in the green skills sector
4. creating new roles and supporting them with the right team, infrastructure, salary, and timescales
5. people with the right skills can be a driver of change

Green skills mean a big change of skills, such as digital skills, engineering skills, waste management skills or carpentry skills. "Jobs of the future" are those that will undergo modifications to provide for global environmental and climate goals in the context of the green transition.

Training offered in green building has increased notably over the past few years. However, employers still face difficulties finding qualified people to perform certain jobs because training is limited, too general, and not sufficiently practical.

We must make the transition just and inclusive for all by tackling the climate and environmental challenges we are facing. We need to develop a strong and lifelong partnership between education and employment stakeholders to maximize these opportunities.

In some cases, there will be a need for people whose jobs are not green to receive training in skills to enable changes that will improve sustainability. For example, a change to building regulations designed to improve energy efficiency creates a one-off change in skills requirements across a range of occupations in the construction sector, and a consequential requirement for training to meet this kills need.

Green building brings new construction techniques, and although most roles can still be filled by skilled workers from existing occupations many workers require an upgrade in their skills. Electricians, for example, are likely to need to be able to install and wire in photovoltaic solar panels. The impact on skills needs can be quantitative as well as qualitative: for example, an expansion of retrofitting will not necessarily require many new skills from trained carpenters, but it may well require an increase in the total number of trained carpenters.

The modernization of **vocational education and training** requires the active involvement of all **stakeholders, including policy makers**.

The stakeholders, managers, planners, builders, energy experts and researchers from our focused group on skill changes discussed current situation and technological changes, skills that affect the green building sector. They discussed the future market's expectations and needs and the most promising areas for further research and development in the green building sector. The areas are:

- to analyze data on existing buildings and process them in such a way that it is clear what was the project and what is reality
- to compare existing systems with regard to operation and energy (classic and newly offered). It will make it possible to find out what is most suitable for green buildings
- to analyze existing operations - what was planned, for what purpose it is actually used and how it will be affected by a change in the method of use
- to collect data and analyse them - justified for learning from existing experience
- to carry out research according to the purpose of the building (e.g. research also family houses)
- to prepare a database on family houses, where the owners of the houses themselves would provide real data on consumption
- to collect data on the constructions themselves of various types, which will increase awareness and then verify the data
- certification of green buildings in general, not only green buildings
- need for a SR strategy for the area of green buildings

Advances in building information modeling and the digital skills include programs that allow simulation, the design phase is crucial. Use of BIM - digital model of the future building to optimize the project and construction and subsequent acquisition of data from operations should be common part of the design phase. Only digital tools are not enough, but direct communication is also necessary. The designer should not only be involved in the design, but should be interested in the building itself, its operation and optimization - the entire life cycle of the building (e.g. waste management). There is need to train architects and training in the field of BIM by the Chamber of Civil Engineers as well as in the field of trends and changing their work. They should incorporate the

requirements of designers, as a bad concept makes it difficult to work on green buildings. Outlined need to improve communication between all team members in the preparation of green buildings from the very beginning, to dimension the building structures together becomes crucial in the whole process.

The OECD's policy review of VET, Learning for Jobs, recommends recruiting sufficient teachers and trainers for VET institutions who are well-acquainted with industry experience. Changes to the education system will be important to ensure students are adequately trained for labor and employment opportunities in the future.

To effectively implement and modernize the labor force in **green buildings**, it is important to focus on training programs that provide hands-on experience with green technologies. This includes apprenticeships, internships, and on-the-job training opportunities (OECD, 2020). To conclude, partnerships between industry leaders and educational institutions can help ensure that VET programs are up-to-date with the latest trends and technologies in green building construction and maintenance and will prepare well skilled professionals/ workers to fill the gap in the green building sector.

### 3.1.4 References


[1] UNIDO, 2023: https://www.unido.org/our-focus-cross-cutting-services-green-industry/green-industry-initiative

[2] Liu, T.; Chen, L.; Yang, M.; Sandanayake, M.; Miao, P.; Shi, Y.; Yap, P.-S. Sustainability Considerations of Green Buildings: A Detailed Overview on Current Advancements and Future Considerations.

[3] Cole, L.B. Green building literacy: a framework for advancing green building education. IJ STEM Ed 6, 18 (2019). https://doi.org/10.1186/s40594-019-0171-6

[4] Zhang, D.; Wu, W.; Fang, P. Research on the Development of Green Buildings in China. In the IOP Conference Series: Earth and Environmental Science, Proceedings of the 2020 International Conference on Green Energy, Environment and Sustainable Development, Wuhan, China, 24–25 April 2020; IOP Publishing: Bristol, UK, 2020; Volume 555, p. 012095

[5] Conscience,2022: https://environmental-conscience.com/green-building-pros-cons/

[6] Energy-EC EU,2022. Renewable energy directive: https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en

[7] Kulovesi, K, Oberthür, S. Assessing the EU's 2030 Climate and Energy Policy Framework: Incremental change toward radical transformation. RECIEL. 2020; 29: 151– 166. https://doi.org/10.1111/reel.12358

[8] Blenkinson, 2020 REUTERS: https://www.reuters.com/business/sustainable-business/eu-lay-out-green-industry-plan-counter-us-china-subsidies-2023-02-01/

[9] CBI,2023: https://www.cbi.eu/market-information/eu-green-deal-how-will-it-impact-my-business

[10] Lapierre,2021: https://www.nortonrosefulbright.com/en/knowledge/publications/c50c4cd9/the-eu-green-deal-explained

[11] LIFE-Building,2019: http://lch.grat.at/fileadmin/downloads/LIFE-Building_Platform_Final_Report__12_Aug_2019_.pdf

[12] World Green Building Trends SmartMarket Report

[13] Golej, J. et.al,2018: The overview of green building sector in Slovakia, EAI Endorsed Transactions on Energy Web, DOI: 10.4108/eai.13-7-2018.158874

[14] EC,2023. The Green Deal Industrial Plan: putting Europe's net-zero industry in the lead https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510

[15] Detsch, C.,2023: Waking the sleeping beauty of European industrial policy: https://www.ips-journal.eu/topics/economy-and-ecology/waking-the-sleeping-beauty-of-european-industrial-policy-6512/

[16] ILO,2011. Skills for green job. A global view. https://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_159585.pdf

[17] EC,2023. European education area: https://education.ec.europa.eu/education-levels/vocational-education-and-training/about-vocational-education-and-training

[18] EPA, 2023: https://www.epa.gov/environmental-topics/greener-living

CDI,2023: https://www.globenewswire.com/en/news-release/2023/01/13/2588792/0/en/Buildings-Construction-Market-Is-Expected-To-Reach-around-USD-5-412-80-Billion-by-2022-Grow-at-a-CAGR-Of-7-4-during-Forecast-Period-2023-To-2030-Data-By-Contrive-Datum-Insights-Pvt.html

Euroactiv, 2023. The Green deal: https://euractiv.sk/projekty-eu/

## 3.2 Building and construction industry, Lazio Region, Italy

### 3.2.1 Building and Construction Industry & Sustainable Energy

Within the Industrial ecosystems discussed in the EU Industrial Strategy [1], *Building and Construction Industry (BaCI)* identifies works and supply of services in the built environment, intended as a specific industry of the construction ecosystem [2]. It employs design and construction professionals focusing on performing works and delivering professional services but does not extend to the production chain of construction. In some cases, the BaCI is defined as *Architecture, Engineering and Construction Industry*, especially within the techno-economic field.

In a complex international framework, recently characterised by the Covid-19 outbreaks and the Ukraine conflict, the BaCI faces several primary challenges: green, digital and circular economy transitions. At the same time, it offers enormous potential for reaching EU targets and contributes to climate resilience and energy sustainability in cities. The Climate Adaptation Strategy, the Renovation Wave and the New European Bauhaus are the primary initiatives to promote these transitions [2] Therefore, the Architecture, Engineering, and Construction (AEC) industry is crucial for achieving sustainability in the energy field for several reasons:

i. Environmental Impact: The BaCI is one of the most significant contributors to greenhouse gas emissions and resource consumption. Buildings account for a significant portion of energy consumption and carbon emissions worldwide for operation and construction. Embracing sustainable energy (SE) practices can help reduce energy demand, minimise carbon footprint, and conserve natural resources.
ii. Energy Efficiency and Cost Savings: Sustainable energy practices, such as energy-efficient and passive design, improved insulation, and efficient HVAC systems, can significantly reduce energy consumption in buildings. This leads to lower operating costs for building owners and occupants. Energy-efficient buildings often have lower utility bills and require less maintenance and repair, resulting in long-term cost savings.
iii. Renewable Energy Integration: The BaCI plays a crucial role in integrating renewable energy sources into the built environment. By incorporating technologies as solar panels, wind turbines, and geothermal systems, buildings can generate clean energy on-site, reducing dependence on fossil fuels and contributing to a more sustainable energy mix. This integration requires expertise from architects, engineers, and construction professionals to design and implement renewable energy systems effectively, primarily focusing on smart urban grids and energy communities.
iv. Sustainable Design and Innovation: Sustainable energy practices drive innovation in the BaCI. Architects and engineers are challenged to design buildings that maximise energy efficiency, optimise natural light, utilise renewable energy sources, and minimise environmental impact. This encourages the development of new technologies, materials, and construction techniques that promote sustainability, spurring progress and advancements within the industry.
v. Regulatory Compliance and Certification: Many countries have implemented regulations and building codes that enforce energy efficiency standards. The AEC industry can ensure compliance and avoid penalties by adhering to these requirements. Additionally, sustainable building certifications like LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) are increasingly sought after by clients and developers, emphasizing the need for sustainable energy practices.
vi. Social Responsibility and Reputation: Embracing sustainable energy practices aligns with social responsibility and demonstrates a commitment to addressing climate change and environmental challenges. Clients, investors, and the general public are increasingly aware of the importance of sustainability. Prioritising sustainable energy, AEC firms can contribute to a more sustainable future, enhance their reputation, and attract environmentally conscious clients.

In summary, the field of sustainable energy is crucial for the BaCI because it reduces environmental impact, improves energy efficiency, integrates renewable energy sources, drives innovation, ensures regulatory compliance, and enhances the industry's social responsibility and reputation. By embracing sustainable energy practices, the BaCI can significantly address climate change and create a more sustainable built environment.

Lazio Region Smart Specialisation Strategy - S3 focuses on Tourism digitalisation and safety (Industrial modernisation and Safety) and Sustainable Buildings (Energy). BaCI is called into play on the latter and contributes to local sustainable energy targets by aligning regional priorities with developing and implementing sustainable energy solutions.

Two of the seven S3 priorities identified for Lazio Region are strictly related to BaCI, as explained by the following table:

| BaCI and Lazio Region S3 priorities | Cross-sector innovation areas for BaCI |
|---|---|
| New technologies for the security of citizens and the safeguard of the territory | New technologies and solutions for monitoring and preventing disasters; Disaster resilience; |
| New technologies and solutions for energy saving and environmental sustainability | New technology applications and solutions for environmental sustainability in the construction, energy, waste management and mobility sectors. Smart buildings; Development of green companies; Environmental services; Smart grids. |

Moreover, the five Digital Innovation Hubs existing in Lazio have the following main technical competences related to BaCI:

- Internet of things
- Sensory systems
- Simulation, modelling and digital twins
- Virtual, augmented and extended reality
- Location-based technologies
- Interaction technologies
- Artificial intelligence and cloud computing

The local ecosystem can involve investing in research and development, fostering innovation, and promoting the deployment of sustainable energy technologies and practices in the BaCI. By integrating sustainable energy as a priority, the S3 strategy can drive the transition towards cleaner and more efficient energy systems, supporting local sustainable energy targets.

The RIS3 strategy can focus on BaCI research, innovation, and investment in sustainable energy technologies, processes, and systems aligned with the region's strengths and competitive advantages. This can include fostering collaborations between research institutions, businesses, and other stakeholders to develop and commercialise sustainable energy solutions for buildings as well as sustainable construction processes tailored to the specific needs and opportunities of the region. By integrating buildings energy sustainability into the RIS3 strategy, regions can harness their innovation potential to address local energy challenges, stimulate economic growth, and contribute to the broader goals of the EU S3 strategy.

Moreover, in recent times Next Generation EU and the associated National and Regional policies in Italy, such as the *Superbonus* and the *Piano Nazionale di Ripresa e Resilienza* (PNRR), are counteracting the effects of pandemics, inflation and the Ukraine war. Among sector's challenges, energy sustainability and finding the of

skilled professionals are highlighted as crucial by the OICE (Association of Italian Engineering, Architectural and Technical-Economic Consulting Organizations) [3]. In order to facilitate the solution of these challenges, local and regional authorities must think of themselves as initiators and facilitators of systems innovation processes.

#### *3.2.1.1 Status Quo of the Building and construction industry & SE*

The residential building stock in the EU is relatively old. On average, 21.6% of the building stock is built before 1945, 45.4% before 1969 and 75.4% before 1990. Given the lack of significant investments on building energy efficiency an old building stock produces low average for the entire National stock [4]. As the building renovation rate is about 1% a year and the construction rate is significantly higher than the demolition rate, the building stock is naturally extending in size. This means that the increasing size will lead to increasing energy consumption and consequently increasing greenhouse gases emissions.

The level of technological upgrading is a key element in measuring the construction industry's adequacy for the green challenge. In 2022 ten types of construction technology have been highlighted as impacting for the industry: AI; BIM and HBIM modelling; Lidar; Connected Hardhats; Smart Infrastructure; VR and AR; 3D Printing; Exoskeletons; Humanoid Labourers; Robot Swarms.

Sustainability in construction is implemented by European Commission by seeking coherence between industrial, environmental, climate and energy policy. This enables the growth of an optimal business environment for SE development, job creation and innovation. To achieve the SE growth energy containment goals, the Commission has set an ambitious agenda: to transform the EU economy into a circular economy, where the value of products and materials is retained for as long as possible, bringing significant economic benefits. The Commission is also supporting European industry in moving to a climate-neutral economy and improving the energy efficiency of products through eco-design legislation. Therefore, technological upgrading and circular economy are two pillars of current evolution of BaCI.

**EU energy savings' target from changes to the Building and Construction industry for 2030**

To increase material efficiency and reduce climate impact on 2030, EU commission have a comprehensive new strategy for a sustainable built environment based on learnt lessons. European Directive COM/2021/558 establishes, dividing them among countries, a target of reducing gas emissions to at least 55 percent by 2030 from 1990 levels.

To achieve these goals, the European Commission Work Program for 2021 includes the "Fit for 55" package aimed at reducing greenhouse gas emissions by at least 55 percent by 2030 and achieving a climate-neutral European Union by 2050. The Commission proposes [*Fit for 55*, 2022] to:

- require Member States to renovate at least 3% of the total floor area of all public buildings annually;
- set a benchmark of 49% of renewables in buildings by 2030;
- require Member States to increase the use of renewable energy in heating and cooling by +1.1 percentage points each year, until 2030;

In addition, circular principles throughout the lifecycle of buildings are advocated by:

- addressing construction products' sustainability in line with the Construction Product Regulation's revision, including potential recycled content requirements for certain construction products;
- promoting the durability and adaptability of built assets in line with the circular economy principles for buildings design;
- developing digital logbooks for buildings;

- using level(s) to integrate life cycle assessment in public procurement and the EU sustainable finance framework as well as to explore potential carbon reduction targets and carbon storage;
- considering a revision of material recovery targets set in EU legislation for construction and demolition waste;
- promoting initiatives to reduce soil sealing, rehabilitate abandoned or contaminated brownfields and increase the safe, sustainable and circular use of excavated soil.

#### *3.2.1.2 Major technological changes in Building and construction industry & SE*

Investment in energy efficiency in buildings is picking up but the speed of change lags behind overall building construction investment [5]. In the same way the major technological changes that effects in Building and construction industry which have an impact on energy efficiency and result to the sustainability of the energy sector are strictly connected to the technological changes in the overall Building and construction industry.

The growing and intersecting economic, energy, security and climate crises both challenge and highlight the progress needed to decarbonize and to improve the resilience of the global buildings sector. Opportunities include improving existing buildings efficiency and use, high-performance new buildings, efficient lighting appliances and equipment in buildings, integrating renewables in buildings, and decarbonizing production of building materials [5].

As major trends in the construction sector are towards the use and integration of intelligent and smart systems in every aspect. These new systems not only facilitate operations and lower costs but also reduce energy consumption, promote safety and eliminate human-made mistakes. Finally with environmental consciousness there is also increasing demand for flexible buildings that use technology to adapt to external conditions. To pursue recyclability and circular economy design firms are being asked more and more to analyze the reuse of existing infrastructures and built elements to reduce new construction and minimize the carbon footprint of the buildings stock [6].

The Marrakech Partnership for Global Climate Action Human Settlements Pathway (2021), which is co-led by GlobalABC, has developed the Action Table, and in particular the following *Table 1* "SUMMARY OF ACTIONS BY STAKEHOLDER GROUP". The original table contains all the stakeholder (), here are reported only the affected professions / specializations pertaining to the current treatment:

*Table 1. SUMMARY OF ACTIONS BY STAKEHOLDER GROUP. Marrakech Partnership for Global Climate Action Human Settlements Pathway, 2021.*

| SUMMARY OF ACTIONS BY STAKEHOLDER GROUP | | |
|---|---|---|
| **Policymakers (national, subnational, local levels)** | **Technology Providers and Innovators** | **Business and Service Providers** |
| • Include specific measures to address the emissions from the Built Environment in NDCs<br>• Establish roadmaps for a net zero built environment and develop supporting policies and targets, in coordination with key stakeholders across the value-chain<br>• Develop and implement mandatory building codes that reduce both operational and embodied emissions<br>• Mandate life cycle assessment (LCA) on during design and | • Develop and widespread use of digital solutions to accurately measure and automatically optimise built asset operational performance in real time; and measure and freely share as-built embodied carbon emissions over the asset life cycle<br>• Develop and widespread use of low carbon construction processes and materials Develop energy efficient and clean energy solutions for the built environment<br>• Enabling low carbon operation and maintenance of built assets | • Businesses across the built environment value chain commit to net zero and decarbonise assets under their control<br>• Corporate occupiers decarbonise the buildings they occupy collaborating with building owners<br>• Developers, architects, engineers, contractors and asset managers/owners assess, minimise and report project emissions through design, construction, and use, prioritising emissions released before 2050<br>• All businesses across the value chain collaborate to develop and use new viable, low carbon solutions for buildings and infrastructure<br>• Developers, architects, engineers, and contractors demand better environmental practice and lower |

| | | |
|---|---|---|
| construction to minimise whole life carbon emissions of projects<br>• Collect as-built embodied carbon emissions data and monitor operational carbon emissions to inform development of performance benchmarks<br>• Drive widespread deep energy retrofits aligned to net zero carbon standards<br>• Use urban planning to minimise resource (materials and energy) use whilst meeting the needs and improving health and wellbeing of communities | | carbon technologies and innovations from the supply chain<br>• Developers, architects, engineers, and contractors reduce water and energy use in households and buildings<br>• Develop skills to enable the transition to a net zero built environment |

These actions are already having an impact on Building and construction industry, which surely will grow in the future years, and in particular on technological changes into the sector. According to several transformation consultancy companies for the AEC sector (e.g. digital transformation consultancy and software development company – Intellectsoft and Imaginovation; communications provider to the construction industry – UK connect; SaaS-based procurement intelligence and analytics provider – Beroe), as well as insurance companies operating in the sector (e.g. MAPFRE Global Risks) the technological advancements and the most adopted technologies, processes, and materials in the construction industry can be summarized in the following point:

- **New materials**:
  - **Translucent concrete**: Over the years, concrete has been modified, improved and adapted to construction needs. Although still considered experimental, translucent concrete is a major innovation in the sector. This is polymeric concrete that includes cement, aggregates and additives in its composition, allowing the passage of light and providing superior mechanical characteristics than those of traditional concrete.
  - **Self-repairing concrete**: According to Oficemen, the Spanish Association of Concrete Manufacturers, concrete is the second most consumed material in the world after water. Its popularity led to multiple research initiatives, such as that of the Delf University of Technology, in which a bio-concrete capable of repairing itself was developed. Capsules containing bacteria and calcium lactate are inserted into the concrete: if a crack occurs, the next rain breaks these capsules, causing a chemical reaction that repairs the crack.
  - **Aerogel**: One of the most innovative products for thermal insulation. Originally used widely in the aerospace industry, today, it is making its way into the construction sector. It has a texture similar to polystyrene once hardened, and its solidity is similar to glass.
  - **Sustainable materials**: Environmentally friendly buildings are prominent, and there is a material boom taking place, towards minimizing CO2 emissions. This is achieved by using recycled, natural or locally sourced materials. In addition, efficient models that generate less waste during their manufacture and take into account both their useful life and their subsequent recycling are being used.
- **Innovative techniques:**
  - **BIM**: The greatest promise in modernizing and improving the construction sector. Building Information Modeling (BIM) is a collaborative work methodology that centralizes, in a digital and accessible database that is updated in real time, all information related to the construction and management of the infrastructure.

- **Virtual Reality and Augmented Reality.** Virtual Reality (VR) refers to the creation of an entirely simulated environment and has a relatively long history within the construction industry. However, Augmented Reality (AR) involves superimposing computer-generated images and real-world image information. VR is an important piece of construction technology for the industry in a variety of ways, these include training, safety, structure walkthroughs, plan reviews and similar aspects. VR can also help equipment operators on site seamlessly run simulations that could be too dangerous to replicate, I.e., natural disaster or major equipment malfunction. While AR can provide construction site workers with virtual feedback on real-world progress ensuring everyone is on the same page and errors are reduced on-site. AR is an excellent tool for the transmission of information by overlaying data with real-world information for the end-user.

  Augmented and virtual reality are proven pieces of construction tech for the industry, with many benefits, for example, a site contractor could hold a tablet up inside a home and see the locations of every necessary drill hole without having to check the physical building plan.
- **IoT:** The Internet of Things makes it possible to optimize all types of processes, and in the field of digital innovation, construction is one of the sectors with the greatest potential when it comes to applying its solutions. It can be applied at different stages of the construction process and offers great advantages both in the first phase of calculation, planning and design, as well as in subsequent on-site works.
- **Digital Twin.** Solving operation management issues, the digital twin is the newest technology in the AEC industry. It involves the use of simulation in creating a building prototype. Digital twin trends and functionality cover the use of intelligent multidimensional digital models. In 2023 and beyond, there will be fewer buildings with operational issues, all due to the ability of digital twins to simulate, predict and inform decisions based on real-world conditions. Digital twins carry out performance analysis considering occupants' behaviours with the use of patterns and space.
- **Blockchain Technology**. In 2023 and beyond, the entire AEC industry will have better cost management and efficient procurement strategies via blockchain. It was no more than a decade ago when this technology was introduced to the construction industry, serving as linked collections of data "blocks" that make up a digital ledger, with the records of all transactions and completed milestones. It can be compared to a literal chain, with each link representing a distinct transaction in a project, and it automatically balances itself. Unlike others, it is safe, decentralized and adaptable to projects of any size.
- **Artificial Intelligence.** Artificial intelligence or AI has become a key technology advancement for many industries including construction. AI offers the construction industry the ability to speed up planning and make entire operations faster and more efficient. Thus, creating a greater need for AI technology within the industry as a result of ALICE, an AI assistant designed specifically for the construction industry was created. The technology within the bot is designed to reduce project build lengths and costs by as much as 15%. Whilst also being able to evaluate millions of data and generate scheduling options that are specifically optimised with time and cost in mind, allowing projects to stay up to date.
- **Prefabrication**: Prefabricated parts save 70% of energy and 50% of water consumption, improving the efficiency of the construction process, as stated by Shaanxi Construction Engineering Corporation. Shaanxi Construction Engineering Corporation is a Chinese company, one of the first to opt for this methodology. Prefabricated parts also reduce pollution and noise, generating little waste.

- **Versatile tools:**

- **3D Printing**: The benefits of this development have been seen in all industries, with construction and urbanism already benefiting. 3D printing, although not as widespread as BIM, is one of the newest technologies in the construction industry. Its mechanism, which involves making three-dimensional buildings from digital models, was first used in 1995. Currently, there are no devices capable of printing entire buildings, however, the trend is clear: places like Dubai have imposed by law that, by 2025, a quarter of every building constructed will have to be made by 3D printing.
- **Construction robot**: Five years ago, the Australian Mark Pivac created the Hadrian X robot, capable of laying 1,000 bricks per hour. For some months now, this amazing bricklayer robot has been working on real-life projects and building its first houses. In fact, it does not just lay bricks: it cuts blocks with millimetric precision and lays adhesive, among others.
- **Drones**: These devices are an advantage due to their autonomy, the possibility of adding other equipment to their structure and their application in complex tasks, thereby replacing human teams. In the construction world, they are used for land exploration and the creation of visual content for the purposes of inspections and safety guarantees. This technological innovation reduces operating time, risks and costs.
- **Pocket LIDAR**: LIDAR is the most accurate and efficient tool to verify that any finished construction phase corresponds to the digital BIM model. To date, the most frequent scanning equipment has been bulky and somewhat uncomfortable. Now, thanks to two of the tech giants: Apple and Google, a mobile app that makes it much more convenient has been developed.
- **Connected Hardhats.** From smartwatches to smartphones, wearable tech has already smashed the personal gadget space, however, there is certainly more room to grow for wearable devices in the construction space. As a result of this, companies like Shimabun have released upgrade kits that can be fitted to standard hardhats, providing workers with a new extensive range of advanced safety capabilities. The Shimabun-equipped hardhat monitors location, motion, and temperature. As a result of this, it can enable it to warn that a worker might be lightheaded or overheated. Another capability of this construction technology is that it can also perceive if a worker has fallen and trigger an emergency call to first responders. The exactness of the data collected also makes it possible to perform better assessments of site mistakes to better prevent repeat occurrences and help reduce overall health and safety issues and risks on site before they occur.
- **3D Laser Scanner**. Among the newest construction technology in the AEC industry is the 3D laser scanner. Its interoperability and modifications each year make it a consistently fresh innovation. It's known for its ability to scan and analyse real-world objects. It has been deployed for on-site surveying, mapping, project inspection, safety and many other tasks in construction. Its accuracy makes construction planning easy with significant cost savings.
- **Exoskeletons.** Another technological advancement for 2022, is the use of exoskeletons within the construction industry. Exoskeletons are another piece of wearable technology that works in tandem with the user, allowing site workers to carry out more work than humanly possible. The aim of this technology is to minimise strain and injury to the workers' bodies whilst also helping to increase worker productivity as workers appear less fatigued when using this technology. As a result, this construction technology advancement will help increase safety on site and reduce the number of lost hours due to injuries. There are a variety of different versions of exoskeletons, all of which have their own purpose. These include: Power Gloves – Gripping tools and materials; Arm and shoulder support – Overheard activities and lifting; Back support – Stopping, lifting or reaching; Standing and crouching support – Task that requires prolonged standing I.e., drilling; Whole body suit – Lifting and carrying heavy tools and or objects; There are also two significant types of Exoskeletons: the

mechanical which is designed for redistribution of weight and the electrical which is designed to enhance strength.

- **Humanoid Labourers.** In response to the continued labour shortage concerning many labour industries worldwide, Japanese researchers have developed Humanoid labour technology called: HRP-5P. HRP-5P is a humanoid robot capable of performing basic physical tasks like installing drywall or bricklaying independently. Alongside HRP-5P, there are also other robotic advancements such as TyBot, Doxel AI, and many other built robotics i.e. Automated Track Loader, or ATL. Each of which has its own features and responsibilities. However, there can be both positives and negatives to this construction technology advancement. For example, it automates dangerous tasks meaning human workers out of the risk of harm and health and safety risks are reduced. There is also a fear that advancement in technology would also take them out of the workforce and cut down the need for human labour. With many industry leaders recommending widespread retraining to help retain employees in fields that are already short on workers.

Some of these technological changes have also been highlighted as fundamental for the BaCI sector by the interviewed stakeholders, and a summary is given below with respect to the professions mainly affected by the change in the *Table 2*.

*Table 2. Technological changes and Affected professions / specializations according to interviewed stakeholders*

| Technological change | | Affected professions / specializations |
|---|---|---|
| **Advanced IoT sensors** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers |

| | | |
|---|---|---|
| | | • Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |
| **AI-controlled Digital Twin** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Risk Management Specialists |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |
| **High efficiency solar energy technologies** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |

| | | |
|---|---|---|
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |
| **Renewables energy storage** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants Risk Management Specialists |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |
| **Local renewab** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers |

| | | |
|---|---|---|
| | | • Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Risk Management Specialists |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |
| **Building and Urban Water management** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers |

| | | |
|---|---|---|
| | | • Building Managers |
| **Digital advanced simulation of building performances** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Facilities Managers<br>• Building Managers |
| **Circular building materials and components** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Remote Sensing Scientists and Technologists |
| | Operation and Maintenanc | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Sustainable Design specialist |

| | | |
|---|---|---|
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |
| **Sustainable composite materials** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems |
| | Operation and Maintenanc | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers |

### 3.2.2 Qualifications and Skills (Q&S)

The methodology applied in this section by the research group encompass the organization of a focus group composed of representatives of professional associations, public authorities, construction companies, and design studios (*Figure 1*), to whom has been submitted an interview form (see Table 3).

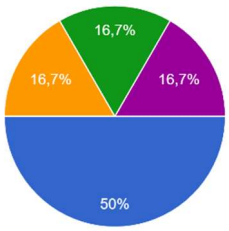



*Figure 1. Distribution of typology of stakeholders included in the focus group. In blue: "public authorities", in red: "companies"; in yellow: "professional associations"; in green: "design firms"; in purple: "others".*

*Table 3. Questions included in the interview form, prepared by the authors, and submitted to focus group.*

| **Interview form** |
|---|
| **SECTION A: Main technological changes caused by energy sustainability in the building and construction sector** |
| ***With reference to the building and construction sector in Italy:*** |
| 1. What recent technologies (digital or not) oriented towards energy efficiency, ecology, and sustainability do you know?<br>2. How do you believe these advancements will affect the sustainable energy sector in the short and long term?<br>3. What technologies do you think will be adopted widely in the near future and why?<br>4. In your opinion, what are the most promising areas of innovation and technological development in the building and construction industry, oriented towards energy efficiency, ecology, and sustainability?<br>5. What do you think will be the role of digitalization in the building and construction industry (especially for design and construction)?<br>6. What do you think will be the main guidelines for the development of digitalization in the sector?<br>7. What do you think will be the main guidelines for the development of sustainability in the sector?<br>8. What do you think will be the main guidelines for the development of energy efficiency in the sector?<br>9. What do you think are the current limitations to overcome and the challenges to face for a more concrete and organic application of digital and sustainable technologies in the building and construction sector?<br>10. In your opinion, are there any other important technologies or trends for energy sustainability in the building and construction sector in the future? |
| **SECTION B: Current professional Q&S for energy sustainability in the buildings and construction sector** |
| ***With reference to energy sustainability in the building and construction sector in Italy, currently:*** |
| 1. In your opinion, what are the most relevant and requested Q&S in the sector at various levels (operators, technicians, designers, managers, etc.)?<br>2. What new technologies and systems are currently being used in the sector? How have they affected the Q&S needed?<br>3. How have the Q&S needed in the sector changed in the last 5 years?<br>4. In your opinion, what Q&S are currently being overlooked or undervalued in the sector?<br>5. How do companies in your field/sector currently acquire and develop the necessary Q&S for their workforce?<br>6. In your opinion, how can vocational education and training programs better align with the current Q&S needed to develop energy sustainability in the building and construction sector? |
| **SECTION C: Professional Q&S necessary to address the technological changes caused by energy sustainability in the building and construction sector** |
| **With reference to the future of energy sustainability in the building and construction sector in Italy:** |
| 1. Are there any other technological trends, developments or changes that you believe will affect the Q&S needed in the future?<br>2. How do you see the sector and Q&S needed for it evolving in the next 5 years?<br>3. How do you see the sector and Q&S needed for it evolving in the next 10 years?<br>4. Based on these developments, which Q&S do you think will be more in demand in the future and why?<br>5. What actions do you think should be taken to ensure that workers in the sector have the Q&S needed for success in the near future?<br>6. In your opinion, how can vocational education and training programs better align with the future Q&S needed to develop energy sustainability in the building and construction sector? |

### *3.2.2.1 Current Q&S of the Building and construction industry & SE professionals*

Digital technologies are rapidly evolving in the construction sector, despite often they are not effectively and broadly used [7]. This makes it difficult for the different figures of the construction sector to cope with the integration of the numerous new technological changes with the traditional roles and processes [8].

The skills that are needed to be digitally competent change as digital innovations change and develop over time. Digitalization currently dominates construction innovations, nevertheless, often is possible to identify a lack of digital literacy among the labor workers employed [9]. Encourage the development of a broader culture of the available digital technologies is a pivotal point for the new generation of professionals and construction firms related to energy sustainability in the building and construction sector [10].

This section aims to identify and highlight the current skills and qualifications (Q&S) required for a job profile able to operate today with proficiency for energy sustainability in the buildings and construction industry (B&CI). *Table 4* summarizes the review of current professional Q&S, identified through the interview form – presented in Section 3.2.2 (Table 3) – prepared by the Sapienza team and submitted to the selected focus group. The results have been integrated with a literature review process.

*Table 4. Current Qualifications and Skills related to energy sustainability in the buildings and construction sector.*

| Siting and Design | Construction | Operation and Maintenance | Renovation and Deconstruction | Education and Policy, Promotion | Professions / specializations related to BaCI | Current Qualifications and Skills |
|---|---|---|---|---|---|---|
| x | | | x | | Construction Company: management<br>• Construction Company Managers and Business Functions | • project management skills, to understand, coordinate, and cooperate effectively with each figure of the construction processes;<br>• business and economic management and ability to cooperate with other construction companies;<br>• ability to understand problems and interferences between various disciplinary sectors encountered in a complex design; |
| x | | | x | | Technicians: designers<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Architects and Civil/Structural/ Environmental Engineers | • certifications in BIM proficiency, such as BIM Manager, BIM Coordinator, and BIM Specialist;<br>• project management skills, to understand, coordinate, and cooperate effectively with each figure of the construction process;<br>• ability to design latest generation heating and cooling systems;<br>• ability to understand problems and interferences between various disciplinary sectors encountered in a complex design; |

| | | | | | | |
|---|---|---|---|---|---|---|
| x | | | x | | Technicians: technical drawers<br>• Architectural Technicians / Technical Drawing Specialists | • certifications/skills in CAD, in BIM proficiency, such as BIM Specialist;<br>• ability to program with specific languages, such as Python, R, Ruby, Java;<br>• technical and vocational education and training project management skills, to cooperate effectively with each figure of the construction process; |
| x | | | x | | Technicians: specialists and consultants<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | • certifications/skills in CAD, in BIM proficiency, such as BIM Specialist;<br>• technical and vocational education and training project management skills, to cooperate effectively with each figure of the construction process;<br>• ability to program with specific language, such as Python, R, Ruby, Java; |
| | x | | | | Building site: management<br>• Building Site Supervisors, Site Engineers, and Site Architects<br>• Environmental health and safety specialist | • for the technical supervisor of the construction site, the ability to coordinate the project in relation to the construction phases;<br>• ability to understand problems and interferences between various disciplinary sectors encountered in a complex design; |
| | x | x | | | Building site: workers<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems) | • highly skilled workers in construction processes, especially in relation with the most recent techniques; |
| | | | | x | Property management<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers<br>• Energy Managers | • Monitoring and maintenance of facilities<br>• Certified Energy Manager<br>• Certified Energy Auditor<br>• Certifications in CAFM (Computer Aided Facility Management) proficiency |
| | x | | | x | IT and sensing management<br>• Remote Sensing Scientists and Technologists<br>• IT & System Technicians<br>• Developers | • Proficiency knowledge in Infrastructure and systems, both in designing and installing |
| | | | | x | Public authorities:<br>• Policy Makers, Urban Planners<br>• Public Servants Working in Procurement and Management of Buildings | • project management skills, to understand, coordinate, and cooperate effectively with each figure of the construction process;<br>• ability to understand problems and interferences between various disciplinary sectors encountered in a complex design; |
| | | | | x | Manufacturing and production: | • Certification in environmental and sustainability standards and protocols; |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | • Manufacturers and Distributors of Green Building Materials and Products | |
| | | | | x | Research institutes:<br>• Educators and Information Providers, Researchers | • ability to program with specific language, such as Python, R, Ruby, Java; |

### *3.2.2.2 Q&S needed to address the technological changes*

The numerous technological changes expecting until 2030 in the buildings and construction sector – present in Section 3.2.1.2 – will cause new needs in the professional Q&S. *Table 5* summarize the review of future professional Q&S required to address energy sustainability in the buildings and construction sector. As well as for Section 3.2.2.1, a focus group composed by expert in the sector has been involved to discuss the topic.

*Table 5. Future Qualifications and Skills needed to address the technological changes in the buildings and construction sector in relation to energy sustainability, according to interviewed stakeholders.*

| Technological change | | Affected Profession/ specializations | Required Qualifications and Skills |
|---|---|---|---|
| **Advanced IoT sensors** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | • Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes<br>• Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists | • Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • Advanced technical experience on the field |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes<br>• Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |

| | | | |
|---|---|---|---|
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • Advanced qualifications in digital modeling and code checking<br>• Advanced technical experience on the field<br>• Advanced skills in managing the interoperability processes |
| **AI-controlled Digital Twin** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Risk Management Specialists | • Qualifications and certification of digital skills<br>• Skills and qualifications in coding<br>• Skills in Common Data Environment (CDE) management<br>• Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes<br>• Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists | • Qualifications and certification of digital skills<br>• Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Qualifications and certification of digital skills<br>• Skills and qualifications in coding<br>• Skills in Common Data Environment (CDE) management<br>• Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes<br>• Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors |
| | Education and | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers | • Qualifications and certification of digital skills<br>• Advanced technical experience on the field |

| | | | |
|---|---|---|---|
| | | • Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes |
| **High efficiency solar energy technologies** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants | • High specialization<br>• Forecast interferences between the different sectors during complex design processes<br>• Ability to creatively interact with AI for design<br>• Qualifications and certification of digital skills<br>• Skills and qualifications in coding<br>• Skills in Common Data Environment (CDE) management |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists | • High specialization<br>• Ability to interact and monitor different operators<br>• Forecast interferences between the different sectors during complex design processes |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • High specialization<br>• Ability to interact and monitor different operators |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • High specialization<br>• Forecast interferences between the different sectors during complex design processes<br>• Ability to creatively interact with AI for design<br>• Qualifications and certification of digital skills<br>• Skills and qualifications in coding<br>• Skills in Common Data Environment (CDE) management |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants | • Ability to creatively interact with AI for design<br>• Qualifications and certification of digital skills<br>• Skills and qualifications in coding<br>• Skills in Common Data Environment (CDE) management |

| | | | |
|---|---|---|---|
| | | • Facilities Managers<br>• Building Managers | |
| **Renewables energy storage** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants Risk Management Specialists | • High specialization<br>• Forecast interferences between the different sectors during complex design processes<br>• Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to conceive and design new technological solutions<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Certification of digital skills |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists | • High specialization<br>• Ability to interact and monitor different operators<br>• Forecast interferences between the different sectors during complex design processes<br>• Ability to install and manage new technological solutions<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for the coordination designer and construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Skills in the proper installation of new technological solutions<br>• Ability to manage the installation of new technological solutions in conditions different from the traditional ones<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and the technician/installer with skills in electronics) |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • High specialization<br>• Ability to install and manage new technological solutions<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Skills in the proper installation of new technological solutions<br>• Ability to manage the installation of new technological solutions in conditions different from the traditional ones<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and the technician/installer with skills in electronics) |
| | Renovation and | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists | • High specialization<br>• Ability to interact and monitor different operators |

| | | | |
|---|---|---|---|
| | | • HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Forecast interferences between the different sectors during complex design processes<br>• Ability to install and manage new technological solutions<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for the coordination designer and construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Skills in the proper installation of new technological solutions<br>• Ability to manage the installation of new technological solutions in conditions different from the traditional ones<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and the technician/installer with skills in electronics) |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • High specialization<br>• Ability to creatively interact with AI for design<br>• High specialization<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Certification of digital skills |
| **Local renewables production** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Risk Management Specialists | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to conceive and design new technological solutions<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists | • Ability to install and manage new technological solutions<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for the coordination designer and construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Operation and | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians | • Ability to install and manage new technological solutions |

| | | | |
|---|---|---|---|
| | | • Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to install and manage new technological solutions<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for the coordination designer and construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• IT & System Technicians<br>• Developers<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • Specific and advanced skills on green and alternative system engineering and energy solutions |
| **Building and Urban Water management** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to conceive and design new technological solutions<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for the coordination designer)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Storage and Distribution Managers<br>• Water resources specialist<br>Remote Sensing Scientists and Technologists | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to install and manage new technological solutions *(for contractors)*<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • Ability to install and manage new technological solutions<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |

| | | | |
|---|---|---|---|
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to install and manage new technological solutions *(for contractors)*<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • Specific and advanced skills on green and alternative system engineering and energy solutions |
| **Digital advanced simulation of building performances** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | • Ability to use Building Information Modeling (BIM) tools<br>• High qualifications and skills in coding (e.g., Python, R, Ruby, Java) |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems<br>• Storage and Distribution Managers<br>• Water resources specialist<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems)<br>• Remote Sensing Scientists and Technologists | • Ability to use Building Information Modeling (BIM) tools |
| | Operation and Maintenance | • Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating (Large Building or District) and Combined Heat and Power (CHP) Systems | • Ability to use Building Information Modeling (BIM) tools |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Ability to use Building Information Modeling (BIM) tools |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• IT & System Technicians<br>• Energy Managers | • Ability to use Building Information Modeling (BIM) tools<br>• Ability to professional training in the use of BIM methods and tools *(for educators)*<br>• High qualifications and skills in coding (e.g., Python, R, Ruby, Java) |

| | | | |
|---|---|---|---|
| | | • Public Servants Working in Procurement and Management of Buildings<br>• Facilities Managers<br>• Building Managers | |
| **Circular building materials and components** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to conceive and design new technological solutions *(for designer)*<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for the coordination designer)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Remote Sensing Scientists and Technologists | • Ability to install and manage new technological solutions<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions *(for construction site technician)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Operation and Maintenanc | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians | • Ability to install and manage new technological solutions<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Sustainable Design specialist | • Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to conceive and design new technological solutions *(for designer)*<br>• Ability to install and manage new technological solutions *(for contractors)*<br>• Specific and advanced skills on green and alternative system engineering and energy solutions |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• Energy Managers<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • Specific and advanced skills on green and alternative system engineering and energy solutions |
| **Sustainable composite** | Siting and Design | • Construction Company Managers and Business Functions<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers | • Qualifications and certification of digital skills<br>• Programming skills and qualifications<br>• Skills in Common Data Environment (CDE) management |

| | | | |
|---|---|---|---|
| | Construction | • Building Site Supervisors, Site Engineers and Site Architects<br>• Environmental health and safety specialist<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Installers<br>• Electricians, IT Technicians and Installers of Energy Management Systems | • Skills in the proper installation of new technological solutions *(for contractors and workers)*<br>• Ability to manage the installation of new technological solutions in conditions different from the traditional ones<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and the technician/installer with skills in electronics) |
| | Operation and Maintenance | • Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians | • Skills in the proper installation of new technological solutions *(for contractors and workers)*<br>• Ability to manage the installation of new technological solutions in conditions different from the traditional ones<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and the technician/installer with skills in electronics) |
| | Renovation and Deconstruction | • Construction Company Managers and Business Functions<br>• Architects and Civil/Structural/ Environmental Engineers<br>• Architectural Technicians / Technical Drawing Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Surveyors, Renovators, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Sustainable Design specialist | • Qualifications and certification of digital skills<br>• Programming skills and qualifications<br>• Skills in Common Data Environment (CDE) management<br>• Skills in the proper installation of new technological solutions *(for contractors and workers)*<br>• Ability to manage the installation of new technological solutions in conditions different from the traditional ones |
| | Education and Policy, Promotion | • Policy Makers, Urban Planners<br>• Financing<br>• Educators and Information Providers, Researchers<br>• Manufacturers and Distributors of Green Building Materials and Products<br>• Public Servants Working in Procurement and Management of Buildings<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers | • Qualifications and certification of digital skills<br>• Programming skills and qualifications<br>• Skills in Common Data Environment (CDE) management |

### 3.2.3 Synthesis- Recommendations

#### *3.2.3.1 Future impact on Q&S- Most interesting trends for CoVEs*

As the adoption of sustainable building design and construction practices becomes more widespread thanks to digital innovation, it opens up new market opportunities that can lead to increased job prospects for future workers. While certain occupations in BaCI, such as urban planners, architects, building and civil engineers, mechanical engineers, typically require a minimum of a bachelor's degree, many construction and trade positions can be learned through on-the-job training or apprenticeships.

Centers of Vocational Excellence (CoVEs) play a crucial role in providing training and education to professionals in the BaCI industry, focusing on sustainable design principles, renewable energy technologies, digital tools and processes. The primary objective of CoVEs is to develop a skilled workforce capable of meeting the growing demand for sustainable building design and construction. Therefore, CoVEs are instrumental in efforts to reduce environmental impact and enhance energy efficiency within the construction industry, looking toward climate neutrality and circular economy in this field. They achieve this by delivering training and education to professionals working in various roles, contributing to the overall improvement of sustainable practices. Table 6 presents the structural requirements for CoVEs based on specific professions, the necessary qualifications and skills, and the available training opportunities in green buildings.

*Table 6 Required Q&S report the results in Table 5 according to interviewed stakeholders; in brackets, the authors added specifications from literature research.*

| Affected Profession/specializations | Required Q&S | Existing Q&S/Available Training | Structural needs for CoVEs |
|---|---|---|---|
| Construction Company: management<br>• Construction Company Managers and Business Functions | • Advanced skills in managing the interoperability processes (with knowledge on IT technology, digital twins, BIM methods, and sensoring)<br>• Advanced technical experience on the field<br>• Advanced managerial skills across multiple disciplinary sectors<br>• Ability to coordinate complex construction sites involving the installation of advanced technological solutions<br>• Ability to use Building Information Modeling (BIM) tools | Partially. Management and coordination skills are mostly acquired on the field. There is a training gap for the application of these new technologies in the field. | New training should improve the required skills through the use of these new technologies; in particular, digital skills, interoperability, AR/VR, and IoT sensoring. |
| Technicians: designers<br>• Architects and Building/Structural/Environmental Engineers, Sustainable Design Specialists<br>• HVAC, Electrical, Mechanical, Sanitary, RE & Building Services Engineers / Designers<br>• Architects and Civil/Structural/ Environmental Engineers | • Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes<br>• Advanced technical experience on the field (upgrade with new technology and materials)<br>• Advanced managerial skills across multiple disciplinary sectors<br>• Qualifications and certification of digital skills<br>• Skills in Common Data Environment (CDE) management<br>• Ability to find technological solutions to adapt new sustainable technologies to existing buildings<br>• Ability to conceive and design new technological solutions<br>• Ability to use Building Information Modeling (BIM) tools<br>• Specific and advanced skills on green and alternative system engineering and energy solutions | Partially. The current skills required are mostly acquired during the studies and on the fields. Some training is available in digital skills and energy solutions, nevertheless, they are not correlated to each other. | New training should include specific programs that correlate digital skills and green solutions. |
| Technicians: technical drawers<br>• Architectural Technicians / Technical Drawing Specialists | • Advanced qualifications in digital modeling and code checking<br>• Advanced skills in managing the interoperability processes | Partially. The current skills required are mostly | New training should include specific programs on the |

| | | | |
|---|---|---|---|
| | • Qualifications and certification of digital skills<br>• Skills in Common Data Environment (CDE) management<br>• Forecast interferences between the different sectors during complex design processes<br>• Ability to creatively interact with AI for design<br>• Ability to use Building Information Modeling (BIM) tools<br>• High qualifications and skills in coding (e.g., Python, R, Ruby, Java) | acquired during the studies and on the fields. Some training is available on coding, but they are not specific in relation to energy sustainability in the building and construction sector. | application of new technology (e.g., coding and AI) to the energy sustainability sector. |
| Technicians: specialists and consultants<br>• Surveyors, Energy and Water Efficiency and Waste Management Analysts, Consultants and Advisors, Botanist, Vegetation specialist, Risk Management Specialists | • Advanced skills in managing the interoperability processes<br>• Advanced technical experience on the field<br>• Skills in Common Data Environment (CDE) management<br>• Forecast interferences between the different sectors during complex design processes<br>• Ability to creatively interact with AI for design<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Ability to use Building Information Modeling (BIM) tools<br>• High qualifications and skills in coding (e.g., Python, R, Ruby, Java)<br>• Specific and advanced skills on green and alternative system engineering and energy solutions | Yes. Specialistic trainings are currently available. | The training program should be regularly updated according to the constant evolution of technology in the sector. |
| Building site: management<br>• Building Site Supervisors, Site Engineers, and Site Architects<br>• Environmental health and safety specialist | • Ability to coordinate complex construction sites involving the installation of advanced technological solutions | Partially. Management and coordination skills are mostly acquired on the field. There is a training gap for the application of these new technologies in the field. | Training to improve the skills through the use of these new technologies; in particular, digital skills, interoperability, AR/VR, and IoT sensoring. |
| Building site: workers<br>• Specialized workers (Bricklayers; Carpenters; Glaziers; Masons; Roofers; Plasterers; Painters/Decorators)<br>• Plumbers, Heating, HVAC and Heat pump Maintainers<br>• Electricians/Maintainers of Energy Management Systems and IT Technicians<br>• Maintainers of Solar Thermal Systems, Biomass Heating systems Maintainers of Mass Heating | • Advanced technical experience on the field (in IoT Sensoring)<br>• High specialization (in high efficiency solar energy technologies)<br>• Ability to interact with different operators<br>• Skills in the proper installation of new technological solutions<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and | No/partially. Training currently available are limited to the current most diffused technology. | New training should focus on new technologies with constant upgrades (e.g., AR/VR in construction sites, use of exoskeletons, drones, etc). |

| | | | |
|---|---|---|---|
| (Large Building or District) and Combined Heat and Power (CHP) Systems<br>• Installers of Renewable energy systems (Solar, Biomass Heating, Small-scale Wind, Mass Heating and Combined Heat and Power Systems) | the technician/installer with skills in electronics) | | |
| Property management<br>• Householders and Tenants<br>• Facilities Managers<br>• Building Managers<br>• Energy Managers | • Advanced technical experience on the field (in IoT Sensoring)<br>• Advanced skills in managing the interoperability processes<br>• Qualifications and certification of digital skills<br>• Skills in Common Data Environment (CDE) management<br>• Ability to creatively interact with AI for manage<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Ability to use Building Information Modeling (BIM) tools | Partially. Current trainings are focusing on CAFM, widely used in management systems, with less interoperability with other phases of building process. | The training program should improve basic knowledge in BIM process to cooperate with CAFM and interoperability processes between digital and green solutions. |
| IT and sensing management<br>• Remote Sensing Scientists and Technologists<br>• IT & System Technicians<br>• Developers | • Skills in Common Data Environment (CDE) management<br>• Ability to install and manage new technological solutions<br>• Qualifications towards the definition of new professional figures (e.g., the digital worker and the technician/installer with skills in electronics) | Yes. Specialistic trainings are currently available. | The training program should be regularly updated according to the constant evolution of technology in the sector. |
| Public authorities:<br>• Policy Makers, Urban Planners<br>• Public Servants Working in Procurement and Management of Buildings | • Advanced skills in managing the interoperability processes<br>• Qualifications and certification of digital skills<br>• Skills in Common Data Environment (CDE) management<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Ability to use Building Information Modeling (BIM) tools | Partially. Management and coordination skills are mostly acquired on the field. There is a training gap for the application of these new technologies in the field. | The training program should improve the skills through the use of these new technologies; in particular, digital skills, interoperability, AR/VR, and IoT sensoring. |
| Manufacturing and production:<br>• Manufacturers and Distributors of Green Building Materials and Products | • Specific and advanced skills on green and alternative system engineering and energy solutions | Partially. Current trainings are focusing on some specialist aspects. | The training program should include interoperability and new technologies contents for green and alternative system engineering and energy solutions. |

| | | | |
|---|---|---|---|
| Research institutes:<br>• Educators and Information Providers, Researchers | • Advanced qualifications in digital modeling and code checking<br>• Advanced technical experience on the field (in IoT Sensoring)<br>• Qualifications and certification of digital skills<br>• Skills in Common Data Environment (CDE) management<br>• Specific and advanced skills on green and alternative system engineering and energy solutions<br>• Ability to professional training in the use of BIM methods and tools<br>• High qualifications and skills in coding (e.g., Python, R, Ruby, Java) | Yes.<br>Specialistic trainings are currently available. | The training program should be regularly updated according to the constant evolution of technology in the sector. |

### *3.2.3.2 Recommendations for policy makers for the modernisation of VET*

Achieving sustainability targets in the energy field has become essential in recent years for the Building and Construction Industry. This industry is constantly evolving in driven by technological innovation, with special reference to digital and climate climate-neutral (green) transitions. The labour force needs to be trained and prepared to these transitions trough Vocational education and training programs, to develop crucial skills and remain employable. VET programs offer accessible short-term training, certificates, and degrees that can benefit many workers by providing in-demand skills [11].

VET demonstrates adaptability by quickly adjusting to evolving demands in the job market. Acquiring skills in sustainable building design and construction is a wise career investment due to its significance in the construction industry, energy sector, and overall economy. The sector is projected to expand, creating a greater number of employment opportunities and improved job prospects for workers involved in sustainable building design and construction worldwide. Hence, investing in training programs that impart these skills can equip individuals for a successful career in this thriving field.

In recent years, there has been a significant rise in the availability of training programs focused on sustainable building design and construction practices. Despite this growth, employers continue to encounter challenges in finding skilled individuals for specific job roles. This is primarily due to limitations in the training provided, which is often too broad in scope, lacks practical applications, and fails to meet industry requirements. To fully capitalize on the potential of sustainable energy opportunities in the BaCI industry, it is crucial to establish a robust and enduring partnership between educational institutions and employers. This collaboration will ensure that training programs align closely with industry needs, offering practical and specialized instruction that prepares individuals to excel in sustainable building design and construction building careers.

The modernization of vocational education and training requires the active involvement of all stakeholders, including policy makers. The focused group involved in interviews on skill changes discussed current situation and technological innovations. They discussed the future market's expectations and needs and the most notable and promising areas for further research and development in the BaCI sector areas are as follows.

- Internet of things and smart building technologies
- Sensory systems
- Simulation, modelling and digital twins for energy efficient building design

- Renewable energy integration with energy storage solutions
- Virtual, augmented and extended reality
- Location-based technologies
- Interaction technologies
- Artificial intelligence and cloud computing
- Grid integration and energy management: demand response programs, vehicle-to-grid (V2G) systems, and microgrids
- Circular building construction process and recycled or bio-based materials: together with advanced LCA methodologies and energy modeling tools.

Continued research and development endeavors persistently push forward progress in these domains, resulting in the creation of buildings and infrastructure that are more sustainable and energy-efficient. However, it is essential to invest in targeted training to ensure that companies, public employees, and individuals can acquire the requisite skills and knowledge locally-necessary for effectively and safely implementing, managing, and maintaining these technologies. By doing so the role and involvement of local stakeholders is essential to guarantee efficient and secure utilization of these advancements and prepare highly-skilled workers for the near future. Educators, industry leaders, policymakers, top professionals must collaborate to ensure innovative VET programs.

### 3.2.4 References


[1] EU COM/2021/350 final https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:350:FIN

[2] COMMISSION STAFF WORKING DOCUMENT Scenarios for a transition pathway for a resilient, greener and more digital construction ecosystem https://ec.europa.eu/docsroom/documents/49407

[3] Rilevazione annuale sul settore delle società italiane di ingegneria, Consuntivo 2021 – Previsioni 2022, Edizione n. 38 OICE – Confindustria.

[4] The EU Building Stock Observatory (BSO) web tool monitors the energy performance of buildings across Europe https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en

[5] Global Alliance for Buildings and Construction. (2020). EXECUTIVE SUMMARY OF THE 2020 GLOBAL STATUS REPORT FOR BUILDINGS AND CONSTRUCTION. www.globalabc.org.

[6] Aldo Norsa, 2022. REPORT 2022 on the Italian Architecture, Engineering and Construction Industry.

[7] Reyhaneh S. Shojaei, Gemma Burgess, Non-technical inhibitors: Exploring the adoption of digital innovation in the UK construction industry, Technological Forecasting and Social Change, Volume 185, 2022, 122036, ISSN 0040-1625, https://doi.org/10.1016/j.techfore.2022.122036.

[8] Sambo Lyson Zulu, Ali M. Saad, Saheed O. Ajayi, Mohammed Dulaimi, Maria Unuigbe. (2023) Digital leadership enactment in the construction industry: barriers undermining effective transformation. *Engineering, Construction and Architectural Management* 22.

[9] Zulu SL, Saad AM, Gledson B. Individual Characteristics as Enablers of Construction Employees' Digital Literacy: An Exploration of Leaders' Opinions. Sustainability. 2023; 15(2):1531. https://doi.org/10.3390/su15021531.

[10] Zulu, S.L., Saad, A., Ajayi, S., Unuigbe, M. and Dulaimi, M. (2023), "A thematic analysis of the organisational influences on digitalisation in construction firms", *Journal of Engineering, Design and Technology*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JEDT-10-2022-0513

[11] European Commission, 2023. European education area: https://education.ec.europa.eu/education-levels/vocational-education-and-training/about-vocational-education-and-training

## 3.3 Cybersecurity, Artificial Intelligence and IT, Basque Country, Spain

### 3.3.1 Cybersecurity, Artificial Intelligence and IT & SE

The energy sector is a fundamental pillar of Basque industry. In the Basque Country there are around 350 companies linked to the sector with a worldwide turnover of 47,000 million euros, of which 15,000 million are in the Basque Country. The Basque energy sector generates 63,000 jobs worldwide, 21,000 of them in the Basque Country [1]. Long-term goals are zero oil consumption for energy use by 2050 and zero fossil fuel consumption with net zero GHG emissions by the end of this century, as well as an 30% reduction and 80% reduction in GHG emissions by 2030 and 2050, respectively, compared to 2005, according to Basque Country Energy Strategy 2030 [2].

This chapter aims to explore the interplay between Cybersecurity, Artificial Intelligence (AI) and Information Technology (IT) in the context of the Sustainable Energy (SE) sector. These technologies play a crucial role in securing critical infrastructure, optimizing energy usage, and developing renewable energy systems. The rationale behind analysing this topic is its significant relevance to the sustainable energy targets of the region, aligned with the regional innovation strategies, RIS3 Euskadi. Incorporated in the Science, Technology, and Innovation Plan 2030 (PCTI) [3], it defines the Energy as one of the three key priorities, with the European Green Pact's goal of zero greenhouse gas emissions by 2050 in mind.

**Cybersecurity:** Cybersecurity is the practice of protecting networks, devices and data from unauthorised access or criminal use [4]. It is essential in protecting energy infrastructure from cyber-attacks that could disrupt energy supply or compromise the integrity of energy systems. This includes securing critical data, such as customer information and operational data, and safeguarding against malware and other cyber threats.

As pointed out in a report prepared by the Spanish Centre for Industrial Cybersecurity (CCI) and the Naturgy Foundation [5], the impact of a power cut because of a cyberattack could have very significant consequences in all sectors, in addition to affecting end users. With the integration of renewable generation and the digitisation of grids, as well as smart meters and advanced metering systems, new challenges are emerging in the field of cybersecurity. For instance, the study indicates that companies must open to a greater number of manufacturers to incorporate new technologies, so it is "fundamental" to analyse risks at different levels. This must be considered from design to every phase of the implementation of new projects, as well as in the necessary adaptations and renovations.

The PCTI 2030 considers cybersecurity as a core technology in its digital-tech transition. An example of this is CYBASQUE [6the Association that represents Cybersecurity Industries of the Basque Country, with 61 partners of the sector. Mission of CYBASQUE is to promote Cybersecurity in all private areas of the territory, promoting collaboration with other sectors and fostering the development of new products / services, technologies, and markets.

**Definition of AI:** The European Commission's High-level expert group on artificial intelligence (HLEG)´s definition on AI proposed is the following [7]: “Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals.” Namely, intelligent machines that can perform tasks that typically require human intelligence, such as learning, problem-solving, and decision-making.

Artificial Intelligence (AI) is increasingly used in the energy sector to improve efficiency and support decision-making. AI can be used in all energy sources, and particularly for grid management, where it uses data analytics to estimate energy consumption and optimize production. This can help energy companies manage the grid,

meet demand and avoid wastage. AI can also improve maintenance practices by predicting when repairs are needed, avoiding energy loss. As energy companies seek to digitize their operations, AI is expected to play an even larger role in the transition to greener alternatives. AI plays a crucial role in the energy sector by addressing big data challenges, advancements in deep learning and machine learning, smart robotics, integration of renewable energy, IoT expansion, cybersecurity, and increased computational power [12]. In particular, AI algorithms can detect faults in power transformers, power lines, hydroelectric generators, photovoltaic systems, and wind turbines. AI also supports cybersecurity in detecting cyberattacks and anomalies in power systems [13].

The Basque PCTI 2030 considers AI as a core technology in its digital-tech transition. It is therefore essential to investigate these technologies to contribute towards the local SE targets.

**Definition of IT:** It refers to the use of digital technology in industrial settings to improve manufacturing processes, supply chain management, and overall operational efficiency. This includes technologies such as robotics, automation, sensors, and data analytics, among others. The IT industry plays a crucial role in enabling a more sustainable energy sector by providing the tools, technologies, and expertise necessary to optimize energy usage, reduce waste, and integrate renewable energy sources. The IT industry can help energy companies to better monitor and control their energy systems, predict, and prevent maintenance issues, and integrate renewable energy sources into the grid.

The IT industry in the Basque Country has an important role to play in achieving these targets. The region is home to several IT companies that are developing innovative solutions for the energy sector, such as energy management software, renewable energy forecasting tools, and smart grid technologies. These solutions can help energy companies to reduce their carbon footprint, increase energy efficiency, and integrate more renewable energy sources into the grid. In addition, the IT industry in the Basque Country is also a major contributor to the local economy, providing high-quality jobs and driving innovation and growth. By leveraging the expertise and capabilities of the IT industry, the Basque Country can build a more sustainable and competitive energy sector that supports economic development while also protecting the environment.

#### *3.3.1.1 Status Quo of Cybersecurity, Artificial Intelligence and IT & SE*

The Fit for 55 package is a set of climate and energy-related legislative proposals released by the European Commission on July 14, 2021. The package includes a range of measures designed to help the EU meet its target of reducing greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels) and become climate-neutral by 2050. The package includes updates to existing legislation, such as the Emissions Trading System (ETS) and the Effort Sharing Regulation, as well as new proposals on renewable energy, energy efficiency, and carbon pricing. Some of the key proposals in the package include increasing the share of renewable energy in the EU's energy mix to 40% by 2030, introducing a Carbon Border Adjustment Mechanism (CBAM) to prevent carbon leakage, and expanding the ETS to cover more sectors and reduce emissions faster. The Fit for 55 package is a significant step towards achieving the EU's climate and energy goals and is expected to have a major impact on a range of industries, including energy, transport, and manufacturing.

In the Basque Country, the Basque Energy Agency has launched several initiatives to promote energy efficiency and the use of renewable energy sources, such as the Intelligent Energy Europe program and the Basque Energy Cluster. The region has also set a target of achieving a 20% reduction in energy consumption by 2030. The adoption of Cybersecurity, Artificial Intelligence and IT is expected to play an important role in achieving this target.

**Cybersecurity**: According to GII Global Information, The Europe Cyber Security In Energy Market would witness market growth of 10.1% CAGR during the forecast period (2022-2028) [8]. The Germany market dominated the

Europe Cyber Security In Energy Market by Country in 2021, and would continue to be a dominant market till 2028; thereby, achieving a market value of $1,043.1 million by 2028. The UK market is anticipated to grow at a CAGR of 9.2% during (2022 - 2028). Additionally, The France market would exhibit a CAGR of 10.9% during (2022 - 2028).

Cybersecurity Strategy aims to ensure a high level of cybersecurity for energy infrastructure and to promote cooperation between member states. The NIS Directive sets out specific security requirements for operators of essential services, including energy companies. There are three main challenges related to cybersecurity in the energy sector. The first challenge lies in the consequences, which may be severe and will also be felt immediately. In addition, problems in one network can easily cascade to other networks, thereby multiplying the effect. Finally, energy infrastructure consists both of legacy and state of-the-art technology, making the system as a whole very vulnerable.

The Directive on Security of Network and Information Systems [9] (Directive 2016/1148, "NIS Directive") was passed in 2016 to address some of those challenges. The NIS Directive is applicable since May 2018 after it had been implemented in the Member States. In its core, the Directive aims to oblige Operators of Essential Services ("OES") to take appropriate security measures and to notify serious cyber incidents to the relevant national authority. Several countries, such as Germany, UK, Sweden, Denmark, and Italy have published sector specific cyber security guidance to help energy sector companies focus their efforts. Others, such as Netherlands, Hungary, Spain, France, and Finland, along with the NIS Cooperation Group and the European Union Agency for Cybersecurity have published general cybersecurity guidance and best practices.

**IA & IT:** According to AI in Energy Market Research, 2021, The global artificial intelligence (AI) in energy market size was valued at $4.0 billion in 2021, and projected to reach $19.8 billion by 2031, growing at a CAGR of 17.4% from 2022 to 2031 [10].

The European Union (EU) is considering new legislation, the Artificial Intelligence (AI) Act, that aims to strengthen rules around data quality, transparency, human oversight, and accountability. The legislation proposes a classification system that determines the level of risk an AI technology could pose, including four risk tiers: unacceptable, high, limited, and minimal. High-risk AI systems, including autonomous vehicles and medical devices, are permitted but require rigorous testing, proper documentation of data quality, and human oversight. The proposed law also aims to establish a European Artificial Intelligence Board, which would oversee the implementation of the regulation and ensure uniform application across the EU.

The EU has also launched several initiatives to support the adoption of AI in the energy sector, such as the AI4EU project, which aims to establish a European AI-on-demand platform for SMEs. At the national level, countries such as Germany have developed national strategies for AI, which include measures to support the adoption of AI in the energy sector. The German Federal Ministry for Economic Affairs and Energy has launched several initiatives to support the development and adoption of AI in the energy sector, such as the AI in Energy research program.

To meet these 2030 targets, the EC has launched financial support that directly affects cybersecurity, AI and IT. The European Commission's Digital Europe Programme [11] will provide funding €2.1 billion for artificial intelligence, including investment in AI use by businesses and public administrations, setting up a European data space, and supporting existing AI testing and experimentation facilities. Additionally, €1.6 billion will be allocated for cybersecurity, aiming to strengthen coordination between Member States and deploy cybersecurity capacities across the economy. €580 million will be dedicated to advanced digital skills, while €1.1 billion will be used to ensure the wide use of digital technologies across the economy and society, including supporting high

impact deployments in areas of public interest, building up the network of European Digital Innovation Hubs, and supporting the uptake of advanced digital technologies by the industry and public administration.

#### *3.3.1.2 Major technological changes in Cybersecurity, Artificial Intelligence and IT*

This chapter aims to identify the major technological changes in Cybersecurity, Artificial Intelligence and IT which have an impact on energy efficiency and result to the sustainability of the energy sector.

This work has been carried out by Experts of the field (IT, cybersecurity, AI…) in a Workshop organised by GAIA, inside its Information Systems Committee. The working method was as follows: different experts were divided into working tables, depending on the expertise (AI, Cybersecurity, IT) and ideas were shared and aspects mentioned in the following chapters were discussed.

The changes with the respective professionals / occupational profiles / businesses that are involved in the industry are shown in the following Table.

| Technological change | Impact on Energy Efficiency and Sustainability | Affected professions / specializations |
|---|---|---|
| Cybersecurity Automation | Improves security of energy infrastructure and reduces risk of cyber-attacks, resulting in higher energy efficiency and sustainability. | Cybersecurity experts, IT professionals, energy companies |
| Blockchain Technology | Enables secure and transparent peer-to-peer energy transactions, reducing transaction costs and promoting renewable energy use, resulting in higher energy efficiency and sustainability. | Blockchain developers, energy traders, renewable energy companies |
| Artificial Intelligence (AI) | AI can be used to optimize energy use and reduce waste in the energy sector. For example, it can be used to predict energy demand and supply, improve energy storage and distribution, and optimize renewable energy systems. | Energy consultants, energy management companies, utilities, renewable energy companies, software developers, data analysts. |
| AI-based Predictive Maintenance | Enables proactive maintenance of energy equipment, reducing downtime and energy waste, resulting in higher energy efficiency and sustainability. | Data scientists, AI engineers, maintenance professionals, energy companies |
| Internet of Things (IoT) | Enables real-time monitoring and control of energy systems, optimizing energy usage and reducing waste, resulting in higher energy efficiency and sustainability. | IoT developers, energy management professionals, energy companies |
| Cloud Computing | Enables remote data storage and processing, allowing for more efficient energy management and reducing energy consumption associated with on-premises data | Cloud architects, IT professionals, energy companies |

| | | |
|---|---|---|
| | centres, resulting in higher energy efficiency and sustainability. | |
| Edge Computing | Enables real-time data processing and decision-making at the edge of the network, reducing energy consumption associated with data transmission and enabling faster response times, resulting in higher energy efficiency and sustainability. | Edge computing engineers, IT professionals, energy companies |
| Machine Learning | Enables accurate forecasting of renewable energy production, optimizing energy usage and reducing the need for backup power sources, resulting in higher energy efficiency and sustainability. | Data scientists, renewable energy professionals, energy companies |
| Big Data Analytics | Enables analysis of large volumes of data to identify patterns and trends, optimizing energy usage and reducing waste, resulting in higher energy efficiency and sustainability. | Data scientists, IT professionals, energy companies |
| Virtual and Augmented Reality | Enables remote training and visualization of energy systems, reducing the need for travel and enabling more efficient knowledge transfer, resulting in higher energy efficiency and sustainability. | Virtual and augmented reality developers, training professionals, energy companies |
| Digital Twins | Enables real-time monitoring and simulation of energy systems, optimizing energy usage and reducing waste, resulting in higher energy efficiency and sustainability | Digital twin developers, IT professionals, energy companies |

### 3.3.2 Qualifications and Skills (Q&S)

#### *3.3.2.1 Current Q&S of Cybersecurity, Artificial Intelligence and IT*

This chapter is used for mapping of the current Q&S of the labour force of Cybersecurity, Artificial Intelligence, and IT. We identify in the following table the existing labour force which contributes to the sustainability of the energy sector in Cybersecurity, Artificial Intelligence and IT and a list with the provided Q&S. The next table was filled with the work carried out in the Workshop mentioned before.

| Professions / specializations related to Cybersecurity, AI & IT | Short description of the profession focusing on SE | Current Qualifications and Skills |
|---|---|---|
| Cybersecurity Analyst | Ensures the security of computer systems, networks, and sensitive data from cyber threats such as hacking, phishing, and malware attacks, which can affect the energy sector by disrupting the | Knowledge of security frameworks (ISO 27001, NIST, etc.), understanding of network protocols and cyber threats, and certifications such as CompTIA Security+, CISSP, CISA, etc. |

| | | |
|---|---|---|
| | distribution and generation of energy. | Understanding of cybersecurity risks and vulnerabilities, experience in conducting vulnerability assessments and penetration testing, knowledge of firewalls, antivirus software, intrusion detection and prevention systems. |
| AI Engineer | Develops and implements AI technologies in the energy sector for efficient energy management, predictive maintenance of energy systems, and intelligent automation of energy operations. | Understanding of AI models and algorithms, proficiency in programming languages such as Python, R and Java, knowledge of machine learning and deep learning frameworks, experience in data analysis and visualization. |
| IT Infrastructure Manager | Ensures the smooth operation and maintenance of IT systems and infrastructure in the energy sector, which includes data centres, servers, storage devices, and networks. | Understanding of network protocols and architecture, experience in server and storage management, knowledge of virtualization technologies, experience in cloud computing and storage. |
| Data Analyst | Collects, analyses, and interprets large sets of data from energy systems to identify patterns and insights that can improve energy efficiency and reduce energy waste. | Knowledge of data analytics tools and techniques, experience in data mining and statistical analysis, familiarity with data visualization tools, understanding of energy systems and energy data. |
| Sustainability Consultant | Advises energy companies on sustainable practices and technologies that can reduce energy consumption, lower carbon emissions, and minimize environmental impact. | Knowledge of sustainable energy technologies, experience in conducting energy audits, understanding of energy efficiency and conservation practices, familiarity with environmental regulations and standards. |
| Renewable Energy Analyst | A renewable energy analyst researches, analyses and reports on renewable energy trends, policies, and technologies, and identifies opportunities for sustainable energy generation and consumption. They may work for government agencies, energy companies, consulting firms or non-profit organizations. | Knowledge of renewable energy technologies and policies, data analysis and modelling skills, familiarity with energy and environmental regulations |

| | | |
|---|---|---|
| Smart Grid Engineer | A smart grid engineer designs, implements and maintains the infrastructure and systems that enable a smart grid, a modernized electricity grid that integrates renewable energy sources, energy storage, electric vehicles, and other smart devices. They may work for utilities, technology vendors, government agencies or research institutions. | Knowledge of power systems, communication networks, software programming, cybersecurity and data analytics, familiarity with smart grid standards and protocols. |
| Green IT Specialist | A green IT specialist helps organizations reduce their environmental impact and improve their energy efficiency by optimizing their IT systems and operations. They may advise on hardware and software procurement, data centre design, virtualization and cloud computing, energy-efficient networking and storage, and IT waste management. They may work for IT vendors, consulting firms, non-profit organisations, or in-house IT departments. | Knowledge of energy-efficient IT technologies and practices, familiarity with green IT standards and certifications, project management and communication skills |

#### *3.3.2.2 Q&S needed to address the technological changes*

This chapter's goal is to identify the required Q&S to comply with the labour market's needs of the professions related to Cybersecurity, Artificial Intelligence and IT until 2030. The starting point will be Table of 2.1.3 for the "Technological changes" and the "Affected Profession/ specializations" columns Q&S that are required from the professionals in order to be able to work effectively with the technological changes of the Green Buildings Industry will be specified. This was carried out in the Workshop mentioned before.

| Technological change | Affected Profession/ specializations | Required Qualifications and Skills |
|---|---|---|
| Cybersecurity Automation | Cybersecurity experts, IT professionals, energy companies. | Knowledge of cybersecurity principles and technologies, understanding of energy infrastructure and systems, experience in risk assessment and management, proficiency in programming languages and software tools used for automation. |
| Blockchain Technology | Blockchain developers, energy traders, renewable energy companies. | Understanding of blockchain technology and its applications, knowledge of energy markets and trading, experience in developing blockchain-based applications, proficiency in programming |

| | | |
|---|---|---|
| | | languages and tools used for blockchain development. |
| Artificial Intelligence (AI) | Energy consultants, energy management companies, utilities, renewable energy companies, software developers, data analysts. | Understanding of AI principles and technologies, knowledge of energy systems and markets, experience in data analysis and modelling, proficiency in programming languages and software tools used for AI development. |
| AI-based Predictive Maintenance | Data scientists, AI engineers, maintenance professionals, energy companies. | Understanding of AI principles and technologies, knowledge of energy infrastructure and maintenance processes, experience in data analysis and modelling, proficiency in programming languages and software tools used for AI development. |
| Internet of Things (IoT) | IoT developers, energy management professionals, energy companies. | Understanding of IoT principles and technologies, knowledge of energy systems and their components, experience in IoT development and integration, proficiency in programming languages and software tools used for IoT development. |
| Cloud Computing | Cloud architects, IT professionals, energy companies. | Understanding of cloud computing principles and technologies, knowledge of energy systems and data management, experience in cloud architecture and deployment, proficiency in programming languages and software tools used for cloud computing. |
| Edge Computing | Edge computing engineers, IT professionals, energy companies. | Understanding of edge computing principles and technologies, knowledge of energy systems and data processing, experience in edge computing development and deployment, proficiency in programming languages and software tools used for edge computing. |
| Machine Learning | Data scientists, renewable energy professionals, energy companies. | Understanding of machine learning principles and technologies, knowledge of energy systems and renewable energy technologies, experience in data analysis and modelling, proficiency in programming languages and software tools used for machine learning. |
| Big Data Analytics | Data scientists, IT professionals, energy companies. | Understanding of big data principles and technologies, knowledge of energy systems and data management, experience in data analysis and modelling, proficiency in programming |

| | | |
|---|---|---|
| | | languages and software tools used for big data analytics. |
| Virtual and Augmented Reality | Virtual and augmented reality developers, training professionals, energy companies. | Understanding of virtual and augmented reality principles and technologies, knowledge of energy systems and training needs, experience in VR/AR development and deployment, proficiency in programming languages and software tools used for VR/AR. |
| Digital Twins | Digital twin developers, IT professionals, energy companies. | Understanding of digital twin principles and technologies, knowledge of energy systems and their components, experience in digital twin development and deployment, proficiency in programming languages and software tools used for digital twin development. |

### 3.3.3 Synthesis- Recommendations

#### *3.3.3.1 Future impact on Q&S- Most interesting trends for CoVEs*

This chapter synthesizes the 2 results of the previous study: having identified the current and future required Q&S. It defines the trends, needs and adjustments in terms of structures of the CoVEs for carrying out the training. This work was carried out in the Workshop mentioned before. The results are shown in the following table.

| **Affected Profession/ specializations** | **Required Q&S** | **Existing Q&S/ Available Training** | **Structural needs for CoVEs** |
|---|---|---|---|
| Cybersecurity experts, IT professionals, energy companies | Knowledge of cybersecurity principles and technologies, understanding of energy infrastructure and systems, experience in risk assessment and management, proficiency in programming languages and software tools used for automation | Cybersecurity principles and technologies, some knowledge of energy systems, limited experience in risk assessment and management | Access to specialized training in energy systems and risk assessment, cybersecurity-focused programming and software tools, advanced training in energy infrastructure and systems |
| Blockchain developers, energy traders, | Understanding of blockchain technology and its | Understanding of blockchain technology and its applications, some | Access to advanced training in blockchain technology and its applications, specialized |

| | | | |
|---|---|---|---|
| renewable energy companies | applications, knowledge of energy markets and trading, experience in developing blockchain-based applications, proficiency in programming languages and tools used for blockchain development | knowledge of energy markets and trading, limited experience in developing blockchain-based applications | training in energy markets and trading, exposure to real-world blockchain projects and applications |
| Energy consultants, energy management companies, utilities, renewable energy companies, software developers, data analysts | Understanding of AI principles and technologies, knowledge of energy systems and markets, experience in data analysis and modelling, proficiency in programming languages and software tools used for AI development | AI principles and technologies, some knowledge of energy systems and markets, limited experience in data analysis and modelling | Access to advanced training in AI principles and technologies, specialized training in energy systems and markets, exposure to real-world AI projects and applications |
| Data scientists, AI engineers, maintenance professionals, energy companies | Understanding of AI principles and technologies, knowledge of energy infrastructure and maintenance processes, experience in data analysis and modelling, proficiency in programming languages and software tools used for AI development. | Understanding of AI principles and technologies, some knowledge of energy infrastructure and maintenance processes, limited experience in data analysis and modelling. | Access to specialized training in energy infrastructure and maintenance processes, advanced training in AI principles and technologies, exposure to real-world AI projects and applications |
| IoT developers, energy management | Understanding of IoT principles and technologies, knowledge of energy | Understanding of IoT principles and technologies, some knowledge of energy | Access to specialized training in energy systems and their components, advanced training in IoT principles and |

| | | | |
|---|---|---|---|
| professionals, energy companies | systems and their components, experience in IoT development and integration, proficiency in programming languages and software tools used for IoT development | systems and their components, limited experience in IoT development and integration | technologies, exposure to real-world IoT projects and applications |
| Cloud architects, IT professionals, energy companies | Understanding of cloud computing principles and technologies, knowledge of energy systems and data management, experience in cloud architecture and deployment, proficiency in programming languages and software tools used for cloud computing | Understanding of cloud computing principles and technologies, some knowledge of energy systems and data management, limited experience in cloud architecture and deployment | Access to advanced training in cloud computing principles and technologies, specialized training in energy systems and data management, exposure to real-world cloud computing projects and applications |
| Edge computing engineers, IT professionals, energy companies | Understanding of edge computing principles and technologies, knowledge of energy systems and data processing, experience in edge computing development and deployment, proficiency in programming languages and software tools used for edge computing | Understanding of edge computing principles and technologies, some knowledge of energy systems and data processing, limited experience in edge computing development and deployment | Access to specialized training in energy systems and data processing, advanced training in edge computing principles and technologies, exposure to real-world edge computing projects and applications |
| Data scientists, renewable energy | Understanding of machine learning principles and | Some knowledge of machine learning, data analysis and programming, | Training programs in advanced machine learning techniques, specialized |

| | | | |
|---|---|---|---|
| professionals, energy companies | technologies, knowledge of energy systems and renewable energy technologies, experience in data analysis and modelling, proficiency in programming languages and software tools used for machine learning | familiarity with renewable energy systems | training in renewable energy technologies and their integration with machine learning, access to high-performance computing resources, collaboration with renewable energy companies and researchers for real-world application testing |

#### *3.3.3.2 Recommendations for policy makers for the modernisation of VET*

The rapid pace of technological advancements has significantly altered the labour market's expectations and needs. As a result, it is crucial to prepare the workforce for the future market's demands by modernizing and implementing effective vocational education and training (VET) programs.

The Sustainable Energy sector has seen a significant increase in the use of technology and digitalization in recent years, with Cybersecurity, Artificial Intelligence, and IT becoming increasingly important for the sector's development. The growing need for energy efficiency and the reduction of carbon emissions require skilled professionals with expertise in these areas. In addition, the future of the energy industry will heavily rely on digitalization, and a well-prepared workforce with up-to-date skills is crucial for the success of the sector. Cybersecurity is becoming increasingly important in the energy sector, given the vulnerability of energy systems to cyber-attacks. Professionals with knowledge of cybersecurity principles and technologies, and experience in risk assessment and management, are critical to ensuring the protection of energy infrastructure and systems. Artificial Intelligence (AI) is also transforming the energy sector, enabling improved decision-making, predictive maintenance, and energy efficiency. Skilled professionals with expertise in AI principles and technologies, and data analysis and modelling, are necessary to support these advancements. Additionally, IT plays a significant role in the energy sector, particularly in the areas of cloud computing, big data analytics, and the internet of things (IoT).

Given the need for to train workers for these jobs, we advise the following steps:

1. Based on the the analysis of the current and future labour market needs and the skills and qualifications required by the cybersecurity, artificial intelligence, and IT professions (Table in 3.3.3.1), develop a curriculum that aligns with the needs of the identified professions and integrate the latest technological advancements and emerging trends in the respective fields.
2. Provide access to state-of-the-art infrastructure, equipment, and software tools for hands-on training and practical experience.
3. Partner with industry leaders and experts to provide real-world training opportunities, such as internships, apprenticeships, and job shadowing.

4. Encourage the continuous professional development of the trainers and instructors to ensure that they are equipped with the latest skills and knowledge to deliver high-quality training.
5. Create a supportive and inclusive learning environment that caters to the diverse needs of the learners and encourages active participation and collaboration.
6. Utilize innovative teaching methods and tools, such as gamification and digital learning platforms, to enhance the learning experience and increase engagement.
7. Regularly evaluate and update the curriculum to ensure that it remains relevant and responsive to the evolving market demands and technological advancements.

### 3.3.4 References


[1] https://www.bizkaiatalent.eus/pais-vasco-energias-renovables/

[2] https://www.euskadi.eus/informacion/estrategia-energetica-de-euskadi-2030/web01-a2ingkli/es/

[3] https://www.euskadi.eus/contenidos/informacion/despliegue_pcti_euskadi/es_def/adjuntos/PCTI-EUSKADI-2030.pdf

[4] https://www.eib.org/attachments/lucalli/20220206-european-cybersecurity-investment-platform-en.pdf

[5] https://www.cci-es.org/wp-content/uploads/La-nueva-distribucion-electrica-ciberseguridad-transformacion-digital.pdf

[6] https://www.cybasque.eus/en_US/home-cybasque

[7] https://digital-strategy.ec.europa.eu/en/policies/expert-group-ai

[8] https://www.giiresearch.com/report/kbv1261274-europe-cyber-security-energy-market-size-share.html

[9] NIS Directive and the energy sector: a patchwork of national implementations

[10] https://www.alliedmarketresearch.com/ai-in-energy-market-A12587

[11] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/programmes/digital

[12] Ahmad, T., Zhang, D., Huang, C., Zhang, H., Dai, N., Song, Y., & Chen, H. (2021). Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities. Journal of Cleaner Production, 289, 125834. ISSN 0959-6526 https://doi.org/10.1016/j.jclepro.2021.125834.

[13] Szczepaniuk, H., & Szczepaniuk, E. K. (2023). Applications of Artificial Intelligence Algorithms in the Energy Sector. Energies, 16(1), 347 https://doi.org/10.3390/en16010347

## 3.4 Local administration (municipalities), Porto Metropolitan Area, Portugal

### 3.4.1 Local administration & SE

With the emergence of new technologies and more resources at our disposal, it becomes increasingly important to generate synergic dynamics between universities and research centers, industry, companies, civil society, and public administration entities, to take advantage of the significant opportunities that are yet to be explored.

In the energy sector, new and old professions lack qualifications and specialized and readjusted training to respond to current needs.

It is fundamental to stimulate training offers focused on sustainable energies based on collaborative arrangements, in a network or consortium, diversifying and complementing the existing offer in these areas in which the synergies between higher education, Public Administration, and business and industrial activity, are revealed most useful for renewing skills in the labor markets.

Nevertheless, the municipalities have an important role here, which is not only related to facilitating the interaction between the different agents but also needs to acquire knowledge and skills, which allow them to adopt, more knowledgeably and consciously about emerging technologies in their facilities.

The local Administration's relationship with the sustainable energy sector needs to be constantly updated, remaining as a promotor of change towards cleaner and more ecological energies. In this way, the need arises to understand how municipalities approach technological changes in the energy domain, understanding the current qualifications and skills and providing them with the right tools and knowledge about innovation in technology for clean and sustainable energy.

This approach is in line with the strategic vision for the Economic Recovery Plan of Portugal 2020-2030, the Portuguese Recovery and Resilience Plan (PRR)[1], the National Energy and Climate Plan 2030 (PNEC2030)[2], and the Roadmap for Carbon Neutrality 2050 (RNC2050)[3], which refers to a significant investment in innovative green technologies such as the production of Green Hydrogen[4] and other renewable energies, as well as increasing the storage capacity of energy produced through renewable sources, the promotion of the bioeconomy and continuation with the commitment to sustainable mobility[5].

As a resume, municipalities are vital stakeholders in promoting emerging technologies in the territory, through direct acquisition, allowances, or other means of facilitation. For this to happen municipalities need to have the right competencies and not only be dependent on private companies or external consultants.

#### *3.4.1.1 Status Quo of the Local administration & SE*

##### *3.4.1.1.1 The country*

It is not possible to analyze the current state and plans for the future of Local administration without having a holistic view of the country's plans in the transition to Sustainable Energy or more in-depth the decarbonisation and energy transition policies.

In Portugal, the promotion of energy transition through the support of Renewable Energies has been a strategic objective, having led this process at the European level.

It is intended to continue this reform, now with a focus on the production of green hydrogen and other gases from renewable sources, including other areas already in pursuits, such as equipment and wind repowering, and hybrid systems, among others, which do not require public investment support.

The country's energy transition, to progressively reduce the use of fossil fuels, also involves reducing energy dependence, ensuring the end of electricity production from coal in Mainland Portugal, and promoting the phase-out of electricity production from fuel oil and diesel in the Autonomous Regions.

Since the end of 2021, the national electrical system has stopped producing electricity through the burning of coal, thus leaving electricity production through renewable sources and combined cycle power plants fueled by natural gas (which emit about half as much carbon dioxide for every megawatt hour of electricity compared to emissions from coal-fired power plants).

This progressive discontinuity of the use of fossil fuels for electricity production, in particular coal, is essential to ensure the energy transition towards a carbon-neutral society. Thus, in this dimension, national objectives are based on three priorities [2]:

- Reduction of greenhouse gas emissions between **45**% and **55**% by 2030, compared to 2005 values;
- A **47**% incorporation of renewable energy sources in gross final energy consumption;
- A commitment to energy efficiency, resulting in a **35**% reduction in primary energy.

#### *3.4.1.1.2 Public administration*

In line with national plans for energy sustainability, public administration also has an important role to play in leading this decarbonisation path, with the role of research and innovation being equally essential.

Although the search for sustainability has always been a concern, national studies show that since 2010 Local Administration has been reducing its energy consumption, both in public buildings and in public lighting, as a result of energy efficiency measures and the application of new technologies that have been applied since then, as shown on Figure 1 and 2[6].

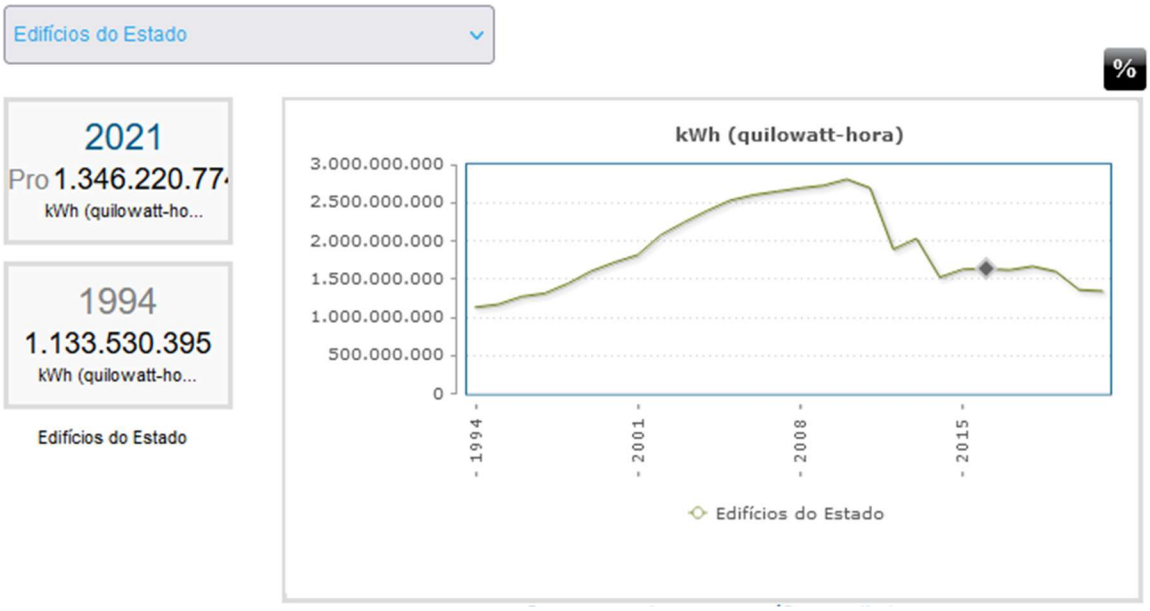



*Figure 2: Consumption in State Buildings 1994-2021*

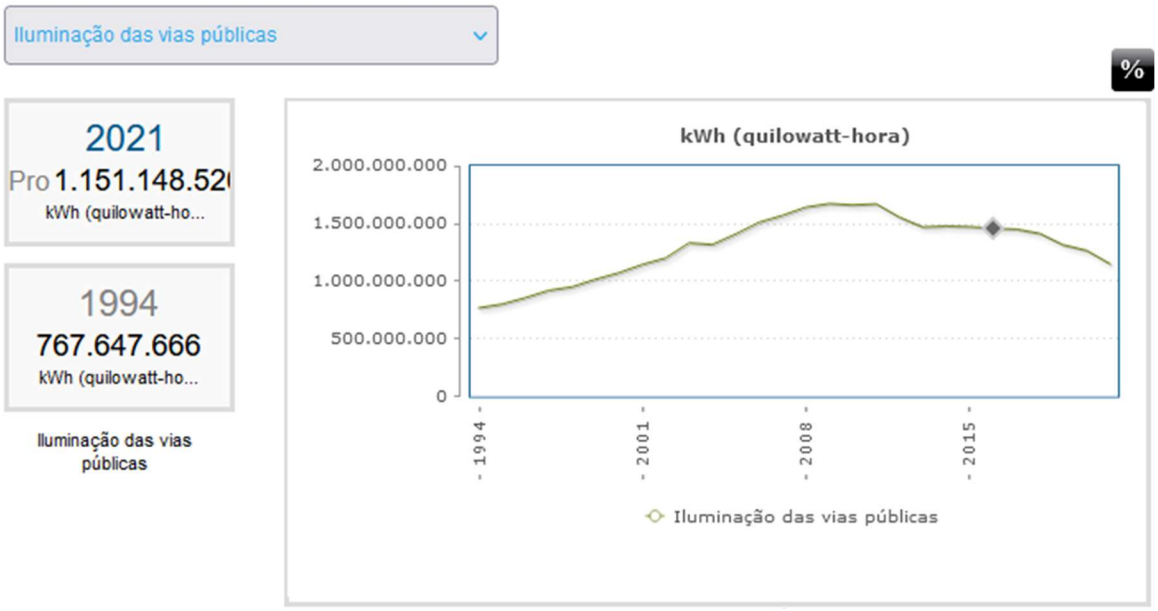



*Figure 3: Public Road lighting 1994-2021*

Promoted by the central government, investments are planned in a significant wave of energy renovation of central public administration buildings and educational institutions (at all levels, including higher education), to encourage energy and resource efficiency and to reinforce the production of energy from renewable sources on a self-consumption basis, through actions similar to those described below:

- Passive improvements to the surroundings, though, for example, thermal insulation of walls, thermal insulation of roofs, and glazing;
- Active improvements through, for example, a climatization system for heating and/or cooling (eg heat pumps) and domestic water heating (eg solar thermal);
- Active improvements through, for example, the implementation of systems for the production of electricity from renewable sources, in self-consumption regime or renewable energy community;
- Interventions aimed at water efficiency, including replacing equipment with more efficient equipment;
- Interventions that promote the incorporation of biomaterials, recycled materials, natural-based solutions, green facades and roofs, and bioclimatic architecture solutions, on urban buildings or their existing autonomous fractions.

### *3.4.1.2 Major technological changes in Local administration (municipalities) & SE*

| Technological change | Affected professions/specializations |
|---|---|
| ***Hydrogen in the energy system (In general)*** | • Municipality as a facilitating entity:<br>  ○ In Research and Development<br>  ○ In the implementation of technology<br>  ○ in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies; |

| | |
|---|---|
| | • Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of the technological developments. |
| ***Green Hydrogen <u>production</u> in municipalities*** | **Technology:**<br>Renewable energies for hydrogen production.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  o Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>  o Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Equipment Sizing:<br>  o Engineers capable of sizing equipment according to the needs of the municipality, avoiding oversizing and respective unnecessary costs.<br>• Installation of equipment:<br>  o Municipal technicians able to monitor or correctly install renewable energy production equipment;<br>  o Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>  o Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or even being able to carry out maintenance.<br>  o Engineers and Municipal Technicians with knowledge about the different life stages of the equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  o Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>**Technology:**<br>Biomass for hydrogen production.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  o Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>  o Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Equipment Sizing: |

| | |
|---|---|
| | ○ Engineers capable of sizing equipment according to the needs of the municipality, avoiding oversizing and respective unnecessary costs.<br>• Installation of equipment:<br>○ Municipal technicians able to monitor or correctly install renewable energy production equipment;<br>○ Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or even being able to carry out maintenance.<br>○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>• Fuel Management:<br>○ Managers and engineers able to assess where the implementation of Biomass systems are more appropriate according to the characteristics of the place, promoting production and consumption close to the fuel extraction site.<br>○ Employees responsible for capturing waste from forests, industry, livestock, and agriculture and capturing derivatives of living organisms (animal and vegetable) for subsequent hydrogen production. |
| ***Green Hydrogen in the energy <u>consumption</u> of municipalities*** | **Technology:**<br>Green hydrogen injection into the natural gas network.<br>**Required Specializations:**<br>• Evaluation of characteristics between different equipment offers on the market:<br>○ Managers, Engineers, and Municipal Technicians need to be able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>○ Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Equipment Sizing:<br>○ Engineers capable of sizing equipment according to the needs of the municipality, avoiding oversizing and respective unnecessary costs.<br>• Installation of equipment:<br>○ Municipal technicians able to carry out the monitoring or correct installation of equipment for the consumption of hydrogen from the network.<br>• Maintenance:<br>○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or able to carry out maintenance. |

| | |
|---|---|
| | ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>○ Managers and Engineers with knowledge of the technical characteristics of existing municipal consumption equipment, streamlining performance in the management of inspections and maintenance, whether preventive, planned, or corrective. |
| ***Green Hydrogen in the energy consumption of road transport by municipal fleets*** | **Technology:**<br>Use of hydrogen for the production of different types of fuel (liquid or gaseous).<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>○ Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>○ Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Equipment Sizing:<br>○ Engineers capable of sizing equipment according to municipal needs, avoiding oversizing and associated costs.<br>• Installation of equipment:<br>○ Municipal technicians able to carry out the monitoring or correct installation of equipment;<br>○ Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or being able to carry out maintenance.<br>○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>**Technology:**<br>Use of hydrogen for the production of electricity applied to electric mobility (Conversion into Electricity).<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>○ Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>○ Municipal Technicians being able to develop public tenders regarding new emerging technologies. |

| | |
|---|---|
| | • Equipment Sizing:<br>  ○ Engineers capable of sizing equipment, according to municipal needs, avoiding oversizing and associated costs.<br>• Installation of equipment:<br>  ○ Municipal technicians able to carry out the monitoring or correct installation of equipment;<br>  ○ Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or being able to carry out maintenance.<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>**Technology:**<br>Hydrogen vehicles feeding "Fuel Cells" facilties in the territory.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  ○ Managers, Engineers, and Municipal Technicians being able to evaluate the different solutions and characteristics of the market solutions, to certificate, and permit the facility development;<br>  ○ Municipal Technicians being able to evaluate the requirements (e.g. security).<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows territory security (e.g. monitoring the maintenance of equipment);<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of the equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective. |
| ***Green Hydrogen to increase the <u>storage</u> capacity of energy produced through renewable sources*** | **Technology:**<br>Hydrogen gas compression to integrate the different storage systems (high or low pressure) facilities in the territory.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  ○ Managers, Engineers, and Municipal Technicians being able to evaluate the different solutions and characteristics of the market solutions, to certificate, and permit the facility development;<br>  ○ Municipal Technicians being able to evaluate the requirements (e.g. security). |

| | |
|---|---|
| | • Maintenance:<br>  ○ Municipal technicians with the knowledge that allows territory security (e.g. monitoring the maintenance of equipment);<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>**Technology:**<br>Liquefaction of hydrogen as a storage system (Cryogenic Storage) facilities in the territory.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  ○ Managers, Engineers, and Municipal Technicians being able to evaluate the different solutions and characteristics of the market solutions, to certificate, and permit the facility development.<br>  ○ Municipal Technicians being able to evaluate the requirements (e.g. security).<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows territory security (e.g. monitoring the maintenance of equipment);<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>**Technology:**<br>Physical or chemical storage in the form of metal hydrides facilities in the territory.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  ○ Managers, Engineers, and Municipal Technicians being able to evaluate the different solutions and characteristics of the market solutions, to certificate, and permit the facility development;<br>  ○ Municipal Technicians being able to evaluate the requirements (e.g. security).<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows territory security (e.g. monitoring the maintenance of equipment);<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features: |

| | |
|---|---|
| | ○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective. |
| ***Biomethane Production (in general)***[7] | • Municipality as a facilitating entity:<br>○ In Research and Development<br>○ In the implementation of technology<br>○ in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies;<br>• Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of technological developments. |
| ***Production of Biomethane, exclusively from renewable energy sources*** | **Technology:**<br>Biomethane by electrolysis from water using electricity from renewable energy sources facilities in the territory.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>○ Managers, Engineers, and Municipal Technicians being able to evaluate the different solutions and characteristics of the market solutions, to certificate, and permit the facility development;<br>○ Municipal Technicians being able to evaluate the requirements (e.g. security).<br>• Maintenance:<br>○ Municipal technicians with the knowledge that allows territory security (e.g. monitoring the maintenance of equipment);<br>○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned, or corrective. |
| ***Integrated management system (in general)*** | • Municipality as Manager of the different energy vectors of its buildings and equipment. |
| ***Integrated Management System (IMS)*** | **Technology:**<br>Implementation of an integrated management system, based on the sharing of resources in training, reinforcement of means and equipment and knowledge of the territory.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>○ Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in |

| | |
|---|---|
| | the acquisition of equipment, according to the needs of the municipality.<br>• Training for IMS usage:<br>  ○ Engineers and Managers and Municipal Technicians in the different areas of activity. |
| ***Production of electricity from renewable sources (in general)*** | • Municipality as a facilitating entity:<br>  ○ In Research and Development<br>  ○ In the implementation of technology<br>  ○ in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies;<br>• Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of technological developments. |
| ***Production of electricity from renewable sources*** | **Technology:**<br>Energy produced from renewable sources (Solar Energy, Hydro Energy, Wind Energy, Wave Energy, Tidal Energy and Geothermal Energy).<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  ○ Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>  ○ Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Equipment Sizing:<br>  ○ Engineers capable of dimensioning equipment according to the needs of the municipality, avoiding oversizing and respective unnecessary costs.<br>• Installation of equipment:<br>  ○ Municipal technicians capable of monitoring or correctly installing renewable energy production equipment;<br>  ○ Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or able to carry out maintenance.<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining |

| | |
|---|---|
| | performance in the management of inspections and maintenance, preventive, planned or corrective. |
| ***Commitment to sustainable mobility (in general)*** | • Municipality as a facilitating entity:<br>  o In Research and Development<br>  o In the implementation of technology<br>  o in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies;<br>• Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of technological developments. |
| ***Commitment to sustainable mobility*** | **Technology:**<br>Extension of the Electric Vehicle Charging Station Network (EVCS).<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  o Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment on the market, achieving more assertiveness in the acquisition of equipment, according to the needs of the municipality;<br>  o Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Installation of equipment:<br>  o Municipal technicians able to monitor the installation of equipment;<br>  o Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>  o Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or even being able to carry out maintenance.<br>  o Engineers and Municipal Technicians with knowledge about the different life stages of the equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  o Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining performance in the management of inspections and maintenance, preventive, planned or corrective.<br>**Technology:**<br>Replacement of municipal fleets by electric vehicles (garbage collection cars, police vehicles, fire trucks, public transport or employee transport, among others).<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market: |

| | |
|---|---|
| | ○ Managers, Engineers and Municipal Technicians able to evaluate the different solutions and characteristics of vehicles on the market, achieving more assertiveness in their acquisition, according to the needs of the municipality;<br>○ Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Maintenance:<br>○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or even being able to carry out maintenance.<br>○ Engineers and Municipal Technicians with knowledge about the different life stages of the equipment and the respective needs in each of these stages.<br>• Knowledge of vehicle characteristics:<br>○ Managers and Engineers with knowledge of the technical characteristics of existing municipal vehicles, streamlining performance in the management of inspections and maintenance, whether preventive, planned or corrective. |
| ***Promotion and reinforcement of the increasing use of public transport (in general)*** | • Municipality as a facilitating entity:<br>○ In Research and Development<br>○ In the implementation of technology<br>○ in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies;<br>• Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of technological developments. |
| ***Promotion and reinforcement of the increasing use of public transport*** | **Technology:**<br>Creating an efficient, inclusive and accessible public transport network.<br>**Required Specializations:**<br>• Evaluation of Characteristics between different mobility options:<br>○ Managers, Engineers and Municipal Technicians able to evaluate the different solutions and characteristics of each solution, according to the needs of the municipality;<br>○ Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Network Planning:<br>○ Managers and Engineers with the knowledge that allow the correct planning of the Public Transport Network according to the needs of citizens.<br>• Maintenance:<br>○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or even being able to carry out maintenance.<br>○ Engineers and Municipal Technicians with knowledge about the different life stages of the equipment and the respective needs in each of these stages. |

| | |
|---|---|
| | • Knowledge of characteristics of the public transport network:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of the infrastructures integrated in the network, streamlining the performance in the management of inspections and maintenance, preventive, planned or corrective. |
| ***Implementation of water management processes to stop the increasing problem of water scarcity.*** ***(in general)***[8] | • Municipality as a facilitating entity:<br>  ○ In Research and Development<br>  ○ In the implementation of technology<br>  ○ in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies;<br>• Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of technological developments. |
| ***Implementation of water management processes to stop the increasing problem of water scarcity*** | **Technology:**<br>Introduction of hydro efficiency solutions and monitoring of water consumption in parks and buildings in the municipality.<br>**Required Specializations:**<br>• Evaluation of characteristics between different offers on the market:<br>  ○ Managers, Engineers, and Municipal Technicians able to evaluate the different solutions and characteristics of the equipment achieving more assertiveness in its acquisition and according to local needs;<br>  ○ Municipal Technicians being able to develop public tenders regarding new emerging technologies.<br>• Equipment Sizing:<br>  ○ Engineers capable of sizing equipment according to the needs of the municipality, avoiding oversizing and respective unnecessary costs.<br>• Installation of equipment:<br>  ○ Municipal technicians being able to carry out the monitoring or the correct installation of the solutions;<br>  ○ Municipal technicians in charge of the implementation supervision, need new knowledge of emerging technologies and best practices.<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment, or even being able to carry out maintenance.<br>  ○ Engineers and Municipal Technicians with knowledge about the different life stages of the equipment and the respective needs in each of these stages.<br>• Knowledge of equipment features:<br>  ○ Managers and Engineers with knowledge of the technical characteristics of existing municipal equipment, streamlining |

| | |
|---|---|
| | performance in the management of inspections and maintenance, preventive, planned, or corrective.<br>**Technology:**<br>Promotion of new consumption patterns, based on resource efficiency, sustainability, and circularity of value chains.<br>**Required Specializations:**<br>• Assessment of consumption patterns, based on resource efficiency, sustainability, and circularity of value chains:<br>  ○ Managers, Engineers, and Municipal Technicians being able to assess consumption patterns, based on resource efficiency, sustainability, and circularity of value chains.<br>• Promotion among employees and citizens of methods and strategies for good water management:<br>  ○ Municipal technicians able to disseminate and promote changes in the consumption patterns of employees and citizens. |
| ***Introduction of innovative intercity energy sharing concepts (in general)*** | • Municipality as a facilitating entity:<br>  ○ In Research and Development<br>  ○ In the implementation of technology<br>  ○ in the production of green energy<br>• Municipality as a promoter of inspections and surveys;<br>• Municipality as Manager of the different energy vectors for its buildings and equipment;<br>• Municipal Technicians being able to develop public tenders regarding new emerging technologies;<br>• Municipality as a territory manager can facilitate the development/investment of emerging technologies.<br>• Engineers and Technicians need to constantly update their knowledge of new emerging technologies and best practices.<br>• Regarding green hydrogen, new tenders are being released by European funds and/or national funds, thus being necessary to be aware of technological developments. |
| ***Introduction of innovative concepts for inter-municipal energy sharing*** | **Technology / Concept:**<br>Inter-municipal energy sharing through the concept of Renewable Energy Communities (REC).<br>**Specializations required by professionals:**<br>• Training in Collective Self-Consumption Management:<br>  ○ Managers, Engineers, and Municipal Technicians able to manage a *Self-Consumption Management Entity* and the different stakeholders.<br>• Maintenance:<br>  ○ Municipal technicians with the knowledge that allows monitoring the maintenance of equipment allocated to the Renewable Energy Community. |

### 3.4.2 Qualifications and Skills (Q&S)

| *Green Hydrogen in the production of energy in municipalities* | |
|---|---|
| **Technology** | **Renewable energies for hydrogen production** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Equipment Sizing; Installation of equipment; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |
| **Technology** | **Biomass for hydrogen production** |
| Current Q&S | Current qualifications and skills are low or inexistent in this technology for municipal staff. Although energy managers might know about biomass energy, presently the use of biomass for hydrogen production is not known within the municipalities. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Specific market licensing in the territory; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |

| *Green Hydrogen in the energy consumption of road transport by municipal fleets* | |
|---|---|
| **Technology** | **Use of hydrogen for the production of different types of fuel (liquid or gaseous)** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Equipment Sizing; Installation of equipment; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |
| **Technology** | **Use of hydrogen for the production of electricity applied to electric mobility (Conversion into Electricity).** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Equipment Sizing; Installation of equipment; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |
| **Technology** | **Hydrogen vehicles feeding "Fuel Cells" facilities in the territory.** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |

| | |
|---|---|
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |

| *Green Hydrogen to increase the storage capacity of energy produced through renewable sources* | |
|---|---|
| **Technology** | **Hydrogen gas compression to integrate the different storage systems (high or low pressure) facilities in the territory.** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |
| **Technology** | **Liquefaction of hydrogen as a storage system (Cryogenic Storage) facilities in the territory.** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all the qualifications and skills necessary for this technology. |
| **Technology** | **Physical or chemical storage in the form of metal hydrides facilities in the territory.** |
| Current Q&S | Current qualifications and skills are reduced or inexistent in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs all qualifications and skills necessary for this technology. |

| *Production of Biomethane, exclusively from renewable energy sources* | |
|---|---|
| **Technology** | **Biomethane by electrolysis from water using electricity from renewable energy sources facilities in the territory.** |
| Current Q&S | Current capabilities and skills are high for this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs the an update for all the qualifications and skills. |

| *Integrated Management System (IMS)* | |
|---|---|
| **Technology** | **Implementation of an integrated management system, based on the sharing of resources in training, reinforcement of means and equipment and knowledge of the territory.** |
| Current Q&S | Current qualifications and skills are reduced in this technology for staff of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Training for IMS usage. |
| Present gaps | The municipality needs more qualifications and skills necessary for *Evaluation of characteristics between different offers on the market* and *Training for IMS usage*. |

| *Production of electricity from renewable sources* | |
|---|---|
| **Technology** | **Energy produced from renewable sources (Solar Energy, Hydro Energy, Wind Energy, Wave Energy, Tidal Energy and Geothermal Energy).** |
| Current Q&S | Current capabilities and skills are high for *Evaluation of features between different offers on the market*, *Equipment Sizing*, *Knowledge of equipment features*.<br><br>Regarding *Equipment Installation* and *Maintenance* for solar energy municiplaties staff have high skills and competences. As for other reneable energy sources, ther are low or no skills and competences. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Equipment Sizing; Installation of equipment; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs more qualifications and skills for the *Installation of equipment* and *Maintenance*. |

| *Commitment to sustainable mobility* | |
|---|---|
| **Technology** | **Extension of the Electric Vehicle Charging Station Network (EVCS).** |
| Current Q&S | Current capabilities and skills are high for *Evaluation of features between different offers on the market*, *Knowledge of equipment features*.<br><br>Current skills and abilities regarding *Installation of equipment*, *Maintenance* for EVCS are high. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Equipment Sizing; *Installation of equipment*; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs more qualifications and skills for the *Installation of equipment* and *Maintenance*. |
| **Technology** | **Replacement of municipal fleets by electric vehicles (garbage collection cars, police vehicles, fire trucks, public transport or employee transport, among others).** |

| | |
|---|---|
| Current Q&S | Current capabilities and skills are high for *Evaluation of features between different offers on the market*, *Knowledge of equipment features*.<br><br>Current skills and abilities regarding *Maintenance of electric veichles are high*. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs more qualifications and skills for the *Installation of equipment* and *Maintenance*. |

| ***Sustainable Managment*** | |
|---|---|
| **Technology** | **Creating an efficient, inclusive and accessible public transport network.** |
| Current Q&S | Current capabilities and skills are high for this technology on municipal staff. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Network Planning; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs the maintenance for all the qualifications and skills. |
| **Technology** | ***Implementation of water management processes to stop the increasing problem of water scarcity*** |
| Current Q&S | Current capabilities and skills are high for this technology for employees of the municipality. |
| Future Q&S needs | Evaluation of characteristics between different offers on the market; Equipment Sizing; Installation of equipment; Maintenance; Knowledge of equipment features. |
| Present gaps | The municipality needs the maintenance for all the qualifications and skills. |
| **Technology** | **Promotion of new consumption patterns, based on resource efficiency, sustainability, and circularity of value chains.** |
| Current Q&S | Current capabilities and skills are high for this technology for employees of the municipality. |
| Future Q&S needs | Assessment of consumption patterns, based on resource efficiency, sustainability, and circularity of value chains; Promotion among employees and citizens of methods and strategies for good water management. |
| Present gaps | The municipality needs an update for all the referred qualifications and skills. |

| ***Introduction of innovative concepts for inter-municipal energy sharing*** | |
|---|---|
| **Technology** | **Inter-municipal energy sharing through the concept of Renewable Energy Communities (REC).** |
| Current Q&S | Current capabilities and skills are high for this technology for municipal staff. |

| | |
|---|---|
| Future Q&S needs | Training in Collective Self-Consumption Management; Maintenance. |
| Present gaps | The municipality needs an update for all the referred qualifications and skills. |

### *3.4.2.1 Current Q&S of the Local administration (municipalities) & SE professionals*

| Professions / specializations related to Green Buildings | Short description of the profession focusing on SE | Current Qualifications and Skills |
|---|---|---|
| Politicians | Responsible for the political decision of the measures and actions to be taken. | Knowledge in Environmental Science, Renewable Energy Technologies, Environmental Regulation, International Politics, and Participation in Civil Society. |
| Energy Managers/ Engineers | Discrimination and characterization of consumption for the different sources of energy and water;<br>Management of energy performance certifications;<br>Disseminating and encouraging the adoption of more efficient behaviors and better environmental performance;<br>Dynamization and verification of improvement measures;<br>Analysis of solutions;<br>Sizing of solutions;<br>Monitoring the implementation of solutions... | They are the ones with the most technical knowledge.<br>They provide support as staff of the Municipality or Energy Agencies.<br>Although current skills are compatible with existing technologies on the market, there is a constant concern about updating knowledge for emerging technologies, there is a dispersion or lack of information that does not allow quick action in the implementation of emerging technologies. |
| Municipal Technicians | Support in the collection of consumption data;<br>Installation and maintenance of equipment. | They carry out tasks in a competent/reasonable way for existing technologies on the market such as photovoltaic systems or hot water production. There is a lack of updated knowledge of current and emerging technologies that allow excellence in carrying out their functions. |

### *3.4.2.2 Q&S needed to address the technological changes*

| ***Green Hydrogen <u>production</u> in municipalities*** | | |
|---|---|---|
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Renewable energies for hydrogen production | Managers, Engineers, and Municipal Technicians<br>/ | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production; |

| | | |
|---|---|---|
| | Evaluation of characteristics between different offers on the market | • Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity; |

| | | |
|---|---|---|
| | | • Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/ | • Recognize the concepts and equipment used; |

| | | |
|---|---|---|
| | Knowledge of equipment features | • Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| Biomass for hydrogen production | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation; |

| | | |
|---|---|---|
| | | • Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation; |

| | | |
|---|---|---|
| | | • Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers / Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| | Managers and engineers and employees / Fuel Management | • Recognize the concepts used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them. |
| ***Green Hydrogen in the energy consumption of municipalities*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Green hydrogen injection into the natural gas network | Managers, Engineers, and Municipal Technicians / Evaluation of characteristics between different equipment offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs; |

| | | |
|---|---|---|
| | | • Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation; |

| | | |
|---|---|---|
| | | • Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |

| *Green Hydrogen in the energy consumption of road transport by municipal fleets* | | |
|---|---|---|
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Use of hydrogen for the production of different types of fuel (liquid or gaseous). | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyze, select, synthesize and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |

| | | |
|---|---|---|
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation; |

| | | |
|---|---|---|
| | | • Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| Use of hydrogen for the production of electricity applied to electric mobility (Conversion into Electricity) | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs; |

| | | |
|---|---|---|
| | | • Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs; |

| | | |
|---|---|---|
| | | • Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| Hydrogen vehicles feeding “Fuel Cells” facilities in the territory. | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers and Municipal technicians | • Recognize the concepts and equipment used; |

| | | |
|---|---|---|
| | / Maintenance | • Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers / Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| ***Green Hydrogen to increase the <u>storage</u> capacity of energy produced through renewable sources*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Hydrogen gas compression to integrate the different storage systems (high or low pressure) facilities in the territory. | Managers, Engineers, and Municipal Technicians / Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project; |

| | | |
|---|---|---|
| | | • Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |

| | | |
|---|---|---|
| Liquefaction of hydrogen as a storage system (Cryogenic Storage) facility in the territory. | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |

| | | |
|---|---|---|
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| Physical or chemical storage in the form of metal hydride facilities in the territory. | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation; |

| | | |
|---|---|---|
| | | • Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| ***Production of Biomethane, exclusively from renewable energy sources*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Biomethane by electrolysis from water using electricity from renewable energy sources facilities in the territory. | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers and Municipal technicians | • Recognize the concepts and equipment used; |

| | | |
|---|---|---|
| | / Maintenance | • Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers / Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| ***Integrated Management System (IMS)*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Implementation of an integrated management system, based on the sharing of resources in training, reinforcement of means and equipment, and knowledge of the territory. | Managers, Engineers, and Municipal Technicians / Evaluation of characteristics between different offers on the market and Training for IMS usage | • Recognize the concepts and ysystems used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques; |

| | | |
|---|---|---|
| | | • Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| ***Production of electricity from renewable sources*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Energy produced from renewable sources (Solar Energy, Hydro Energy, Wind Energy, Wave Energy, Tidal Energy, and Geothermal Energy). | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation; |

| | | |
|---|---|---|
| | | • Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems; |

| | | |
|---|---|---|
| | | • Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| ***Commitment to sustainable mobility*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Extension of the Electric Vehicle Charging Station Network (EVCS). | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Municipal technicians<br>/ | • Recognize the concepts and equipment used; |

| | | |
|---|---|---|
| | Installation of equipment | • Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment; |

| | | |
|---|---|---|
| | | • Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| Replacement of municipal fleets by electric vehicles (garbage collection cars, police vehicles, fire trucks, public transport, or employee transport, among others). | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts, vehicles, and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for diagnosis of the system. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems; |

| | | |
|---|---|---|
| | | • Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of vehicle features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy in the system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| ***Promotion and reinforcement of the increasing use of public transport*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Creating an efficient, inclusive, and accessible public transport network. | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of Characteristics between different mobility options | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Managers and Engineers<br>/ | • Recognize the concepts and equipment used; |

| | | |
|---|---|---|
| | Network Planning:<br>• Knowledge that allows the correct planning of the Public Transport Network according to the needs of citizens. | • Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply planning techniques;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and connections to be installed;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Engineers and Municipal technicians / Maintenance. | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of characteristics of the public transport network | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity. |

| *Implementation of water management processes to stop the increasing problem of water scarcity* | | |
|---|---|---|
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Introduction of hydro efficiency solutions and monitoring of water consumption in parks and buildings in the municipality. | Managers, Engineers, and Municipal Technicians<br>/<br>Evaluation of characteristics between different offers on the market | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for the diagnosis of system anomalies. |
| | Engineers<br>/<br>Equipment Sizing | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |

| | | |
|---|---|---|
| | Municipal technicians<br>/<br>Installation of equipment | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment for installation;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use installation techniques. |
| | Engineers and Municipal technicians<br>/<br>Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation; |

| | | |
|---|---|---|
| | | • Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |
| | Managers and Engineers<br>/<br>Knowledge of equipment features | • Recognize the concepts and equipment used;<br>• Identify and characterize energy recovery processes;<br>• Analyze the environmental impact of the energy production system;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding the professional activity. |
| Promotion of new consumption patterns, based on resource efficiency, sustainability, and circularity of value chains. | Managers, Engineers, and Municipal Technicians<br>/<br>Assessment of consumption patterns, based on resource efficiency, sustainability, and circularity of value chains | • Recognize the concepts and equipment used;<br>• Identify and characterize water consumption processes;<br>• Analyze the system's environmental impact on water consumption;<br>• Identify and characterize energy recovery processes;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Use reporting procedures and technical documentation;<br>• Identify the various phases of work to be carried out and the activities inherent to them. |
| | Municipal technicians<br>/<br>Promotion among employees and citizens of methods and strategies for good water management. | • Recognize the concepts used;<br>• Identify and characterize consumption processes;<br>• Analyze the system's environmental impact on consumption;<br>• Identify and characterize energy recovery processes;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Use reporting procedures and technical documentation;<br>• Identify the various phases of work to be carried out and the activities inherent to them. |
| ***Introduction of innovative concepts for inter-municipal energy sharing*** | | |
| **Technological change** | **Affected Profession/ specializations** | **Required Qualifications and Skills** |
| Inter-municipal energy sharing through the concept of Renewable | Managers, Engineers, and Municipal Technicians<br>/ | • Recognize the concepts used;<br>• Identify and characterize energy production processes; |

| | | |
|---|---|---|
| Energy Communities (REC). | Training in Collective Self-Consumption Management | • Analyze the system's environmental impact on energy production;<br>• Identify and characterize energy recovery processes;<br>• Calculate and evaluate the feasibility of the project;<br>• Apply project management methodologies;<br>• Apply cost/benefit analysis techniques;<br>• Identify maintenance needs;<br>• Use reporting procedures and technical documentation;<br>• Analyse, select, synthesize, and keep up-to-date technical information for management;<br>• Identify and use suitable measurement and control equipment for installation, start-up, and diagnosis of system anomalies. |
| | Engineers and Municipal technicians / Maintenance | • Recognize the concepts and equipment used;<br>• Identify and characterize energy production processes;<br>• Analyze the environmental impact of the energy production system;<br>• Apply health and safety standards and procedures regarding professional activity;<br>• Define the means for installing and maintaining the equipment;<br>• Apply planning techniques and equipment assembly;<br>• Identify maintenance needs;<br>• Apply corrective actions and propose, if necessary, changes to the implemented equipment and systems;<br>• Use reporting procedures and technical documentation;<br>• Identify the equipment and accessories to be installed and the physical conditions required for installation;<br>• Identify the various phases of work to be carried out and the activities inherent to them;<br>• Identify the different types of materials and their behavior, as well as the equipment to be used in the installation;<br>• Identify and use suitable measurement and control equipment;<br>• Identify and use testing techniques;<br>• Identify anomalies in the system;<br>• Identify and use maintenance techniques. |

### 3.4.3 Synthesis- Recommendations

#### *3.4.3.1 Future impact on Q&S- Most interesting trends for CoVEs*

| Affected Profession/ specializations | Required Q&S | Existing Q&S/ Available Training | Structural needs for CoVEs |
|---|---|---|---|
| **Specialization in Green Hydrogen in energy production and consumption.** | • Evaluation of characteristics between different offers on the market;<br>• Equipment Sizing;<br>• Installation of equipment;<br>• Maintenance;<br>• Knowledge of equipment features. | Partially. Training is too vague and generalist. It does not fully prepare people for the job market in the hydrogen field. | • Knowledge of technologies and suppliers;<br>• Knowledge of its characteristics;<br>• Technical knowledge that allows installation and maintenance. |
| **Specialization in *Green Hydrogen to increase the storage capacity of energy.*** | • Evaluation of characteristics between different offers on the market;<br>• Maintenance;<br>• Knowledge of equipment features. | Partially. Training is too vague and generalist. It does not fully prepare people for the job market in the hydrogen field. | • Knowledge of technologies and suppliers;<br>• Knowledge of its characteristics;<br>• Technical knowledge that allows installation and maintenance. |
| **Specialization in *production of Biomethane, exclusively from renewable energy sources*** | • Evaluation of characteristics between different offers on the market;<br>• Maintenance;<br>• Knowledge of equipment features. | Partially. More targeted towards general features. | • Knowledge of technologies and suppliers;<br>• Knowledge of its characteristics;<br>• Technical knowledge that allows installation and maintenance. |
| **Specialization in *Production of electricity from renewable sources*** | • Evaluation of characteristics between different offers on the market;<br>• Equipment Sizing;<br>• Installation of equipment;<br>• Maintenance;<br>• Knowledge of equipment features. | Yes, insufficient. Training of a few hours given mainly by private entities. | • Knowledge of technologies and suppliers;<br>• Knowledge of its characteristics;<br>• Technical knowledge that allows installation and maintenance. |
| **Specialization in *Sustainable mobility*** | • Evaluation of characteristics between different offers on the market;<br>• Equipment Sizing;<br>• Installation of equipment;<br>• Maintenance;<br>• Knowledge of equipment features. | Yes, insufficient. Training of a few hours given mainly by private entities. | • Knowledge of technologies and suppliers;<br>• Knowledge of its characteristics;<br>• Technical knowledge that allows installation and maintenance. |

| | | | |
|---|---|---|---|
| **Specialization in management of Inter-municipal Energy Sharing Communities** | • Training in Collective Self-Consumption Management;<br>• Maintenance. | No. | • Knowledge of the concept and interpretation of legislation;<br>• Knowledge of technologies applied to the concept;<br>• knowledge of management and maintenance. |
| **Specialization in *Integrated Management System*** | • Knowledge of equipment features.<br>• Training in Collective Self-Consumption Management; | Partially. More focused on the basic characteristics of the circular economy. | • knowledge of management and maintenance.<br>• Knowledge of the characteristics of the equipment integrated in the system.<br>• Knowledge of the type of consumption and units of measurement;<br>• knowledge of how to achieve better savings. |

### *3.4.3.2 Recommendations for policy makers for the modernisation of VET*

Modernization in training excellence in VETs (Vocational Education and Training) is essential to ensure that students are equipped with the skills and knowledge necessary to face the challenges of the modern world. This is particularly important around Renewable Energy, where technology is constantly evolving.

With the growing demand for energy sources that are alternative to fossil fuels, clean and renewable, training in emerging technologies is essential to ensure that there are qualified professionals to meet this demand.

Training at VET centers can help improve the quality of education and increase students' employability by closing the gap between required and available skills. This not only benefits the person and company receiving the training but also contributes to the country's economic development and helps to protect the environment.

Policymakers have a key role in supporting and implementing emerging technologies around sustainable energy, creating incentives for companies and individuals to adopt renewable energy technologies, as well as promoting policies that make the transition to a greener economy easier.

Furthermore, municipalities have the opportunity to lead and support the shift toward sustainability by promoting public policies that encourage the adoption of sustainable practices and renewable energy technologies.

It is important to emphasize that training should not be limited to the general public, but should also be extended to municipal employees. These play an important role in the implementation of public policies related to energy and the environment as well as they are key stakeholders for technology testing in the territory.

Training for municipal officials in the various forms of renewable energy, including green hydrogen, is essential to ensure the country's energy sustainability. Green hydrogen is a promising technology and one of the biggest bets at the national level, where municipalities cannot be left out. Being produced from renewable energy sources, such as wind and solar energy, it does not emit greenhouse gases in the entire process and can be stored or injected into existing natural gas pipes, which makes it an excellent alternative to fossil fuels.

Specific training in green hydrogen will allow municipalities to be more autonomous in choosing the technologies most suited to their needs, as well as allowing adequate installation and maintenance. This training will also allow for better management and integration in energy-sharing networks, directing energy to where it is most needed at a given moment in time.

Due to the importance of the role of competent training in the green transition, guaranteeing the energy sustainability of the country, policy makers must support the implementation of these technologies and invest in specific training, ensuring that companies, public workers, and individuals can acquire the skills and knowledge necessary for the implementation, management, and maintenance of these technologies, efficiently and safely.

### 3.4.4 References


[1] M. do Planeamento, “Plano de Recuperação e Resiliência,” 2021.

[2] “PLANO NACIONAL ENERGIA E CLIMA 2021-2030 (PNEC 2030),” 2021.

[3] Legislação, Resolução Conselho Ministros n.o 107/2019 - Roteiro para a Neutralidade Carbónica 2050 (RNC 2050). 2019.

[4] Presidencia do Conselho de Ministros, “Resolução do Conselho de Ministros n.o 63/2020 de 14 de agosto,” in Diário da República, 1.a série, 2020.

[5] A. III, “Estudo Mobilidade Elétrica - Implicações e Oportunidades Empresariais,” 2022.

[6] PORDATA, “Portugal: Consumo de energia elétrica: total e por tipo de consumo | Pordata.” https://www.pordata.pt/portugal/consumo+de+energia+eletrica+total+e+por+tipo+de+consumo-1124-9094 (accessed Feb. 24, 2023).

[7] DRE - Diario da República Elétronico, “AMBIENTE E AÇÃO CLIMÁTICA Portaria 15/2023.” Accessed: Mar. 01, 2023. [Online]. Available: https://files.dre.pt/1s/2023/01/00300/0003400036.pdf

[8] ADENE, “Hídrica - ADENE.” https://www.adene.pt/hidrica/ (accessed Mar. 01, 2023).

## 3.5 RES Systems, Attica Region, Greece

### 3.5.1 The RES Systems industry

EU has adopted a transition to a low-carbon society, due to the climate change caused by the greenhouse gases emissions. In order to achieve low carbon, the development of sustainability in the energy sector is necessary, improving quality of life, creating jobs and reinforcing energy security. In the document *A Clean Planet for all* (COM (2018), 773) [1] is clearly mentioned that the EU energy policy is targeting towards a clean energy transition which "*would result in an energy system where primary energy supply would largely come from renewable energy sources, thereby significantly improving security of supply and fostering domestic jobs*".

The European Green Deal (COM/2019/640) [2] presents the domains where the transformative policies for a sustainable future are referring to, starting with (1) Increasing the EU's climate ambition for 2030 and 2050, and continuing with (2) Supplying clean, affordable and secure energy, as is also shown in the following figure.

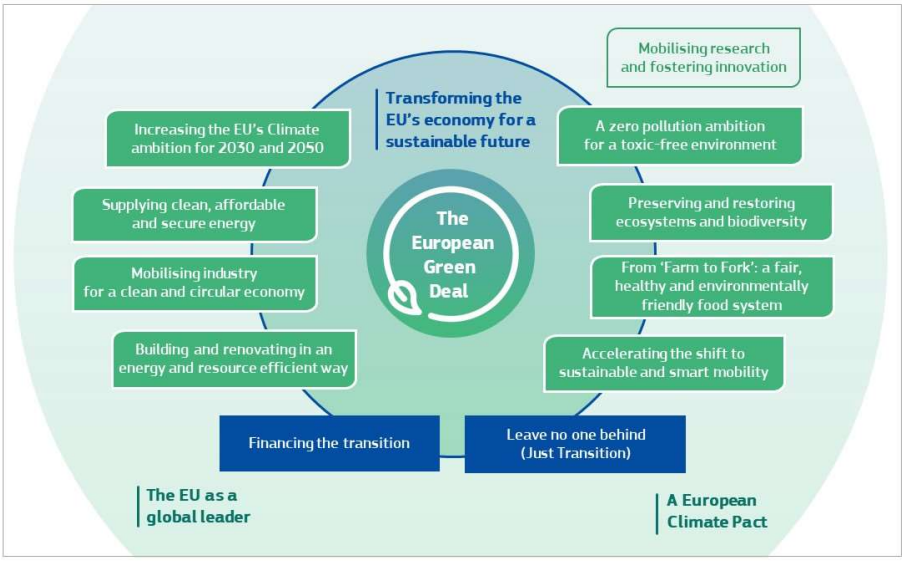



Figure 1: The European Green Deal *[Source: "The European Green Deal" (COM/2019/640)]*

In the same document, the first European 'Climate Law' (EU 2021/1119) [3] is announced, which entries into force in June 2021, making official the Climate neutrality by 2050, with the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

Furthermore, in March 2022 the REPowerEU plan (SWD 2022/230) [4] was launched in order to create a more energy independent EU from gas, oil and coal imports from Russia. The REPowerEU plan is "*fast forwarding the clean transition"* according to the following Figure.

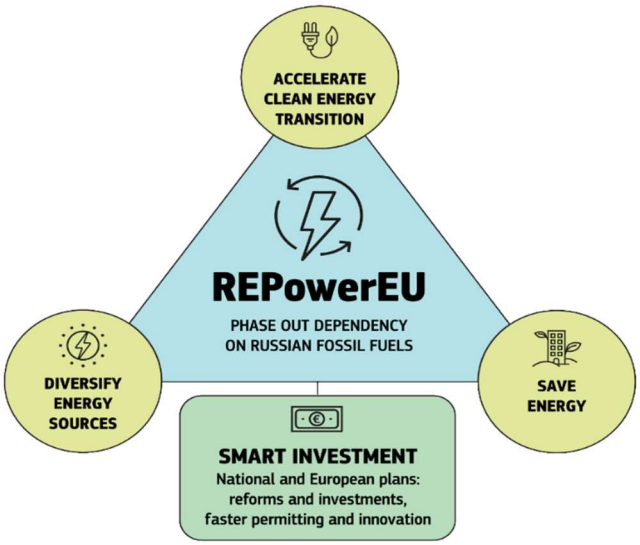



Figure 2: REPowerEU plan [Source: REPowerEU plan (SWD 2022/230)]

In order to achieve this acceleration, the REPowerEU plan is boosting the RE sector by "*proposing to increase the target in the Renewable Energy Directive to 45% by 2030, up from 40% in last year's proposal. This would bring the total renewable energy generation capacities to 1236 GW by 2030, in comparison to 1067 GW by 2030 envisaged under Fit for 55 for 2030" [4].* Furthermore, employment in RES industry is growing globally, offering approximately 12, 7 million jobs in 2021 worldwide, according to IRENA website, as it can be seen in the following Figure [5].

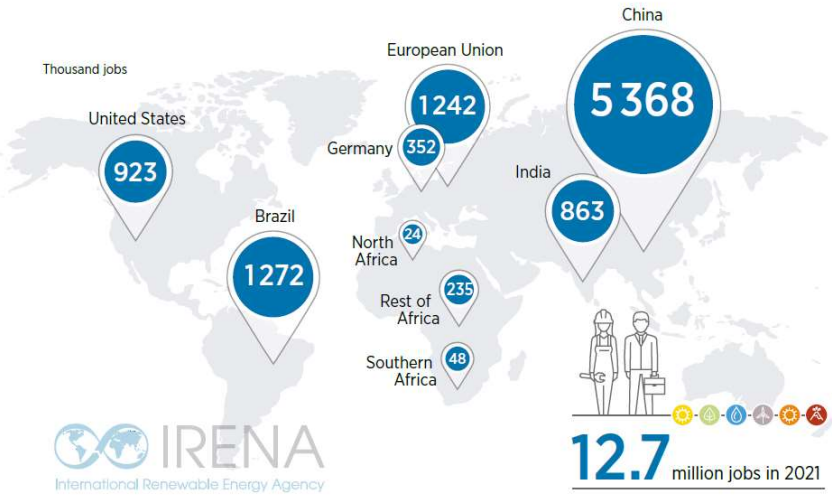



Figure 3: Renewable energy employment in selected countries [*Source: IRENA jobs database, also available at (IRENA 2022)*]

In accordance with the above, Greece prepared a revision of its National Energy and Climate Plan (NECP) [6] where *a 55% drop in CO2 emissions would be achieved, alongside a renewable penetration of 80% in the electricity mix by 2030, until the almost complete decarbonisation by 2050*. Photovoltaics are expected to reach 34 GW, while onshore wind would be at 10 GW and offshore wind at 17 GW) [7].

More specifically, energy is one of the eight priorities of the national RIS3 Strategy [8] (1. Agri Food 2. Health Biosciences 3. ICT 4. Energy 5. Environment & Sustainable Development 6. Transport & Logistics 7. Materials & Construction 8. Tourism, Culture & Creative Industries). The Fields of Smart Specialization in Attica are shown in the following Graph. In the RIS3 Strategy for Attica Region, Energy is considered as one of the challenged priorities. On one hand, 35,4% of the national population is living in the Region, while "*the field of energy is an important field of new discoveries and action for the scientific and technological potential of Attica*" [8]. In the RIS3 report is mentioned the number of applications for RES patents at the European Patent Office by energy technology 2000-2011 by Greek institutions and individuals, which is significant in comparison to other areas. On the other hand, as also mentioned in the SWOT analysis in the same document, there is *"little progress in the utilization of RES"* [8].

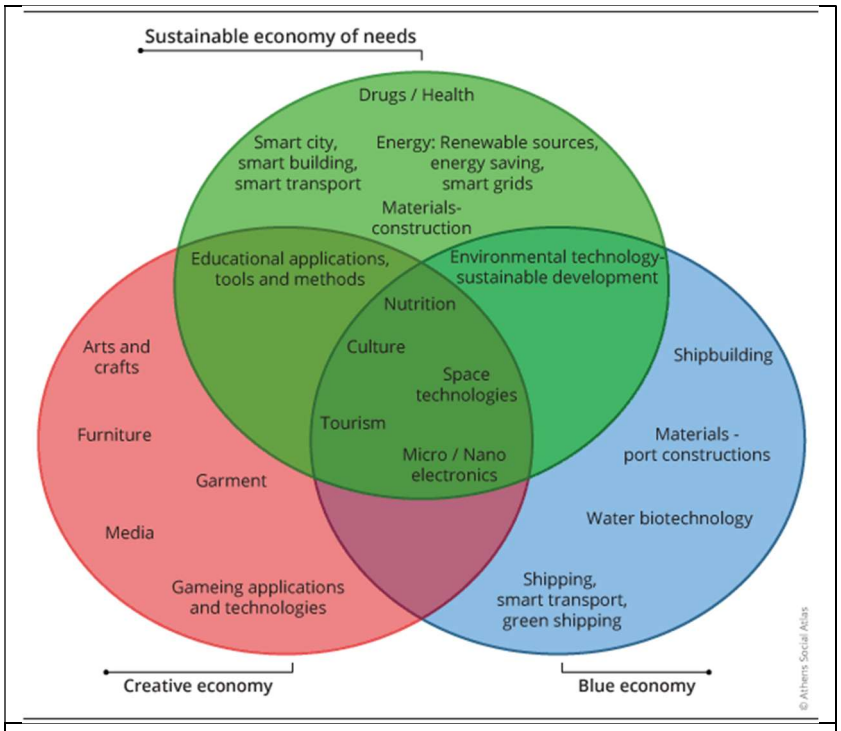



Figure 4: Fields of Smart Specialization in Attica [*Source NRIS [8]*]

For these reasons, the RES industry for the Region of Attica has been chosen to be analyzed in the report. The application of EU, national and regional legislations and strategies are expected to create more jobs in the RES field in Attica. This document aims to identify the future skill and qualification needs of the required labor force in RES industry so that the Region of Attica can raise up to the national targets successfully.

### *3.5.1.1 Status Quo of the RES Systems industry*

According to IRENA's Annual Review (2022) on Renewable Energy and Jobs [5], in Europe, there were a total of 1.5 million jobs in the RES sector. The majority of those jobs (approximately 1.2 million) are located in the European Union (EU-27), with the bioenergy sector being the largest employer in the RE industry on the

continent, as it is shown in the following graph. Solid biomass, used for heat and electricity, is the leading subsector, employing around 360,000 individuals (314,000 in the EU-27). Biofuels follow with 155,000 jobs (142,000 in the EU-27), and biogas employs 67,000 people (64,000 in the EU-27).

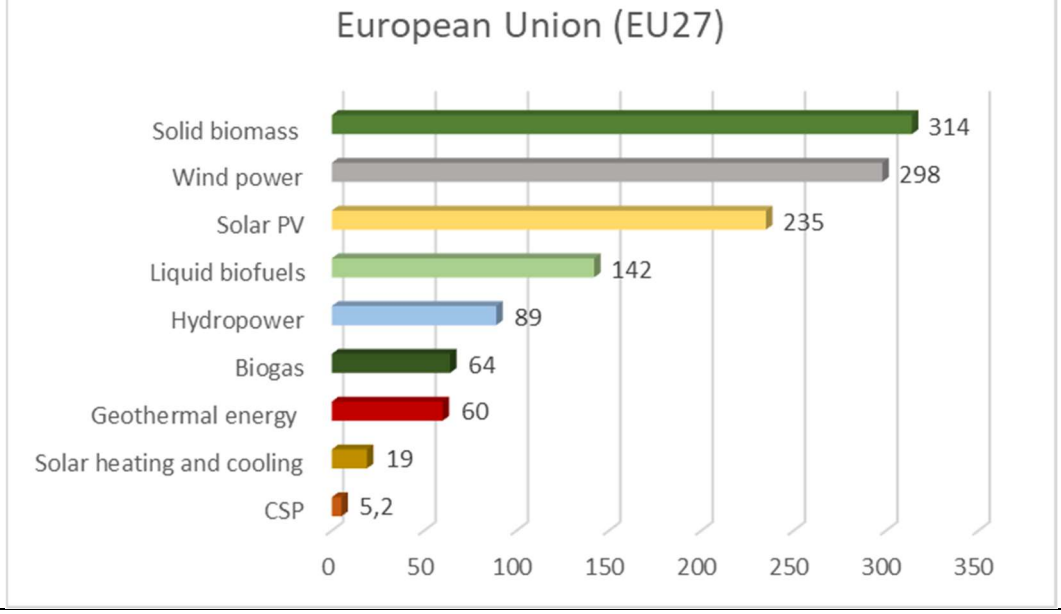



Figure 5: EU renewable energy employment by technology, 2021 *(Data from IRENA, 2022)*

The wind power sector is also a leading employer, providing work to 351,500 individuals, according IRENA's estimations, with 297,600 of those jobs being in the EU-27. In 2021, the EU-27 added 10.4 GW [9], bringing its total capacity to 187.5 GW, while the total wind-generating capacity on the continent reached 222 GW in 2021, with approximately 14.2 GW of newly added.

The electricity produced by the solar photovoltaic (PV) sector in Europe increased around 23 GW of capacity in 2021, 21.4 GW of them being installed in the EU-27 [9]. According to IRENA, employment in the solar PV industry in the EU-27 was estimated at 235,000 jobs in 2021. However, according to SolarPower Europe [10], there were approximately 357,000 solar sector jobs in the EU-27 in 2020, with the majority of jobs in deployment (80%), followed by operations and maintenance (10%), manufacturing (6%), and decommissioning and recycling (4%).

Most solar PV equipment used in Europe, except for inverters and certain balance-of-system components, is imported from Asia. The EU-27's module capacity is 8.3 GW, while cell production capacity is only 0.8 GW [5]. SolarPower Europe has launched the Solar Manufacturing Accelerator to support consortia of companies planning new manufacturing facilities based on innovative technologies, aiming to deploy up to 20 GW of manufacturing capacity in Europe by 2025 [11]. It is anticipated that solar PV manufacturing employment will significantly increase, potentially doubling to 50,000 jobs in the medium scenario and more than tripling to 74,000 jobs in the high scenario by 2025. This increases the total solar employment in 2025 by a 9%, which could rise to as many as 768 000 workers [10].

Ethanol fuel production in the EU-27 initially declined after reaching a peak of 5 billion litters in 2018 but increased to an estimated 5.2 billion litters in 2021. Biodiesel output peaked at 16.3 billion litters in 2019. In 2020, biofuel employment in the EU-27 was estimated at around 141,600 jobs (data from EurObserv'ER, 2022

[12]). If the increase in biofuel output in 2021 corresponded to a similar increase in employment, this would create approximately 147,500 jobs [5].

In the following Table, the above-mentioned data of the employment in the RES industry the EU27 are gathered, while the global employment figures are also presented.

**Table 1: Global & EU27 RE employment by technology, 2021** ***(Source: IRENA, 2022)***

| | **World** | **European Union (EU27)** [g] |
|---|---|---|
| Solar PV | 4 291 [e] | 235 |
| Liquid biofuels | 2 421 | 142 |
| Hydropower[a] | 2 370 | 89 |
| Wind power | 1 371 | 298 |
| Solar heating and cooling | 769 | 19 |
| Solid biomass [b,c] | 716 | 314 |
| Biogas | 307 | 64 |
| Geothermal energy [b,d] | 196 | 60 [d] |
| CSP | 79 | 5.2 |
| **Total** | 12 677 [f] | 1 242[f] |

*Note: Source: IRENA jobs database. The figures presented here are the result of a comprehensive review of primary national entities, such as ministries and statistical agencies, and secondary data sources, such as regional and global studies. Empty cells indicate that no estimate is available. Columns may not add up to totals due to rounding.*

*a. Direct jobs only.*

*b. Power and heat applications.*

*c. Traditional biomass not included.*

*d. Includes 7 400 jobs for ground-based heat pumps in EU countries.*

*e. Includes an estimate of 342 000 jobs in off-grid solar PV in South Asia and in East, West and Central Africa. f. Includes 39 000 jobs in waste-to-energy.*

*g. Solar PV and wind jobs are for 2021; hydropower figures for 2020 and 2021; other technologies are for 2020.*

In the Table below is presented the employment distribution in EU27 in the main RES Sector, as registered by the EurObserv'ER's annual report The State of renewable energies in Europe (2022) [12]. The data for Greece are also presented in the following pie.

**Table 2: Employment distribution in RES industry in the EU27, 2022** ***(Source: EurObserv'ER, [12].)***

| | Total | Heat pumps | Solid biofuels | PV | Wind | Biofuels | Hydro | Biogas | Solar thermal | MSW | Geothermal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | 256 800 | 27 400 | 41 300 | 56 000 | 69 200 | 12 400 | 4 700 | 24 200 | 17 000 | 3 900 | 700 |
| Italy | 206 100 | 141 300 | 21 100 | 15 100 | 6 100 | 5 700 | 6 300 | 6 300 | 1 500 | 1 700 | 1 000 |
| France | 167 800 | 64 600 | 24 900 | 23 300 | 14 500 | 18 800 | 15 500 | 2 600 | 1 500 | 1 300 | 800 |
| Poland | 129 300 | 8 200 | 46 900 | 35 200 | 8 600 | 21 400 | 500 | 2 600 | 2 800 | 1 900 | 1 200 |
| Spain | 124 000 | 33 600 | 17 400 | 25 400 | 23 000 | 13 500 | 4 000 | 1 300 | 5 400 | 300 | <100 |
| Netherlands | 79 300 | 20 100 | 23 300 | 21 700 | 10 500 | 1 200 | <100 | 500 | 100 | 800 | 1 000 |
| Sweden | 65 600 | 15 000 | 22 900 | 3 100 | 14 100 | 7 300 | 2 100 | 100 | 100 | 800 | <100 |
| Denmark | 54 400 | 3 700 | 12 900 | 3 500 | 31 900 | <100 | <100 | 300 | 1 500 | 300 | <100 |
| Portugal | 50 200 | 22 500 | 8 700 | 7 200 | 7 200 | 300 | 2 700 | 500 | 800 | 200 | <100 |
| Finland | 35 500 | 7 700 | 19 200 | 2 000 | 4 400 | 1 000 | 500 | 300 | 100 | 200 | <100 |
| Hungary | 35 500 | 1 800 | 12 100 | 2 300 | 700 | 17 000 | 200 | 400 | 400 | 100 | 500 |
| Romania | 33 300 | 1 100 | 8 700 | 1 900 | 2 000 | 17 800 | 1 400 | <100 | 100 | <100 | 100 |
| Austria | 30 200 | 2 600 | 9 800 | 5 000 | 2 000 | 2 600 | 4 500 | 400 | 1 900 | 1 300 | 100 |
| Czechia | 30 100 | 1 900 | 15 900 | 2 200 | 600 | 4 300 | 1 400 | 3 400 | 200 | 100 | <100 |
| Greece | 26 600 | 5 500 | 800 | 7 000 | 6 600 | 2 600 | 900 | 700 | 2 300 | <100 | <100 |
| Lithuania | 23 500 | 2 500 | 9 200 | 1 500 | 2 200 | 7 200 | 300 | 300 | <100 | 100 | <100 |
| Latvia | 22 700 | <100 | 17 700 | 100 | 200 | 3 300 | 500 | 500 | <100 | <100 | <100 |
| Bulgaria | 21 100 | 700 | 12 200 | 1 800 | 700 | 3 100 | 800 | 300 | 1 300 | <100 | <100 |
| Croatia | 16 500 | <100 | 10 400 | <100 | 2 600 | 1 600 | 600 | 800 | 100 | <100 | <100 |
| Slovakia | 14 500 | 3 100 | 5 400 | 200 | <100 | 4 400 | 500 | 500 | 100 | <100 | <100 |
| Estonia | 14 300 | 2 300 | 8 300 | 2 500 | 300 | 400 | <100 | <100 | <100 | <100 | <100 |
| Belgium | 14 200 | 4 200 | 1 000 | 4 300 | 2 000 | 1 600 | 200 | 400 | 100 | 300 | <100 |
| Ireland | 6 000 | 1 200 | 2 100 | 300 | 1 600 | 300 | 100 | 100 | 100 | 100 | <100 |
| Slovenia | 5 000 | 2 800 | 1 100 | 100 | <100 | <100 | 400 | 100 | <100 | <100 | <100 |
| Malta | 4 100 | 3 100 | <100 | 200 | <100 | <100 | <100 | <100 | <100 | <100 | <100 |
| Cyprus | 1 700 | <100 | 100 | 600 | 100 | <100 | <100 | 100 | 300 | <100 | <100 |
| Luxembourg | 1 700 | <100 | 300 | 500 | 100 | <100 | 200 | 100 | <100 | 100 | <100 |
| **Total EU 27** | **1 470 000** | **377 300** | **353 800** | **223 100** | **211 500** | **148 300** | **48 800** | **47 100** | **38 300** | **14 500** | **7 300** |

*Source: EurObserv'ER*

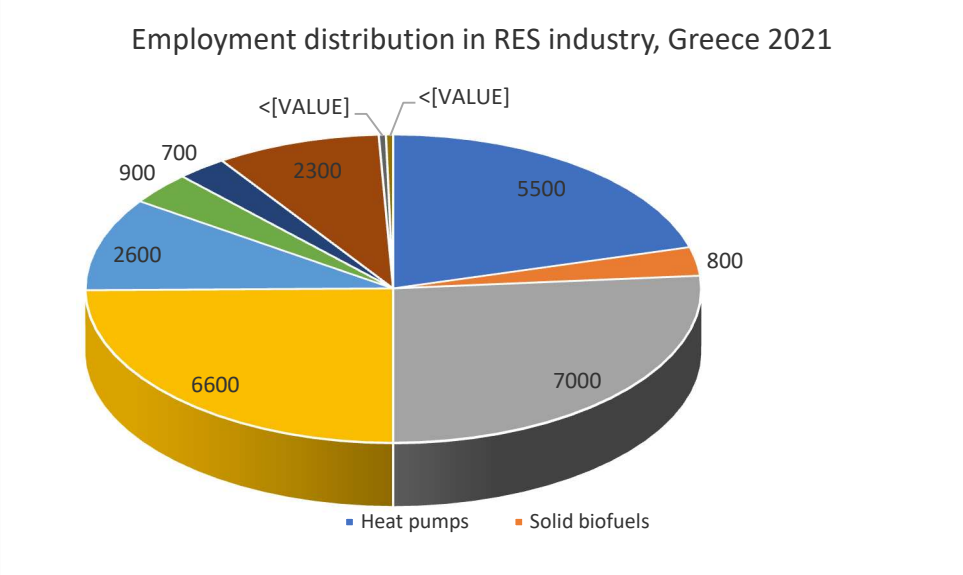



Figure 6: Employment distribution in EU27, 2022 (Source: EurObserv'ER, [12].)

### *3.5.1.2 Major technological changes in the RES Systems industry*

The Research and Development in the solar energy technology is a growing sector, given the immediate implementation for energy production. One possibility is the production of solar thermal energy, which can be used to generate electricity by implementing concentrating solar power collectors or developing new heat storage materials and techniques. Solar thermal energy can also be utilized for heating and cooling applications, such as through the digitalization of solar thermal systems, the development of hybrid systems in intelligent buildings, the integration of solar thermal systems into smart grids, and the establishment of standardized solar thermal systems for heat generation in industrial processes [13].

Furthermore, solar energy holds great potential in the form of photovoltaic (PV) energy, both on the field and on the integration of PV systems into buildings and other infrastructures, such as industrial facilities. There is also a focus on developing high energy efficient multi-contact technology PV cells, as well as monitoring and operating systems for PV parks and installations. [13].

According to the Global Market Insights [14] "the solar PV module market has witnessed some transformative growth in the recent past, with technological innovations trending across the value chain. Even some of the major challenges, such as operations during night-time, are being addressed using innovative solutions. […] Increasing cell efficiency in solar panels is one of the key aspects associated with competitive module manufacturing since it directly helps in decreasing the overall cell processing costs" [14].

As mentioned in the same article, the 3 major technological milestones are: PERC Technology, Bifacial Cells and Half Cells technology. In April 2022, Greece inaugurated a 204-megawatt (MW) solar farm in Kozani, in the country's Western Macedonia region, which is the biggest solar farm with bifacial panels in Europe [15].

The establishment of PV Parks also opens up possibilities for research and development in the field of hydrogen production units connected to renewable energy sources. Strong investment interest has already been expressed in this area. Storage units can provide cleaner energy offering benefits such as safety, flexibility, stability, and reduced electricity [13].

Biomass is another highly promising energy source that is anticipated to be utilized extensively in the post-coal era. In Greece there is a focus on the development, demonstration, and scaling up of solid, liquid, and gaseous bio-energy intermediates through various conversion processes (biochemical, thermo-chemical, and chemical) from sustainable biomass. The National Organization for the Certification of Qualifications & Vocational Guidance (EOPPEP) has published the Educational framework for the Technician for Biomass Management and Utilization [16] however there is no specific course in the existing vocational system for this expertise.

In the following years, emphasis will be placed on the operation and maintenance of RES systems/ parks using digitalized systems and automations. Furthermore, energy storage is a growing industry since the supply from wind or solar power is not constant. There is a growing need for skilled management at both the grid and system levels. Greece serves as a prime example, with its interconnected mainland system and autonomous island systems. The significant interest in storage systems, with approved applications is already totaling around 14.3 GW, despite no installations being implemented yet, as mentioned in the IENE Workshop "Electricity Storage and Grid management for Maximum RES Penetration" [17] which took place on September 2022. The situation regarding energy storage is expected to undergo significant changes, which will have a profound impact on the overall landscape of renewable energy installations. As the legal framework is clarified, and the first battery and pump storage units are connected to the grid in the coming years, the dynamics will shift dramatically. Consequently, the increasing presence of RES will gradually lead to the phasing out of conventional power units

with high inertia rotating mass. This shift will strengthen the role of power electronics in RES and storage systems, as well as innovative protection and control systems in future grids (as mentioned in the announcement of the Workshop).

Hydrogen is recognized as a key pillar in the energy transition, alongside renewable energy, renewable-based electrification and energy efficiency [18] "Hydrogen, as an energy carrier, is a key pillar of the EU's strategy to achieve its 2050 decarbonization goals, with an estimated 24% of hydrogen contributing to the total energy demand by 2050 and a 15% reduction in local emissions"[19], as mentioned in the Erasmus- funded project "Green Skills for Hydrogen" [19] which is fast-tracking the upskilling and reskilling of students and members of the workforce all over Europe. University of Western Macedonia is a partner in this project and Region of Attica could also benefit from the upskilling and reskilling opportunities, through VET programs.

The development of smart grids has been a major focus in the RES industry. Smart grids use advanced communication and information technologies to optimize the performance of the grid and facilitate the integration of renewable energy sources.

Finally, offshore wind energy is also a technology which presents an interest growth in the energy sector, however it is not developed in this document, since it is not a technology applicable in the Region.

| Technological change | Affected professions / specializations |
|---|---|
| PV related (PERC technology, Bifacial Cells and Half Cells) | PV technicians |
| Hydrogen | Chemical, mechanical, electrical engineers/ technicians, renewable energy technician |
| Energy storage | Mechanical, electrical engineers/ technicians, renewable energy technicians |
| Lifecycle management/ recycling/ circular economy | Waste management and recycling technician, electrician, mechanic, chemical engineers, managers & technicians |
| Automations | Computer engineers & technicians, energy companies, software developers, RES technicians |
| Smart Grids | Computer, mechanical, electrical engineers/ technicians, renewable energy technicians |

### 3.5.2 Qualifications and Skills (Q&S)

#### *3.5.2.1 Current Q&S of the RES Systems professionals*

Currently the only specialization existing in VET in RES Installer, which gathers all technicians like an umbrella. However, EOPPEP has defined the Professional Profile of the Biomass Technician [16], of the Small Hydroelectric Power Station Operator [20], and of the Technician of constructing solar energy installations [21]. These specializations are concerning mainly technicians (usually electricians or mechanics) who have obtained specific professional qualifications through work experience.

For example, for the License of an Installer of Small-Scale Photovoltaic System can apply technicians which have graduated from [22]:

- EPAL (Vocational High School): Electrical Installations
- EPAS (Vocational School of Apprenticeship): Electrical Technicians
- IEK (Institute of Professional Training): Technician of Internal Electrical Installations, Elevator Technician
- TEE (Technological Education Institute) A' Cycle: Building Electrical Installations
- TEL (Technological Education School): Internal Electrical Installations
- TEE (Technological Education Institute) B' Cycle: Building and Industrial Space Installations
- TEL (Technological Education School) specialization: Building and Industrial Space Installations
- EPL (Higher Professional School): General Electrical Applications

In order to get the License, the technicians should have proven professional experience and pass successfully the respective examinations in their Prefecture.

In the following Table, the professions/ specializations related to RES industry are indicated. The data are either extracted from the professional profiles or curriculums for Greece or from other sources (desk research).

| Professions / specializations related to RES | Short description of the profession focusing on SE | Current Qualifications and Skills |
|---|---|---|
| RES Installer [23] | The RES Installer works under the supervision/ guidance of the Head Engineer for the installation as well as the Maintenance of large electricity generation units from RES sources | • Ability to connect with inverters and auxiliary installations (panels, meters).<br>• Understanding of construction and electrical drawings.<br>• Identification of "out of the box" solutions.<br>• Analysis of product life cycle costs.<br>• Implementation of basic safety and health regulations.<br>• Ability to install the necessary equipment for storing electrical energy from PV Systems in batteries for future use.<br>• Ability to install appropriate wind turbines on specialized bases.<br>• Ability to install the necessary equipment for storing electrical energy from wind turbines in batteries for future use.<br>• Ability to install the necessary equipment in the ground for converting geothermal energy into heating / cooling.<br>• Ability to install the necessary equipment in the ground for converting geothermal energy into heating /cooling.<br>• Ability to install the necessary equipment in the ground for converting solar thermal energy into heating. |
| Machinist of road construction machinery (PV) [24] | They operate and maintain a road construction machine and they prepare and fill in reporting documents. | • Conduct Operation & control<br>• Capability of monitoring the operation of the construction<br>• Capability of Equipment selection<br>• Conduction of Equipment maintenance<br>• Capable of Repairing<br>• Ability of Practical thinking<br>• Troubleshooting<br>• Ability of Coordination<br>• Show Dependability<br>• Ability of Stress tolerance |

| | | |
|---|---|---|
| PV fitter/installers [24] | Photovoltaic Installers, or Solar PV Installers, assemble, install, and maintain solar photovoltaic systems on roofs or other structures. They do so in compliance with site assessment, plans, and schematics | • Conduct Operation & control<br>• Capability of monitoring the operation of the installation<br>• Show Practical thinking<br>• Troubleshooting<br>• Show Persistence<br>• Show Dependability<br>• Ability of Stress tolerance |
| PV operation and maintenance technicians [24] | They manage preventive, corrective, and predictive maintenance in the field as well as plant equipment monitoring. | • Conduct Operation & control<br>• Conduct Quality control analysis<br>• Capability of Equipment selection<br>• Systems evaluation<br>• Equipment maintenance<br>• Repairing<br>• Practical thinking<br>• Troubleshooting<br>• Judgment & decision-making<br>• Dependability<br>• Persistence<br>• Stress tolerance |
| PV electricians [24] | They assemble, install, test and maintain PV-related electrical/electronic wiring, equipment, appliances, apparatus and fixtures | • Capability of Equipment selection<br>• Systems evaluation Equipment maintenance Repairing<br>• Practical thinking<br>• Troubleshooting<br>• Judgment & decision-making<br>• Dependability<br>• Persistence<br>• Stress tolerance |
| Machine operators (wind) [24] | They set-up, operate, and are responsible for ensuring the machine produces high quality products, runs smoothly and at capacity, and is properly maintained. | • Conduct Operation & control the machines<br>• Conduct Operation monitoring<br>• Equipment maintenance<br>• Equipment selection<br>• Practical thinking<br>• Troubleshooting<br>• Coordination<br>• Dependability<br>• Stress tolerance |
| HVAC system installers [24] | They work with heating, ventilation, and air conditioning systems, primarily installing new systems in homes and offices. | • Conduct Operation & control of the systems<br>• Conduct Operation monitoring<br>• Practical thinking<br>• Troubleshooting<br>• Persistence<br>• Dependability<br>• Stress tolerance |
| Maintenance and repair electricians [24] | They perform routine maintenance procedures and repairs that are required | • Conduct Operation monitoring<br>• Quality control analysis<br>• Equipment selection<br>• Systems evaluation |

| | | |
|---|---|---|
| | due to normal wear on the system. | • Equipment maintenance<br>• Repairing<br>• Practical thinking<br>• Troubleshooting<br>• Judgment & decision-making<br>• Dependability<br>• Persistence<br>• Stress tolerance |
| Energy electricians [24] | They assemble, wire, and maintain equipment that generates clean wind energy. | • Equipment selection<br>• Systems evaluation<br>• Equipment maintenance<br>• Repairing<br>• Practical thinking<br>• Trouble shooting<br>• Judgment & decision-making<br>• Dependability<br>• Persistence<br>• Stress tolerance |
| Heat pumps technicians | They conduct the assessment study, the sizing of the installation by calculating the energy parameters, doing the maintenance, cleaning and service of the heating system. | • Understanding of construction and electrical drawings.<br>• Identification of "out of the box" solutions.<br>• Analysis of product life cycle costs.<br>• Ability of applying the basic safety and health regulations.<br>• Ability of installing the necessary equipment<br>• Ability of understanding of heat pump systems, including their components, operation, and maintenance.<br>• Identification of the different types of heat pumps, such as air-source, ground-source (geothermal), and water-source heat pumps.<br>• Ability of troubleshooting and Repairing Skills to diagnose and resolve issues<br>• Identify electrical, mechanical, or refrigerant-related problems and perform necessary repairs or replacements.<br>• Strong understanding of safety procedures and protocols when working with electrical systems, refrigerants, and potentially hazardous components |
| Small Hydroelectric Power Station Operator [20] | They work as members of the operation team, employed in the particular energy production small electrohydraulic power stations usually combined with renewable, of public or private or local authorities' organizations. | • Understanding of hydroelectric power systems, including their components, operation, and maintenance.<br>• Be familiar with the principles of hydropower generation, water turbine technology, electrical power transmission, and control systems.<br>• Understanding of safety protocols and regulations specific to working in hydroelectric power plants or related environments.<br>• Understanding of mechanical systems, such as turbines, generators, and pumps, as well as electrical systems, including power distribution, transformers, and control panels. |

| | | |
|---|---|---|
| | | • Ability of using computer software and systems for data analysis, monitoring, and control of hydroelectric power plants.<br>• Problem-solving skills to diagnose and resolve issues with hydroelectric power systems.<br>• Troubleshooting electrical and mechanical problems, analyze data, and implement effective solutions. |
| Biomass management and utilization Technician [16] | They work in units of production, management, and utilization of various types of biomass, with the aim of energy production or soil improvement through compost | • Strict implementation of Health and Safety regulations<br>• Describe the General Principles of Recycling.<br>• Describe Combustion, Fuels, Lubricants.<br>• Ability of Burner Repairs<br>• Explain the Physicochemical Characteristics of Biomass.<br>• Identify the Methods of Biomass Transportation.<br>• Identify the Methods of Biomass Storage Depending on its Origin.<br>• Recall the Operation of Pollution Control Systems and operate them (settling chambers, cyclones, multicyclones, Electrostatic Filters, Bag Filters, spray chambers, scrubbers, etc.).<br>• Ability of Operation of Liquid Waste Treatment Systems.<br>• Implementation of Waste Recycling. |
| Technician of constructing solar energy installations [21] | They can construct applications of solar energy (thermal and OV) system and be responsible for the installation and maintenance of the solar thermal systems | • Strict implementation of Health and Safety regulations<br>• Reading technical designs and specifications<br>• Identify the Orientation and inclination of solar thermal<br>• Conduct the Operation monitoring<br>• Conduct the Equipment maintenance<br>• Ability of Repairing<br>• Ability of Troubleshooting and Problem-Solving<br>• Judgment & decision-making |
| Geothermal | They work on the installation, operation, and maintenance of geothermal energy systems and equipment | • Ability to recognize Geothermal drilling techniques, geothermal heat pumps, and geothermal power plant operations.<br>• Ability to install and operate Electrical and mechanical systems<br>• Ability of Troubleshooting and Problem-Solving<br>• Safety and Compliance with safety protocols, requirements and regulations.<br>• Ability of Repairing<br>• Communication and collaboration when working in multidisciplinary teams or coordinating with contractors and suppliers. |

The BUILD UP Skills Greece (BUS-GR) [25] project focused on the development of the National Qualification Roadmap (NQR) which outlined strategic measures and actions boosting the continuous vocational training and the improvement of skills of the building sector workforce in the fields of energy efficiency and renewable energy [25]. During the following -up project BUS UPSWING, 9 pilot training programs based on the results of BUS-GR were implemented. The training aimed the upskilling of the technicians' workforce in selected sectors for energy

efficiency (insulation technicians, aluminium and metal constructions craftsmen and installers-maintainers of burners). In another recent study [36] the current needed skills of the RES specializations mentioned in the following Table were identified, in line with the BUS-GR report for training priorities [37].

| RES systems installations | Affected Profession/ specializations | Required Qualifications and Skills |
|---|---|---|
| Installers of small-scale biomass boilers and stoves [36] | plumber, heat and air-conditioning technicians | • Selection and proper dimensioning of the chimney according to the type of the boiler and burner biomass, chimney placement-path according to the requirements of building regulation.<br>• Taking measurements and analysis of biomass burning and lumps, flue gas and gaseous pollutants, adjust burner and combustion air, emission control in accordance with environmental legislation.<br>• Taking measurements for determination of moisture content, calorific value, the apparent density and energy potential of biofuels.<br>• Implementation of handling and storage biomass techniques and determination of available biomass fuel sources locally (fuel type, suppliers, prices). |
| Solar photovoltaic and solar thermal systems installers [36] | Plumber, electrician | • Fluency with all types and technologies of solar thermal space heating systems and domestic hot water, conventional solar water heaters, central solar systems, COMBI systems.<br>• Understanding of the basic specifications of the solar panels, heat sinks and hydraulic equipment.<br>SOLAR THERMAL:<br>• Proper implementation of configuration techniques and hydraulic interconnection of solar panels (choosing the appropriate piping type, fluid solar flow control per solar collector array, solar thermal field insulation pipe).<br>• Implementation of interconnection techniques of heat sinks hot water storage (simply containers, thermal stratification containers) with central heating and domestic hot water production installations.<br>• Understanding and selecting the correct position and inclination of the support structure of solar panels for greater energy efficiency<br>• Advising the client on the correct equipment supply and the efficient and safe use of it.<br>SOLAR PV: |

| | | |
|---|---|---|
| | | • Application of installation techniques, mounting PV frames with the most efficient energy, in relation to the available space and in accordance with the existing standards.<br>• Conducting the electrical connections according to the specifications for the respective electrical voltage, and synchronization of PV systems with the network.<br>• Advising on the efficient operation and maintenance of optimal performance of the installation.<br>• Ensuring of the necessary health and safety conditions at work up on roofs and to protect against risks of electrocution.<br>• Understanding the function and ability to connect smart meters and micro-inverters in PV systems.<br>• Operation startup, conduction of electrical audits and inspections, operation monitoring and failure recovery of the installation.<br>• Fluency in designing and installing hybrid and autonomous systems. |
| Shallow geothermal systems and heat pumps installers [36] | Plumber, refrigeration technician, electrician | • Understanding the operating principles of a heat pump and its characteristics sizes, of the available heat pump technologies and the heat exchanger types.<br>• Understanding and proper dimensioning and installation of the heat pump and the containers of storage and inertia from the side of the heat exchanger and from the side of the load.<br>• Implementation of appropriate construction techniques for the heat exchanger piping network of each type.<br>• Testing and inspections, operation startup, cleaning and maintenance of heat exchangers, inspection and maintenance of compressors |

#### *3.5.2.2 Q&S needed to address the technological changes*

In the following Table the Q&S related to the more essential technological changes are developed. Since the wind and solar energy production is a well-established industry in the country, the companies are providing the necessary training for their technicians when a new technology is used. On the other hand, there is a lack in training in the chosen trends on the RES industry, and those gaps were chosen for further analysis and development. Finally, since the automation and IT sector is developed in detail in Chapter 3.3, there is no further analysis here.

| Technological change | Affected Profession/ specializations | Required Qualifications and Skills |
|---|---|---|
| Green transition / RES | Medium skill level: solar PV/wind turbine/ biomass systems: installers, technicians, plant managers, quality engineers.<br>Existing trades with new relevant knowledge and skills: electricians; plumbers; heating, ventilation and air-conditioning technicians | • Environmental awareness/ willingness and capability to learn about sustainable development<br>• Adaptability and transferability skills, to enable workers to learn and apply the new technologies and processes required to green their jobs<br>• Teamwork skills, reflecting the need for organizations to work collectively on tackling their environmental footprint;<br>• Resilience, to see through the changes required<br>• Communication and negotiation skills, to promote required change to colleagues and customers; Entrepreneurial skills, to seize the opportunities of low-carbon technologies and environmental mitigation and adaptation;<br>• Occupational safety and health (OSH) [26] |
| Energy storage | RES technician, electrician, mechanic, chemical technician | • Ability to implement a Storage management system<br>• Mechanical, hydraulic, and electrical skills for troubleshooting, repair, installation, commissioning<br>• Electrical and mechanical schematics, project management, team leadership, using hand tools. [27]<br>• Ability to identify the Energy Storage system components and technology<br>• Ability to apply Grid-connected and off-grid energy storage<br>• Implementing Safety, risks and risk mitigation measurements<br>• Calculating the System sizing<br>• Ability to design and organise Reuse and recycling procedures of the wastes [28]<br>• Indicating the types of electrical energy storage and key characteristics<br>• Indicating the Parameters for electrical energy storage<br>• Indicating the Operational characteristics of electrical storage<br>• Estimating the Costs and pricing<br>• Integration of energy storage into electrical grids<br>• Ability to design Off-grid systems, architecture and sizing<br>• Ability to describe and operate small scale battery storage systems |

| | | |
|---|---|---|
| | | • Ability to operate types and applications of thermal energy storage [29] |
| Hydrogen | RES technician, electrician, mechanic, chemical technician | • Operating principles of a hydrogen facility<br>• Design principles of a hydrogen system [30]<br>• Ability to operate hydrogen production, storage, and handling,<br>• Ability to work with electrolyzes and fuel cells,<br>• Integration of different renewable and hydrogen technologies into complete systems,<br>• Strict implementation of Hydrogen safety issues,<br>• Operating hydrogen injection, distribution, and mobility [31]<br>• Ability to design and perform risk and security management |
| Circular economy- recycling [32] | Waste management and recycling technician, electrician, mechanic, chemical | • Operation and maintenance of various devices and automated, semi- and non-installations, receiving processes, material separation, storage, dispatch, transportation, improvement of facility performance.<br>• Operation, repair, and maintenance of the first stage of various main equipment in the production processes of recycling materials (secondary raw materials) and the aforementioned processes.<br>• Strict implementation of Health and Safety regulations<br>• Ability of Individual and team work<br>• Compose Reports |
| Smart grids | RES technician, electrician, mechanic, computer technician | • Management of energy demand,<br>• Design of a smart grid<br>• Integration with technologies<br>• Maintenance and repair<br>• Energy standards<br>• Troubleshooting<br>• Safety and personal data protection<br>• Grid Architecture<br>• Smart metering – building<br>• Microgrids [33] |

### 3.5.3 Synthesis- Recommendations

#### *3.5.3.1 Future impact on Q&S- Most interesting trends for CoVEs*

| Affected Profession/ specializations | Required Q&S | Existing Q&S/ Available Training | Structural needs for CoVEs |
|---|---|---|---|
| All relevant professions (RES installer, Electrician, plumber, | Safety and health | Partially | There are courses on Health and safety, however special |

| | | | |
|---|---|---|---|
| mechanic, heating, ventilation and air-conditioning technicians) | | | mention should be given in the CoVEs in the specific technologies' requirements. |
| Electrician, mechanic, chemical technician, RES installer | Hydrogen | Sporadically | The Green Skills for Hydrogen project provides material and methodology that can be integrated in the CoVEs |
| Electrician, mechanic technician, RES installer | Energy storage | Sporadically | The UNIWA has implemented a seminar on Technologies of Energy Storage [34] in the frame of HORIZON 2020 TILOS project on 2016. The context of the seminar could be a base for an updated syllabus. |
| Waste management and recycling technician, technicians | RES recycling | Partially | There is no mention in the recycling of RES systems |
| All relevant professions | Green transition / RES | | These could be a common course for all specialities |
| All relevant professions | Circular economy | | |
| Computer engineers, technicians | Automation, RES and SE | Sporadically | Specialized training in energy systems and data processing, advanced training in edge computing principles and technologies, exposure to real-world edge computing projects and applications (as also mentioned in 3.3) |
| Computer engineers, technicians | Smart grid | Partially | There are available Master courses [35] or seminars [33] in Universities on Smart Grids. There are no seminars or courses for technicians. CoVEs could make the relevant adjustments |

| | | | |
|---|---|---|---|
| | | | for the vocational training. |

#### *3.5.3.2 Recommendations for policy makers for the modernisation of VET*

Greece has an increasing RES industry, especially on wind and solar energy. Given the decarbonization targets and the implementation of the REPowerEU plan, the development of more RES technologies could create an extra boost on the sector and enhance the target's achievement. This project provides an opportunity on focusing on the trends on RES technologies which are not yet developed in the educational/ training system, covering the gap of the qualifications of the workforce for the labour market.

Under this framework, it is suggested to focus on the modern technologies which are not widely mentioned in the vocational education system, such as smart grids, hydrogen, energy storage, recycling and automations. Some general knowledge on the green transition, on health and safety issues and on circular economy should also be analysed to the workforce.

Hence a suggestion would be to create a vertical syllabus on the common core courses (green transition, circular economy, health and safety) and then more specific courses on the other mentioned technologies. Health and safety could need some extra specialization, depending on the technology. The already existing courses, seminars and EU projects could be used as a base for the development of the courses. Furthermore, there are some existing university level courses/ seminars which could provide material to be adjusted for the technicians.

### 3.5.4 References


[1] A Clean Planet for all (COM (2018), 773). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018DC0773

[2] European Green Deal (COM/2019/640). Available at:: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0640

[3] European 'Climate Law' (EU 2021/1119). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32021R1119

[4] REPowerEU plan (SWD 2022/230). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD%3A2022%3A230%3AFIN

[5] IRENA, 2022. Renewable Energy and Jobs, Annual Review. Available at: https://www.irena.org/publications/2022/Sep/Renewable-Energy-and-Jobs-Annual-Review-2022

[6] National Energy and Climate Plan (NECP) of Greece. Available at: https://energy.ec.europa.eu/topics/energy-strategy/national-energy-and-climate-plans_en

[7] Balkan Green Energy News, article:" Greece boosts 2030 renewable energy target by 9 GW, adds hydrogen" by Aposporis H., 18/01/2023. Available at: https://balkangreenenergynews.com/greece-boosts-2030-renewable-energy-target-by-9-gw-adds-hydrogen/

[8] National Research and Innovation Strategy for Smart Specialization, 2014-2020. Available at: https://www.pepattikis.gr/sites/default/files/field/file/media/2021-01/%CE%95%CE%93%CE%9A%CE%95%CE%9A%CE%A1%CE%99%CE%9C%CE%95%CE%9D%CE%97-RIS3.pdf

*Executive Summary in English, available at:http://www.gsrt.gr/Financing/Files/ProPeFiles20205/Executive%20Summary-2015-09-17-v04(1).pdf*

[9] IRENA, 2022a. Renewable Capacity Statistics 2022, International Renewable Energy Agency, Abu Dhabi. Available at: https://www.irena.org/publications/2022/Apr/Renewable-Capacity-Statistics-2022.

[10] SolarPower Europe, 2021. EU Solar Jobs Report 2021 – Towards Higher Solar Ambitions in Europe, SolarPower Europe, Brussels, Belgium. Available at: https://mcusercontent.com/2702b812ce1f3e6da64933b9d/files/2d5e419b-e798-27de-d61c-733559fc2d3f/SPE_EU_Solar_Jobs_Report_2021.pdf. [also in IRENA, 2022]

[11] SolarPower Europe, 2022. *EU Market Outlook for Solar Power 2021-2025*, SolarPower Europe, Brussels, Belgium. Available at: www.solarpowereurope.org/insights/market-outlooks/market-outlook.pdf [also in IRENA, 2022]

[12] EurObserv'ER, 2022. The State of Renewable Energies in Europe, 2020 Edition, EurObserv'ER, Paris Available at: https://www.eurobserv-er.org/ [also in IRENA, 2022].

[13] TRACER project, May 2022. D6.3&6.4 Roadmap for the Region of Western Macedonia. Available at: https://tracer-h2020.eu/national-policies-and-challenges/

[14] Global Market Insights, article, 27.06.2022. "3 Key Technology Trends Powering Solar PV Module Deployment in 2022 & Beyond". Available at: https://www.gminsights.com/blogs/major-trends-powering-solar-pv-module-market

[15] Electrek, article, 08.04.2022. "Greece launches the largest bifacial solar farm in Europe". Available at: https://electrek.co/2022/04/08/greece-launches-the-largest-bifacial-solar-farm-in-europe/

[16] EOPPEP, Professional Profile of Biomass Technician. Available at: https://www.eoppep.gr/images/EP/EP145.pdf

[17] IENE Workshop, 28.09.22. Electricity Storage and Grid Management for Maximum RES Penetration. Announcement available at: https://www.iene.eu/en/congress/49/iene-workshop-electricity-storage-and-grid-management-for-maximum-res-penetration

[18] IRENA, 2023. Creating a global hydrogen market: Certification to enable trade. Available at: https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Jan/IRENA_Creating_a_global_hydrogen_market_2023.pdf?rev=cad6962f55454a46af87dec5f2e6c6e8

[19] Green Skills for Hydrogen EU project. Masterclass: "One-Day Hydrogen", 01.02.2023. Available at: https://greenskillsforhydrogen.eu/masterclass-one-day-hydrogen/

[20] EOPPEP, Small Hydroelectric Power Station Operator. Available at: https://www.eoppep.gr/images/EP/EP77.pdf

[21] EOPPEP, Technician of constructing solar energy installations. Available at: https://www.eoppep.gr/images/EP/EP80.pdf

[22] Department of Technical Implementation of the Direction of Industry, Energy and Natural Resources of the General Directive of Development of the Prefecture of Central Macedonia. Available at: https://www.pkm.gov.gr/biomhxanias/Hlektrologoi%20A.html

[23] General Secretariat for Lifelong Learning and New Generation, Vocational Training Institute, July 2017. Technician of RES Installations, Study Guide. Available at: https://docplayer.gr/55059288-Odigos-spoydon-eidikotita-tehnikos-egkatastaseon-ananeosimon-pigon-energeias-kodikos.html

[24] RES-SKILL EU project, 2021. Skills matching analysis and development of transition profiles. IO2_Analysis Report. Available at: https://res-skill.eu/wp-content/uploads/2023/01/RESSKILL_IO2_AnalysisReport_20210709.pdf

[25] Upgrading the Construction Sector Workforce Training and Qualification in Greece (UPSWING BUILD UP SKILLS), D2.4: State of the art report on the design of the training courses, 31.07.2015 www.skills-upswing.eu

[26] ILO, 2019. Skills for a greener future: A global view. Available at: https://www.ilo.org/skills/pubs/WCMS_732214/lang--en/index.htm

[27] American Clean Power, Energy Storage Technicians- position requirements. https://cleanpower.org/occupation/energy-storage-technician/

[28] DNV, Energy Storage training course (online). https://www.dnv.com/training/energy-storage-training-course-online--67426

[29] The Renewable Energy Institute, Energy Storage training course (online). https://www.renewableinstitute.org/training/energy-storage-course/

[30] University of the Highlands and Islands (UHI). Hydrogen: an Introduction for Technicians (SCQF level 7) PDA (online course). https://www.uhi.ac.uk/en/courses/pda-hydrogen-an-introduction-for-technicians-scqf-level-7/#tabanchor

[31] Green Skills for Hydrogen EU project. Hydrogen Summer ScH2ool (03-07/07/2023, Kozani) https://greenskillsforhydrogen.eu/hydrogen-summer-sch2ool/

[32] Edujob e-mentoring. Waste management and recycling technician http://edujob.gr/node/159334

[33] Kapodistrian University of Athens. Smart Energy Grid online course. https://elearningekpa.gr/courses/eksupna-energeiaka-diktua-smart-energy-grid#course-curriculum

[34] University of West Attica (UNIWA), Lab of Soft Energy Applications. TILOS, EU project -HORIZON 2020, Seminar "Modern Technologies of Energy Storage" http://www.sealab.gr/pages/viewpage.action?pageId=17039822

[35] University of Thessaly, Dep of Electrical and computer engineering. MSc Studies in "Smart Grid Energy Systems" https://www.e-ce.uth.gr/studies/postgraduate/smart-grid-energy-systems/?lang=en

[36] GIZ- INZEB, 2020. "Feasibility Study with an Assessment of Options as well as Recommendations for the Establishment of one or more National Certification Scheme(s) or Equivalent Qualification Scheme(s) for Installers of Small-Scale RES Technologies and Energy-Related Building Elements in Greece" Available at: https://inzeb.org/publications/feasibilitystudy/

[37] Build Up Skills project, 2011. D4.2: Report on the priorities for training of the building workforce. *As mentioned in "Feasibility Study with an Assessment of Options as well as Recommendations for the Establishment of one or more National Certification Scheme(s) or Equivalent Qualification Scheme(s) for Installers of Small-Scale RES Technologies and Energy-Related Building Elements in Greece" GIZ- INZEB, 2020.*

# 4 Conclusions – recommendations – outcomes

The transition towards a greener energy production has already started in the EU and globally. This joint report of the consortium's partners aims to identify the upskilling and reskilling training needs of the existing and future workforce for the VET in order to be able and ready to respond to the current and future needs of the market.

The consortium decided to the analysis of 5 sectors of sustainable energy: green buildings, renewable energy sources, Cybersecurity, Artificial Intelligence and IT, and the role of municipalities in the sector. The synthesis of the conclusions and recommendations for the vocational education and training centres and for the respective stakeholders has resulted to the outcome of this research, presenting the key findings for the policy makers and practitioners.

The modernization of vocational education and training centers involves changes in three main pillars. On one hand, there is the need to include courses on the new technological trends. There is a lack of consistent training in core technological modern issues, like hydrogen, on general sustainability business issues, like circular economy, on soft skills, like communication and collaboration, on more sensitive issues, like cybersecurity and the vulnerability of energy systems to cyber-attacks etc. The curriculums that the VETs can develop in order to cover the existing gap on the needed skills on the sustainability in energy sector are creating an umbrella of variety of courses, which has been analyzed more detailly in this document. However, the more important recommendation for the VET centers is to be flexible and to constantly follow the trends and changes in the sustainability sector, in order to quickly adapt to them, since modern times are characterized by fast changes.

The second pillar for the modernization of VET centers answers to this issue, since it consists of the collaboration of the market and industry leaders with the education and training system. Partnerships are encouraged between stakeholders, policy makers, technological and industrial innovators and the VET system, so that they can provide the respective framework for the development of the needed curriculums. Furthermore, industry leaders can provide the VET centers with state-of-the-art infrastructure, equipment and tools for hands-on training and offer to the trainees' practical experience though internships, apprenticeships, and job shadowing.

The third pillar for the modernization of the training and education system for the VETs is the transformation of teaching methodology, by the integration of new, modern digital and interactive learning environment, such as gamification, learning platforms, active participation, collaboration, flexible attendance etc.

The well-trained trainers and the dissemination of the trends on the sustainability sector to the general public are also important issues running on parallel with the modernization procedure of VET. It is essential that youngsters, parents and society are informed on the working opportunities in the SE sector, since it has been noticed that it is a non-popular sector in the existing VET courses.

In order to achieve a greener energy production, the provision of efficient technologies, the proper and secure implementation by countries, industry and businesses and the integration of sustainability from the general public are equally essential.

# 5 Appendices

**Appendix I.**

**Proposed questions for interviews or focus group on technology foresight in the SES and related industries:**

1. What are the latest technological advancements in the sustainable energy that you are aware of?
2. How do you believe these advancements will affect the sustainable energy in the short and long term?
3. What technologies do you think will be adopted widely in the near future and why?
4. In your opinion, what are the most promising areas for further research and development in the sustainable energy?
5. How do you see the role of renewable energy sources like solar, wind, geothermal and hydro power in the sustainable energy?
6. How do you see energy storage and distribution technology developing in the near future?
7. How do you believe energy efficiency technology will evolve in the sustainable energy?
8. How do you see the smart grid and internet of things impacting the sustainable energy?
9. What challenges do you believe the sustainable energy currently facing in terms of technology adoption?
10. Are there any other technologies or trends that you think will be important for the sustainable energy sector in the future?

**Appendix II.**

**Proposed questions for interviews or focus group on qualifications and skills in the SES and related sectors:**

1. What are the current skills and qualifications that are most important for success in your field/industry?
2. What new technologies and systems are currently being used in your field/industry and how have they affected the skills and qualifications needed?
3. How do you see the industry and the skills needed for it evolving in the next 5 to 10 years?
4. What skills and qualifications do you think will be in highest demand in the future and why?
5. How have the skills and qualifications needed in your field/industry changed in the last 5 years?
6. In your opinion, what skills and qualifications are currently being overlooked or undervalued in the industry?
7. How do you believe vocational education and training programs can better align with the current and future needs of the industry?
8. How do companies in your field/industry currently acquire and develop the necessary skills and qualifications for their workforce?
9. What steps should be taken to ensure that workers in your field/industry have the necessary skills and qualifications for future success?
10. Are there any other trends or developments that you believe will affect the skills and qualifications needed in your field/industry in the future?