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Addressing green skill shortages in Europe: policy insights from a government and social partners' perspective in Italy

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INTRODUCTION

This thesis aims to explore and analyse the emerging challenges related to the transformation of knowledge, training needs, and skills brought about by the 'green transition' at both the European and Italian levels. Special attention is given to the growing 'skills mismatch,' i.e., the misalignment between skills supply and demand in the labor market. Since there are different types of skills mismatch, this thesis focuses on what the literature taken as a reference calls 'green skills shortage' (EIB, 2023; OECD, 2023), that is, the shortage of skilled workers in emerging green sectors and jobs.

Energy transition, the reduction of greenhouse gas emissions, and the use of clean technologies are among the strategic objectives of economic and industrial policies defined at the national and European levels. In this regard, the ecological (or 'green') transition can be thus defined as a new industrial revolution because of the wide structural impact expected on labor markets worldwide. In light of this scenario, policymakers have two main goals: the first is to create new jobs linked to the renewed pattern of economic growth (the so-called 'green jobs'), and the second is precisely to promote and support sustainable development. The concept of 'green jobs' is not new and is leading to the redefinition of the skills demanded by companies, which are now focused on promoting 'green' products and services. European Union (EU) policies consider green transition as an opportunity to create jobs in existing and emerging economic sectors but also as a chance to reskill and upskill workers with a view to sustainable development. Despite this renewed interest, driven in part by the need to mitigate the impacts of the climate crisis and external shocks such as the Covid-19 pandemic and the international situation, the scope of the new expected professional figures remains to be defined, and more importantly, there is evidence from several international and European reports of a mismatch between the skills required by companies from the workforce and those actually possessed by those already employed or seeking employment. In this regard, the unavailability of the right skills on the labor

market threatens to hinder firms' attempts to launch new projects and develop new products and/or services based on breakthrough technologies or business models. Within a context, that of the green transition, which is mainly characterised by the development of new technologies and changing production processes, the need to possess up-to-date competences is imperative. In this respect, a considerable risk of slowing down the transition arises from skill shortages in the emerging green sectors. Since skills need time to be developed and even more to be taught and understood, threats connected to the insurgence of gaps between the education system and the labor market are likely to widen.

According to the Global Green Skills Report (LinkedIn, 2024), globally, the demand for green professionals is steadily increasing, although the pace is slower in Italy. Data on green job openings analysed by LinkedIn's Economic Graph show that between 2021 and 2024, demand for sustainable skills grew by an average of 5.9 percent per year globally. In Italy, however, the increase was lower, at 0.12 percent. In 2024, however, 8.27% of job openings on LinkedIn in Italy involved green professions, a higher percentage than the 7.7% recorded globally. Additionally, the 'Circular Economy Report,'[1] edited by the Foundation for Sustainable Development in collaboration with the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), has recently been presented. The document clearly confirms Italy as one of the leading countries in Europe in terms of the level of circularity of the economy, performing above the EU average in several strategic areas: from the circular use of raw materials to resource productivity and waste management. In addition, Italy is second among the 27 European member states for overall level of circularity, just behind the Netherlands and ahead of economies such as Germany, France, and Spain. According to an estimate produced by Cassa Depositi e Prestiti,[2] the adoption of circular practices generated savings of more than 16 billion euros for manufacturing companies by 2024. This is an important record, but one that risks remaining partial if it

[1] See more at: 7° RAPPORTO SULL'ECONOMIA CIRCOLARE IN ITALIA - 2025

[2] Brief available at: Economia circolare: una leva per la competitività delle imprese

is not accompanied by quality employment, industrial investment, and active labor policies that are up to the great challenge posed by the climate targets of reducing greenhouse gas emissions and achieving climate neutrality agreed upon in the European Union.

Driven by a personal curiosity about training and skills policies implemented in recent years at both the European and Italian levels within the context of the ecological transition—as well as an interest in exploring the main causes and policy solutions to the growing 'green skills shortages'—this thesis is guided by the following research question:

What training and skills policies are needed in Europe, and especially in Italy, to address green skill shortages?

Through interviews with representatives of SMEs located in the Emilia-Romagna region, namely CNA Emilia-Romagna and its operational arm for training and job orientation in the Ferrara headquarters, i.e., CNA Formazione ('CNA fo.er Ferrara'); with the Territorial Articulation Coordinator at Fondimpresa Emilia-Romagna, a joint inter-professional fund that promotes continuing training in Italy, as well as with CISL Emilia Centrale, trade union organisation committed to the protection of social and labor rights (with strong territorial roots in the provinces of Modena and Reggio Emilia), I propose a qualitative analysis of what the main social partners at the regional level think about this growing issue, i.e., the shortage of skilled workforce with a marked focus on energy savings and lower environmental impact, and also which initiatives they think should be pursued, especially at the national level, to solve the issue at stake. I believe that through the analysis of the interventions that will emerge from the interviews, current and future national policies on training and skills could draw interesting insights into how green skills can be more fully developed by the workforce and the key drivers of such learning, the main one being the spread of systematic collaboration between the government, companies, education and VET

institutions, as well as social partners to strengthen the rollout of high-quality programmes benefiting learners and employers on an equal footing.

CHAPTER I

Understanding skill mismatch and shortages amidst the green transition

1.1. Skill mismatch: types, dimensions, and measurement

The concept of *skill* has often been seen as something difficult to capture as well as to measure.[3] As both Quintini (2017) and the Organisation for Economic Co-operation (OECD, 2017) argued, skills may indicate both cognitive and non-cognitive abilities as well as those specific to a particular job or sector (such as accounting). On one hand, cognitive skills entail the ability to grasp complex ideas and learn from different experiences, as well as the possibility to overcome the daily obstacles through leveraging thought. On the other hand, non-cognitive skills include abilities that intersect the social, emotional, and behavioural domains. Eventually, the interdependence in the use of cognitive and non-cognitive skills result in an individual's technical skills aimed at fulfilling specific tasks (Brunello and Wruuck, 2019).

Additionally, although skills are multidimensional, usually only selected dimensions are taken into account for measurement because of a lack of reliable data (*ibidem*). For instance, a degree in biology will provide a set of different skills than one in law. Although these two subjects entail the same years of academic path, eventually the

[3] According to Brunello and Wruuck (2019), there is still no clear assent in the literature pertaining to what 'skills' are and through which proxy or indicator they should be measured. See also OECD (2017).

skills obtained differ completely and are not interchangeable. As clearly stated by Nedelkoska and Quintini (2018): "*Probably the only way a lawyer could become a decent biologist is to attend the full length of education that biologists undertook.*"
Accordingly, due to the utmost importance of having the right skills in relation to the specific work and job requirements under scrutiny,[4] it has been since the 1940s that the International Labour (ILO) Organisation (1944) highlighted the need for workers to be employed in jobs that give them the opportunity to fully harness their skills and 'match' them with the tasks required in each kind of occupation covered.

Nonetheless, given the complexity of the world of work and the existing labor market frictions related to workers' skills demand, mismatches are inevitable.

Skill mismatch is one of the most pressing challenges that today's labor markets currently face and regards employed workers across different countries and economies (Flisi et al., 2016; Cedefop, 2018). As a matter of fact, about one-third of workers are currently mismatched to their occupations in terms of skills across OECD countries (OECD, 2024). A high and persistent mismatch, however, eventually constitutes a problem for firms, for employees, but most importantly for society and policymakers (ASTD, 2012). Unemployment, difficulties during the recruitment process, skill obsolescence, and people being unable to exploit their full potential are all examples of skill mismatch (Cedefop,[5] 2018).

We are dealing with a complex phenomenon, that of 'skill mismatch,' which can be eventually framed as an umbrella term, i.e., it implies a variety of forms of mismatch, each having its own characteristics, demanding different indicators for measurement, as well as distinct policy strategies and actions.

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[4] Blinder (2009) carried out an insightful data analysis on the relevance the skill level detained by US workers (measured either through educational attainment or wages) had on the related occupations they held.

[5] The European Centre for the Development of Vocational Training.

If we direct our attention to the different *types* and *dimensions* of skill mismatch (Quintini, 2011), it is possible to refer either to macroeconomic mismatches and firm level or to micro and individual level mismatches (McGuinness et al., 2018). The macroeconomic and firm level imply the existence of skill mismatch in the form of skill shortages (when employers do not find suitable employees having the required skills to fill key vacant posts at the ongoing rate of pay), skill surpluses (employees possess more skills than those required by the vacancy), or skill gaps (either the workforce or the labor market is unable to deliver the demanded skills) (Cedefop, 2010). Therefore, skill mismatch at the macro level depicts the existing gap between the aggregate skill supply and demand (usually in a defined geographical unit), as well as a suboptimal match between workers having the right skills for the available jobs (Senkrua, 2021).

Additionally, two phenomena can be distinguished, i.e., that of underskilling and overskilling. In the former case, an individual lacks the demanded skills, while in the latter, employees may not be able to wholly utilise their skills in their job positions (Cedefop, 2018; European Economic and Social Committee, 2018).
At the micro or individual level, skill mismatch occurs when the skill level of an employed worker is different from what is demanded by the job, i.e., when the worker is regarded as either over-skilled or under-skilled if compared with the vacancy.

In terms of measurement, skill mismatch at the macroeconomic level can be evaluated through the comparison of vacancies' composition by either qualification or educational attainment with that of the working-age population as a proxy (Brunello and Wruuck, 2019). The assessment of macroeconomic skill mismatch usually conceives skills in the form of qualifications. In this sense, the so-called 'qualification mismatch' can be used as a proxy for skill mismatch: it stems from the inadequacy between initial education and the position held (Asai et al., 2020).
Alternative options to vacancies include taking into account the composition of either employment (vis-à-vis working-age population) or unemployment (as compared to the

labor force)[6] as proxies of labor demand. Unlike micro mismatch, macroeconomic measures of skill mismatch do not evaluate whether an individual's skills and qualifications are in line or not with their job (in the case of employed workers). As argued by Vandeplas and Thum-Thysen (2019), behind macroeconomic skill mismatch, there can be both cyclical and structural dynamics. In this sense, the main phenomenon observed, especially during economic downturns, is a major increase in the difference in (un)employment rates between qualification groups (*ibidem*). Therefore, skill mismatch manifests itself vigorously mainly during an economic recession and then subsides during the recovery.

Nonetheless, structural reasons may also lie behind broader mismatch dynamics in the (un)employment rate between different education groups. For instance, a faster ageing of low-qualified employed workers than high-qualified ones or a more generous benefit system towards the low-qualified workforce can result in mismatch phenomena on the relative demand for low- versus high-qualified employees.

Instead, skill mismatch at the micro or individual level is usually assessed by comparing the qualifications or skills possessed by an employed worker with those demanded by his or her job (Brunello and Wruuck, 2019). Therefore, a successful match is eventually realised insofar as the employee's skills pair those required by the job under scrutiny.

It is insightful the work conducted by Cedefop and then resulted in different studies (2015, 2018) where a difference between 'genuine' shortages (defined as the inability of employers to fill a vacancy although a competitive salary has been offered) and reported shortages (deriving from suboptimal wage offers) has been made. Building the analysis on the Eurobarometer Flash Survey 304, these studies affirm that, although 47 percent of interviewed employers declare to struggle in finding applicants with suitable skills and capabilities, the total proportion of employers facing genuine skill shortages is lower at 34 percent (McGuinness et al., 2018).

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[6] See also Kiss and Vandenplas (2015).

Nonetheless, skill mismatch negatively affects competitiveness and growth, as well as increasing unemployment and generating various economic and social costs (Pouliakas, 2012). If we look at the data elaborated by the European Centre for the Development of Vocational Training (CEDEFOP) in its latest European Skills and Jobs Survey (ESJS),[7] the results are striking: on average, the skill mismatch phenomenon across the EU27 Member States and UK implies a 2% loss in labor productivity. In addition, the analysis investigated the relationship between skill mismatch and productivity, thus shedding light on the existing differences among different member states. It emerged that states with a higher level of skill mismatch are also those with a lower level of investment in training and education programs and with a labor market that is more rigid and less prone to mobility. It is also possible to delineate specific groups that are most likely to experience skill mismatch in the labor market (Cedefop, 2010).

The most affected segments are especially young adults and immigrants, who tend to suffer more from overskilling, while older or inactive employed workers are more likely to have issues with skill obsolescence. Analysing in detail which professional profiles are most prone to skill mismatch, Cedefop has identified the so-called 'Mismatch Priority Occupations' (MPOs), namely those jobs that are likely to experience skill mismatch problems with relevant implications in the economic system. Within the MPOs are both high-skill occupations (such as physicians, STEM[8] occupations, teachers, and nurses) and jobs such as welders, cooks, and truck drivers, i.e., occupations characterised by low skills (Cedefop, 2018).

It follows, therefore, that policy responses in terms of additional investment in training and acquisition of the required skills (put forward by either public institutions or private firms) will need to take into account both the population segment referred to and the particular skill mismatch phenomenon that is to be overcome.

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[7] See at: https://www.cedefop.europa.eu/en/projects/european-skills-and-jobs-survey-esjs

[8] Science, technology, engineering and mathematics.

1.2 Shedding light on 'green skills' and 'green jobs'

The now decade-long episodes of extreme weather events caused by global warming and climate change have been the main impetus behind the needed transition towards a greener economy and society at a global level. As a matter of fact, the mitigation of global warming will mainly rely on the successful reduction in greenhouse gas (GHG) emissions (IMF, 2022). The issue greatly started resonating from the point of view of international public policies at least since the 2015 Paris Agreement,[9] when policymakers around the world agreed to not go beyond the 1.5°C as the average global temperature increase. Although the chances to meet this ambitious goal seem to be quickly narrowing, as also argued by the latest Reports of the Intergovernmental Panel on Climate Change (IPCC, 2023), moving towards a more circular (D'Amato and Korhonen, 2021) and greener economy (Siksnelyte-Butkiene et al., 2022) is still a pressing issue and a long-term strategy both at the international and at the European level.

As a matter of fact, the European Union and its various legislative initiatives over the past decade[10] have helped raise the bar in achieving sustainability, both environmentally and economically. In this sense, green transition (Cedefop, 2024a) is not just about achieving net-zero emissions and transitioning to a carbon-neutral economy, but it is also a matter of rethinking the world of work and the skills impact arising from the emergence of new productive sectors.

As highlighted by the ILO (2015), the green transition will primarily impact those regions with a high concentration of 'brown jobs' (Vona et al., 2018), and for the workforce currently employed in these high-polluting industries, while regions with a strong concentration of green-related industries will thrive. Therefore, 'greening' the

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[9] See IPCC (2015; 2018) and COP (2015).

[10] Both the European Green Deal and the latest 2023 Green Deal Industrial Plan represent the main Europe's policy frameworks to address climate change.

labour market (ILO, 2015) will inevitably open up new job opportunities and employment gains, as well as possible job losses.

If we want to either prevent or better address future employment shocks stemming from a poorly managed green transition, it seems relevant to clearly understand which kind of investments in training individuals are needed and the skill profiles that are mostly needed to support a peaceful transition across sectors. As a matter of fact, transitioning towards the so-called 'green'[11] and 'circular'[12] economy will inevitably change the skills (and therefore, the tasks) the new professions linked to the achievement of a sustainable economy will be requiring. In this sense, it seems undoubtable that the success of the long-standing international and European Union policies aimed at lowering emissions and tackling climate change will have to take into account which role the so-called 'green skills' and 'green jobs' have amidst the pursuit of a fairer and cleaner low-carbon transition for the overall economy and society.

With regards to the concept of 'green skills,' currently, the literature is uniform in affirming the broadness of the term (Cabral and Lochan Dhar, 2019; Nikolajenko-Skarbalė, Viederytė, and Šneiderienė, 2021; Wegenberger and Ivo Ponocny, 2025) and the diverse definitions given at different institutional levels over time eventually require, especially in the context of the present academic research, a further systematisation effort. As a matter of fact, the need to achieve more clarity on the concept of green skills is highly relevant for different reasons: on one hand, current and future changes in employment needs will have to take into account also the evolution of skills in the already existing occupations (Sulich and Sołoducho-Pelc, 2021). On the other hand, since skills constitute a key factor for the achievement of a sustainable economy (Strachan, Greig and Jones, 2023), it seems relevant to better understand changes in the

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[11] As suggested by the ILO (2018: 38), a 'green economy' is an "economy in which the capacity to satisfy tomorrow's needs is not limited by today's resource use, emissions, and waste".

[12] According to the Ellen MacArthur Foundation, circular economy "tackles climate change and other global challenges like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources". See at: https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

world of work to either prevent or better tackle the emergence of skill shortages[13] (Černý et al., 2024).

If we rely on the joint definition given by both the OECD and Cedefop (2014:16), 'green skills' have to be understood as skills "needed by the workforce, in all sectors and at all levels, in order to help the adaptation of the products, services, and processes to the changes due to climate change and to environmental requirements and regulations." From this point of view, green skills constitute the main building block for achieving a sustainable economy, as also shown by the latest Linkedin 'Global Green Skills Report' (2024). Among the main findings of this work carried out between 2021 and 2024, it is acknowledged that the demand for green skills has grown by an average of 5.9 percent per year globally. Additionally, by analysing different job postings seeking the supply of green skills, the results have recognised the pivotal role the utilities industry has with respect to the others when it comes to the demand for green talent (accounting for 23.1%). Last but not least, job seekers with green skills demonstrated a 55% higher chance of being hired than the overall workforce.

Similarly, the Inter-Agency Working Group on Work-Based Learning[14] attempted in 2022 to come up with a common understanding of green skills for the green transition as "skills and competences but also knowledge, abilities, values, and attitudes needed to live, work, and act in resource-efficient and sustainable economies and societies" (Cedefop, 2022:5). We are dealing with both cross-sectoral technical skills 'required to adapt or implement standards, processes, services, and technologies to protect ecosystems and biodiversity, and to reduce resource energy, materials, and water

[13] As argued by the OECD (2023), skill shortages (along with skill gaps) already constitute one of the major bottlenecks in various green sectors, which eventually threatens future innovation and new technology adoption.

[14] The group was born in 2015, and, among its members, there are the European Commission, the European Training Foundation (ETF), OECD, Cedefop, ILO, and Unesco. Its commitment is sharing knowledge on work-based learning practices and knowledge gaps, as well as fostering joint actions (Cedefop, 2022a).

consumption" and transversal skills "linked to sustainable thinking and acting, relevant to work (across different economic sectors and occupations) and life" (*ibidem*).

It is the same European Commission that welcomed and later adopted this definition. As a matter of fact, it is through its Classification of Occupation, Skills, and Competences (ESCO)[15] database that contributed to adding a further layer of detail in differentiating brown, white and green skills (European Commission, 2022). Particularly, brown skills relate to the production of electricity via coal (therefore, contributing to harm to the environment), white skills pertain to knowledge and skills that do not eventually result in an increase or a reduction of the human activities' negative impact towards the environment, and green skills reduce possible negative impacts, such as power generation from geothermal energy (*ibidem*). We can argue that 'green skills' are therefore a rather narrow concept. Such a statement derives from the fact that, among the 13 890[16] ESCO skills and knowledge concepts, only 571 are eventually labeled as green.[17] This encompasses 381 skills, 185 knowledge concepts, and 5 transversal skills. The green concepts are intended to cover the European's labor market activities. Therefore, skills cross different economic sectors, from energy production to manufacturing processes, from waste management to impact assessment (European Commission, 2022).

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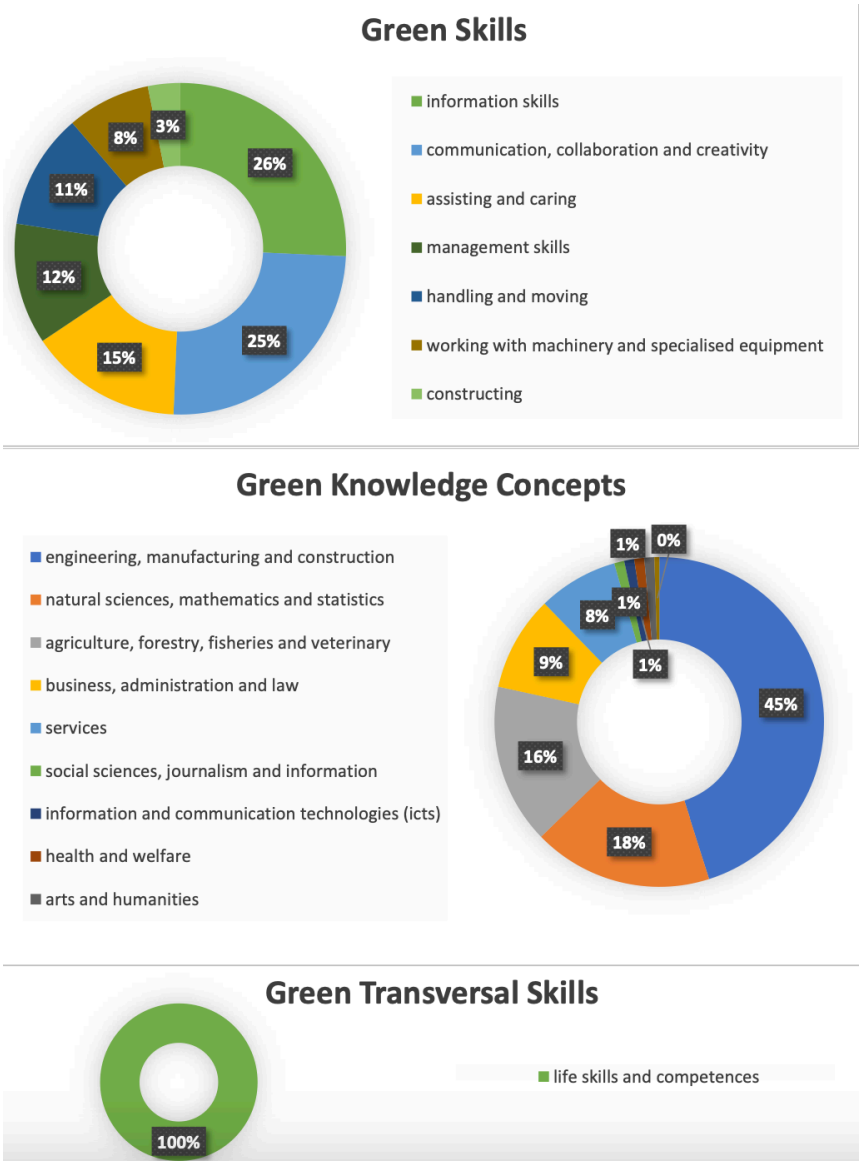
[15] The European Commission's official taxonomy of skills, competences and occupations (ESCO) is critical at the European level due to its commitment to better identifying and classify which skills are mostly needed for each specific job profile. Furthermore, the existence of a taxonomy of skills for the green transition is highly relevant, especially due to the needed investments to support the evolving skillset of the workforce. Therefore, the approach undergone by ESCO is strictly linked to a skills-based one to green jobs (European Commission, 2022).

[16] See at: https://esco.ec.europa.eu/en/about-esco/what-esco

[17] The ESCO's labelling process embraces the machine learning approach. This kind of operationalisation is progressively gaining support since it seems to be effective in successfully grouping jobs and skills (Chiarello et al., 2021). Specifically, the European Commission employed the natural language processing algorithm BERT for the classification of ESCO occupations. The algorithm's training is made possible through the provision of 4 800 strings aimed at classifying ESCO skills as either brown, white or green according to the definitions previously given (European Commissions, 2022).

Figure 1. Green skills and knowledge concepts in ESCO



Source: European Commission, 2022

Furthermore, already before the ESCO classification, several studies attempted to better understand the existing links between skills, tasks, and the green transition (Vona et al., 2015; Bowen, Kuralbayeva, and Tipoe, 2018). In this sense, those skills that are found

to be linked to green jobs and that are often measured through task-based approaches[18] are defined as 'green skills' (Vona et al., 2018; Tyros, Andrews, and de Serres, 2023). In their empirical analysis,[19] Vona et al. (2015) eventually defined the main features of green skills by identifying four categories of green skills that are employed more frequently in green occupations vis-à-vis non-green ones. The results have been the following: green skills entail a high-level analytical set of competences and technical know-how linked to the design, production, management, and monitoring of technology. This has also been confirmed by Cedefop's Green Observatory, which affirmed that transitioning towards a green economy will necessarily rely on the provision of those occupations that handle it (i.e., managers, transport and storage specialists), specialists that make citizens feel part of the green conversion process, and high-skilled digital professional roles (such as sustainability data analyst and renewable energy data engineer) (Cedefop, 2024). Additionally, Vona et al. (2015) found that the demand for green skills is positively related to environmental regulatory stringency (understood as technical criteria and legal standards). Therefore, the increase in the demand for high-level analytical, engineering, and scientific skills is mostly triggered by the enactment of environmental regulation.[20] Bowen, Park, and Elvery (2013) additionally affirmed that, as the share of employment and businesses in green economic sectors grows, states are more likely to enforce green policies as a result.

Only through an adequate supply of the necessary set of skills to carry out green tasks[21] is it possible to speed up the decarbonisation of our productive systems, paired with the

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[18] The task-based framework (Acemoglu and Restrepo, 2017) emphasises the pivotal role of the tasks performed by the workforce. As a matter of fact, since tasks rely on the possession of certain skills, the task-based framework enables us to gain better knowledge about skill demands.

[19] Vona et al. (2015) mainly used the occupation-specific information of the Occupational Information Network (O*NET) as a data-driven methodology for their research.

[20] The analysis takes into account the three main industries that are mostly exposed to environmental regulation: utilities, manufacturing and construction.

[21] According to Tyros, Andrews and de Serres (2023), 'green tasks' can be defined as those whose main focus is on green activities (such as those contributing to a reduction in GHG emissions) and technologies, and are therefore critical for economy's decarbonisation efforts.

associated displacement costs for the workforce concerned. In this regard, Vona et al. (2018) list a set of transferable skills that are mainly needed by those employed in green occupations. They demonstrate that the level of green skills possessed by those employed in brown jobs (i.e., those occupations showing a large employment share in highly polluting industries) is strictly closed to those requested in green jobs. This argument has also been sustained by Bowen et al. (2018), who found that whereas moving to 'indirectly green jobs'[22] is less complicated than transitioning to 'directly green jobs,' all in all, these jobs share the majority of skill set requirements. Therefore, this might imply that, under the possible scenario in which brown industries contract and the green ones thrive, the current workforce employed can swiftly reallocate these transferable skills from brown jobs to green ones. Nonetheless, although individuals working in brown jobs have the necessary green skills on average, still, there are some workers in determined occupations that might be short of other kinds of skills, which are critical for moving to green jobs.[23] From this perspective, it is recognised that, in those countries where the share of the brown workforce who cannot be smoothly reallocated to green jobs is particularly high, correspondingly, active labor market policy as a share of Gross Domestic Product (GDP) is lowest (*ibidem*).

Drawing up from the aforementioned discussion, various endeavours have also been made to formally circumscribe and classify the concept of 'green jobs.'. It is possible to argue that, although the increasing relevance that the concept has acquired over time in both policy and academic debates, no agreement on the meaning of 'green job' has been still defined in the literature (Stanef-Puică et al., 2022; Elliott & Lindle, 2014). Various definitions can be listed, depending on the context of reference, e.g., political, academic,

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[22] The term indicates those jobs that, although key to green economic activities, do not necessarily foresee any green tasks. Differently, 'directly green jobs' must envisage green tasks (Vona et al., 2015). Additionally, there exist various studies (Consoli et al., 2016; Bowen et al., 2018; Vona et al., 2018) that recognise the higher level of education demanded by directly green jobs, as well as accounting for many more non-routine analytical tasks as compared to non-green jobs (i.e., brown jobs).

[23] Tyros, Andrews and de Serres (2023) provide, as an example, individuals employed in production jobs (such as pourers, metal and tire builders) who face, inter alia, one of the highest transition costs for transitioning to green jobs.

or national statistics institutes (Janta et al., 2023). Although there are studies that analyse and understand green jobs in terms of either 'green sectors' or jobs focused on the production of 'green products,' this kind of reasoning could oversimplify the discussion. The lack of a uniformly agreed definition generates a number of issues (*ibidem*). For instance, it is challenging to gather enough data on the specific weight and the peculiar green job needs, as well as to circumscribe the effects that the decarbonisation of the economy will likely be having on both current and future employment opportunities. This in turn might generate further difficulties during policy design's efforts, since there is currently little evidence about the impact produced by the green transition, particularly on local labor markets, frequently referred to as the 'geography of green jobs'[24] (OECD, 2023).

Nonetheless, a variety of studies have chosen to approach the matter of green jobs by following the definition provided by the 2008 "Green Jobs Initiative"[25] jointly issued by the United Nations Environment Program (UNEP), the International Trade Union Confederation (ITUC), the International Organization of Employers (IOE), and the ILO (Stanef-Puică et al., 2022). The initiative mainly aimed to tackle existing shortages in the supply of green jobs, and the first report published by UNEP in 2008 describes green jobs as "those that contribute appreciably to maintaining or restoring environmental quality and avoiding future damage to the Earth's ecosystems' (UNEP et al., 2008: 35). In this regard, it is understood as 'green' those jobs that contribute to the reduction of energy and materials consumption, the promotion of decarbonisation activities, as well as restoring biodiversity or fostering waste management processes. Additionally, the relevance of the initiative consists in having highlighted the need for green jobs to be decent and to be regarded as critical for reducing environmental

[24] The term is used within the context of a bottom-up (occupation-based) approach when defining green jobs, i.e., by analysing jobs based on the skills or tasks required by different occupations and with respect to the extent to which the skills/tasks being considered can be regarded as green.

[25] The Green Jobs Initiative is regarded as the first comprehensive research programme on green jobs (Bohnenberger, 2022a). The main goal was looking for the existence of potential links between greening production processes and fostering decent jobs.

impacts (UNEP et al., 2008). What distinguishes this early definition of green jobs from the others is the prominence given to questions such as safe working conditions and fair wages, as well as social protection and workforce rights.

Currently, the literature on green jobs can be grouped into three main approaches: output, process, and systemic-based approaches.

As sustained by the most common approach in the literature (Janser, 2018), i.e., the output-based approach, jobs can be regarded as green insofar as they deliver goods or services that take into account the welfare of the environment or preserve natural resources (Vona et al., 2015). The majority of existing statistical studies follow the aforementioned definition, specifically through either the identification and measurement of green jobs by considering the production of goods, and services or via grouping these from the sectoral point of view, i.e., the Environmental Goods and Services Sector (EGSS). Eurostat regards the EGSS as including those producers of technologies, goods and services that "measure, control, restore, prevent, treat, minimise, research, and sensitise environmental damages to air, water, and soil as well as problems related to waste, noise, biodiversity and landscapes" and "measure, control, restore, prevent, minimise, research, and sensitise resource depletion" (Eurostat, 2009: 29). This definition mainly focuses on the critical role played by 'cleaner' and 'resource-efficient technologies' (as well as goods and services) in contributing to minimising pollution and natural resource exploitation.

Both UNEP and the ILO provide a definition of 'green-collar' workers based on their respective employment as defined in the EGSS (UNEP et al., 2008). Environmental sector employees are "persons who, during a set reference period, were employed […] in the production of environmental goods and services" (ILO, 2013: 18). Thus, green jobs are classified as jobs that touch upon many sectors (such as construction, manufacturing, installation, agriculture, scientific and technical, as well as service-related occupations) that "[…] contribute substantially to preserving or restoring

environmental quality" (UNEP, 2008: 36). This involves, inter alia, fostering both material and reinstating ecosystems, as well as being well-equipped to face climate change (ILO, 2016).

Nonetheless, this kind of sectoral point of view provided by the output-based approach carries the risk of potentially excluding other definitions of 'green jobs' that can be traced in those sectors not covered by the EGSS definition, such as healthcare, education, and retail (Bohnenberger, 2022b). Furthermore, devoting a great deal of attention only to outcomes provides additional limitations as it ignores whether the process that led to a certain outcome is environmentally friendly or not. For instance, the production of an electric vehicle may involve at the same time technologies with a reduced carbon footprint or, conversely, technological processes with higher waste of resources and energy. To provide viable solutions to this issue, both the US Bureau of Labor Statistics (BLS)[26] and the ILO have taken a process-based approach in their classification.

With regards to the process-based approach, jobs are considered 'green' insofar as the work-related activities concerned eventually define the production processes of the organisation more sustainably from the environmental perspective or exploit fewer resources (BLS, 2013). Therefore, both environmental protection and firms' daily practices are at the core of process-based approaches. This entails the possibility of classifying as 'green jobs' also those activities and traditional economic sectors that may not eventually produce environmental outputs or are usually regarded as high-polluting industries (such as energy-intensive related ones), insofar as they embrace new organisational practices or breakthrough technologies that contribute to maximising energy and resource efficiency gains (ILO, 2013; Janser, 2018). For instance, the definition provided by the ILO identifies employees working in the environmental sector as "workers whose duties involve making their establishment's production

[26] The US Bureau of Labor Statistics (BLS), defines green jobs as "jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources" (namely, output-based dimension) or or as "jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources" (namely, process-based dimension).

processes more environmentally friendly or more efficient in their use of natural resources" (ILO, 2013: 18).

Overall, as affirmed by Urban et al. (2023), the concept of green jobs is multidimensional in nature. Therefore, the above-mentioned approaches need to be well integrated and made more interrelated to each other so that the different facets of green jobs can be effectively measured, and therefore, more effective and tailored skills policies[27] can be better designed eventually. To overcome the overlaps between past taxonomies (such as both the 2013 ILO taxonomy and the 2022 Bohnenberger taxonomy of sustainable employment) that dealt with different dimensions for the measurement of green jobs, the renowned Centre for European Policy Studies (CEPS, 2023) launched at the European level an integrated taxonomy aimed at better identifying which jobs and sectors can be defined as green.

The CEPS (2023) framework is based on four main pillars, each one with different indicators:

I. *Inputs:* sub-dimensions such as Labour (whose indicator for measuring the 'greenness' is the use of green skills), Goods/Capital (indicators on the greenness of capital are still uncertain), and Natural resources (the square kilometres of land used by the production sector concerned are considered a valid indicator) represent the components used within green job processes.
II. *Processes*: tasks (the US Department of Labor's database O*NET is widely used in the literature for measuring the green tasks' share per occupation) and Process impacts (Eurostat[28] provides enough data about the amount of waste generation derived from the production process) constitute the phase where inputs' transformation eventually leads to certain outputs.

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[27] As noted by Jagger, Foxon and Gouldson (2013), the concept of 'skills policy' is mainly based on the key role played by the government in either funding or supporting the provision of training.

[28] See [ENV_WASGEN], available at: https://ec.europa.eu/eurostat/databrowser/view/env_wasgen/default/bar?lang=en

III. *Outputs*: the environmental impact and conservation of resources (whose indicator identified is the previously mentioned EGSS developed by Eurostat in 2009).
IV. *Job quality*: working conditions (Eurofound's industrial relations index of 2018 as a possible indicator) and labor market structure (the Structure of Earnings Survey from Eurostat is a well-suited indicator for measuring possible wage inequalities) are strictly related to questions of 'decent work' (considering dimensions such as the level of wages, health and safety at work, working time flexibility, and others) and social dialogue/industrial relations, as well as the gender pay gap.

1.3 Green skill and labor shortages: main drivers and sectors concerned

So far, our reasoning has revolved around the discussion that delved into the definition of green skills and the characterisation of green jobs. Nonetheless, the present analysis still lacks greater insight toward the possible skills mismatch, and in particular skill shortages, experienced specifically by the green workforce. The shift towards the decarbonisation of the economy inevitably represents a great challenge at the global level, i.e., designing the most effective policies aimed at providing the necessary skills required by both the current and future workforce carrying out those tasks that are mostly needed to achieve by 2050 the main targets for reducing global GHG emissions. Hence, the availability of these skills will be such if the emergence of possible skill shortages linked to the green transition can be effectively stemmed.

Already in 2008, the UNEP posed the issue by affirming that "shortages of skilled labour could put brakes on green expansion […] it is important both to prepare the workforce at large for the skills requirements inherent in green jobs and to ensure that green industries and workplaces do not face a shortage of adequately skilled workers (UNEP, 2008: 16).
As also long ago argued by the Cedefop and the OECD (2014), the wider picture seems to depict a situation where skills bottlenecks (specifically in the form of skill shortages)

constitute a major obstacle for both existing and emerging industries whose actions are directed toward the onerous investment process underway toward a low-carbon economy and climate change mitigation. As a matter of fact, it is expected that the global demand for green skills will exceed the supply of the existing skilled workforce. As recalled in the literature (Dierdorff et al., 2011; Vona et al., 2015), the green transition is tightly linked both to skill and labor shortages in light of the underway technological innovation and regulatory shifts that are progressively reshaping the skill set and the existing tasks carried out by the workforce.

As already discussed at the beginning of the chapter, the OECD (2017) defines skill shortages as a situation in which the existing workers' supply possessing the requested skill set is lower than the demanded workforce with that specific skill set for a given job under the current market conditions (such as wages and working conditions). In this respect, firms all over Europe have already denounced the limited availability of skills as an important factor hampering greater corporate investments (Brunello and Wruuck, 2019). Additionally, companies operating in Europe have declared the emergence of skill shortages for both green and digital skills, according to one of the latest European Investment Bank (EIB, 2023) Report 2022/2023. In the worst-case scenario, skill shortages can negatively influence the decision-making process, eventually leading to the decision of postponing the projected investments, and thus, this might adversely impact a firm's productivity in the long term (Barlett, 2013). According to estimates by the Eurofound (2021), skill mismatches and labor shortages saw an abrupt increase at the EU-wide level between 2013 and 2019, although with differences among member states. This is also what is advocated by a 2018 report issued by the European Economic and Social Committee (EESC, 2018), in which the annual productivity loss linked to skill shortages throughout the European Union was found to stand at 2.14%. Additionally, one of the latest OECD (2023a) publications recognise that there are specific sectors—such as renewable energy and resource efficiency, as well as manufacturing, construction, and environmental services—that are more exposed than others to the risk of the emergence of skill shortages because of the green transition.

Additionally, in 2019, the Eurofound European Company Survey noted that 24 member states had over 20% of firms affirming that more than 60% of their newly hired workforce lacked the specific skills required by their jobs. The analysis showed that construction (one of the most critical sectors for the green transition) was the main sector suffering from skill shortages (39%), followed by manufacturing (28%) and services (22%). Furthermore, the demand for both medium- and high-skilled individuals rapidly increased in these sectors, especially within small and medium enterprises (SMEs), which were also those that suffered the most in finding employees with the demanded skill, as compared to larger companies.

From the local authorities standpoint, both skill and labor shortages seem to hamper the effective implementation of climate change reduction projects, according to 70% of them (EIB, 2023). In this respect, a first brake to the projected investments due to a lack of currently available skills (i.e., environmental planning and engineering) is already taking place. Also, the fact that online job advertisements linked to clean energy deployment across the European Union increased just by 49% in 2022 may be part of the issue (European Commission, 2023a). By 2030, the green transition promises to create up to 30 million new jobs in clean energy sectors, according to the latest estimates diffused by the International European Agency (IEA, 2023).

While the economic theory suggests that in perfectly competitive labor markets shortages would not exist (since both labor demand and supply will eventually reach equilibrium because of the existence of market-clearing mechanisms), Boswell et al. (2004) found at least four relevant factors that usually lead to possible mismatches between the availability of job seekers and unfilled vacancies. They are qualitative/skills mismatch; regional mismatch; preference mismatch; asymmetric information mismatch. Going into details, among the reasons for which vacancies remain unfilled and labor shortages arise it can be mentioned: the existence of either demographic or mobility deficiencies (lack of candidates willing to relocate in different regions); absence of workers possessing the skills and qualifications required by the job vacancy; lack of

information (leading to the mismatch between supply and demand); firms' and workers' behaviour (either in the form of ineffective recruiting practices or poor job candidates' search activity); or the existence of job offers not offering suitable working conditions (such as through poor wage levels) that de facto inhibit the efficient matching between supply and demand. Therefore, it seems evident the fact that, from a policy point of view, there are different paths that can be taken depending on the fundamental cause of the shortage under scrutiny.

In light of climate change mitigation efforts, the efficient matching of the demand for low-carbon skills with the supply of the requested skills needs to be confronted with the existence of specific skills constraints that are peculiar to low-carbon technologies. In this regard, the working paper produced by Jagger, Foxon, and Gouldson (2013) outlines several market and governance failures that are responsible for the insurgence of skill shortages in the context of low-carbon technologies. These are, respectively:

- The role of risk and uncertainty (the potential uncertainty about whether to invest in a specific low-carbon technology is associated with the corresponding uncertainty surrounding the decision to invest in necessary skills to manage that new technology);
- The technological newness related to the deployment of novel skills or a combination of existing ones (in relation to low-carbon technologies, relevant issues about finding suitable trainers for novel skills arise, especially when relying on on-the-job training);
- Lack of small projects, which, in turn, would foster more rapid learning by doing vis-à-vis both skill and labor shortages derived from the quite often promotion of large one-off projects;
- The role played by embeddedness and inertia, specifically in relation to the decision of carrying out potentially risky investments (from the company's point of view) in groundbreaking skillsets of employees rather than seeking the already affirmed skillsets relating to dominant technologies.

Skill shortages have the potential to slow down the low-carbon transition, given the broad range of market and governance constraints previously mentioned (such as the

role of uncertainty, as well as skills novelty associated with the technology and the scale of many investments required).

As argued by Jagger, Foxon and Gouldson (2013), potential negative impacts produced by skill shortages may eventually result in growing financial costs (especially when dealing with patterns of sub-contracting within organisations, meaning that no investments towards additional skill training take place eventually); time delays due to the need to provide to the incumbent workforce the needed on-the-job training; the reduction in competitiveness which in turn may force a nation or a sector to import key-technologies; a decrease in employment — which entail a transition mainly characterised by labor's substitution with capital; increased policy or market uncertainties, which, as a consequence, prevent the additional provision of skills.

Having trained specialists that are able to face the pressing skillset needs to support the shift toward a sustainable economy is of utmost importance. Recent analyses (García Vaquero, Sánchez-Bayón, and Lominchar, 2021; Lobsiger and Rutzer, 2021) have shown that the shortage of the skilled workforce is particularly acute among the group of jobs with high green potential,[29] i.e., for the group of managers and professionals. This is in line with the results that emerged from a study by Vona et al. (2018) on fifteen industrial sectors in fourteen European countries, i.e., the jobs experiencing the fastest growth are biased towards professionals.

Women are still underrepresented in green jobs, since many green employment opportunities demand either technical or managerial skills, and women's contribution in STEM-related jobs is still not widely recognised, especially in terms of equal pay compared to the male counterpart (ILO, 2019; OECD, 2023b). Additionally, about half of the current workforce employed in jobs at risk, i.e., those mainly related to fossil fuel sectors, have the specific skills most demanded in the emerging clean tech sectors (IEA,

[29] The concept of jobs with 'high green potential' draws upon the work conducted by Rutzer et al. (2020). The authors identified the green potential of occupations in the context of the US labor market. The classification system for occupations relied on the Standard Occupational Classification (SOC) and the data used in the research came from the O*NET database, where both skills and tasks for each specific occupation could be detected, as well as the identification of tasks as either green or non-green.

2023). This is why it is of utmost importance to make sure that job transition planning takes into account the critical role played by fostering on-the-job retraining strategies (as one of the possible tools public authorities and firms have to ensure the employability of the workforce) in order to smoothly transition to green jobs, as well as reduce skill shortages. Differentiated policy interventions and forward-looking governance arrangements focused on the specific skills needed to make the low-carbon transition feasible in terms of cost' containment and timeframe are extremely necessary.

The World Economic Forum (WEF, 2025) projected that by 2030 the workforce at the global level will need both upskilling and reskilling as possible active labor market policy tools for mitigating skill shortages and facing the transformative challenge posed by sectors' decarbonisation commitments. As a matter of fact, training constitutes one of the most relevant factors characterising companies' absorptive capacities (Cohen and Levinthal, 1990). This entails that through training, firms can be better equipped to adopt the latest low-carbon technologies and therefore decide to make further investments in green skills. Furthermore, institutional change in terms of fostering a stronger cross-sectoral low-carbon skills agenda has been suggested (Foxon and Gouldson, 2013), especially towards boosting public-private partnerships, which, in turn, may strongly contribute to the diffusion of knowledge and the provision of increased certainty over firms' investment plans.

CHAPTER II

A European policy strategy for green skills promotion

2.1 The European Green Industrial Plan: reforming Vocational Education and Training (VET)

The European Union is one of the leading actors at the global level in the fight against climate change, particularly from a rule-based and governance perspective. It has been since at least November 2018 that the European Commission, through its "A Clean Planet for All," a long-term strategic vision targeting carbon neutrality by 2050, and subsequently in 2019 through the European Green Deal, that this same objective is reaffirmed by Ursula von der Leyen, who made it the focal point for her programmatic term as Commission President. As the most glaring response to the green transition, the European Green Deal (European Commission, 2019) shifted from being a mere political commitment to acquiring the status of a legal obligation according to the European Climate Law. This ambitious plan, the Green Deal, encompasses a wide range of policy measures. These include relevant initiatives, such as the New Circular Economy Action Plan, the Biodiversity Strategy for 2030, and the Zero Pollution Action Plan.

It is also recognised the importance dedicated by the European Green Deal to both skills and training in fostering sustainability and smoothly transitioning to a green economy (European Union, 2022). As a matter of fact, as also argued by Shamzzuzoha et al. (2022), supporting green innovation seems to be fundamental from an economic, environmental, and social perspective. Companies operating in the European Union have to rethink their working practices, as well as recalibrate their investments to make sure that the same concept of environmental sustainability affirmed by the European Commission's 2019 flagship climate Regulation is in line with the services and products delivered.

Today, by ‘green innovation’ we mean those kinds of innovation activities linked to the management of energy conservation and the promotion of energy efficiency, water pollution reduction, as well as devolving massive financial resources towards cutting-edge research and supporting the creation of new green jobs (Lin, Chen, and Huang, 2014; Nielsen, Frøhlich, and Lunkeit, 2023). Furthermore, as part of the European Green Deal, the European Climate Pact, officially launched on 9 December 2020, directly engages European citizens by mobilising individuals to actively contribute to making Europe climate-neutral by 2050. Additionally, EU reports (2022) underline that “the green transformation is a global, cross-sectoral process: it affects all industries, albeit in different ways. Skills play a core role in achieving the green transformation” (SGI Europe, 2023: 4). Having acknowledged the fundamental role played by green skills in delivering sustainability, the pact has, as one of its core pillars, the development of both the previously discussed technical and transversal skills required by the transformation of sectors and occupations for the green transition.

In the previous chapter, we discussed at length the current global issue (OECD, 2023), particularly concerning the European Union, posed by the shortage of relevant skills required to achieve the agreed targets throughout the Bloc.[30] Since the European Green Deal alone was not enough in balancing the projected EU’s climate goals with the need to safeguard industrial competitiveness and supply chain resilience, the Green Deal Industrial Plan for the net-zero age[31] was launched in February 2023 as an initiative designed to help the industrial sector in reaping the benefits of the green transition by placing emphasis on four key priority areas: the simplification of the regulatory environment, access to financing, open trade to streamline the clean transition, and green skills development and training. This comprehensive framework also relates to the urgency of tackling labor shortages within the sectors most affected by the green

[30] Apart from the agreed long-term objective of climate neutrality by 2050, another intermediate step consisting of achieving a 55% reduction in greenhouse gas emissions by 2030 (as compared to 1990 levels) is envisaged.

[31] European Commission (2023b), A green deal industrial plan or the net-zero age, COM(2023) 62 final, Brussels. See at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0062

transition. In this regard, the Plan identifies at least three critical sectors for the green transition, i.e., construction, energy, and waste management, which all rely on the supply of intermediate-skill jobs (Cedefop, 2023). Additionally, the Industrial Plan provides for deploying €806.9 billion through the Next Generation EU, which is the leading recovery instrument issued at the Union level in response to the health crisis posed by Covid-19 in 2020, thus representing relevant financial aid for the green transition. Such a financial instrument also lends itself to advancing the twin transition, especially by developing further training and skills actions in order to boost the supply of skilled workforce. Related to this, there exist action plans developed in each Member State (closely linked to the Recovery and Resilience Facility), along with the European Commission's country-specific recommendations on whether upskilling and reskilling initiatives are needed. Besides this, the main regulatory proposal supporting the plan is the Net-Zero Industry Act (whose main points will be discussed later), which, apart from streamlining regulations pertaining to the manufacturing of vital green technologies, also delivers the possibility for upskilling and reskilling of the workforce thanks to the setting up of skills partnerships and 'net-zero academies.'

According to the ILO (2019) data, although on one side 78 million jobs have the potential to be created along the way towards the transition to a circular economy, on the other side 71 million jobs could be lost at the global level if skills development and further training do not receive due attention, especially by policymakers. Additionally, whether achieving environmental and energy sustainability and the circular economy will eventually be realised, about 2% of the workforce globally will be affected (*ibidem*), thus calling for either the upgrading of skills or training of new ones through vocational education and training to safeguard jobs. Only through forward-looking policies and massive investments in reskilling and lifelong learning could this trend be reversed, even resulting in a net growth of 18 million jobs in the energy sector alone (Nielsen, Frøhlich, and Lunkeit, 2023). What is needed is a holistic and comprehensive strategy for imbuing sustainability and circular economy thinking into the fabric of Vocational Education and Training (VET) systems currently in place at the European

level. On one hand, as recognised by the first principle of the European Pillar of Social Rights, “everyone has the right to quality and inclusive education, training, and lifelong learning in order to maintain and acquire skills that enable them to participate fully in society and manage successful transitions in the labor market” (Employment, Social Affairs, and Inclusion, 2023). On the other hand, the fourth principle is about active support to employment by emphasising the right of everyone to continued education and training, as well as continuous support to improve their employment prospects (*ibidem*). It is undoubtable that, as the stance of Europe towards fighting climate change will become ever more relevant from now on, the role of VET, skills policies, and employment are also in need of being rethought to accomplish the goals set out throughout the Bloc.

To start with, while on one side green jobs are likely to involve higher cognitive skills, still, on the other side there remains the workforce employed in the declining sectors of the economy (such as coal mining) or those occupations whose skills are currently undergoing a process of obsolescence that are in great need of retraining their skills so as to meet the skill needs required by the green transition. In the second place, a substantial number of young individuals and adults need further training experiences in order for the ever-growing demand for green jobs to be eventually adequately matched. It is the same European Union in its ‘European Skills Agenda for sustainable competitiveness, social fairness, and resilience (2020) that underlines the growing necessity to equip young professionals and adults with the skills, knowledge, and adequate competences to empower them to make a just transition to the twin transition (green and digital) amidst turbulent periods from a demographic and an economic point of view. Therefore, this framework for skills policy cooperation at the EU level aims to foster both the upskilling and reskilling of Europe’s workforce, in line with the labor market’s needs. The initiative is part of the EU’s European Year of Skills 2023/2024, whose primary goal is supporting firms, particularly Small and Medium enterprises (SMEs), to tackle skill shortages.

Thirdly, the workforce less affected by changing skill needs will also have to enhance its current skill set. Last but not least, as underlined by Cedefop (2021), emerging professions linked to the development of green industries greatly necessitate further innovation in the provision of green skills. As reminded by the EU's former Commissioner for Jobs and Social Rights, Nicolas Schmit, "the skilling of our workforce is one of the core responses to tackle economic recovery and can prepare for the greening and digital transition" (European Commission, 2020). Forecasts in Europe suggest that if the 'greening of VET,' i.e., the process of aligning and incorporating training experiences and institutional practices of VET operators with the notion of sustainability (Nielsen, Frøhlich, and Lunkeit, 2023) fully realises, from 2020 to 2030, employment opportunities in the EU-27 have the potential to increase by 3.7% and GDP by around 1.7% in 2030, as compared to the baseline. In the overall forecast period, it is estimated that the growth of employment with the European Green Deal in place is higher than without it, eventually (Cedefop, 2021).

According to the recent literature (Bachmann et al., 2024), one of the options to reduce skills shortages in the long term is the contribution made by possible adjustments in educational choices, particularly at both the secondary and post-secondary levels. It is well acknowledged that educational choices related both to the level of education and preferred academic fields differ greatly over time and space (UNESCO, 2024). It is also recognised that the expected (economic) earnings related to different professional careers are significant factors influencing the choice of the field of study. Nevertheless, personal preferences still play a significant role for an individual to choose one field of study over another (Wiswall and Zafar, 2015). Alexeev et al. (2024) have also highlighted that field of study selection is also influenced by the quality of educational institutions. Another factor driving educational choices is changes in the labor market demand (Bourassa-Viau et al., 2022). As a matter of fact, at least 3 years after the outbreak of negative trade shocks, education enrolments show an increase (*ibidem*). However, the literature regarding the effects of technological advancement on educational choices is still in its infancy.

Moving on with the analysis, a key element contributing to the process of developing skills that are fit for a greener economy is the role played by VET as the closest sector of education and training to the labor market. It was 2020 when the EU member states collectively signed the Osnabrück Declaration on vocational education and training[32] as the main driver for economic recovery and just transition to both digital and green economies. Stemming from the Declaration, there is a commitment to deliver tangible actions to better develop VET in Europe by 2025. In this sense, a greater focus that needs to be posed in the coming decades by VET institutions is the promotion of partnerships among the affected stakeholders in the labor market, as well as investing in the provision of transferable skills, since the green transformation is going to affect all sectors and occupations, although to varying degrees.

Along with the 2020 Council Recommendation on VET for sustainable competitiveness, social fairness and resilience, and the European Skills Agenda, these initiatives constitute the current EU VET policy framework and recognise the centrality attained by vocational training for the green transition. As defined by the Council Recommendation (2020), 'vocational education and training' is to be understood as "the education and training that aims to equip young people and adults with knowledge, skills, and competences required in particular occupations or more broadly on the labor market" (Council, 2020: 4). This kind of training may be delivered through either formal[33] or non-formal settings and at all levels of the European Qualification Framework (EQF). The centrality and effectiveness of VET stem from its ability to provide targeted skills that equip the workforce for specific occupations and careers while also providing practical support to companies' daily activities. The Recommendation, among other things, places a strong emphasis on the need to give

[32] Osnabrück Declaration of 30 November 2020

[33] The distinction between 'formal training experiences' and 'informal' ones is the following: in the former case, we are dealing with experiences that involve already foreseen learning objectives and specific activities in terms of content and time devoted (Tannenbaum & Wolfson, 2022). Conversely, by 'informal training' it is described less structured learning experiences that can be either mandated by the organisation itself (such as job shadowing, i.e., a type of on-the-job training) or self-directed, i.e., when the learner plans itself its own learning journey in order to achieve a specific goal and gain skills (Beier et al., 2025).

greater flexibility to VET, as well as reinforcing the provision of work-based learning (covering in particular apprenticeship schemes) and enhanced quality assurance (specifically through the establishment of a European Quality Assurance Reference Framework for Vocational Education and Training as a tool supporting Member States in the refinement of their VET systems).

As the EU constantly faces mounting challenges linked to the mismatch between the supply and the demand of green skills, one major response given at the EU level, specifically in the governance of the greening of VET, is the proposed reform related to the work-based education system. As a matter of fact, work-based learning can represent a viable option for advancing the green transition in VET outcomes, in view of its capability to actively involve all the relevant stakeholders (such as learners, employers, and social partners) in the process of innovation and green skills development through VET. As a matter of fact, researchers at the international level (Tran, 2021; Nikolaos Nikoloudakis and Rangoussi, 2024) have recognised the current discrepancy between the results brought by VET and what the job market actually requires from the workforce in terms of the expected skills and competences (Roll & Ifenthaler, 2021).

As a matter of fact, EU reports (European Commission, 2024a) have recently recognised that greening has the potential to foster social partners' engagement in the overall process of VET. Already in its 2023 Communication on *Strengthening social dialogue in the European Union: harnessing its full potential for managing fair transitions,* the Commission highlights the needed collaboration between the Commission and the social partners in relation to key matters, as in the case of labor shortages, by emphasising the fundamental role played by social partners in tackling such issues (European Commission, 2023c). In this regard, the concept of 'Centres of Vocational Excellence' (CoVEs) represents a relevant feature in the greening of the VET landscape. CoVEs are becoming important venues for local and regional stakeholders (including VET institutions, learners, businesses, and social partners), which are all gathered within the so-called 'skills ecosystems' for innovation, regional development,

and social inclusion. The bottom-up approach inherent in the CoVEs makes them a viable option to enable VET institutions to flexibly provide the needed skill sets required by different economic and social contexts. On one hand, CoVEs are opportunities for young people to freshly start the needed initial training, while on the other hand, these centres represent the ideal venue for adults who quite often need upskilling and reskilling in order to timely adjust their competences vis-à-vis a dynamic labor market, especially in the changing context of both the green and digital transition. All in all, the major goal for the setting up of CoVEs is the establishment of new areas spurring collaboration between researchers and related stakeholders in VET and businesses. Therefore, this entails a changing mission for VET, i.e., embracing a new perspective of networking among the actors involved in the process of skills supply, as well as upskilling and reskilling needs. In the period 2021-2027, funds devoted to CoVEs are delivered by the Erasmus+ programme, which allocates around €400 million to finance the project.

Especially following the outbreak of Covid-19, the need to pursue major reforms in VET curricula, as well as supporting the development of apprenticeships throughout the EU, has been voiced by Baumann and Vossiek (2022). In the latter case, from the perspective of work-based learning, Cedefop (2022b) recognises the vital role played by apprenticeships in tackling horizontal skill mismatches, such as skill shortages, as well as ensuring long-term workers' employability. It was March 2021 when, during a high-level conference on apprenticeships, co-organised by the European Alliance for Apprenticeships (EAfA) and the ILO, Nicolas Schmit again emphasised the growing need to invest in apprenticeships, as well as in the retraining of skills to accomplish the challenges posed by the twin transition within the labor market. The Director of the European Training Foundation, Cesare Onestini, also remarked that "apprenticeships need to evolve with changing skills, and this includes adapting for digitalisation and greening across all sectors" (ETF, 2021).

Thanks also to the effort put forth by EU-related agencies, structural reforms and the term ‘greening apprenticeship’ came to be ever more acknowledged, i.e., the ability of apprenticeship programmes to adapt to green jobs’ training requirements. As a matter of fact, several initiatives across sectors and occupations are currently taking place in a variety of Member States, such as Belgium,[34] Germany, and Greece. Because of its close ties to the labor market and its in-company training element (*ibidem*), apprenticeships are ideal both for young people (at the outset of their education) and adults (through reskilling or upskilling paths). In the latter case, apprenticeships have the potential to support the workforce currently employed in declining sectors of the economy (the so-called ‘brown’ workers) and help them smoothly shift to the growing sectors or occupations most in demand by the transition to a decarbonised economy. Particularly in view of their work-based learning arrangement, apprenticeships seem to accommodate the needs of the adult workforce. Additionally, apprenticeships provide both a contract and a remuneration, thus being a more attractive choice for those who need to also gain a green qualification (Cedefop, 2019). Apprenticeships are just one possible type of work-based learning conveyed through either initial or continuing VET, which eventually has the potential to represent for both learners and employers an effective means for delivering skills having economic value. A study by Cedefop (2022c) particularly showed the potential of workplace learning in encouraging young people to pursue their future careers in apparently unattractive sectors, such as waste management, which are crucial for the green transition.

Overall, based on the different skill needs within a sector or occupation, higher levels of VET should be made available in order to further circularity practices throughout the economic activities. Particularly when it comes to transitioning those declining occupations linked to fossil fuel-based sectors, VET is better equipped to provide the workforce with the specific, although highly transferable, skills required in the developing green occupations. As Cedefop underlined (2023), the relevance of VET not

[34] In Flanders, a one-year training eventually lead to acquiring the qualification of chemical process operator, which also involves an apprenticeship hosted by a chemical company.

only consists in supplying the skill set to process and implement technologies, but it is also a matter of cultivating 'green minds' if we want to innovate and carry through the green transition.

2.2 The EU Net Zero Industry Act: a network approach for a green skilled workforce

In the overarching policy framework of the European Green Deal Industrial Plan launched by the European Commission in February 2023 in order to address the economic side of the net-zero targets, one novel legislative act was aimed at supporting the European clean tech sector, that is, the Net-Zero Industry Act (NZIA) (Regulation (EU) 2024/1735).[35] As a result, the Act finally introduces a new governance architecture in order to support and further advance the EU's clean tech sector. As a matter of fact, this legislative act seeks to develop a comprehensive framework of detailed measures for reinvigorating Europe's ecosystem when it comes to scaling up the manufacturing of clean technologies (such as wind, batteries, heat pumps, solar, etc.).[36] The NZIA provides that, by 2030, at least 40% of the EU's annual deployment needs for the manufacturing of all net-zero technologies occur domestically.[37] It is possible to argue that the NZIA represents a real industrial policy for decarbonisation, especially from the perspective of strengthening the transition of existing industries and the creation of new ones. The initiative also intervenes on the simplification of the administrative framework and other key elements, such as the specialisation of the workforce.

There is currently a shortage of skilled workers in strategic value chain segments featuring net-zero technologies, which eventually threatens the EU's competitiveness in the medium and long term (European Commission, 2023e). As a matter of fact, approximately 800,000 workers will be in high demand so as to meet the EU's goals in

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[35] The NZIA entered into force on 29 June 2024 eventually.

[36] Overall, the NZIA addresses a subset of nineteen net-zero technologies.

[37] However, the 40% target is just a 'benchmark,' i.e., it is non-binding according to the legislation.

the battery industry by the end of 2025 (European Commission, 2023f). Concerning the solar photovoltaic (PV) manufacturing sector, approximately 66,000 skilled workers will be required by 2030 (European Commission, 2024). This adds up to the increasing demand for specialised workers in both deployment and installation activities. As highlighted by the Mario Draghi (2024) report on the future of European competitiveness, when it comes to speeding up industrial innovation and deployment, municipalities frequently lack the needed expertise concerning both climate and environmental evaluations in permitting procedures. If the third quarter of 2023 is taken into account, labor shortages have been reported by a fourth of European businesses operating in the clean-tech manufacturing sectors (*ibidem*). In a scenario where 100% of demand is satisfied by the EU's manufacturing alone, there are an estimated 198,000 to 468,000 new job opportunities in net-zero technologies. Nonetheless, these technologies will not only likely have to confront each other for the attraction of those workers having the specific skills for their deployment but also with the overall job market demand deriving from the green transition.

A key ingredient for the supply of a skilled workforce is formal education. As suggested by the latest Eurostat data (2024), for every 10,000 individuals in at least two European Member States, as in the case of Luxembourg and France, there are 56 tertiary education graduates in salient educational fields (such as mathematics, science, manufacturing, construction, and engineering) in Luxembourg and over 400 graduates in France. Additionally, if we take into account the EU-27, other interesting data from Eurostat reveal that each year there are around 350,000 students who graduate in engineering and roughly 45,000 tertiary graduates in manufacturing. These results are complemented with those related to students who graduate from either secondary or post-secondary education in both engineering and manufacturing every year, who are around half a million individuals (*ibidem*). These projections thus demonstrate the necessity of further efforts for both reskilling and upskilling the workforce in light of the previously discussed increased demand for skilled workers.

Having acknowledged the fact that formal education is and will continue to be a crucial element in tackling skill shortages, lifelong learning and retraining programs will still be key assets for the achievement of the EU's decarbonisation aspirations (Asikainen et al., 2021). Especially in the energy sector, manual workers and technicians are and will be increasingly in demand (*ibidem*). Therefore, it is vital for Member States to guarantee access to proper training aimed at furthering the net-zero technologies manufacturing sector. To possibly help fill these shortages, various EU programmes and funds are currently available, such as the Erasmus+, European Social Fund+ (ESF+), and the Just Transition Fund, although more targeted measures may still be required. With regard to funding opportunities provided by the ESF+, there are currently more than €99 billion allocated for 2021-2027 to be invested in people. Furthermore, the Recovery and Resilience Facility (RRF) consisted of €723.8 billion divided into grants and loans devoted to Member States to alleviate both the economic and social shocks that resulted from the outbreak of the Covid-19 pandemic. The main purpose of this relevant disbursement provided by the RRF was to further advance Member States' reforms (labeled as 'milestones') and investments (the so-called 'targets') also in the area of skills and jobs.

Additionally, the role of industries is crucial since they should massively invest in their education and skills program if they want to develop and subsequently withhold talent effectively. They should also be prepared to align and update the skill set to the evolving needs and technological advancements so as to prevent the emergence of skills mismatch phenomena. Accordingly, the NZIA may thus represent a window of opportunity for upskilling and reskilling the workforce, particularly through the setting up of 'renewable skills partnerships' and 'net-zero academies,' the latter aimed at developing 'training and education on how to produce low-carbon technologies and to enhance the skills of the existing workforce in member states' (European Commission, 2023d). The benefits brought up by these academies will be better appreciated if these are eventually developed in those sectors where the phenomenon of skill shortages is most pronounced and can be better anticipated. It is essential that these academies

integrate within any existing training and skill programs already in the Member States, especially through both the coordination and the implementation of cross-sectoral training activities targeted to the specific needs of net-zero technologies. Furthermore, the Act aims at easing the portability of qualifications in regulated professions.[38] It is the same European Commission that is in charge of supporting the establishment of European net-zero industry academies in order to further the supply of those skills for adequately managing the deployment of clean technologies throughout the bloc.

To tackle the current labor and skill shortages in the solar PV industry, the European Commission launched the first Net-Zero Academy in June 2024, which is the European Solar Academy, whose main goal is to train 100,000 workers in the EU solar PV value chain alone over the next three years (European Commission, 2024). Additionally, a Hydrogen Academy[39] that was originally set up in January 2024 was declared to be converted into a Net-Zero Academy by the same European Commission in June too.[40] Nonetheless, the first example of a net-zero industry academy, i.e., the European Battery Alliance Academy, was already launched in 2017 by the European Commission itself. Ever since, the Alliance has worked in partnership with the InnoEnergy Skills Institute (launched in 2022) in order to provide specialised and immediately expendable training courses through networks of local training providers across Member States. The establishment of networks made up of local partners throughout Member States, i.e., VET institutions, firms, universities, and other education and training suppliers, is, in fact, one of the main peculiarities concerning the deployment of the envisaged Net-Zero Academies at the European level. It is possible to argue that this in turn may contribute to creating venues for collaboration and sharing of best practices to further advance the deployment of similar initiatives in countries having a low-skilled workforce.

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[38] Chapter V of the NZIA.

[39] Additional information is available at: https://hyacademy.eu/

[40] See at: Repowering the EU with Hydrogen Valleys: Commission presents progress towards a European hydrogen economy

One additional factor that should be considered is ensuring that eventually firms effectively harness in their working practices the Net Zero Academies and their related training programs. As underlined in Mario Draghi's report, the designation of Strategic Projects and Net-Zero Acceleration Valleys by Member States should primarily encourage project promoters to contribute to the success of Academies. Fostering the concept of public-private partnerships in this specific context should mean enhancing the emergence of prolific collaborations among key players, namely academia and industry in order to promote lifelong learning and on-the-job training initiatives. A possible measure to think about is dedicated curricula and learning programs deployed by academia, which are aligned to the needs of Net-Zero industrial sectors. A noteworthy example in this direction is represented by the French Battery training School (École de la Batterie).[41] The academy has been launched in 2021 and is dedicated to developing future occupations (such as specialised engineers) in the battery sector, as recalled by the name, as well as tackling the phenomenon of skill shortages in that specific value chain. As a result, a collaboration between the European Institute of Innovation and Technology (EIT InnoEnergy) and the French government seeks to provide reskilling and upskilling programmes to 150,000 people within the French battery storage industry by 2025.[42] A network of 16 local training organisations comprising educational institutions and professionals currently working in the battery sector has been developed to effectively attract more and more students. In this sense, the question of the green transition is therefore closely linked to that of skills, i.e., there will be an increasing need to closely work with universities to provide courses helping in dealing with green technologies. As emphasised by Ilias Livanos, an expert at the Cedefop, skills development is a matter of shared responsibility; thus, firms must collaborate with educational institutions to adequately train Europe's workforce in view of future challenges. The strengthening of public-private partnerships should also seek to foster Net-Zero Academies' rapid implementation (Draghi, 2024).

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[41] See more at: https://ecoledelabatterie.fr/

[42] https://www.smart-energy.com/industry-sectors/storage/new-french-academy-to-address-skills-gap-in-eu-battery-industry/

Another key element is avoiding that workers' existing skill sets fail to be adequately reused when necessary. In this regard, an insightful suggestion (European Commission, 2025) goes in the direction of harnessing the Just Transition Fund as a way to further advance retraining opportunities for the workforce currently employed in coal regions and carbon-intensive industries into net-zero industries. Thus, there is the need to ensure a fairer reallocation of jobs across the EU, and specifically in those regions currently facing either the decline or the restructuring of industries, such as those belonging to the automotive sector or carbon-intensive industries (Strategic perspectives, 2024). Through this perspective, it is possible both to maintain relevant know-how and further strengthen competitiveness.

Lastly, further advancing the introduction of a 'skills passport' as a tool to smoothly compare different professions' skill levels on a transnational scale is crucial. Already in Draghi's report, the concept of mutually recognising skills across the EU has been affirmed to be one of the priorities to effectively address the skills gap. Similarly to this proposal, the role of passports would be that of strengthening professional mobility by documenting and validating skills across borders. Through the record and the transferability of skills, this passport should help integrate skilled workers into the Net-Zero industrial landscape. It will thus serve as a support for people, educational institutions, and businesses in order to better identify both training and hiring needs according to the previously identified skill shortages. Overall, greater harmonisation is needed, especially in relation to certification schemes for a number of professions, such as technicians or logistics professionals, which hampers labor mobility eventually.

2.3 European Commission's action plan on skill shortages: the need for targeted investments

On 20 March 2024, the European Commission released a 'Communication for an Action Plan on Labour and Skills Shortages in the EU,' which is aimed at tackling the

persisting labour and skills shortages, which "are a serious bottleneck for the EU's sustainable and inclusive growth, competitiveness, green and digital transitions" (European Commission, 2024b: 23). Some of the solutions proposed by the plan take into account the current context of fast technological transformation that demands a workforce with up-to-date skills in fields like data analysis, Artificial Intelligence (AI), and advanced manufacturing technology. Furthermore, skills shortages are progressively becoming structural in some regions due to phenomena such as demographic aging and shrinking working-age populations. Such a plan, the drafting of which was also possible thanks to the cooperation of social partners, represents a cornerstone outcome of the 2023 European Year of Skills.[43] Additionally, publication of the plan follows the Val Duchesse Social Partners Summit of 31 January 2024 and is the main outcome of the joint statement signed by the European Commission, the social partners, and the Belgian Presidency of the Council of the EU. The final Declaration of the Val Duchesse Summit affirmed the urgent need to step up cooperation on the root causes of labor and skills shortages among different actors, i.e., the EU institutions, Member States, and key social partners, focusing on skill strategies development in the long run. Following that, the Employment, Social Policy, Health, and Consumer Affairs (EPSCO) Council gathered the employment and social affairs ministers in July 2024 to debate on labor and skills shortages as part of a broader policy discussion closely linked to the European Semester.

Considering the role of the green transition in driving demand for new skills, the Action Plan on tackling labor and skills shortages aims at ensuring sustainable employment opportunities for all, enhanced resilience, and competitiveness through five key pillars (or priority areas):

1. Increasing labor market participation of current underrepresented people
2. Supporting the development of skills through training and education

[43] The key objective of the European Year of Skills was to address the critical issue represented by skills gaps and shortages, in particular by providing training to people in digital and green technology skills, as well as promoting lifelong learning across the EU.

3. Promoting fairer working conditions in specific sectors and/or occupations
4. Further advancing intra-EU mobility of both workers and learners
5. Attracting skilled foreign talents beyond EU's borders

As for the first priority, i.e., increasing labour market participation of current underrepresented people, particular attention is directed towards those population groups that are still underrepresented in the workforce, notably women, older workers, low-skilled workers (that is, those possessing secondary or lower education attainment), young people, persons with disabilities, and migrants. The activation of underrepresented groups represents a key objective to be achieved as soon as possible, especially in view of the main EU's target of reaching by 2030 at least 78% of employment pertaining to the working-age population. Reforms related to active labor market policies, tax reforms, or reforms of pension systems have been suggested as possible ways of contributing to improving activity rates in the identified groups. Active labor market policies constitute a critical element of Member States' RRF plans, as well as of the ESF+ programs. As reported by the Commission's Action Plan, almost all Member States should seek to support faster inclusion of young people into the labor market as a key objective for the implementation of the 'reinforced Youth Guarantee,' which is an EU-wide commitment to provide all young people under the age of 30 with receive fair employment, apprenticeship, and traineeship opportunities.

With respect to the second priority area of the plan, that is, supporting the development of skills by means of training and education, the Commission highlights the results stemming from a Eurofound European Company Survey of 2019, where it is reported that various companies across the EU (particularly SMEs) reveal that around 60% of their recently hired employees do not possess the required skills for the job posted. In this sense, continuing education and training, as part of lifelong learning, seem vital to tackling new task needs powered by the green transition. Hence, Member States have pledged to pursue initiatives that seek to achieve the main target promoted by the

European Pillar of Social Rights Action Plan[44] about adult learning, that is, having at least 60% of all individuals take part in training opportunities every year by 2030. A major feature of the envisaged EU initiatives aimed at addressing skills shortages is the necessity to adopt a sectoral approach for their implementation. This can be viewed through both the launch of the European Skills Agenda[45] and its 12 strategic actions to push forward the digital and green transitions, especially by means of upskilling and reskilling promotion, and the Pact for Skills, whose main objective is upskilling at least 10 million individuals through the setting up of 20 sectoral partnerships. Special reference is made to the previously discussed EU Skills Academies, such as the European Battery Alliance Academy, whose financing from the ESF+ has already resulted in at least 50,000 workers having received training. Additionally, the Commission urgently calls to step up the so-called 'skills intelligence' and forecasting activity as a way to effectively tackle sectoral skill challenges, as well as better highlighting skill needs when it comes to both gathering data on labor and skills shortages, as well as designing the related policies eventually. There is also the need to greatly boost apprenticeships or analogous vocational training actions, particularly in countries where they are not yet a reality, as in the case of Bulgaria, the Czech Republic, Lithuania, Malta, Slovenia, and Slovakia. Additionally, further advancing quality apprenticeships in line with the "Council Recommendation on a European Framework for Quality and Effective Apprenticeships" is needed. There also seems to be the need to harmonise the recognition of skills and certifications not only within the EU but also for third-country qualifications, possibly. The latter would be in line with the Commission Recommendation of 15 November 2023 on the recognition of qualifications of third-country nationals, whose main objective is incentivising Member States to further recognise skills and qualifications achieved outside the EU as a way to counter EU shortages and ensure better job matching by attracting additional talent beyond the EU's borders. With regard to financing and Member States' investments, the Commission

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[44] European Commission Communication. (2021). The European Pillar of Social Rights Action Plan.

[45] European Commission Communication. (2020). European Skills Agenda for sustainable competitiveness, social fairness and resilience.

underlines the great support provided by the EU budget to address labor and skills shortages. In particular, around € 65 billion are provided under the ESF+ to foster VET, lifelong learning, and apprenticeships, as well as support careers in transition. Conversely, the funds provided under the RRF framework bolster the reforms and investments carried out in each Member State with regard to skills and education broadly speaking (such as by further advancing initiatives linked to skills intelligence or recognition of qualifications).

Moving on the discussion to the third pillar, i.e., promoting fairer working conditions in specific sectors and/or occupations, the Commission details a number of factors that would help reduce labor shortages (whose presence is prevalent in those occupations requiring manual skills and/or lower educational attainments), i.e., minimum wages,[46] health and safety at work, ensuring continuous training opportunities, the provision of social protection and work-life balance arrangements (entailing the right to disconnect), as well as the promotion of flexible working schemes. There is also the recognition of the fact that labor shortages are not evenly distributed; hence, there is great variation according to the sector or location concerned. In this regard, as highlighted by Eurofound research (2021), over 40% of occupations linked to domestic and home care services, i.e., cleaners and carers, declare high levels of job strain. This is also true for construction workers and drivers, with more than 30% of them reporting poor health and safety conditions. Particularly for the transport sector, there is currently a lack of drivers because of a mixture of long working hours and insufficient occupational and safety standards conditions (European Commission, 2023g). Among the measures suggested, there is the role played by both collective bargaining and social dialogue as key means of helping promote fairer working conditions.

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[46] In October 2022, the Directive (EU) 2022/2041 on adequate minimum wages was adopted. The main objective of Directive 2022/2041 is that of guiding Member States towards all the necessary measures for the establishment of an efficient minimum wage labor mechanism across the EU (Juhrs Flaire, 2023).

With regard to the fourth priority area, that is, further advancing intra-EU mobility of both workers and learners, the Commission acknowledges that, although by 2023 there were 11 million mobile workers across the EU, the degree of intra-EU mobility is still too low to effectively tackle labor shortages, at least in the short term. According to a Eurofound research report (2024), countries such as Romania (27%), Poland (12%), and Italy (10%) constitute the main countries of origin, whereas Germany (31%), Spain (12%), and Italy (10%) represent the major destination countries. Usually, the typical 'skill profile' of EU movers is characterised by a higher education level than that of nationals. Additionally, EU movers are likely to be more overqualified for low-skilled occupations than nationals (*ibidem*). This is in part due to ongoing struggles with the recognition of qualifications achieved outside the EU borders, as well as other kinds of integration barriers such as race or ethnicity (Eurofound, 2020). Additionally, further challenges in relation to recruitment, particularly on the side of SMEs, arise when the company concerned is not eventually able to hire employees from third countries because of the complexity characterising the administrative practices to get work permits for the workforce. The European Labour Authority (ELA) publishes yearly a report on shortage and surplus occupations in order to contribute to mapping cross-border (and intra-EU) mobility as a way to facilitate the signalling of existing shortages in one country and consequently tackle them through the identification of surpluses in another. Additionally, it has been since 2021 that the ELA managed the activities related to the European Employment Services (EURES) network in order to support job-matching across borders (European Commission, 2024b). In view of the persistent phenomenon of labor shortages across the EU, there are currently many employers' organisations loudly calling for less tight provisions on third-country migrants' access to the EU labor market. A recent survey conducted by Business Europe (2023) revealed that roughly 60% of employers would be favourable in welcoming the still untapped potential of third-country migrants as a means to tackle organisational shortages.

Coming to the last pillar, i.e., attracting skilled foreign talents beyond the EU's borders, the action plan rightly recognises the positive contribution that controlled mobility from

third countries plays in tackling labor and skills shortages. Nonetheless, the plan also comes to the acknowledgment of the ongoing European underperformance when it comes to judging the degree of attractiveness of the continent as a destination for global talent. A major proposal for a Regulation issued by the European Commission, which is also part of a wider package of measures to tackle shortages, is the establishment of an EU Talent Pool,[47] which, in the idea of the EU legislator, would make it easier to employ job candidates coming from third countries. Further actions, such as spurring the recognition of skills as well as validating third-country qualifications, may also greatly contribute to successfully recruiting jobseekers from third countries.

Linked to the five key pillars, the European Commission in the plan pledges to also pursue the following long-term initiatives to effectively sustain the significant jobs growth stemming from the green transition:

- financing projects in order to successfully achieve zero long-term unemployment and on upskilling youngsters currently not in employment, education, or training (NEETs);
- further investing in and co-financing more Centres of Vocational Excellence-related projects, with a target of at least 100 projects by 2027;
- further advancing new sectoral and regional skills partnerships according to the Pact for Skills;[48]
- boosting, as previously mentioned, the role played by skills intelligence, that is, mapping both ongoing and future skill needs

Additionally, social partners as well are invited by the Commission itself to pursue a series of initiatives:

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[47] Proposal for a Regulation of the European Parliament and of the Council establishing an EU Talent Pool (COM/2023/716).

[48] One of the main objectives established under the Pact for Skills (action launched by the European Commission on 10 November 2020) is fostering the establishment of networks of partners (specifically 20 sectoral skills partnerships) that commit to jointly collaborate on improving either the existing skills (upskilling) or training in new skills (reskilling).

- advancing collective bargaining as a means to address poor working conditions, especially in those sectors most suffering from insufficient working conditions, i.e., construction, agriculture, transport, and education;
- supporting the activation of underrepresented groups while seeking to promote additional employment opportunities for older workers
- exploiting the potentialities possessed by social dialogue towards the promotion of both upskilling and reskilling initiatives to adequately address shortages;
- Contributing to updating VET curricula, as well as supporting advanced apprenticeship schemes, would go in the direction of the previously discussed 'greening' of VET and that of apprenticeships, that is, introducing new educational programmes due to the green transition (Cedefop, 2024b) as well as aligning the existing programmes to sustainability practices.

Overall, among the advantages provided by the Commission action plan on labour and skills shortages, there is the reinforced role given to social partners (such as employer and trade unions organisations), that is, that of cooperating in conjunction with the EU institutions and Member States in order to effectively implement the measures foreseen by the plan, as well as fostering a more coordinated approach across EU policies. Conversely, the possible drawback that can be mentioned with respect to the action plan is the lack of commitment to new, more far-reaching legislation. Additionally, the plan also seems to be heavily counting on the support provided by the social partners, thus not providing for greater initiatives on the part of the European institutions toward the promotion of jobs and skills for the green transition.

2.4 Strengthening 'skills intelligence' in European policymaking to identify green skill shortages

As we previously discussed, the growing acceleration of the green transition spurs the demand for highly specialised skills, especially in sectors such as renewable energy. If

we take into account the already mentioned Draghi report (2024), there are various policy proposals within it aimed at filling existing skill shortages. Particularly, digital skills, green skills, and specialist skills, as well as transversal and managerial skills, are the ones most highlighted, which, according to Draghi's analysis, are also those that ought to be reinforced in order for Europe's economy to be competitive in the long run.

The complexity and urgency characterising the transition towards a decarbonised economy necessitate an innovative approach to green policies applied to the area of skills. According to the OECD (2023a), information and evidence on the kind of skills needed to support the green transition are still in their infancy. In addition, there is also recognition that few green policies currently address skills. This might be due in part to the complexity behind many governance structures related to skills policies applied to the green transition. As a matter of fact, most countries share responsibility for these kinds of policies across different ministries, public bodies, and several stakeholders conducting their activities in the field, which eventually necessitates a high level of coordination (*ibidem*). If we want to design and then deliver policies to reduce skill mismatch and shortages, as well as inform on the current and future skill needs required by the labor market (demand) and the availability of skills (supply), a number of 'skills intelligence' tools help develop future policy directions from reliable pieces of information. We recall the definition of 'skills intelligence' provided by Cedefop, which was the first agency in Europe to have coined the term long before skills recently entered the agenda of several policy debates: "Skills intelligence […] is the outcome of an expert-driven process of identifying, analysing, synthesising and presenting quantitative and/or qualitative information on skills and the labour market." As argued by Draghi (2024), this activity is crucial for effectively detecting skills bottlenecks and thus determining the most adequate policy strategies to tackle them. It is just in the latest years that both the public and the private sectors have recognised the crucial role played by skills intelligence as a fundamental tool to bolster organisational preparedness and economic competitiveness. Already since the launch of the 2023/2024 European Year of Skills (officially proposed in October 2022 by the European Commission), one

of the first initiatives inaugurating the plan was a ‘Communication on Harnessing talent in Europe’s regions[49] where it is highlighted the need to foster “good skills intelligence and close cooperation between regional and local authorities, social partner organisations, public and private employment services, local businesses, and education and training providers to ensure that the jointly deployed education, training, and lifelong learning efforts focus on the right skills needed in a particular region (European Commission, 2023h: 15). The main idea behind the notion of ‘skills intelligence’ is that of merging different sources of information so as to try to solve the information mismatch when seeking to identify factors related to both the supply side and demand side, as well as their interactions. Eventually, what we have as an outcome represents the starting point behind further policy interventions, particularly those directed to the pursuit of educational reforms to anticipate changing skill needs and overcome green skill shortages in the context of the green transition. Currently, labor market and skills intelligence should focus on detecting green skills as a key priority. Although it is still difficult to perfectly foresee which skills will be the most requested for the green transition, harnessing different skills anticipation tools appears to be vital to better understand (in the long run) trends, skill needs, and shortages, but also to adequately train (through either upskilling or reskilling initiatives) a workforce ready to take up green jobs.

To provide a comprehensive picture of a well-structured skills intelligence system that supports enterprises, the workforce, and the overall economy, there ought to be at least three areas that should be further advanced: skill taxonomies, data sources, and skill anticipation techniques (Alcidi, 2024). With regard to *skill taxonomies*, a major challenge is setting up a consistent categorisation of skills and tasks. There currently exist several skill taxonomies that get difficult to combine with different data sources, although both the Joint Research Centre and Eurofound have contributed to providing a high degree of coherence in this sense at the European level lately (Fernández-Macías &

[49] European Commission -Press release Harnessing Talent in Europe: a new boost for EU Regions. (2023).

Bisello, 2022). This seems to be the case for the green transition, where the skill sets for new job categories are not yet fully framed and different definitions of 'green skills' (or 'skills for the green transition') currently exist. As for *data sources*, there are several methods for gathering and collecting data, including the so-called 'web scraping'[50] combined with the integration of big data, which is revolutionising the way skills intelligence is conducted. An example of this method of both web-sourced and big data infrastructure in the European Union is the so-called "Skills OVATE,"[51] which is an Online Skills Vacancy Analysis tool born out of the collaboration between Cedefop and Eurostat, the main purpose of which is both to establish official labor market statistics through the EU and detect the latest trends in both green skills and job requirements (Cedefop, 2023). In this regard, Skills OVATE is conceptualised as a pan-European system that aims at collecting and further analysing information stemming from online job advertisements (OJAs) across all EU countries. One of the main benefits brought by OJAs big data is the provision of further insights into skill dynamics, and also, they help signal the latest skill needs and professional profiles most sought by employers (Cedefop, 2025). In this respect, VET initiatives could also benefit from the support that big data-driven analysis brings in potentially contributing to easing short-term skill shortages for the green transition. As a matter of fact, the provision of up-to-date, data-driven information may constitute a valuable tool, especially for policymakers inasmuch as they have the possibility to look at both the job profiles and sectors most hit by greening and consequently take further actions towards possible adjustments and updates in VET contents and curricula. Nonetheless, a possible flaw that has emerged from Cedefop's database is the fact that OJAs do not properly reflect jobs' market demand across sectors and occupations equally; that is, some occupations or sectors may be overrepresented in the case of higher chances to be advertised online, while there are others that may suffer from underrepresentation. Furthermore, generally speaking, the collection of internet-based data might eventually include irrelevant

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[50] 'Scraping' means the extraction of structured data from websites.

[51] For instance, over 15 TB of data currently power Cedefop's Skills OVATE tool in different phases and formats.

information or biases. Nonetheless, it is worth mentioning and discussing a recent effort in the area of skills anticipation and smart governance, i.e., the fourth publication of Cedefop's series of practical skills forecasting guides (realised in close collaboration with UNESCO-UNEVOC), which is entitled «Meeting Skill Needs for the Green Transition: Skills Anticipation and VET for a Greener Future (2025).» The study highlights the crucial contribution brought by VET in bolstering and integrating environmental sustainability into both curricula and adult training programs. As a matter of fact, one of the major goals of this report is attempting to translate skills intelligence into VET policies and skilling initiatives in order to provide a high level of information and practical know-how to both VET and skills ecosystem providers. The guide is intended to target the following groups of individuals:

1. Young learners for occupations in the 'green economy.'
2. Workers currently employed in high-polluting sectors need to be supported in smoothly transitioning to green jobs.

The report reaffirms the crucial role played by VET for "meeting the shifts in labour demand and skill mixes the green transition brings about (Cedefop, 2025: 11). In this regard, VET constitutes one of the major tools helping deliver the skills most needed to overcome short-term shortages in particular, as well as helping people shift to greening through the so-called 'learning, work, and life' approach (Cedefop, 2022b). Furthermore, it is recognised the crucial contribution of VET through a series of policy responses. They are apprenticeships, upskilling, reskilling, validation, and micro-credentials (MCs) use respectively. As previously discussed, apprenticeships are particularly valuable to provide skills for the green transition since they are placed at the crossroads of the educational system and the labor market. As a matter of fact, apprenticeship content can smoothly adjust to labor market evolving needs, as well as reduce short-term skill shortages and contribute to bolstering employability in the long run (Cedefop, 2025). In this area, the term 'greening apprenticeship' is to be framed so as to include initiatives ranging from the provision of short-term modular approaches to the inclusion of green elements across subjects and jobs (Cedefop and OECD, 2022).

There are currently several European case studies showcasing the crucial role played by apprenticeship in the green transition, especially through the exploitation of existing governance structures and the setting up of platforms for collaboration among several interested parties (such as VET institutions, chambers, local/regional authorities, or research facilities) in order to adjust and tailor the content of training to specific sectors or occupations.

With regard to the use of micro-credentials in the context of the green transition, the definition provided by the report is the following: "A micro-credential is the record of the learning outcomes that a learner has acquired following a small volume of learning" (Cedefop, 2025: 49). Thus, one of the major features of MCs is their focus on the output of learning; that is, this approach mainly takes into account what an individual has learned ('learning outcome statements') from the attendance of a small learning experience (such as short online courses or training) rather than putting the attention on where, when, and how the educational course took place. Therefore, the major advantages characterising MCs are their flexibility and the short duration they require to be achieved (Cedefop, 2025). Although they are not thought of as tools replacing traditional VET, they still can be considered valuable complements to it. MCs promote lifelong learning, as well as allowing individuals with different degrees of skills to be quickly upskilled and thus also have higher chances to be easily employed. A 2022 Council recommendation of micro-credentials called on EU Member States to adjust their existing VET systems by welcoming new training provision patterns, including credentialing. According to Cedefop's findings (2024c), over half of them have currently added micro-credentials within their national qualification frameworks or are projecting to do so.

As previously stated, one of the major contributions stemming from skills intelligence is the activity of mapping both ongoing and future skill needs in the demand and supply of labor. In recent years, skills anticipation has also represented one of the major policy responses to address skills mismatch in the labor market. Therefore, skills anticipation is

a key element for firms, training institutions, and policymakers because this tool equips them to make better-informed decisions, as well as make plans for the most in-demand skills of tomorrow. Currently, different ways exist to develop skills anticipation (Nurski et al., 2024). Firstly, the activity of *forecasting* consists of projecting the employment trends of tomorrow by analysing historical data, and thus, it assigns great importance to past trends as reliable predictors of the future. An example of this first method of skills anticipation can be represented by Cedefop's Skills Forecast activity, especially through its European Skills and Jobs Survey (ESJS), which aims at providing comprehensive information on future labor market trends throughout Europe. We know that analysing jobs and skills fit for the green transition must take into account its different impacts and meanings across countries and regions. Trying to analyse the employment effects of the green transition solely through forecasts or surveys can be quite challenging (Cedefop, 2025). Since changes linked to the green transition characterise all sectors and professions, irrespective of whether they are 'green' or 'non-green,' what is mostly needed is timely granular data to better understand several policy settings, as well as existing differences at regional, local, and occupational levels (Cedefop, 2024a).

CHAPTER III

Skill mismatch policies in Italy and social partners' demand for green skills

3.1 Strengthening green skills' provision within Italy's National Recovery and Resilience Plan

It is not just artificial intelligence (AI) that is shaping the labor market, nor is it the digital transition that requires new skills and knowledge. As we have analysed in previous chapters, a new revolution is imposing itself on workers, firms, and institutions: the green and sustainable transition. Thus, the transition to a green economy

represents a major driving force that is profoundly changing the labor market, requiring new skills and generating new occupations. Therefore, there is increasing talk of ‘green jobs,’ jobs that require new skill sets to meet environmental challenges and take advantage of the opportunities of the green transition.

Under the Fit for 55 Package enacted in 2021 by the European Union, Italy is called upon to actively contribute to climate change mitigation, particularly through the fulfilment of specific targets to be achieved by 2030. Particularly, these targets include, among other things, the reduction of greenhouse gas emissions, the increase of energy production from renewable sources, and the improvement of energy efficiency. Furthermore, following the Covid-19 pandemic shock, in 2021 the European Union launched an extraordinary funding plan of which Italy is one of the main beneficiaries, with the National Recovery and Resilience Plan (NRRP) allocating funds of 194 billion euros to Italy. Another area of action in Italy is youth policy, with a focus on integrating young people into the labor market through programs such as Youth Guarantee, which have intensified training and job placement in emerging sectors related to the green and digital transition. Nonetheless, the majority of the resources are disbursed through the Recovery and Resilience Facility (RRF), which is the main instrument of the Next Generation EU program for which the funding provided is required to be expended by 2026.

As highlighted by Monti and Picciolo (2025), key elements such as standardisation, territorialisation, and personalisation are the guiding policy principles that characterise the work behind the NRRP. Firstly, standardisation is mentioned with regard to the need to ensure an essential level of performance of public services provided, such as employment centres throughout the country, through both the strengthening of their administrative capacity and through infrastructural interventions. Instead, the authors speak of territorialisation because of the nature of the policy that is closely interconnected with the local area, both in the governance of the system itself at the local level, which identifies municipalities and regions as the main actors in charge of

implementation, and with the local productive fabric. Lastly, by personalisation is meant the fact that through this new paradigm, the individual is placed at the center of policy itself through a personalised plan of accompaniment and reintegration into the world of work. Therefore, it aims at the introduction of lifelong learning systems capable of developing new knowledge and skills related to strategic sectors required by the local business fabric and beyond, such as green. As a matter of fact, Italy's NRRP has the potential to greatly contribute to driving the green transition, at least in the short run. Information regarding NRRP-funded projects is contained within the Italia Domani website,[52] the Italian government's portal devoted to NRRP monitoring. The whole NRRP's architecture consists of semi-annual disbursements that are subject to the successful completion of both the reforms and investments previously agreed upon in each national agreement with the European Commission, especially following the reformulation that was submitted in July 2023 and later approved by the European Commission itself in November of the same year. It is therefore possible to reflect on Mission 2 of the NRRP dedicated to "green revolution and ecological transition." In particular, "stimulating local investment, job creation, promoting social resilience, and integrating renewable energy" (Italia Domani: 143) are outlined among other objectives. It is emphasised, in addition, how "job creation in the mission's development areas may, in the presence of the necessary skills, increase youth employment (*ivi: 156)*." In addition, the revised Italian NRRP now covers 66 reforms and 150 investments. In this regard, the amendment includes the addition of a new mission, Mission 7, that is dedicated to the objectives of the REPowerEU.[53] Italy's share of additional REPowerEU grant resources corresponds to €2.76 billion. In this sense, Mission 7 is divided into three investment measures and six reforms.

The investment measures cover:

- Energy Networks;
- Green Transition and Energy Efficiency;

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[52] See more at: https://www.italiadomani.gov.it/content/sogei-ng/it/it/home.html

[53] The European Commission has approved the REPowerEU regulation in 2022, especially with the aim of reducing dependence on Russian gas.

- Strategic Industrial Chains.

Specifically, within the six planned sectoral reforms, the third and fourth of these are intended to address green skills in both the private and public sectors, specifically by promoting the training of human resources currently employed in traditional industry and by incentivising specialised training for public administration employees. In the latter, it aims to capture the REPowerEU goal of "accelerated workforce retraining toward green and digital skills." Among the foreseen investments, 'Investment 10' is closely devoted to developing green skills on a supra-regional scale and with a sectoral focus thanks to the involvement of companies and the private sector. We are talking about the pilot project on skills, "Crescere Green," in which training providers nationwide must be accredited in accordance with regional legislation. Training modules focus on sectoral skills for green transition, consistent with occupations identified in the skills pacts, and are monitored at the national level. According to the findings of the independent foundation Openpolis (2024), at least 20,000 beneficiaries of the GOL (Guarantee for Workers' Employability) program have completed the training modules. The investment also aims to increase the capacity of administrations, institutions, and partners involved in planning training activities, to which up to 4 percent of the additional resources allocated to the Ministry of Labor and Social Policy, amounting to 100 million euros, may be allocated. In this sense, reforms and interventions contained in the NRRP aim to support economic and social recovery through strategic investments and reforms prioritised also towards green transition and digitalisation, with the goal of increasing the resilience of the Italian economy in the face of both climate and technological change. Although resource planning happened within an economic and social context that has subsequently mutated due to other shocks that have arisen (such as both the Ukrainian and the Middle East wars' outbreak) as well as changes in fiscal and monetary policy, still, the NRRP constitutes an enormous opportunity for development.

Along these lines, the Italian Plan also underlines the importance of matching the skills of workers, students, and all individuals, broadly speaking, to the challenges of the

future. In this regard, both Mission 5, Component 1, “Active Labor Policies,” and Mission 4 with regard to the education system propose programs for action and reform of vocational training. Within these missions we find interventions already defined at the national level to respond to the challenge of new skills and professionalism needs resulting from the transitions taking place. In this regard, the main national instrument to incentivise further training in firms in the context of both digital and green transitions, namely the New Skills Fund (FNC), is an active policy initially established to counter the economic effects of the pandemic crisis, thus helping firms to hold on by strengthening the skills of their employees. The reference in the first chapter of this thesis to the European ‘ESCO’ classification is useful not only in reconstructing the European framework but also in reconstructing the national framework. As a matter of fact, within the regulation of the New Skills Fund, the skills classified as “green” by the European Commission in January 2022 were again reclassified by Anpal for the purposes of the specific measure.[54] This means that, in order to apply for access to the Fund, employers must identify in the agreement the need for upgrading workers' professional skills as a result of the ecological transition in accordance with one of the processes listed, including, precisely, those upgraded on the basis of the ESCO's guidance.

On December 14, 2021, the Ministry of Labor and Social Policy signed the Decree adopting the Plan, which was then transmitted to the Ministry of Economy for countersignature. The measure set the twin goals of reorganising the upskilling of transition workers and the unemployed through the strengthening of the vocational training system and the establishment of essential quality levels for upskilling and reskilling activities. The plan is based on three main pillars:

I. The first is the ‘Guaranteed Employability of Workers’ (Gol) program,[55] proposed in Mission 5 of the NRRP, which intervenes within the macro area of active policies

[54] See more at: Anpal- Il Quadro di riferimento delle abilità/competenze per la transizione ecologica – classificazione ESCO

[55] Program established pursuant to Article 1, Paragraph 324 of Law No. 178 of December 30, 2020.

to foster the so-called ‘employment law’ (Santoro-Passarelli, 2021). The GOL program is a national program, the main objective of which is to differentiate active labor policy interventions according to several factors such as age, skill level, complexity of need, reconciliation needs, reference labor market context, demand expressed by companies, and concrete employment opportunities. The program update carried out through Italy’s Budget Law 2022 (paragraphs 249-250) provides for the possibility of tailoring interventions and training geared to the needs of territories, thus aiming to overcome the separation between training policies and active labor policies. The use of PNRR funds involves the periodic verification, at fixed intervals, of the achievement of milestones and target groups on which access to EU funding depends. The total resources amount to 4.4 billion euros, plus 600 million euros to strengthen the Employment Centers (400 of which are already in place and 200 additional). In addition, the inter-ministerial decree of October 2023[56] on the definition of the second allocation of resources to the regions and autonomous provinces related to the GOL program included a change on the types of upskilling pathways that focus investments on green and digital transition issues. The target groups identified by the program are at least 3 million GOL beneficiaries by 2025, of which at least 75% must have one or more of the following characteristics: women, long-term unemployed, people with disabilities, young people under 30, and workers over 55; at least 800,000 beneficiaries must be involved in training activities, including 300,000 for the strengthening of digital skills; and by 2025 at least 80% of employment centres in each region must meet the standards defined as essential levels in GOL. According to recent INAPP estimates (2024),[57] from June 2022 to June 2024, the individuals taken on in the training pathways provided for in GOL were 2,570,887.

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[56] Available at: Modalita' di riparto della seconda quota di risorse del PNRR destinate all'intervento M5C1 «1.1 Politiche attive del lavoro e formazione», nell'ambito del Programma nazionale per la Garanzia occupabilita' dei lavoratori (GOL).
The decree amends the inter-ministerial decree Nov. 5, 2021 on the subject of “Pathway 1: employment reintegration” by providing, to improve the employability of beneficiaries, a special investment in the skills of those closest to the labor market, particularly related to the green and digital transition.

[57] Document available at: Lavoro e formazione: ncessario un cambio di paradigma

Tabella 2.1 **Individui presi in carico per tipologia di percorso (v.a. e val.%)**

Percorso	v.a.	%
1. Reinserimento lavorativo	1.290.835	50,2
2. Upskilling	660.450	25,7
3. Reskilling	527.141	20,5
4. Lavoro e inclusione	90.492	3,5
5. Ricollocazione collettiva	1.969	0,1
Totale	**2.570.887**	**100**

Fonte: elaborazioni Inapp su dati MLPS, Sistema informativo unitario (dati al 30/06/2024)

As can be seen from the table above, more than half of the individuals were assessed as ready to work and therefore directed to pathway 1, 'reinserimento lavorativo.' Conversely, one out of four individuals is referred to the upskilling pathway and 20.5% to the reskilling pathway. With regard to the last two routes envisaged by the Programme, these were of a more limited scope. As a matter of fact, INAPP argues (*ibidem*) that marginal has been the share of the most fragile individuals addressed to pathway 4, that is, 'Work and inclusion' (they were 3.5% of the total number of those entrusted), since it was a minority audience that needed the activation of different and additional services compared to those aimed at job placement.

II. The second pillar is the "Dual System" investment program, which promotes the acquisition of new skills by young people between the ages of 15 and 25, pushing on school-to-work alternation and the dual apprenticeship contract to cross the education and training system with the labor market. The goal is to reduce the mismatch between the skills required by the labor market and the training programs of the education and training system. In particular, these must be pathways of shorter duration than those ordinarily provided for upskilling pathways, but in any case not less than forty hours, and have as their outcome a skills certification.
III. The third line of intervention relates to the adoption of the PNC, which pursues the achievement of the so-called 'essential levels of performance' (ELP) of upgrading and qualification or retraining measures; the personalisation of interventions; the

expendability of learning outcomes in local and national labor markets; as well as promoting the integration of training policies with active labor policies. Principles such as universality of reforms and selectivity of investment; subsidiarity of governance and proximity of services; and gradualness and increment in the development of systems and services underpin the PNC. In addition, another important objective is to ensure the proportionality and differentiation of skills enhancement pathways and services according to personal characteristics and according to needs and concrete employment opportunities, including through the enhancement of skills already possessed. Therefore, the skills acquired must contribute to increasing opportunities to achieve or maintain a satisfactory employment status that is in line with both the needs of beneficiaries and firms. In this framework, the PNC sets *standards* that need to be ensured for those benefiting from upskilling or retraining pathways. To this end, vocational training paths must be personalised and aimed at achieving the skills required by the market. Among the different measures, short-term refresher courses can be undertaken, aimed at addressing skills needs arising from green or digital transitions.[58] Finally, the PNC, through its programs, shows the need to develop and strengthen analytical tools for knowledge of local labor systems, as also called for at the European level, such as labor market intelligence, skills forecasting, and skills intelligence.

IV. Lastly, dedicated to employed workers, the PNC provides for the 'New Skills Fund' (or Fondo Nuove Competenze), already established on an experimental basis during 2020 (and included in the NRRP in Mission 5. C1) with the aim of allowing companies to reschedule working hours, without paying the wage and social security charges of the hours allocated to training, in such a way as to encourage the training of employees through specific collective agreements with trade unions. It

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[58] The training paths have a maximum duration of 150 hours to which an internship can, if necessary, be combined. In addition, retraining pathways are characterised through professionalizing training interventions of a longer duration that can also be associated with raising the level of qualification. For this reason, they have a duration of more than 150 hours and can reach up to 600 hours to which internships can be cumulated, Finally, basic skills upgrading paths of short duration can take place according to the needs and requirements of the individual subject and have a maximum duration of 60 hours net of the additional hours of the internship.

> remains, however, the responsibility of companies, the costs of training for which the use of inter-professional funds is possible. Funding was initially provided through the use of national and European Social Funds (ESF), then only from ESF (REACT-EU), and currently from ESF+. However, some weaknesses seem to emerge from the very characteristics of the inter-professional funds. As a matter of fact, the latter should have contributed in a more coherent way to the training of workers within the project carried out by the New Skills Fund, in particular, by updating their training catalogue programmes and focusing the training on the real needs of firms. Indeed, as highlighted by Valente (2020), at the end of the first phase of training financed by the Fund, the objectives set were not very ambitious. It is sufficient to mention the fact that the training objective of the call was to obtain a qualification at EQF level 3 or EQF 4. In other words, the worker acquires the skills corresponding to a professional certificate (EQF 3) or professional diploma (EQF 4). Nothing to do with EQF 5, 6, 7, or 8, which correspond to the qualifications obtained after attending a so-called 'Istituto Tecnico Superiore' (ITS) or a degree course among those most in demand by enterprises, which could and should have been the priority objectives.

Furthermore, the greatest fruits of NRRP funds will be reaped in the next few years, which eventually will also influence the need for an adequate supply (in terms of both qualifications and quantity) of manpower. As a matter of fact, it is possible to recognise that NRRP resources represent a key element that will considerably affect VET needs in the forthcoming years. Although it does not yet place green jobs at the center, the NRRP highlights the need to align skills with new market realities, with an emphasis on improving sustainability and firms' competitiveness, as well as reducing territorial gaps. To that effect, the latest available Excelsior Report (2023)[59]—a five-year analysis carried out by Unioncamere in collaboration with the Italian Ministry of Labour and Social Policy—-underlines that, thanks also to the impact of the NRRP's investments,

[59] See more at: https://excelsior.unioncamere.net/sites/default/files/pubblicazioni/2024/report_previsivo_2024-28.pdf

two main sectoral supply chains, such as construction and related industries (which are also particularly affected by a strong demand for green skills), will express a considerable need for a qualified workforce, which then translates to between 260,000 and 290,000 workers over the five-year period under consideration (2024-2028). Once again, according to Unioncamere's Excelsior information system, the demand for green jobs is characterised by a higher qualification of skills and experience, directing almost 16 percent toward university graduates (versus 13 percent of other employed), 23 percent toward those with previous specific professional experience (versus 18 percent of the rest), and this despite the fact that 45 percent of firms emphasise the need for suitable training after joining the company. According to Unioncamere, green skills will be increasingly in demand in the next five years. It is estimated that more than 2.3 million workers will be required to have green skills by 2028. Additionally, those demanding green qualifications place a higher demand for enabling and transversal skills than other firms, particularly for problem solving (43% vs. 37% of other firms).

If we go into more detail, according to the study, specific skills will increasingly be required in recycling and waste management, raw material control, knowledge of organic production, and quality and safety control. In this regard, the teaching staff, on the other hand, will need to possess the necessary skills to raise students' awareness of environmental and energy-saving issues. The green transition of companies will also see the consolidation of specialised figures capable of leading this phase. Green lawyers, environmental economists, and professionals with expertise in transformation energy and recycling will gain increasing weight in the labor market. The analysis also found that among the most in-demand professional profiles are skilled construction workers (particularly in the maintenance of building structures and construction refinement), but also architects, specialists in land restoration and conservation, and construction site management technicians. In terms of specific skills required in the above sectors, the study (*ibidem)* identifies certain ‘green skills’ that will be most needed, i.e., experience in low-energy design, urban efficiency, regeneration, and knowledge of environmental protection regulations, as well as skills related to renewable energy, especially in the

field of photovoltaics. Among the most needed professional profiles, there will be an increasing demand for solar installers, who will need to be responsible for assembling solar panels and installing solar energy systems. Nonetheless, the green transition goes along with the digital one; thus, green skills will be paired with digital ones. In this sense, the Report recognised that digital skills will be increasingly relevant: engineers, architects, and technicians in the supply chains previously mentioned will need to be able to use advanced digital tools for the design and management of infrastructure projects (such as 3D modelling).

The lack of a skilled workforce is one of the biggest problems in Italy: technical skills, for instance, for which Italian industry and craftsmanship are known around the world. As mentioned previously, cases of skill shortages involve jobs that are permanently unfilled due to a lack of suitable people to fill them (Ichino, 2014). These situations, however, vary according to both the qualification sought and the geographical distribution, from northern to southern Italy. Nonetheless, generally speaking, according to some estimates in the same Unioncamere-Anpal[60] (2023) report, in the next few years, the Italian economic system, based on the assumption of a positive economic growth scenario, may need the entry of just under 3.8 million workers, two-thirds of whom will result from the need to replace the workforce leaving the labor market. Notwithstanding, the forthcoming years will be marked by the effects of the twin transition on the demand for qualified workers, through the destruction of certain types of employment (those in particular that are more easily automated) and instead through new employment opportunities. All this could lead toward profound needs for transformation and renewal. It is the same report that reiterates how "a large part of the jobs of the future will be digitally intensive, green, and will have to take into account the increasing demographic issues, without forgetting the importance of soft skills (cognitive skills, social skills, etc.) that will have to complement technical skills"

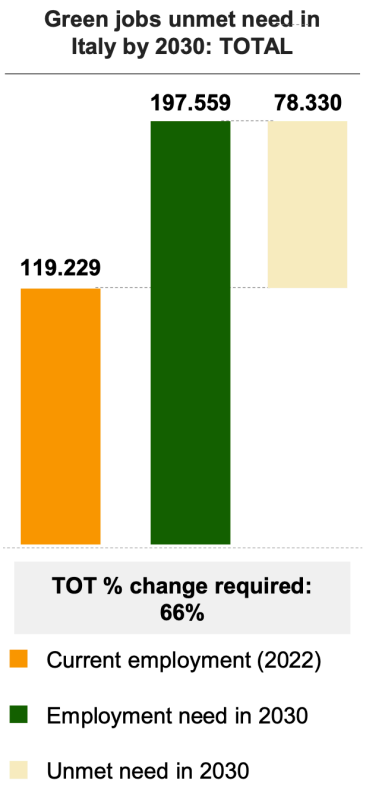
[60] Anpal was the Italian National Agency for Labor Policies, which was in charge of carrying out programmes and initiatives to foster the right of work in Italy. As a matter of fact, the agency's main responsibilities have been recently transferred to the newly created 'Sviluppo Lavoro Italia', which is fully operational since March 2024.

(Unioncamere, 2023: 6). Regarding so-called ‘soft skills’ (or otherwise called ‘soft skills’), these are essential within any organisation facing green transition. Just think of emerging professions related to such skills, such as the environmental engineer, the energy manager, the mobility manager, and the urban sociologist. Nonetheless, some structural challenges persist: the mismatch between skills supply and demand, territorial disparity, and the need for retraining programs for older workers are major obstacles to the full success of current transitions.

Within this framework, it is also possible to affirm that, as a result of the energy crisis triggered by Russia's aggression against Ukraine in 2022, there has been an acceleration of the green transition path that Italy, however, had already taken, following European decarbonisation goals. For instance, with regard to energy efficiency, according to the NRRP, Italy currently disposes of 3.64 billion euros of investments for the development of hydrogen. Additionally, 2 billion of these funds are devoted to encouraging decarbonisation in both carbon- and energy-intensive industries, specifically through the development and use of green and renewable hydrogen. This acceleration has also resulted in a greater propensity of firms to make green investments and an increasing focus in the labor market on professional figures who can facilitate this transition through their skills. As a matter of fact, following the data provided by the Excelsior Report (2023), particularly over the period 2018-2023 (with the exception of the Covid-19 pandemic), there has been a steady and progressive growth with regard to the number of companies deciding to allocate their investments in green skills: from 49% in 2018 to 56% in 2023. In this regard, the relevance of the transition in companies’ investments is highest for medium-sized firms, 25% of which declare an investment of 30% or more for green transition initiatives, while it is reduced for micro and large companies, which mostly affirm the allocation of less than 10 percent of their annual financial expenditure dedicated to green transition initiatives (Look4ward, 2024).

Additionally, if we consider the geographical distribution of these investments across Italy, they are lower for companies operating in the northwest, while they are higher for

firms located in the south and islands (*ibidem*). This could be due to an increased perception of the effects of climate change in businesses operating in territories that experience significant increments in average temperature and heat extremes (Istat, 2023). Nonetheless, global warming will also greatly affect northern Italian regions, such as Lombardy, Veneto, and Emilia Romagna, which have been recently included in the list of European regions that will be most exposed to extreme weather events and climate change in 2050 (Look4ward, 2024). Moreover, according to Intesa Sanpaolo group estimates (2023), there are currently in Italy 120,000 jobs (0.47% of total occupations) that can be defined as 'green jobs.' Nonetheless, as later emerged from the analysis, there are still occupational profiles that are still in great need of green job creation, i.e., agriculture, forestry, and fishing workers. As a matter of fact, there has been registered a shortage of roughly 67,470 jobs in occupations such as gardeners, fishermen, and farm labourers, which represent nearly 90% of the whole unmet need for green jobs (*ibidem*).



Source: Intesa Sanpaolo (2024)

The reforms adopted between 2020 and 2024 have redesigned the content and mode of service delivery, promoting enhanced collaboration between the different actors. In this sense, the NRRP has adopted several strategies and tools that, considering skills as a key element to address the ecological transition underway, promote their exploitation through an integrated approach between training systems (as reaffirmed by the National Plan for New Skills, the New Skills Fund, and the New Skills-Transition Plan, the latter at the center of the analysis in the following paragraph) and territorial services for work (such as the GOL Programme and the Dual System Investment Programme).

Nonetheless, there are still problems faced by workers and companies, which are twofold: the rapidity with which companies' demands for green skills are increasing every year and the lack of adequate worker training, which is still too disconnected from the required skill needs and the market.

In light of this framework, some working tracks emerge to ensure that the expectations of the NRRP are effectively confirmed. Policymakers should better devote their attention to the following aspects:

1. On **skills**, which are the focus of this thesis as well as being a central aspect of the whole greening process, both in the school and university training paths and with corporate training of employees and entrepreneurs. In fact, as has emerged in previous analyses, the green transition requires figures who have technical knowledge or qualified training that is functional in introducing practices devoted to sustainability and technological innovation into new work patterns;
2. On **culture**, through increasing awareness among companies (especially the smallest ones), specifically regarding the importance of investing in environmental sustainability, including by working alongside institutions — such as those operating at the local level— both in technical and technological issues and in assisting better access to resources and services;
3. On **regulations** and **taxation** more generally, through simplifying procedures related to tax breaks and also making investments in environmental sustainability fiscally attractive;

4. Incentivise the **creation** of **markets for sustainability** by facilitating the matching of supply and demand for green-related products and services (such as through green public procurement, Minimum Environmental Criteria, as well as dedicated e-platforms for purchasing green products and services).

3.2 Italy's 'Plan for New Skills-Transitions': governance actions to counter green skills mismatch

The green transition needs an organic process of labor policy reforms, that is, active training policies to promote new kinds of skills. It is therefore necessary to update the 'catalog' of labor policies so that labor market transformation can become an active component of the ongoing transition process. In this respect, 2024 was a year marked by the launch of several reforms currently underway in Italy concerning active labor and training policies.

Following the Ecofin Council Decision on December 8, 2023, in which the Repower chapter of the Italian NRRP was approved, among other items considered, and the Council Implementing Decision (CID)[61] has been given to the Ministry of Labor and Social Policy, the faculty to pursue a new reform and make a new investment thanks to a budget of about 1 billion euros. As previously highlighted, this is Reform (or *milestone*) 5 of Mission 7, which introduces the Plan for New Skills-Transitions (PNST, or 'Piano Nuove Competenze-Transizioni' PNC-T), adopted last March in agreement with the State-Regions Conference, and the Investment 10 Pilot Projects on Green Skills (Progetto pilota 'Crescere Green'), particularly designed for the private sector. The PNC-T is within and is also complementary to the implementation and regulatory framework of active labor market policies established by the NRRP. The plan's stated goal is to increasingly develop the process of integrating training and labor, in particular

[61] Through the new Council Implementing Decision, changes and additions were made to the NRRP, in particular there was an increase in the resources allocated to the Italian Plan equivalent to nearly 3 billion euros.

by equipping Italy with "stable mechanisms to contain and counter the phenomenon of mismatch between labor demand and supply, that is, the mismatch between professionalism and skills required by companies and those actually possessed by people seeking employment or already employed, including and with particular attention to key sectors of smart and sustainable growth, including green growth (Ministero del Lavoro e delle politiche sociali, 2024: 3).

In this regard, the new reform updates and complements the New Skills Plan (NSP) previously adopted in 2021, defining some general principles to be developed and declined by the regions by September 30, 2025. These are, respectively:

I. Greater participation of the private sector in the planning and implementation of training provision: in this respect there is the recognition of the important added value for the qualitative growth of training and employment provided through businesses' involvement;
II. Better recognition of on-the-job training and micro-credentials, including through new modes of learning;
III. Further advancing the implementation of ex ante labor market analysis systems (or skills intelligence) and monitoring the effects of funded training on employment. These are all fundamental tools for increasing knowledge on both the needs and the dynamics characterising the labor market in each single area.

On the one hand, the starting point is precisely the individual territory, within which an effort is made to invest in continuous, lifelong, and inclusive training, involving companies in the design of training paths through targeted interventions where the very imbalance they want to counteract is registered. On the other hand, it is about interventions for the territory so as to establish integrated, thematic, and sectoral networks that are able to create a direct junction between training and employment. What the PNC-T introduces will later be clearly defined through the publication of specific regional laws, as per the next *milestone* to be achieved by 2025. Regions, in setting their policies, will be able to independently identify the most appropriate lines of

action at the local level, also making use of the results of the pilot project on skills, "Crescere Green."[62] A strong territorial dimension clearly emerges in the plan, where the goal is precisely to promote increasing cooperation between institutions and the private sector in order to design and subsequently launch customised training paths based on the connection between territory and industry. In this framework, local governments are called upon to play a strategic governance role in the planning and implementation of interventions that must necessarily be firmly grounded on interdependence: between education and training, between research and business, and between training and employment (Ministero del Lavoro e delle politiche sociali, 2024). In this sense, listening to individual territorial realities also passes through the need for complementarity of the public-private sphere, which is embodied in the institution of public-private partnership. The main lines of action identified by the plan therefore turn out to be the so-called 'Supply Chain Academies' (Accademie di Filiera) and 'Territorial Pacts for Skills and Employment' (Patti territoriali per le competenze e per l'occupazione), the latter of which are implemented through the establishment of partnerships composed of public and private entities from a given territory, sector, and/ or supply chain. In the case of the Supply Chain Academies, on the other hand, the aim is to incentivise greater dynamism and innovation within the fabric of medium- and small-sized enterprises by establishing skills *hubs* to ensure training targeted to needs, as well as by promoting dialogue with accredited training agencies, companies, trade unions, and universities.

Therefore, a major attempt that the PNC-T seeks to develop is, on the one hand, trying to intervene by introducing a mechanism that is capable of fostering a broader dialogue between the world of education and training and labor. On the other, it represents an opportunity for regions and autonomous provinces to exercise a relevant role as facilitators of such discussion. This highlights the need to realise on the ground a

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[62] As previously discussed, the launch of these projects is possible thanks to investment 10 of Mission 7. Particularly, these are training programs aimed at some beneficiaries of the GOL Program (20,000) concerning jobs (particularly those supporting the green transition) previously identified through the skills pacts under the PNC-T.

renewed collaboration between institutions and the private sector, also through the promotion and subsequent activation of partnerships. With the dual purpose of anticipating market needs and training the workforce, a work-based learning approach is also promoted through the choice to adopt the internship tool and the introduction of ‘training vouchers’ on a regional basis in particular. In fact, in order to reduce the mismatch between labor supply and demand, some regions and autonomous provinces have chosen vouchers as a tool to bridge the gap of profiles and skills at the hiring stage through the financing of training paths combined with employment incentives. A specific type is the “just in time” training vouchers, i.e., personalised and timely training interventions in response to the employment needs of companies. In order to cut down the time barrier between the company's request for new hires, the process of candidate selection, and the training course preparatory to the start of the employment relationship, funding (voucher disbursement) is provided for training courses for unemployed individuals for whom a request for employment has been made by the company itself. Thus, just-in-time training vouchers represent tools that allow access to customised and targeted training paths, right when the need emerges, to acquire the specific skills required by the labor market and to respond to new professional needs.

3.2.1 The promotion of a universal certification system: the piloting of the ‘Identification, Validation and Certification of Competences’

In recent years in Italy, significant efforts have been made at the national, regional, and local levels to pursue measures that adequately recognise the skills acquired by citizens throughout their lives. An example of this is the Identification, Validation and Certification of Competencies (IVC) system, which arose from the need to provide operational support at the local level (particularly to job centres and regions) for the realisation of a nationally shared system. The IVC system is presented as a ‘universal service’ (Ministero del Lavoro e delle politiche sociali, 2024), potentially certifying to citizens the skills acquired in different learning areas. In this regard, promoting the

universality of the certification system is one of the goals of the PNC-T to realise a close connection between training policies and active labor policies, thus encouraging the mobility and expendability of skills across the country. Particularly interesting in the fight against skills mismatch is the stated intention within the PNC-T to develop a platform that, through the use of matching algorithms and the proactive use of data acquired as part of the specialised guidance activity (complemented by the skills transparency service provided within the regional IVC system), could enable the matching of labor demand and supply, declined in terms of skills needed by the labor market. The tool in question, in fact, should provide information on the skills shortages and would make it possible to conduct analyses aimed at planning and carrying out, at least in the medium run, more specific and effective training activities according to firms' needs, thus accelerating the processes of insertion or eventual reintegration into the world of work.

However, as also highlighted by Monti and Piciollo (2025), it seems to be increasingly necessary to define a shared strategy for both course design and the development of digital skills attestation systems valid for both formal (courses) and informal (extracurricular internships) learning. In this sense, one possible tool is 'micro-learning,' which involves the delivery of training content in small, easily accessible segments. This is a way of delivering continuing education because of its flexibility and ability to adapt to the specific needs of enterprises and workers. Thus, it could be argued that the reskilling and upskilling activities included within the NRRP programming (such as the GOL program) and PNC could outline further prospects for the use of so-called micro-credentials (as a valuable tool for counteracting skills mismatch), i.e., ways of recognising, validating, and certifying skills acquired through micro-learning. As highlighted in the previous chapter of this thesis, in order to close the skills mismatch (in particular, skills shortages) in sectors related to both the green and digital economy, the European Union considers continuing education and new forms of learning essential, as reiterated in the EU Action Plan on Labor and Skills Shortages in the EU of March 2024, developed in agreement with the social partners. To counter the skills mismatch, internal retraining activities, targeted training programmes, and digital

certifications, such as micro-credentials, are therefore of particular relevance to workforce development. Therefore, continuing education and lifelong learning emerge as key tools for reducing the skills mismatch. When considering the goal of engaging at least 60 percent of adults in training activities by 2030, Cedefop (2023b) found through surveys on the perception and use of micro-credentials in Europe that 63 percent of employers believe that micro-credentials motivate companies to invest more in workforce development, as long as training providers rely on skills intelligence systems. It also highlights the added value that companies have experienced in terms of competitiveness (61 percent), productivity (56 percent), upskilling and reskilling for transitions (53 percent), as well as from the standpoint of improving retention of their employees (46 percent).

Thus, through the PNC-T, more tools are made available than originally envisioned. In particular, efforts are gradually being made to encourage vocational training that is more oriented toward ‘work-based learning,’ especially in the form of apprenticeship and/or extracurricular internship. All of this could be seen within the broader process of change initiated in recent years, mainly through the NRRP, and places the reform within the broader framework of strategic coordination defined in this area,[63] aimed at enabling Italy to be competitive in the global economy, to ensure high levels of employment, education, and training, and to face, under the best possible conditions, the new challenges and seize the opportunities arising from the green and digital transitions. This is a relevant window of opportunity for our country to increase productivity, innovation, and employment; ensure wider access to education and culture; and close territorial gaps. Forecasts of employment and professional needs in Italy in the medium term for the years 2024 to 2028 (Unioncamere, 2024) certify the labor market's tendency to demand increasingly specialised workers with higher skills. In fact, an increasingly large share of employment needs, about 39 percent, will involve highly

[63] The following are part of the strategic coordination framework of interventions: the Guarantee for Workers’ Employability (GOL) Program, the New Skills Plan (NSP), and the Dual System (SD) Investment program. Added to these is the New Skills Fund (NSF) instrument.

skilled and other personnel, such as management and technical figures. In this sense, rapid action is needed to raise people's skills, especially those defined as strategic, thus aligning them with the labor market's demand. A competitive, innovative, and quality educational offer is, in fact, the main lever of change for people and society as a whole because it is able to offer new opportunities and contribute, in a significant way, to overcoming inequality, marginalisation, and, ultimately, to the inclusive and sustainable growth of Italy.

3.3 The role of social partners in driving demand for skills and green jobs: The Emilia-Romagna case study

The shortage of green skills in the Italian labor market generates significant employment and social consequences. Particularly, the difficulty of finding skilled labor hinders the growth of companies, especially small and medium-sized enterprises (SMEs), and delays the transition to a greener development model. This results in fewer employment opportunities for young people, a skills shortage that requires reskilling and training for workers, and increasing difficulty for companies to innovate and compete internationally. As revealed in an analysis by Confartigianato (Demenego, 2023), in 2022 Italian micro and small companies planned to hire about 1.47 million workers with green skills, but 46.6 percent of these positions were difficult to fill.

Among the Italian regions, Emilia-Romagna has been recognised (Romagna et al., 2024) as an important hub for the energy and sustainable industry, with increasing investment in renewable energy, particularly solar and wind power. Several companies in the region are leaders in the development of green technologies and the promotion of environmental sustainability through the adoption of low-impact industrial processes, efficient resource management, and the introduction of material circularity technologies. Additionally, Emilia-Romagna is one of the most advanced Italian regions in terms of research and development (R&D). It benefits indeed from an innovation ecosystem that

fosters collaboration among companies, universities, and research institutions, thus creating a fruitful environment for digital transformation, new product development, and industrial process improvement. Furthermore, the region hosts various internationally renowned research centres and universities, such as the University of Bologna, the University of Modena and Reggio Emilia, and the CNR (National Research Council), which work closely with the industrial ecosystem to promote innovation and the development of new technologies. In fact, at the level of the Emilia-Romagna region, efforts have been made for years to support the productivity of SMEs on various issues, including that of ecological transition, by incentivising them toward greater openness to the territory and by absorbing the approaches and organisational models that larger companies pursue from the standpoint of investing toward sustainability training for their employees. In this regard, towards the end of 2020, the Emilia-Romagna Region embarked on a process for the development of a sustainable economic model by signing the 'Pact for Work and Climate.' The Pact aims at fostering an increasingly close relationship with Emilia-Romagna's higher education network, as well as strengthening the regional ecosystem of research and innovation, investing particularly in the areas of health and digital transition and ecological transition. It is a shared project[64] that pursues several targets, including complete decarbonisation by 2050, 100 percent renewable energy by 2035, and 3 percent of regional GDP allocated to research. Under the Pact, the region has invested a total of 2,178,300 euros (as of November 2021) for the realisation of 34 editions of 10 higher education pathways, targeting up to 1,200 participants for more than 4,300 hours of training (Sviluppo Lavoro Italia, 2023). In addition, from the point of view of European funding available on the training side, thanks to the resources derived from the European Social Fund, the region is also trying to invest in individual supply chains through the promotion of ad hoc public calls for proposals to stimulate more positive contamination between large

[64] The Pact was signed by the region together with all the relevant social partners, that is, trade unions and companies—local authorities, environmental associations, the Third Sector, chambers of commerce, and banks, including all four universities in Emilia-Romagna (Bologna, Ferrara, Modena and Reggio Emilia, and Parma), and more than 55 unions representing the entire regional community. The Pact also saw the participation of the Milan Polytechnic and the Università Cattolica del Sacro Cuore of Milan—universities with offices in Piacenza.

companies and small businesses, thus linking different training moments. The main example is the Regional Call for the 'Strengthening of Skills for Industrial, Digital, and Green Transition'[65] for the period 2021-2027. The call identifies as a priority the activation of a policy mix based on the strong link between skills and innovation, with the aim of reducing the growing mismatch between skills demand and supply, including from a gender perspective. This action supports the strengthening of skills within SMEs to support the digital and ecological transition, the innovation of production and organisational methods, materials, and production processes in a smart, sustainable, and continuous way, the development of managerial skills, and the attractiveness and retention of talent. Thus, it is often a matter of funding opportunities in which also large companies pool their knowledge for the benefit of sub-supplier companies with a view to all going at the same pace and all having the same sensitivity to the issue of sustainability. Nonetheless, Confartigianato's findings (Demenego, 2023) also highlighted that Emilia-Romagna has a 55.5 percent shortage of green transition support skills.

Therefore, I want to devote my attention to deepening what the main social partners at the regional level (representatives of SMEs and trade unions in the area) think about this growing issue (which is also nationally relevant), i.e., the shortage of skilled workforce with a marked focus on energy savings and lower environmental impact, and also what initiatives they think should be pursued, especially at the national level, to solve the issue at stake. To do so, I conducted four interviews electronically with two representatives of SMEs in the area, namely CNA Emilia-Romagna and its operational arm for training and job orientation in the Ferrara headquarters, that is, CNA Formazione ('CNA fo.er Ferrara'); with Fondimpresa Emilia-Romagna, a joint inter-professional fund that promotes continuing training in Italy; as well as with CISL Emilia Centrale, a trade union organisation committed to the protection of social and labor rights, with strong territorial roots in the provinces of Modena and Reggio Emilia.

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[65] 'Bando per il rafforzamento delle competenze per la transizione industriale, digitale e green lungo la direttrice della S3' (PR-FESR 2021-2027).

Therefore, the first interview is with Marcella Contini, currently Head of the Industrial and European Policies Department at CNA Emilia-Romagna. I asked eight questions related to how CNA-associated enterprises are responding to the shortage of green skills in the workforce in the area where they operate on a daily basis. Additionally, I also tried to grasp CNA's role in supporting them throughout their internal process of reconverting their production activities to a more sustainable key. The second interview, on the other hand, involved Giulia Pellecchia, current Territorial Area Manager of Ferrara on behalf of CNA Formazione, i.e., the training company developed by CNA to accompany both employed and job seekers on their training and career path. In this case, the main element of conversation revolved around the in-depth study of a higher technical education and training (IFTS) course launched in the Ferrara CNA headquarters starting in 2021, with which they sought and are still continuing to train the professional figure of 'Technician for sustainable production in support of the green and digital transition.' The course under consideration was financed with resources from the ESF+ 2021-2027 Program of the Emilia-Romagna region. The third interview sought to focus on the responses provided to the green skills and labor shortage by one of the main trade unions most deeply rooted in the territorial fabric. Therefore, Rosamaria Papaleo, current Secretary of the largest CISL trade union organisation in Emilia-Romagna and the seventh largest in Italy, i.e., CISL Emilia Centrale, set out both the main initiatives carried out by the union she leads and food for thought regarding the construction of a new union culture that can then be translated into a general and shared strategy of unions with respect to training on environmental issues for workers. Last, but not least, the last interview was with Tommaso Termanini, who currently covers the role of Territorial Articulation Coordinator at Fondimpresa Emilia-Romagna and Training, Human Capital, and Labor Area Officer at Confindustria Emilia-Romagna.

3.3.1 Interview with Marcella Contini- Head of the Industrial and European Policies Department at CNA Emilia-Romagna

1. As part of the 2023/2024 European Year for Skills, the European Commission's Directorate-General for Employment and Social Affairs (DG EMPL), in partnership with Eurobarometer,[66] released the results of its own survey dedicated to skills shortages in small and medium-sized enterprises (SMEs), which confirmed how skilled workers are a key element for European SMEs. Specifically, nearly 40 percent of SMEs cited skills shortages as an obstacle in finding a highly skilled workforce to support the company's internal green transition. In the case of CNA Emilia Romagna, do you feel you agree with the results that emerged from the survey mentioned above and, if so, what strategies and policy initiatives is promoting (or has carried out in the past) CNA Emilia Romagna to support SMEs in overcoming the shortage of highly specialised skills, particularly those needed for the ecological transition?

Contini: As CNA Emilia-Romagna we confirm the data that is presented, particularly on SMEs up to twenty employees. I must say that the sensitivity of firms has increased a great deal in recent years, despite the seesaw of pro-green transition or anti-green transition policies. In general, what we see on the side of companies is a sensitivity that is gradually increasing every year. What we, as CNA, have tried to do and are continuing to do is to raise awareness among businesses toward sustainability in ESG logic,[67] so both on the environmental side and on the social and governance side. This is for a number of reasons: one is that we believe this is the way in the long run. We have a duty to anticipate certain dynamics to companies. Another reason is that supply chains, and in particular the supply chain leaders for whom our companies work, the latter mostly sub-suppliers (within sub-supply chains) of large players, are obliged by those before them in the supply chain to meet certain requirements. So they are already meeting sustainability requirements, particularly environmental ones. In some sectors more than others (such as fashion or manufacturing) they are really called upon to do

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[66] *Eurobarometer*. (2023). [online] Available at: https://europa.eu/eurobarometer/surveys/detail/2961

[67] ESG, i.e., 'Environmental, Social, and Governance,' is a framework that includes a series of standards through which an organisation can be measured from an environmental and social impact perspective.

that. What we want is for them not to passively undergo it, but for it to be a process that they govern. Another element to highlight is that of credit: the issue of sustainability is now being strongly evaluated by the banking system and finance in general. Since SMEs in Italy are particularly dependent on the traditional credit system, namely banking, banks are imposing ESG assessment models. So that's also why we are very convinced that companies not only have to learn to codify what they already do. Because another thing that emerges from our analysis is that many good practices companies apply them, they implement them, but they don't tell and they don't codify them. So they don't value them, for example in the world of finance and credit. In fact, it is often a matter of guiding them in the analysis and then bringing out these best practices. We did an experiment last year in 200 enterprises in Emilia-Romagna. As CNA Emilia-Romagna we represent more than 65,000 artisan businesses and SMEs in this region. These are mostly in the 1-50 employees range, but also from one to 20 employees. We set up a sustainability assessment tool that investigates the three ESG dimensions and administered it, through direct interview with the entrepreneur, to an initial sample. The level of sustainability and the level of investment readiness for sustainability was assessed. This is a process that we think needs to be accompanied constantly and without losing focus continuously. We will therefore repeat another analysis this year on other firms and so for the coming years. This is an analysis that then goes to intervene on what we photograph in the enterprise: services are then provided to improve the dimensions investigated. Where there are points with room for improvement we propose services that CNA provides or that CNA provides together with external partners.

2. In this analysis you conduct to assess the level of internal sustainability within the enterprise, have you explored the issue of skills shortages for the green transition?

Contini: Firms are finding it difficult to find skilled labor in general and certainly also on the green transition side. What we saw on the green theme last year and the previous year in a project in partnership with the Università Politecnica delle Marche and other European partners ('Amoceab', design of a Master’s Degree on the theme of green and

environmental innovation, in collaboration between different universities overlooking the Adriatic) is that, especially in less structured companies within them, they cannot afford to have an environmental manager. Thus, a need that has emerged fairly evenly across the countries participating in the project is that for less structured enterprises, it might be interesting to have some kind of 'innovation manager' (already existing, by the way) shared between several companies, but with a greater focus on the theme of environmental and climate sustainability. The shortage of labor is a cross-cutting and very serious issue that our companies are experiencing: on one hand because there are not enough qualified people and on the other hand because the population is progressively getting older and therefore the young people available to work are becoming fewer every year and all this is beginning to be felt in companies.

3. From the perspective of CNA Emilia Romagna, which sectors and professions are most affected by the skills shortage related to the ecological transition in Emilia-Romagna?

Contini: Certainly the manufacturing sector urgently needs a skilled workforce on the topic of environmental sustainability, but as far as we are concerned, so does the whole construction and building sector. We associate thousands of SMEs in the latter two sectors.

4. Is the shortage of highly specialised skills linked to European objectives and targets for decarbonisation of manufacturing activities affecting the competitiveness and innovation capacity of CNA associated SMEs?

Contini: The lack of green skills is certainly having a major impact. The failure to introduce new skills and the difficulty of bringing in young and skilled workers means that even the level of innovation and productivity of these firms does not evolve and therefore remains anchored in obsolete patterns. There is also the question of remuneration: our companies are used to paying people fair wages in order to retain talent. The problem is that when talents are few, they take them away from each other. There is therefore a question of economic resources being invested in the training of

people who then leave, forcing companies to start over. In addition, there is the great issue of generational change, which unfortunately does not exist: many companies, even successful ones, close because they do not have a new generation ready to further innovate them. There is therefore a great theme that is linked to the fact that many of our companies are often born as family businesses and then tend to think that the new generation should reside within the family, but many times this is not case. There is a fundamental error: to focus everything on the family, when instead perhaps you could look at skills taken from outside. The result is that the generational change is very complicated, and we see many closures, but without transfer and without the generational transition to others. We also see the closure of structured enterprises (composed of 50 employees, for example) that close because the owner is elderly, and on the other hand, we note the opening of catering enterprises, very often composed of only one employee. Even the balance that can be seen from the data of the Chamber of Commerce in many cases is not positive: the level of employment guaranteed by a company often does not translate into new businesses that are born.

5. Does CNA Emilia-Romagna promote (or has it promoted in the past) partnerships with training institutes, universities or Centres of excellence (‘Centres of Vocational Excellence’) to align training offerings with the needs of local businesses in the context of the ecological transition?

Contini: Yes, as CNA, we are used to collaborating with the universities in all territories we preside over. For example, 2 or 3 years ago we entered into a partnership (later formalised) with the Foundation for Vocational Graduates (therefore oriented on profiles of graduates, but at the same time technically ready to start a work path at the end of graduation, the so-called 'professionalizing degrees'). In addition, we have many active collaborations with foreign universities within European collaborative projects. The collaboration with the university is therefore essential from our point of view.

6. As for the so-called ‘micro-credentials,’ do you use them or have you used them in the past?

Contini: Our training providers provide them, from the longest and most complex to the shortest, such as e-learning. We have ITS courses, IFTS (part of the training courses financed by the European structural funds via the regions), and different types of training, such as those financed by the ESF structural funds that are also made available to enterprises.

7. Are there regional and/or national training and support tools currently available to CNA Emilia- Romagna associated companies to support them in the process of specialising their workforce in the ecological transition? If yes, do you consider them adequate to meet the challenge of ecological transition for CNA Emilia-Romagna associated companies?

Contini: There are many opportunities: The European Social Fund in particular, which finances many of the lines we have mentioned, is very rich. It has a budget of one billion in the 2021-2027 programming currently underway. We have one billion ESF (this is still a good margin) and one billion ERDF (in the process of being exhausted). Often, a formal problem with these European programmes is that many of these training initiatives are not aimed at entrepreneurs but only at employees. When an enterprise is very small, it is in itself a major deficiency not to bring the entrepreneur into the classroom. Our training bodies are pressing very hard with the Region to have courses also for entrepreneurs. The opportunities are many, the problem (even with universities) is that there are not enough children. There is little supply and a lot of demand.

8. What tools or innovations do you think should be implemented and pursued to structurally address the problem of green transition-related skills shortages in SMEs?

Contini: Policies should be promoted to encourage companies to invest in projects related to the green transition. We see the great leaps in business when there is an industrial policy, which has been lacking for many years in Italy. When there was the Plan 4.0 (later Enterprise 4.0), it gave a huge shock: companies have digitalised and integrated processes thanks to systems and enabling technologies. When there is an

incentive (and a certainty in the time of this incentive), companies invest. At this moment this is missing. Transition 5.0 has proved to be an inadequate tool for SMEs, which have so far had a low level of spending. If there is no instrument that makes available certainty at the national level throughout the territory and gives prospects to companies who, knowing that they must invest, have a few years to do so. Transition 5.0, in addition to the wrong thresholds, also has the timing that was completely wrong. Companies do not have enough time to concretely realise the planned investments. Also, even with regard to the topic of photovoltaics, companies would be ready to invest in the technology, but the national measure for photovoltaics is just a few hundred million. There has been a well-designed industrial policy on the digital transition side, and if it were serious with also tax credits on the green transition, it would certainly lead to a general rise in the level of companies, which would ultimately affect skills. There is no industrial policy at the moment. So there is no long-term vision.

3.3.2 Interview with Giulia Pellecchia- Territorial Area Manager of Ferrara on behalf of CNA Formazione

1. What is it that drew ‘CNA Formazione’ to launch the Higher Technical Education and Training (IFTS) course to train a 'Product and Process Industrialisation Technician with a specialisation in green manufacturing’?

Pellecchia: First of all, we have been working on this profile for four years. The need arises mainly from a few large companies in the area with a greater sensitivity to environmental issues. The motivation was to try to insert a highly specialised professional profile, especially in a territorial fabric like that of Ferrara, which especially consists of SMEs tending to resist innovation, although there are a few exceptions, such as companies with well-established sustainability offices. The figure we went to form is not a professional profile with basic skills, and, moreover, the choices were made both in relation to the territorial condition and to the objectives and

strategies, both regional and European. What the Region asks us through public tenders is to introduce qualified figures based on the needs of the company, but above all it asks us to think in terms of what will be the needs of the companies and the entrepreneurial fabric today and for the forthcoming years. The choice was to specialise the figure on those who, both from a digital point of view and from the management skills' point of view, could effectively manage the sustainability process at 360 degrees. In particular, among the main tasks required of the profile in question are: warehouse management, production management, and waste management, the latter is a skill in great demand by companies, especially at the sectoral level. To do this, we have collaborated and still collaborate with companies with this type of sensitivity, especially at the university. In particular, we collaborate with the Department of Economics of the University of Ferrara, which has degree programs and a specific focus on corporate and manufacturing sustainability. We have turned to the manufacturing sector primarily. As partners, we have had companies in the mechanical, chemical, and plastic sectors, also with a size of 150 employees. The companies have made themselves available by bringing their own experience but also by hosting some of the students enrolled in the courses through internships. It should be stressed that, during the first years of the launching of the course, this figure was welcomed as a novelty with great enthusiasm also in terms of job placements. For example, a partner company with 30 employees decided at the end of the training course to hire two young people who had attended the course in question. However, it should be noted that one of the main critical points we register in our associated companies is that the timing for the effective start of these sustainability-oriented processes is still muddled. Most of the time, what happens is that the professional figure we seek to train is interesting in terms of the basic skills it brings to the company, but the process is still slow.

2. Behind the launch of this professionalising course is there also a demand for higher technical skills that comes from the firms themselves?

Pellecchia: Yes, of course. This is a request that is first addressed to the basic skills provided for by the IFTS profile, according to national specialisations, which is then

subsequently declined in a further specialisation, which is that of '*green manufacturing*.' Therefore, all the components of the training modules respect these requirements: from the minimum skills required by the profile to both technical and transversal skills that are precisely those of sustainability understood as a tool for business and innovation for companies. Our mission is to bring qualified personnel to companies that have not yet made this step towards greater corporate sustainability.

3. From the first edition of the course until today, what is the ‘identikit’ of the people who attended the classes?

Pellecchia: The majority of those interested in the course are holders of at least a bachelor’s degree, or in alternative they have previous work experience or a technical diploma with prior work experience. Indeed, this type of person has revealed to be the most in demand by companies. To be able to follow a path of this type, which addresses various topics, from the company organisation to how organising production, quality and control systems, and management of workflows, the perfect candidate and the one desired by the company is most of the time a graduate.

4. As CNA Emilia-Romagna and CNA Formazione, have you drawn on the funding provided through the 'New Skills Fund'?

Pellecchia: For companies that already had a clear and well-defined training objective, we worked on it as a system. We sent the application for our companies, as well as for CNA Formazione and CNA Emilia-Romagna. For the time being, we are waiting for the outcome and approval of the application before the submission of projects.

5. Is there anything that you think could be improved on in relation to the Fund in question?

Pellecchia: A possible criticality could be the timing and management by Anpal that could be improved: it often happens that a response to the company arrives long after the training need has already been met by the company with its own resources.

6. How would you judge the current ‘state of health’ of active labor policies in Emilia-Romagna?

Pellecchia: I think the current offer for 2021-2027 is relevant. For Emilia Romagna there was also a refinancing with regard to active labor policies, including the various clusters provided by the GOL programme. In addition, extremely important public calls were issued: from continuing training for companies to lifelong learning, IFTS and green related calls.

7. If you could highlight possible policy actions regarding the training of a workforce that can support the decarbonisation targets of our productive activities, what would you focus on?

Pellecchia: Overall, it will be necessary to focus more on the skills and competences related to the sustainability of the company because it is not only an issue of environmental impact but also, at a time when companies incur even important costs in terms of consumption (such as manufacturing companies), the development of a company management and attention both with regard to production itself, but also with regard to logistics and procurement strategies becomes essential. This is why, for 2025, we have decided to propose within the IFTS related to the green a new project based on an even more specialised profile, because, with regard to both the standard IFTS profile and specialisation, it will be a technician of the programming of the production but also technical logistics planning. Currently, there is increased attention to the theme of the so-called ‘intermodality’ as a strategy to have less and more strategic impact on the environment. In addition, we will continue to work on the development of skills and digital systems that can be introduced in the company, so as to streamline processes and be able to think about strategies with less impact not only from an environmental point of view but also from a business point of view. It is therefore a question of understanding the advantages associated with the application of this type of approach. At the moment we are also thinking about 'simplified logistic zones', which are areas where companies operating there can actually get tax advantages, but also advantages in hiring additional workforce. So in this sense, 'thinking green' also brings an economic

advantage to the company. This is a bit of what we are aiming for to do what we said at the beginning, to ensure that the more forward-looking companies can be the driving force behind and make the benefits of investing in innovation for green transition understood even by those firms which have either not done so or have done a small part.

8. As for the so-called 'micro-credentials,' do you use them or have you used them in the past?

Pellecchia: At the moment we are working on sustainability and credit paths, that we are developing with the CRIF group in Bologna and these courses touch on different topics, from sustainable supply chain to sustainability in communication and how a company can communicate sustainability, to sustainability reporting. They are courses ranging from three to four hours and want to be pills to raise awareness on these issues. Now the 'Call for ICT and Green Skills' has just been approved by the Regional Council of Emilia-Romagna, and we will also work on this on routes that will go from about 36 to 48 hours. There are courses that can be accessed by both the employed and the unemployed, and it is also planned to include a small specialisation designed on the themes of accompanying corporate sustainability. Therefore, as CNA Training we follow the demand of companies, but also trying to achieve the objectives set by the European and regional strategies, Therefore trying to keep in mind not only the needs of the moment but try to think and invest on what will be needed in the coming years.

3.3.3 Interview with Rosamaria Papaleo- Secretary of CISL Emilia Centrale

1. As part of the 2023/2024 European Year for Skills, the European Commission's Directorate-General for Employment and Social Affairs (DG EMPL), in partnership with Eurobarometer, released the results of its own survey dedicated to skills shortages in small and medium-sized enterprises (SMEs), which confirmed how skilled workers are a key element for European SMEs. Specifically, nearly 40 percent of SMEs cited skills shortages as an obstacle in finding a highly skilled

workforce to support the company's internal green transition. In the case of CISL Emilia Centrale, do you share these results? If yes, could you indicate some of the main difficulties linked to the lack of 'green skills' in the territory of Central Emilia from the point of view of your trade union organisation?

Papaleo: CISL Emilia Centrale shares these findings. We believe that one of the main factors contributing to this skills shortage is the insufficiency of STEM graduates: the lack of science, technology, engineering and mathematics (STEM) graduates is a factor contributing to the green skills shortage, because many of the skills required in this field are related to these disciplines. As a trade union, we must remember that the approach to sustainability at work is translated into a set of practices that promote the dignity, well-being and rights of the workforce, respect the environment, and contribute to sustainable economic development. This means adopting transparent behaviour, meaning promote the respect of diversity and inclusion, ensuring safe working conditions, as well as fair wages and opportunities for professional growth.

2. What are, if any, the major social and employment consequences of the lack of 'green skills' in the territorial area that your trade union represents?

Papaleo: The lack of green skills in the provinces of Modena and Reggio Emilia is adversely affecting the labor market and the process of ecological transition. It is essential to invest in more training opportunities and qualification of staff, such as promoting school orientation towards green jobs and encouraging collaboration between schools, companies and training providers to bridge this gap and promote further sustainable development of the territory. Furthermore, green skill shortages can contribute to exacerbate social inequalities, as less skilled workers are at risk of being excluded from the new employment opportunities offered by the ecological transition. In addition, limited access to credit is an additional barrier for SMEs to invest in green technologies. Nevertheless, many companies have made investments in sustainable areas, demonstrating a commitment to green transition. To face this challenge, I think of the launch of projects such as 'Free Energies' (‘Energie Libere’) in Modena, which

involve young people in training activities on environmental sustainability and bring them closer to the world of work through the promotion of green entrepreneurship.

3. There have been, or are currently being, initiatives promoted by CISL Emilia Centrale - or to which it has joined - to support the training and/or retraining of the workforce you represent, In view of the green transition in the local context?

Papaleo: Yes! We can recall the following initiatives: Summer Camp for the Ecological Transition - organised in collaboration with Unindustria Reggio Emilia, the Universities of Modena and Reggio Emilia and Ferrara, and EduIren. The summer camp offered educational workshops and guided tours on topics such as alternative energies, recycled materials and green design. It is aimed at students of the 3rd and 4th year of secondary schools in the province of Reggio Emilia. Furthermore, I can mention the course on Sustainability Budgets - The CISL National Study Centre offers a course for trade union leaders, focused on reading and interpreting corporate sustainability budgets. The aim is to strengthen union participation in the ecological transition and collective bargaining. There was also the training course organised by the national CISL on ‘The just. transition: policies, tools, paths' from 12 to 14 September 2022 at the Centro Studi CISL in Florence, in collaboration with the European trade union CES and the European trade union training centre ETUI. The topics covered were: supporting trade unions in undertaking; initiatives for a sustainable future at company/sector level through social dialogue. In January 2025, the CISL Emilia Romagna organised a training course in collaboration with the University of Bologna on the European sustainability directive that deepened the topics related to: the functions of the sustainability budget. The mandatory sustainability reporting according to D.lgs. 125/2024 and ESRS. The IAL Emilia Romagna, a vocational training institution and an integral part of the CISL, offers training courses for young people and adults in various sectors, including mechanics, catering, aesthetics and ICT. The courses are designed to improve professional skills and promote employability, with a focus on innovation and sustainability, such as the training course on Skills for the Digital and Green Transition of the ICT Chain. In addition, CIS Training offers free courses, funded by the European

Social Fund+, to develop digital and green skills in the ICT sector. The routes, with a duration of 32, 48 or 64 hours, are available in person or online and are addressed to residents or domiciled in Emilia-Romagna.

4. CISL Emilia Centrale promotes, or has promoted in the past, partnerships with local and national training institutions to encourage the integration, training and retraining of green skilled workers, in particular in line with the objectives and guidelines addressed to social partners, including trade union organisations, contained in the 'European action plan against labour shortages and skills' published by the European Commission in 2024?

Papaleo: Yes, CISL Emilia Centrale has promoted and continues to actively support partnerships with local and national institutions to encourage the integration, training and retraining of workers with green skills. We can list some projects: Agreement with Fondimpresa for the Green Transition, regional project Competences for the Green Transition. There have also been proposals for training in the meat processing sector: The FAI CISL (trade union of the agri-food sector) Emilia Centrale has proposed the creation of an academy for meat processing, with the aim of providing young people with new skills and professionalism. The project aims to raise awareness of environmental sustainability, waste reduction, circular economy and food safety. Although not specifically focused on green skills, the initiative highlights CISL's commitment to promoting sustainable practices in the agri-food sector. I remember also company agreements with focus on training and safety - The FAI CISL Emilia Centrale has reached agreements with six companies in the Modena agri-food sector, allocating more than 6 million euros to 3,770 workers for training, safety, welfare and new rights. These agreements, while not specifically oriented towards green skills, reflect the CISL's commitment to improving working conditions and promoting continuing training. In summary, CISL Emilia Centrale has undertaken several initiatives to promote the training and retraining of workers with green skills, collaborating with local and national institutions and with the business world. These actions demonstrate a concrete commitment to ecological transition and sustainability in the world of work.

On the institutional side to address this challenge, the Emilia-Romagna Region has signed a memorandum of understanding with the National Agency for Active Labour Policies (ANPAL) to develop green skills. The aim is to create, re-train and adapt skills to support the ecological transition and promote sustainable growth.

5. Are there currently regional and national training and support programmes or tools for the workers represented by CISL Emilia Centrale, aimed at supporting them in the process of specialisation and/or retraining within the context of climate and environmental transition? If so, do you think they are adequate to meet the challenge of the green transition?

Papaleo: In Emilia-Romagna, the Region funds green training programmes to develop skills in environmental sustainability, with courses ranging from basic training to post-graduate specialisation. These courses, which are also financed by European funds, are organised by accredited training bodies and are aimed at graduates and workers. At national level, the focus on green training is an integral part of the European Green Deal and other European programmes. The National Recovery and Resilience Plan (NRRP) supports green training projects, contributing to the transition towards a more sustainable economy. With Fondimpresa, which is a fund dedicated to the continuous training of employees of industrial enterprises born from agreements between Confindustria and Cgil, Cisl and Uil, a Notice 5/2024 - Training in support of the Green Transition and the Circular Economy has been created. With the Notice no. 5/2024 "Training in support of the Green Transition and the Circular Economy in the participating companies", Fondimpresa finances shared plans aimed at training workers in companies participating in the Fund who are implementing a project or intervention of Green Transformation or Circular Economy within their own activities. The objective of the training plan is linked to Green Transformation interventions in the participating enterprises that relate to the introduction of new strategies, products and/or processes, or a substantial improvement of existing ones, requiring in one or more stages of implementation the training of the workforce concerned. In addition, in Modena and Reggio Emilia there are numerous free and funded courses for the retraining of green

and digital skills, aimed at workers, professionals and companies. For example, the course funded by Formart (training institution linked to Confartigianato), for 'Technical Expert in the Management of Systems for Environmental Sustainability' might be an example. There are also Circular Economy projects or interventions in member companies that involve the introduction of new strategies, products and/or processes or a significant improvement of those already existing, and which require, in one or more stages of implementation, training of the staff concerned. In addition, with the Aldini Valeriani Foundation, training courses dedicated to the acquisition of specific skills have been planned: Digital & Green Transition for the Mechanical Industry, aimed at the sectors of Mechanics, Mechatronics, Motor Engineering and Biomedicine.

6. What points of improvement would you like to highlight regarding the need to acquire more and more skills related to environmental sustainability in the territory that you and the trade union organisation represent?

Papaleo: Green economy means first of all a greater empowerment of the economy and industrial activities with respect to the rights of happiness and prosperity of future generations from the enjoyment of the basic good of human existence that are natural resources: from the quality of air, to the quality of water resources, to the quality of food resources that biodiversity offers us. This is also why CISL has collected signatures for a draft law on participation, to create industrial relations that are ever closer to the needs of workers and with a greater sense of responsibility and competence also to address the theme of transitions, energy, green and digital. Industrial relations in the Green Economy can be a laboratory of excellence for quality development, capable of guaranteeing the proper use of natural resources and materials, the development of human resources and the creation of value useful to the balanced remuneration of the capital, the human resources employed and the local community of the territory belonging to and operating. The role of the trade union has sometimes been that of 'protagonist', able to conceive first original proposals in favour of sustainable development, while in other cases the primogeniture of innovative projects is attributable to company management or local institutions. But in all cases the role of the

trade union must be to accept the challenge and propose itself as a partner for change, grasping and exploiting the synergies between quality of work and quality of industrial processes, also from the point of view of environmental sustainability: In short, it is no longer necessary to contract the quality and quantity of work in the company, but also to deal with ‘what’ is produced (sustainable products "from cradle to grave") and ‘how’ is produced (production processes and their impact on the environment). We must follow the path of mobilisations for health and safety at work. Throughout Europe, thanks to the importance of the issue of health protection for workers, we have obtained the establishment of a specific representation of workers, with specific rights and spaces for information, training and trade union initiative in the workplace. The environment will also need to be directly represented by employees at work. The experience of the national contract of the Italian workers in the chemical sector that has unified in the Safety Worker Representative also the representation of the environmental protection rights of the territory by the workers, may be a useful guide to be extended on a European scale. Taking as central the environmental theme, the role of the trade union is enriched by new and more important responsibilities, and pushes to use an approach of "Climate policy mainstreaming", as established by the strategy ‘Europe 2020’. In this sense, a new trade union culture (with respect to environmental issues) should be visible at the level of general strategy of the unions, and should "cross" all the policies dealt with by the trade union (labor, investment, human rights, globalisation, etc.). We cannot confine the environmental issue as if it were simply a new negotiating theme in addition to the traditional ones, since it is pervasive and tends to influence whatever topic we are called upon to discuss. If we are talking about work, we must ask ourselves how to promote the ‘just transition’ and thus ensure a bridge between old and new trades and professional roles even in traditional sectors (to be "re-inverted") and those with a higher environmental impact; If we are talking about investments, we must be careful that until the design of new plants and new production activities is given due attention to their full sustainability in the use of primary resources and in the management and recycling of packaging, waste; when we talk about human rights and globalisation, we must not forget the universal value of the ecological issue, and we are therefore

committed to preventing relocations from becoming an easy route for the transfer of highly polluting productions and unhealthy or dangerous jobs to weaker countries, as well as the health and safety of workers and local communities.

3.3.4 Interview with Tommaso Termanini — Territorial Articulation Coordinator at Fondimpresa Emilia-Romagna and Training, Human Capital, Labor Area Officer at Confindustria Emilia-Romagna

As also mentioned by Rosamaria Papaleo, Fondimpresa is the largest inter-professional fund in Italy that promotes continuing training for the workforce. It is a nonprofit association established by the Interconfederal Agreement signed by Confindustria, CGIL, CISL, and UIL on January 18, 2002, to promote continuing vocational training in pursuit of business competitiveness and worker employability. The mission of Fondimpresa is financing corporate, sectorial, and territorial training plans shared between the social partners, which adhering companies decide to implement for their employees.

1. How does Fondimpresa Emilia-Romagna support lifelong and continuing education of companies in the area with respect to the topic of ecological transition?

Termanini: As Fondimpresa Emilia-Romagna, we receive the training projects that companies submit to us. In particular, through the promotion of thematic calls that are repeated year by year, we give attention to the theme of ecological transition. So we are the financing entity for the training courses that companies apply for. In fact, for several years now Fondimpresa has been publishing a Notice dedicated to sustainability and the green theme, the so-called "Formazione a sostegno della Green Transition e della Circular Economy nelle imprese aderenti".[68] Through this Thematic Notice dedicated

[68] The latest Fondimpresa Notice aimed at financing the training of workers in Fund member companies that are implementing a Green Transformation or Circular Economy project or intervention as part of their activities is available here: Avviso 5/2024 - Formazione a sostegno della Green Transition e della Circular Economy

precisely to the Green Economy and Circular Economy Fondimpresa Emilia-Romagna intervenes in a twofold way: that is, with a line of funding dedicated to specific projects of the individual company that wants to invest in green technologies and organizational models, but it also does so in an aggregate form, in the sense that it allows companies to develop shared paths on issues of common interest. In this sense, it ends up directing training policies related to the greening of enterprises and facilitates any latent needs in company choices. In fact, we note how the issue of sustainability is still perceived to be distant from the priorities of many companies, even more so if we are talking about SMEs. Therefore, through these initiatives that allow for bringing together different realities, stimulating them, and inducing them to reflect on a type of need and how strategic it can be to invest in certain skills and training interventions, I still consider it a policy that directs companies toward a greater sensitivity and attention to green issues.

2. What is the general profile of companies that typically respond to the Notices published by Fondimpresa Emilia-Romagna?

Termanini: The core of Fondimpresa Emilia-Romagna members are often medium/ large companies, although there are often many SMEs. Once the company responds to our periodic Notices, we view the titles, contents of the individual company's training programmes, and thanks to this data our internal observatory is able to estimate possible trends for the period with respect to the needs expressed by the companies. In addition, among our various activities, we periodically conduct a series of direct interviews with companies. The main objective of the interviews is to understand what kind of training the company has decided to undertake, for example, with respect to the topic of sustainability. We thus receive first-hand information directly from area companies regarding their training needs and whether and how the company was able to fill them thanks to Fondimpresa support. In addition, we have in Fondimpresa the so-called 'Training Account' (Conto Formazione): this is an individual account available to Fondimpresa member companies, which allows them to manage the financial resources - paid and set aside - for the training of their workers directly online, autonomously and immediately. What emerges from our analyses is that investments related to ecological

transition are unfortunately not yet the most present. In fact, as hours devoted to training, we are around 2 percent. There are several macro-areas available to companies and on which they can decide to invest in training, including one related to 'environmental impact.' The latter we understand to be the one that is rarely chosen by adhering companies to Conto Formazione. However, these are only categories, so this does not exclude that when it comes to personal skills or production techniques there may not be a focus on developing green technology.

3. Do you recall cases of particularly virtuous companies on the sustainability training side?

Termanini: Yes, there have been some companies that have particularly distinguished themselves on the green training side. Recently, among the companies that adhered to our Circular Economy Notice, there was a textile company in our area consisting of 300 employees that decided to invest heavily in different training activities dedicated to its employees regarding the topic of sustainable textiles, such as the use of raw materials and cultivation techniques that are more eco-sustainable and less impactful on the environment. This led to the definition of ad hoc professional figures, and we were able to note how this greater initiative of the individual company then aroused in several operators, both technicians and research and development figures in the area, a greater awareness of the need to orient the entire production cycle towards a more sustainable perspective. Moreover, the textile company in question was thus able to inaugurate its first sustainability report. Moreover, for what is our perception of the area, although there are few companies that invest heavily in green transition-side training, those few, however, that do invest in the continuous up-skilling to support the green transition are very focused on the issue at hand. In fact, for the latter companies, training is the strategic lever and focus of the entire business, even going so far as to influence employees' orientations and approach to work, as well as the philosophy and mission of the company itself. The exercise that we observe on the part of the largest companies at the training level thus results in more training initially ‘sprinkled’ over a large part of the company's population and then going on to change people's outlook and make

people adhere to the company's philosophy. Often, all this results in more or less direct repercussions on their sub-supply chain, and in this way they are able to reach and influence even smaller companies' training choices.

4. Could you mention, from your perspective, the main critical issues related to the current approach toward continuing education to counter the green skills shortage?

Termanini: We still detect little awareness and little ability to understand how strategic the green transition argument can be for a company and consequently investments in the training of ad hoc professional figures. First of all, there has been a great difficulty in finding professional profiles of all kinds to be placed in companies for a few years now. Moreover, with the shrinking population, the trend is bound to worsen in the coming years. Then there is an issue related to the ability of the enterprise to make itself attractive. In the case of the Emilia-Romagna region, despite a very high level of employment, there are still a number of companies in need of skilled labor, and this forces them to compete for the most in-demand job profiles among themselves or pushes them to attract additional talent from abroad. In addition, we still detect low in-house training within the enterprise. With particular reference to SMEs, attracting a young person coming out of any kind of education is not easy. For example, in our manufacturing fabric, which is purely engineering, there are thousands of small and medium-sized engineering companies that no one knows about, but they are highly specialized and are part of subcontracting chains of large companies, such as Ferrari or Maserati, but the student often knows only the large companies. I believe that sensitivity to the green theme and respect for the environment have grown a lot in recent years, especially in younger generations. At a time when these small and medium-sized companies find themselves having to attract a young graduate or recent graduate to their companies, already showing that they are attentive to these values is the first way to better engage the younger generation entering the world of work. I think it's much more attractive for a young person who has to choose a company whose history he or she doesn't know to leverage as a first step the communication of all those aspects related to the vision and values of 360-degree sustainability on the part of the company. We note

that there is, in fact, a greater awareness on the part of the younger generations not only for professional profiles explicitly aimed at the green sphere (such as energy engineer, or environmental engineer) but also for other professions. However, I believe that there is still a lack of attention toward the training of highly specialised professionals such as, for example, that of a circular economy specialist. Attention to these jobs is mainly lacking as an approach of the companies themselves with respect to the topic of circular economy and the lack of their adherence to a new paradigm, with very few exceptions. However, the fact remains that, somewhat induced by European regulations and somewhat by constraints related to clients or the markets in which companies invest, there is a training component that cannot be properly defined as 'green' but nevertheless has a connection to issues of ecological transition, such as ESG certifications, certain types of production design, or the issue related to waste disposal and recovery. A further critical issue concerning the industrial policy approach, especially at the European level, is the current exclusion of training aid from state aid, as there are still ceilings that companies cannot exceed, and this is a huge bureaucratic constraint that companies often impact.This is also one of the reasons behind the current low awareness of continuing training at the regional level. Therefore, existing limitations related to state aid for training inevitably lead to the exclusion of the ability, particularly of SMEs, to plan and invest further in the training of their employees.

5. You are also Head of Training, Human Capital, Labor Area at Confindustria Emilia-Romagna. What is the position of Confindustria Emilia-Romagna with respect to the issue of training related to the green transition?

Termanini: At the association level, on the Confindustria Emilia-Romagna side, the issue of sustainability is definitely central to the support we provide to businesses. In fact, in the dialogue with the region, the issue is very central. However, I don't deny that it is very arduous, especially at the level of sensitivity of companies, sometimes even the larger ones, to make them understand the strategic value that a larger investment made today can bring more customers and more savings tomorrow. The impression is that the issue focuses more on training in specific macro areas such as waste

management and the topic of photovoltaics. Thus, the circular economy design from design to reuse is still a topic that is not given much attention. There are still few investments, and those that are there are at a level of complexity that is still too low and generic from the point of view of raising awareness among the corporate population. Fairly generic courses are still being provided, which can be taken by any citizen, and the course is very often not related to the specific professionalism of the training recipient in the company. Conversely, of the specific training to people something is there, such as the training initiatives previously mentioned and funded by Fondimpresa, which also train profiles that deal with product design. However, there is more of an attempt to try to create those highly specialised figures at the regional level, which still almost do not exist, and this is also being attempted thanks to the contribution coming from IFTS courses and ITS Academies. ITS and IFTS respond fairly quickly to a need for vocational profiles that is double or triple the output of the profiles on average, so the demand would be much greater.

3.3.5 Interviews' takeaways

From the interviews conducted, respectively, with the leading employers' organisation for SMEs and artisans in the Emilia-Romagna region, that is, CNA Emilia-Romagna; the regionally accredited training and employment agency of the CNA system, i.e., CNA Formazione (Ferrara headquarters); with the Territorial Articulation Coordinator at Fondimpresa Emilia-Romagna; and with the trade union CISL Emilia Centrale (which represents and protects workers and retired people in the provinces of Modena and Reggio Emilia), interesting insights emerged regarding the phenomenon of the green skills shortage on both the entrepreneurial side and workforce representation in the Emilia-Romagna region.

From the first interview, that with Marcella Contini, several interesting key takeaways can be grasped. First of all, CNA Emilia-Romagna agrees with recent European data

showing that skills shortages, especially for green and highly specialised skills, represent a relevant obstacle for SMEs, particularly those with less than 20 employees. Nonetheless, according to Contini, there currently seems to be a growing sensitivity among SMEs toward sustainability and green transition, mainly driven by larger companies operating in the territory, as well as supply chain requirements and the increasing importance of ESG (Environmental, Social, and Governance) criteria in access to credit. Another interesting insight that emerged from the discussion is that the majority of CNA-associated SMEs already embrace good levels of sustainability practices. Nonetheless, a relevant flaw is their inability to effectively communicate them to external stakeholders and the general public, thus missing opportunities for further recognition in finance and the credit system. In this regard, the main strategic approach that CNA Emilia-Romagna decided to adopt is raising awareness and trying to codify SMEs' established sustainable practices. To do so, an assessment tool aimed at analysing the level of sustainability of CNA's associated companies has been developed by CNA Emilia-Romagna. Through direct interviews with local entrepreneurs, the main assessment's aim is the identification of areas for improvement, especially with respect to SMEs' level of performance on ESG dimensions. Then, the results obtained allow CNA to offer targeted support services, either directly or with external partners. I believe that the introduction of either sustainability or skills assessment tools, especially at the sectoral level, and the subsequent tailored support to SMEs (depending on the results obtained) should become a structural ingredient behind each policy that seeks to tackle the emergence of green skill shortages affecting the workforce. Furthermore, from the perspective of the nature and causes of green skill shortages, CNA Emilia-Romagna's point of view is clear: CNA's associated SMEs, especially less structured ones, are currently struggling to find skilled labor for the green transition, especially in both the construction and manufacturing sectors. Additionally, the shortage is further exacerbated by demographic trends, such as the process of an aging population combined with fewer young workers. In this regard, a major challenge besides that of green skill shortages is that of 'talent retention,' i.e., the ability of companies (especially SMEs) to not only invest in the training of their talents but also then know how to retain

them in the organisation in the long run. From a regulatory perspective, Emilia-Romagna is at present the only Italian region to have enacted a law for talent attraction and retention. In fact, the main objective of Regional Law 2/2023[69] is to contribute to the competitiveness of the Emilia-Romagna system by promoting the attraction, permanence in the territory, and enhancement of highly specialised young talents. 'Talents' are understood to be people who have gained (or are gaining) knowledge and experience of particular relevance in areas of research and innovation. This law is part of a wide range of initiatives already undertaken in previous years by the region, such as the development and strengthening of the regional skills intelligence system for the joint processing and dissemination of information regarding labor supply and demand. The tool is particularly aimed at education and higher education providers to encourage the updating of training courses in line with regional labor market needs. I believe that, especially through the use of the ESCO (European Skills, Competencies, qualifications and Occupations) classification to identify and categorise occupations, this project is of particular interest at the national level as a best practice for the creation of an integrated information system for skills needs analysis. And in fact, it is thanks to the analysis of the more than 378,000 advertisements published between April 2022 and March 2023 and the implementation of the ESCO classification, that the profiles with the highest degree of difficulty of finding at the regional level could be identified: specialised engineers, mechanical engineers, and electronic engineers.[70] From the discussion, Contini also highlighted the unfeasibility, especially on the side of smaller companies, to personally invest in the training and subsequent induction of newly emerging occupations such as that of the 'environmental manager.' Therefore, a potential solution could be the introduction of a shared 'innovation manager' (a professional figure already existing in many corporate realities) with a special focus on greening the company's processes across multiple SMEs. Of the interview, what positively surprised me is the

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[69] See more at: LEGGE REGIONALE 21 febbraio 2023, n. 2
The interventions under the law are financed through the European Structural Funds, particularly for training, employment, and housing, and with resources from the regional budget.

[70] Find out more at: Skills Intelligence Emilia-Romagna presenta i profili professionali e ad alta specializzazione più ricercati sul territorio

constant dialogue between CNA Emilia-Romagna and the universities located not only in the region but also with those operating throughout the national territory, and from whose collaboration resulted projects that have involved additional universities and research centres operating at the European level on issues related to sustainability. Nonetheless, Contini points out that among the main weaknesses that especially discourage small and medium-sized enterprises represented by CNA Emilia-Romagna from making further investments in skills is the lack of a forward-looking and long-term industrial policy at the national level. In fact, when we talk about industrial policy, it is a mixture of different policies, among which there is also the ability to provide training and advance investments towards the skills of the future. As a matter of fact, there might be companies, especially SMEs, that are not able to understand which kinds of investments they have to make and what skills they need for their workforce. In this regard, to further support SMEs, it would be particularly useful to be able to refocus the Transition 5.0 Plan clearly on the industrial system by stabilising resources and tools over time as well as effectively strengthening it on the skills development side, which still appears to be the one most lacking. Therefore, a structured national industrial policy should seek to identify the most critical gaps in terms of skills needed to support the twin transition (digital and green).

The second interview with the Territorial Area Manager of Ferrara on behalf of CNA Formazione, Giulia Pellecchia, allowed me to discover an insightful IFTS course launched in 2021 by CNA Formazione Emilia-Romagna (Ferrara headquarters), which has since then decided to invest in the training of a ‘Green Industrial Production Technician,’ an essential figure in high demand by several companies operating in Ferrara and surroundings. As a matter of fact, as highlighted by the Excelsior Information System Bulletin (Unioncamere-Anpal, 2021), among the occupations most difficult to find by companies are precisely technicians in the management of production processes of goods and services (67 percent), on a par with artisans and skilled workers in construction finishing (67 percent). Through the additional specialisation in ‘green manufacturing,’ the new professional figure will then be able to

monitor all processing steps in the various production processes from the perspective of sustainability. And it is the further specialisation of the profile that will enable the implementation of green-oriented solutions through the management of technologies for energy efficiency, waste reduction, and digital control of management and production. As Pellecchia mentioned, the need to train such a professional role stems from a number of critical issues related to the presence of limited production chains and the saturation of the local market, far from the larger production sectors, which require local companies to transform production processes and make them more modern and sustainable. Therefore, companies in the area demand technicians who can protect the entire production process, squeezed between rising production and transportation costs and the speed with which competitors invade the local market. Today, in fact, there is a need for highly skilled workers, young and often women, trained on a new concept of production that allows, with adaptive and integrated technologies, to increase the speed of production, reduce waste, introduce new materials, and adopt new ways of working. Additionally, during the interview with Giulia Pellecchia, the close collaboration between CNA and the university ecosystem for the organisation of the course emerged. As a matter of fact, what emerges is that companies are increasingly aware of the need to continuously update the skills of their employees to keep up with technological changes and market dynamics. In this context, educational institutions (universities, vocational schools, training centres) can play a crucial role, offering continuing education programs, specialisation courses, or master's degrees on emerging topics. Within a context like that of Ferrara, where the majority of companies are small and medium-sized and therefore have less spending capacity, collaboration with the education and university system is vital to encourage even more investment in continuing education for their workforce. As a matter of fact, it often happens that SMEs do not dispose of their own training departments, and thus, linking in-company trainers to researchers from universities or other educational institutions is key for updating the way the enterprise conducts its workforce training process, such as through apprenticeship opportunities. In this sense, in-company trainers can be guided by university researchers and schoolteachers by focusing on the skills that most need to be

further trained, especially in emerging fields such as that of sustainability. Collaboration with universities and research centres can also be useful to in-company trainers since they can leverage this external support to shape internal training plans to drive and develop skills for the green transition within the workplace. In addition, such collaboration also enables universities to improve the reputation and quality of their curricula and attract funding and resources for research and support for their students. Overall, the picture outlined within both the interviews suggests an evolving path on the side of small and medium-sized enterprises in the Emilia-Romagna region toward greater sustainability, but also the need for more integrated and targeted interventions to accelerate the spread of green jobs, green skills, and eco-sustainable initiatives throughout the national territory.

From the point of view of those engaged in the protection of workers and pensioners, in this case the CISL Emilia Centrale trade union, which mainly operates between Modena and Reggio Emilia, green skill shortages are not only firms' issue but also a social and labor concern. During the interview I had with the Secretary of CISL Emilia Centrale, Rosamaria Papaleo, a number of her remarks caught my attention. First of all, Papaleo confirms the concern that emerging green skills shortages are currently posing within the social and business fabric, especially in the Modena and Reggio Emilia area. Particularly, she indicates the lack of STEM graduates as a structural bottleneck, which has repercussions not only from a lacking skills standpoint, but also from a social perspective. In this regard, one of the major risks is linked to the possible exclusion of less qualified workers from new job opportunities, as well as the exacerbation of the existing inequalities in the Italian labor market. This is not a surprise, since previous research indicated that, although Italy has already allocated €59.46 billion in investments from 2021 to 2026 to support the green transition through both its NRRP and other national strategies (Giulia Lanfredi et al., 2022), still, the pool of skills in Italy currently demonstrates to be insufficient to adequately meet future demand. As a matter of fact, if not well managed, the green transition on the side of jobs and inclusivity risks completely excluding the less qualified workforce from further upskilling and reskilling

opportunities. In this regard, Papaleo reaffirms the crucial role played by trade unions in further underlining the importance of just transition principles when tackling green skills shortages in the local context. Through a series of projects CISL Emilia Centrale has joined in the past (such as the project ‘Energie Libere’ in Modena, which sought to introduce young people to green entrepreneurship, and in training activities on environmental sustainability); the signing of partnerships with regional vocational training institutions (such as in the case of IAL Emilia Romagna) to launch training courses for young people and adults in various sectors (ranging from mechanics, catering, aesthetics, and ICT) with a focus on innovation and sustainability (such as the training course on Skills for the Digital and Green Transition of the ICT Chain), what emerges is a proactive approach taken by the union in actively supporting workers throughout the ongoing transitions, as well as reinforcing the need to invest towards a culture of continuing education over the long run. Among the possible points for improvement, according to Papaleo, on the green transition topic, unions should focus the debate on not only fair wages and opportunities for professional growth but also on ‘what’ is produced (sustainable products "from cradle to grave") and ‘how’ it is produced (production processes and their impact on the environment), eventually making sustainability a cross-cutting concept permeating all union strategies. In terms of policy recommendations, this would mean, for not just regions like Emilia-Romagna, but for Italy also, the ever-growing need to build and support a skills ecosystem that aligns with both local specificities and European ambitions.

From the interview with Tommaso Termanini, the strategic role played by Fondimpresa Emilia-Romagna as a support for companies’ training strategies emerged, specifically thanks to a series of specific calls for applications this financing body for companies’ training projects launches periodically. In particular, the focus of Fondimpresa on environmental issues, which now finds expression in the latest published Notice 5/2024 —“Training in Support of the Green Transition and Circular Economy”—is one of the Fund's cornerstones. As a matter of fact, while the Notice to Support Companies'

Investments in Training for Green Transition comes in at its fourth edition, ‘Environment’ notices have been published by the Fund since 2009, demonstrating sensitivity and foresight to an issue central to contemporary society. Through this opportunity, Fondimpresa finances the implementation of Shared Training Plans aimed at training the workers of companies that are members of the Fund and are implementing a Green Transformation or Circular Economy project or intervention as part of their activities. It can be seen as the relevance of this initiative finds further confirmation in the results of a recent ISTAT survey (2025) that reports that more environmentally conscious firms report significant improvements in profits, open new markets, and increase value added, as well as employment. What surprised me is that, despite the availability of funds, there are still few companies that decide to dedicate training hours to green skills development. Nonetheless, as in the case of the reported textile firm having 300 employees, once the decision to heavily green the whole production (in this case via investments toward more sustainable textiles and through different cultivation techniques) was made, not only new professional profiles and greater awareness among companies’ employees emerged, but this also influenced the choices of this firm’s sub-suppliers (which are mainly SMEs) of the territory. This is what also confirmed Marcella Contini, from CNA Emilia-Romagna, when she affirmed that the majority of SMEs represented by CNA are already committed in meeting sustainability requirements, mainly due to large players’ investments for whom they work toward green transition. As a matter of fact, she also recalled that in some sectors more than others, such as fashion or manufacturing, SMEs in the Emilia-Romagna territory are particularly called upon to do that. Therefore, it can be seen that thanks to these ‘virtuous’ cases, training has the potential to become a valuable asset to companies’ strategy, thus benefitting not only employees’ skills but also the wider local supply-chain ecosystem. Nonetheless, a drawback that emerged from the interview is the current lack of attention to training highly specialised green roles, such as that of circular economy specialists. Conversely, the majority of training still provides pretty basic and generic skills that everyone can acquire, rather than being training programmes devoted to filling specific professional needs. It thus emerges the need to

widen the launch of targeted programmes for specialised green roles to be also developed transversally, that is, in every sector and at every career stage. In this regard, the introduction of flexible learning pathways, in the form of micro-credentials or the launch of IFTS programmes could be seen as suitable options (among others) to quickly respond to vocational profile needs. Nonetheless, the promotion of partnerships between VET providers, universities, and firms to collaborate on shared green skills training needs throughout the sectors is key in the long term.

CONCLUSION

What training and skills policies are needed in Europe, and especially in Italy, to address green skill shortages?

In conclusion, attention to the environment remains central to the various initiatives regarding the ecological transition that the European Union has undertaken in recent years. Although there remain some perplexities raised by the latest decisions and guidelines issued by the renewed Commission led by Ursula von der Leyen regarding the environmental issue, there is no backtracking on the goals of decarbonisation and climate neutrality. Still, currently, implementation of these major objectives is being postponed to planning interventions, regulatory reforms, and substantial investments that, in the current scenario, seem increasingly difficult to implement, especially following the recent decision to commit both to national and European defence efforts. Moreover, it seems clear that both decarbonisation and circular economy goals identified in the recently approved *Clean Industrial Deal*[71] cannot be separated from European industrial policy, confirming—in concrete terms—the need for policies aimed

[71] Approved by the European Commission last February 2025, the *Clean Industrial Deal* is an important step for the Union because it represents a further component toward the development of a European industrial policy.

at increasing integration among the different members of the Union and for targeted support for climate and environmental goals.

As sustained throughout this thesis, achieving the climate goals agreed upon across the European Union requires a workforce with environmental and sustainability skills in every sector of the economy. Particularly, both ‘technical’ and ‘transversal’ skills to support the workforce throughout the green transition are needed. As for the first case, these involve the ability to adapt and implement processes and technology, as recognised by the definition provided by Cedefop (2021). Regarding ‘transversal’ skills, these include a more holistic approach, since they are mainly linked to thinking and acting green (*ibidem*). In this regard, a strong Technical and Vocational Education and Training (TVET) should be a relevant piece of the puzzle for the training of a skilled workforce that supports the shift to a greener economy. Nonetheless, as discussed throughout this contribution, the supply of workers having the right skills to further advance the green transition currently seems insufficient throughout Europe. In this respect, I have chosen to devote my attention to the pressing issue posed by the shortage of skills necessary for a smooth ecological transition in Europe and, specifically, in Italy, i.e., green skills. As a matter of fact, shortages of skills related to clean sectors had already been found among the factors hindering the decarbonisation of the European industry.

In particular, the green revolution has become focal for Italy's economic recovery, and as a result, businesses are also finding themselves needing to enhance and increase these skills. As highlighted throughout this thesis, possession of green skills is sought by nearly 80 percent of occupations in Italy, with the goal of enhancing actions with a view to eco-sustainability (Unioncamere-Anpal, 2021). Therefore, green skills will be in increasingly widespread demand. As a matter of fact, in the next five years, both companies and the public sector will require 2.4 million employees to possess aptitude for energy conservation and environmental sustainability, and for 60 percent of these, such skills will be required at a high level.

Mario Draghi's recent report, ‘The Future of European Competitiveness,’ presented to the European Commission and published on September 9, 2024, provides an in-depth and critical analysis of the competitiveness of the European Union, including offering a special focus on the importance of training and skills development within member countries. Draghi says that the EU’s competitiveness should no longer depend only on relative labor costs, but especially on the skills and knowledge of the workforce. In other words, human capital and its skills are recognised as one of the main drivers of economic growth and innovation. As a matter of fact, the chapter on skills and training is crucial, as it addresses issues of mismatch between the skills required by the market and those actually available. Therefore, it seems ever more important to implement at both the EU and at the national level a continuous and rigorous review of training activities, monitoring the results as well as the costs and the subsequent impact of training initiatives.

Within this framework, vocational education and training (VET) is key if the European Union and member states want to effectively govern changes in labor and skills demand that the green transition gives rise to. Particularly, labor and skill shortages for highly demanded occupations (e.g., in the renewable energy sector, as well as in the construction and manufacturing sectors) necessitate immediate actions to solve the current skills mismatch associated with the green transition. Nonetheless, in light of the ongoing shrinking characterising in particular, the younger cohort age, this would mean further investing in training, as well as supporting the existing workforce to smoothly make the transition to green jobs. Particularly with respect to the issue of low youth employment, throughout these years the European Commission has developed a package of actions to be funded by the Next Generation EU to support youth employment in tune with changes in the world of work and new skills in demand. It is the document entitled “*A Bridge to Jobs for the Next Generation*.” In doing so, the Commission supported member states in offering young people a pathway into the world of work, a proposal aimed at accelerating the digital and green transition toward which the world of work is heading. In such a changing context, in order to facilitate the

transition of young people from education to work in Italy, it is important to push for technical training while thinking about more punctual and circumscribed skills that can accompany the more radical transformations that some companies choose to undertake. Additionally, it is also crucial to bolster activities such as those leveraging skills intelligence tools (for instance, through skills foresight, skills forecasts, skills surveys, and big data analysis), which are crucial for the identification and mapping of emerging skill needs, as well as the skill shortages that hinder not only the greening of our production processes but also affect innovation, growth, and competitiveness. Therefore, skills mapping and analysis are key processes for identifying the level of workforce readiness and areas for development. If we want to implement more forward-looking governance approaches, the promotion of skills intelligence activities in increasingly cross-cutting policy domains and objectives is key. In this regard, the adaptation of training curricula to the needs of the green transition, as well as accelerated investments in training programs for the new skills required, are crucial elements in achieving the transition and reducing the green skills shortage, as outlined at the European level within the Commission's 2024 Action Plan on Skills and Labor Shortages, but also according to the objectives included within the REPowerEU program, the latter shared by the Italian government.

As a matter of fact, I believe that from the analysis conducted so far, and thanks also to discussions with representatives of the business fabric and that of the workforce in a region like Emilia-Romagna that experiences difficulties in finding personnel with green skills over 50 percent,[72] it emerged that in order to overcome skill shortages (particularly in SMEs), new training policies need to be implemented. It will also be significant to develop closer relationships between research institutes, the university system, and businesses. As revealed from the interviews I had with both employers' and workforce representatives, companies demand specific skills that graduates and professionals often lack due to a mismatch between market needs and educational

[72] See at: https://www.confartigianato.it/2023/10/studi-nelle-mpi-mancano-687mila-esperti-green-granelli-carenza-manodopera-ostacola-sviluppo-sostenibile/

offerings. Therefore, through renewed collaboration between businesses and academic institutions, this gap could be bridged, thus enabling companies to influence educational pathways so that they reflect the real needs of the industry. This approach not only makes young people better prepared and more competitive in the world of work but also contributes to greater synergy between education and employment, fostering the development of talent capable of facing market challenges. Furthermore, it is useful to note that continuing education and training are increasingly relevant elements that need to be focused on. In fact, first with the digital transition and now with the green transition, we are seeing some major changes in employment such that support from the standpoint of training as a spendable asset for the worker throughout his or her professional life becomes essential. Therefore, the central issue remains, which is to increasingly direct the enterprise to become more sensitive to further advancing investments in continuing education for its internal workforce. Similarly, there should also be more attention from public agencies on investment in continuing education as well. In this respect, it should become ever more important for Italy to leverage a number of skills development and lifelong learning strategies, such as apprenticeship, up- and reskilling training, and micro-credentials. From employers' perspective, further investing in apprenticeships could be a strategic solution to skill shortages. As a matter of fact, recent analyses of online job advertisements conducted by Cedefop (2025) throughout Europe reveal that many skills and competencies demanded in sectors such as cybersecurity and green technology perfectly align with training models of apprenticeships, that is, the combination of education with employment. In Italy, the development of apprenticeships happens through the establishment of regional partnerships. In this regard, it would be highly advisable for the future to further ease modes of shared governance and systematic collaboration between the government, companies, education and VET institutions, and social partners to strengthen the rollout of high-quality programmes benefiting learners and employers on an equal footing. Furthermore, whether they are specialised or transversal professional figures, it is necessary to intervene through additional upskilling and reskilling training, especially for the low-skilled adult population. These are, on the one hand, jobs close to profiles

that have already been working for some time in the field of sustainable development processes and in the area of environmental certification management systems, towards which action needs to be taken to strengthen those skills and knowledge necessary for companies to give substance to the processes of digital and ecological transition. On the other hand, there is a need to strengthen and update skills and knowledge from a circular economy perspective also for traditional professional profiles that are already widely established in the labor market and for tasks and roles whose complexity has been gradually increasing in parallel with the issues of environmental sustainability of production processes. As for the development of additional systems for the recognition of non-formal and informal learning, this contribution supports the need to further invest at both the European and national levels in micro-credential-based training programmes as a way to certify the acquisition of green skills outside traditional educational contexts and highlight them to employers. Nonetheless, it would also be particularly useful to devote more attention to 'transferable' skills currently shared between different job roles that can help individuals to quickly shift into new occupations and sectors, that is, from 'brown' (fossil fuel based) to 'green' ones. Policy makers' contribution in supporting the high transition costs the workforce will likely face will be a crucial success factor. In this respect, a national jobs plan could be considered in light of the ecological transition underway to enhance the sectors that contribute most to climate neutrality and the promotion of both the green and circular economy, just as more investment should be made to support continuing education. Additionally, a system of public incentives tied to employment protection and the improvement of job quality could complement this major initiative.

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