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The role of skills in the Green Transition and the implications on labour markets

An analysis of sustainable labour market protection policies and the importance of skills and mismatches in a Green Transition

Supervisor:
Prof. Stefano Sacchi

Candidate:
Simone Anzelini

To my mother, a kind and beautiful soul who always stayed by my side, every step of the way, for which I'll never be able to thank her enough.

To my father, to whom I can always turn when in need for advice.

To Lorenzo, wishing him the best luck in his new university journey.

To my grandparents, for whom I will always have profound love and gratitude.

To my friends and relatives, who are probably tired of my complaints but always encouraged me showing nothing but love.

And to me, shall I always keep on pursuing my goals with enthusiasm. One step at the time.

This work is dedicated to all of you, from the deepest of my heart.
Thank you.

Simone

Contents

Abstract

Contemporary labour markets are deeply affected by environmental changes, whether they are impacted by climate change natural phenomena, climate migration or by effects generated by policy interventions aimed at mitigating environmental threats. To tackle the negative consequences on employment rates and on natural and built environment, world economies are developing several decarbonization strategies: the shared objective would be to reach a so-called Green Economy, a sustainable economic model that does not harm the environment while maintaining or fostering growth and employment.

The first goal of this thesis is to investigate the main actions that have been and are being taken to address environmental issues and the main consequences that both interventions and climate change itself carry on the working population. A similar analysis is also conducted over the model of Circular Economy, a concept that expands and evolves the one of Green Economy by promoting the extraction of more value and consumer utility from existing stocks of products.

The pursuit of an effective Green (or Circular) Transition that does not harm the working population, however, is highly dependent on the availability of the right sets of skills to allow for the transition to happen in the first place, and to fill the new jobs and tasks that will be created in the future. Misalignment between skills demand and supply are called 'skill mismatches' and can have many forms.

The second goal of this thesis is to provide an overview of the major skill mismatch types and their magnitude, along with the analysis of the possible future skill needs of a Green/Circular Economy, at the extent of providing insights on the competences that will be mostly required during and after the transition to sustainable business models.

Finally, our third objective is to identify and analyse the public and private initiatives/policies that could mitigate skill mismatches and therefore job displacement, while facilitating shifts toward emerging green sectors and the provision of skills for the future green jobs.

All the points will be addressed through the review of the prominent literature and the analysis of real cases of application of policies and interventions in different countries. Also, an in-depth review of the project Circular Re-Thinking will be proposed, as a representation of an Italian initiative launched by Trentino Sviluppo S.p.A., aimed at developing skills and knowledge through related to the Circular Economy and open to the participation of local freelancers and employees.

Introduction

Climate change is a topic that has been central to international discussions for decades. Our planet is deteriorating and the main cause is our behaviour in its regards. Scientists made all sorts of predictions, from the optimistic to the tragic ones, and debates have been made over the right course of action to respond to the alarming environmental situation. Despite the many different opinions on the plans to be implemented, the scientific community agrees on giving one simple alarm to the world:

We need to act, and we need to act now.

The urgency in this statement is also being increasingly shared by the global population, especially by its youngest share, who wish to guarantee not only our survival on Earth, but also a decent life for the future generations. Social movements and initiatives such as Fridays for Future contributed in the last few years to raise awareness and social pressure on governments and industries, accused of not being enough committed to preserving the environment as they should be. Meanwhile, over the last decades, governments and international institutions have been developing plans, agreements and treats to establish standards, rules and regulations at the extent of reducing carbon emissions and pollution, but unfortunately this is not yet enough. Natural disasters are increasing in intensity and frequency, observatories and scientists all over the world are stating that in few years we will face severe water scarcity and that global temperatures are bound to rise. Now more than ever we need to take responsibility for our actions and change our lifestyle, from our consumption and recycling habits to our business models, from the use of energy that we make at home to the way that same energy is produced.

In this urgency situation, fast and effective actions need to be taken. However, the risk connected to a rapid implementation of these measures is that some variables of the equation might not be taken into consideration enough, one of which being the working population. A sudden change in our economy, as in the case of a shift towards a sustainable Green Economy (term opposed to our current 'brown' economy, in which growth is largely dependent on environmentally destructive activities), entails significant restructuring in business and consumption models, as well as innovation in processes and technologies and exploration of alternative solutions. Some parts of the working population may face severe consequences from these changes, especially the ones employed in industrial sectors that are bound to fade out due to their high pollution levels.

The process aimed at achieving sustainability might put at risk the jobs and lives of a significant share of the population, who shall not be left behind. For these reasons, a green transition should be designed around the people – mainly the current and future workforce, but also the other citizens – and aim at creating decent and sustainable jobs in better societies, within communities living more in synergy with the environment. If well implemented, this evolution might one day lead to the creation of what is defined as a Circular Economy, a model that seeks the creation of a self-restorative and regenerative symbiosis between the environment, the people and the economic activities.

Concerns over the future of workers in a green transition are what led me to identify the first research question, around which the first two chapters of this thesis revolve:

What are the employment implications of climate change and decarbonization policies?

In the course of these chapters, I try to investigate the main actions that have been and are being taken to address environmental issues and the main consequences that both interventions and climate change itself carry on the working population. We will see that policy tools and strategies can be implemented to benefit both the environment and employment, but that they can also induce negative externalities if they are not designed taking into consideration all the factors and actors involved. The difference between the concepts of Green and Circular Economy will also be discussed, as well as the policies and enablers that would allow for the transition to both, so as to give a more complete overview of the possibilities available and the results that could be achieved in the future.

When discussing the changes that the working population will face, one inevitably incurs in the topic of skills. Skills are the main driver of workers' careers and also the main factor of selection of employees during candidates' selection processes in job applications. Possessing specific competences may facilitate young people in entering the labour market, as well as experienced workers in retaining their job or move to other companies, industries or even countries. On the other hand, lacks in skills can possibly lead to displacements, difficulties in finding a job, even persistent unemployment in some cases. In times of technological change, innovation and business transitions, skill needs evolve rapidly and sometimes unpredictably, and established competencies of brown jobs tend to become obsolete more easily. green transition contexts make no exceptions in this sense: developing sustainable market solutions, changing production, distribution and consumption models, shifting to de-carbonized technologies takes

a significant effort in new skills development and workers need to be prepared to adapt to these new challenges. For this reason, the second research question of this thesis is:

What skills should workers develop in a Green or Circular Economy?

I try to answer to this question in the third chapter, mainly by analysing extensive literature works addressing the topic of skill mismatch, which represents the misalignment between labour market demand and supply of skills. By identifying the main challenges in matching the competencies needed by industries to move to greener solutions with the current and future skill sets of the workforce, I propose a review of the main characteristics that workers should develop to retain or change their job in a Green/Circular Economy. Interestingly, I found that while technical skills are still important in this regard, a significant role is also played by the attitude and capacity of adaptation of workers, as well as their problem-solving, lateral and system-thinking abilities (the so-called soft skills).

The development of 'green' skills is of crucial importance for businesses too: failing in acquiring the necessary competences to manage the transition may lead to losses in competitive advantage, investments and growth opportunities. For this reason, firms, governments and private initiatives are increasingly working on providing solutions that can enhance workers capabilities and fill the gaps that are already present in the workforce skill sets. From this, the third and last research question of this work:

What can be done to foster green and circular skills development?

At the extent of providing suggestions and examples of successful applications in this sense, in the second part of the third chapter I use real cases analysis and literature review to discuss different solution approaches to skill mismatch problems in a Green Economy. Finally, in the fourth chapter I provide an extensive analysis of the Italian project 'Circular Re-Thinking', an initiative born with the objective of helping workers in developing circular skills, as well as acquiring knowledge and awareness on Circular Economy themes. Through interviews with the key partners and promoters of the project, I propose a qualitative analysis of the initiative's outcomes. An attempt was also made to obtain quantitative data through a questionnaire proposed to the former participants of the project: unfortunately, given the limited number of answers, no statistically significant data could be produced. Nonetheless, I believe the case represents a valid example of how green and circular skills can be developed by the working population and the enabling factors of such learning, the main one being collaboration between firms and institutions.

Chapter 1

The effects of environmental change and regulations on the labour market

Contemporary labour markets are strongly affected by changes in environmental conditions. Strong and prolonged alterations in climate carry profound effects on the population in several countries and have potential catastrophic effects on living conditions that could affect each individual person on the planet to some extent. Global temperature rises and increasing pollution contribute to amplifying the magnitude of adverse natural phenomena such as floods, heat waves, disruptive changes in precipitation levels or diseases spreading. These catastrophic, unpredictable events often lead to significant damages to both natural and built environments, creating inevitable repercussions on labour markets as well. The consciousness of the possible threats associated with uncontrolled climate change led over the last decades to the implementation by governments and institutions of several types of mitigation measures, both at local, national and international levels. These actions come in numerous forms – which will be analysed more in deep throughout this thesis – and can significantly influence the labour market.

The impacts of climate change mitigation actions can be of different nature and scope: policies can be created at the extent of addressing specific environmental problems, such as excessive water consumption or water pollution levels, to foster sustainable industrial sectors, such as renewable energy production or electric cars manufacturing, or perhaps have broader scopes like generic carbon emissions reduction. Each of these forms of action is likely to shake the portion of labour market linked to the target area or issue, which can suffer from alteration either in the levels of demand or supply of labour or witness consequences on the sets of competences needed by employees to fulfil the new requirements that may be born from such changes. Moreover, other employment sectors indirectly linked with the ones in object may experience changes in their mechanisms: an example of this phenomenon may be the shifts of automotive manufacturing companies towards electric cars production as a result of regulations and taxes imposed on the petrol production and distribution sector. These changes may positively affect to some extent the demand for electric and mechanical engineers with specific sets of skills suitable to handle the transition, while on the other hand have potential negative impacts on currently employed personnel.

The purpose of this chapter is to provide a classification of the different types of impacts the environmental change has on labour markets based on prominent research works from several international organizations, and to furtherly provide and analyse real case scenarios of such implications. Moreover, we will investigate the effects on employment of carbon-reduction policies and their effectiveness in reducing pollution levels while fostering green innovation and growth and promoting sustainable development goals and principles. Finally, we will review some of the most common environmental policy strategies providing examples of applications in different countries.

As previously stated, employment implications related to climate change may come in several forms and as results of different causal actions, and they may be both positive or negative depending on the reason inducing the change and the sector/perspective looked at. Consequences of environmental change are often mixed and linked one another, and they produce reverbs in several, sometimes unpredictable, areas. This makes it somewhat difficult for researchers and institutions to break down single effects on labour markets due to climate change and link them to specific causal roots. In this thesis, we identify and analyse four main clusters of environmental-related causes of change in employment, being:

- Climate change natural phenomena
- Climate migrations
- Policies and regulations on labour and businesses
- Carbon pricing policies

All of these can either have direct or indirect effects on employment rates and mechanisms, but it is also important to notice that such effects can result in other (in)direct consequences on employment. As an example (that will be furtherly discussed later on), climate change and natural phenomena can create direct repercussions on employment levels in the countries affected but can also induce changes in other countries which may become destinations for climate migrants.

1.1 Climate change natural phenomena

It is often easy to forget how many jobs are somehow linked to environment and are either favoured or disrupted by good or bad weather conditions. Agriculture, for instance, is a sector that cannot prosper in the case of constant adverse climate, and it employs around 4% of

European total employment (ILOSTAT Database estimates of 2021). The agricultural sector is a valuable part of the economy – especially in countries that highly rely on the agricultural productions for export and alimentary industries such as Italy, where this sectors accounts for approximately 2% of GDP, employs about 4% of total employment in farming activities and has strong connections with food related markets like export of processed products (e.g. wine, oil, cereals, pasta), catering and restaurant activities or with the general food retail sector (International Trade Administration observations, 2021).

Adverse natural phenomena can produce catastrophic damages to crops and farms and create long-term repercussions due to the difficulties and time needs related to agricultural processes. Although these effects are, at the time being, usually witnessed in countries which are more prone to suffer adverse climate conditions (e.g.: floods, heat waves, droughts, abrupt changes in precipitation levels) and less technologically prepared to face such events (i.e.: developing and poor countries), less 'obvious' consequences of climate change on developed countries agricultures should not be underestimated. In 2009, a GHK study predicted that while a slight increase in the mean temperature level might benefit Northern European countries by allowing the use of bigger portions of land for cultivation purposes, it might on the other hand negatively influence Southern-Mediterranean countries, damaging crops and consequently impacting employment levels in the sector (GHK, 2009). The 2022 outlines however depict a far more worrying situation: a *series of record-breaking environmental disasters has swept the globe during this year's summer period. While unprecedent floods have brought death and destruction to Central Europe and China, heatwaves hit North America and Southern Europe – with wildfires burning hectares of forests in Greece and Sicily as well as in Canada and Siberia.* (K. Bragason, General Secretary of European Federation of Food, Agriculture and Tourism workers, 2022). Extreme natural events profoundly affect natural ecosystems and their frequency increased during the last few years. Moreover, the increase in global temperature has significant implications on every job, especially the outdoor ones, farming included. Heat can have serious implications on workers' productivity and raises high concerns for their health as well. These concerns on unbearable climate conditions, natural events affecting ecosystems and possible loss of fertile lands and forests are bound to directly affect labour markets, possibly causing reductions in labour supply, altering employment mechanisms and conditions and calling for the introduction of more severe regulations to protect workers.

Sectors other than agriculture experience negative impacts directly related to changes in environment and weather as well. For instance, many energy production activities highly rely

on the provision of water, whether it is used to fuel cooling systems or to directly generate energy (i.e.: hydroelectric power production plants). If temperatures were to rise too high, the levels of water available for energy production purposes would likely be limited and could generate losses in the energy sector, possibly affecting the related levels of employment. On the other hand, the same increase in global temperature also affects the market demand for energy since it would be needed for air conditioning purposes and to sustain cooling down systems across different industries (EPA, 2017).

Heat waves and general increases in mean temperature carry also less observable but potentially significant effects on labour productivity. Workers suffering from heat stress are proven to be less efficient and less productive, needing longer breaks to avoid heat strokes and lacking focus. Estimates state that between 2000 and 2015 around 23 million working-life years of work were lost due to heat stress all over the world and if temperatures should rise by 1.5°C by 2030 (best case scenario), the amount of working time lost would increase by almost 2%, a labour productivity loss equivalent to 72 million full-time jobs (ILO, 2018). Although this loss is likely to affect prevalently countries which suffer from extreme heat and have workplaces that are not fully equipped to deal with high temperatures (e.g.: India, Indonesia), given the globalized nature of most of the current industrial and service sectors it is reasonable to assume that these situations will have repercussions also on several other countries to some extent, possibly also via climate-related migrations.

1.2 Climate and labour migration

Climate migrants are defined as people who, *predominantly for reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad* (International Organization for Migration, 2007). The displacement of people due to worsening of climate conditions in their country of origin is a well-known phenomenon that since 2008 has led about 21.5 million people per year to leave their home and move in different countries (UNHCR, 2016). Assumptions may be made on how these migrations can in some cases create voids in labour supply and skill sets availability in the origin countries, while, if not correctly addressed and incentivized, may result in increases in shares of unemployment in destination countries or in the employment of overqualified and over-skilled workers who are in need for a job to survive.

However, real case studies can sometimes outline several positive aspects of the reciprocal effects created by migration and green innovation.

The ODI working paper *Migration for climate action - How labour mobility can help the green transition* (ODI, 2022) highlights how migration does not only carry potential issues but, if well addressed and incentivized, can strongly sustain the labour market needs and moreover boost productivity. Labour migration is in fact linked to green innovation in several ways: migrant workers already are a significant part of the employment in sectors related to climate change mitigation and sustainability and in a possibly short-medium timespan they might need to update and eventually re-train their skills in order to keep up with the changes in their sectors of work. For example, responsible cobalt mining activities for car battery production purposes or chemical treatments and water control in agriculture and wastewater treatments are fields which will likely require additional training and re-skilling for both local and immigrant workers. Moreover, labour migration channels promoting training activities on green skills, such as student mobility, represent an important opportunity to push for the development of new projects and green skills. In the US, STEM subjects (Science, technology, engineering, mathematics) are the preferred courses of study for the majority of incoming international students, courses that are generally easily linked with environmental and sustainability topics. Cultural exchanges favour the development of communication networks that may prove beneficial to the extent of training the future workforce in green hard and soft skills. In fact, most of the high-employability skills for the growing green sector are linked to general soft skills such as communication, problem-solving or teamwork (ILO, 2019). These types of exchanges are sometimes referred to as “circular migration”, meaning the creation of opportunities for the development of skills and the transfer of technical knowledge across countries.

Finally, human mobility can also benefit the labour market by filling the gaps in sectors which are relevant for the green transitions and that suffer from lack of labour supply in the destination country. Such sectors are usually found in STEM-discipline fields, where the growing need for workforce in newly created green jobs and for emerging skills in greened activities might lead to high demand/supply ratios. In 2022, the European Commission highlighted that construction, transport, energy and manufacturing sectors are in need for additional labour and new competences development, and found in legal migration a phenomenon that can accompany the green transition towards a green and digital economy.

Although all countries may benefit from some degree of international labour migration, it is important to notice that sectoral, cultural and income-level differences play an important role in defining the level of need and opportunities of a specific country concerning green transition and green skills development. High-income countries usually face less opportunities to foster workers' re-training activities and to address skill gaps in the workforce since most of the working population is usually already employed and less prone to enhance their competences. On the other hand, low-income countries (LICs) offer several possibilities concerning green skills training due to their high levels of unemployment and informal employment. If correctly sustained, LICs may enhance their educational institutions and vocational training systems, offering great potential for the provision and creation of green transition-related skills and occupations (ODI, 2022).

1.3 Policies and regulations

Although direct effects originated by climate changes in the form of natural phenomena must not be ignored or underestimated, it is from policies and regulations' introductions that the most important impacts come. From a broad point of view, climate change regulations include all policy interventions aimed at reducing negative spill overs and externalities affecting the environment. Although most of these interventions have impacts on the labour market, consumers' behaviour and general economic conditions to some extent, a distinction can be made between those directly targeting labour on supply and demand side from those that affect them indirectly. Moreover, one should consider that policies can be specifically introduced to target employment issues or to create job opportunities in the Green Economy, or on the other hand affect the labour market indirectly while targeting environmental issues or objectives. In this section we will focus on the effects on employment of a set of policies interventions and strategies, dividing them by direct and indirect effects, while also observing whether these have direct or indirect impacts on environment (*Figure 1*). The policies we will analyse are:

- *Alternative income sources, Socio-Ecological Job Guarantees, VET provision, Work-Time Distribution* – which **directly** target the labour market by affecting employment levels or working conditions
- *Conversion of plants and businesses, Environmental decommodification* – which **indirectly** affect employment levels or working conditions

		Effects on employment and working conditions	
		Direct	*Indirect*
Environmental impact	*Direct*	**Alternative income sources Socio-ecological Job Guarantees**	**Conversion of plants and businesses**
	Indirect	**Vocational Education and Training Work-Time Distribution**	**Environmental decommodification**

Figure 1: Policy strategies and interventions' type of effect on employment and environment

1.3.1 Direct effects of policy strategies and interventions on employment

In this section we will analyse policy strategies and interventions that mainly target employment while having repercussions on environment as well. These may either or both affect employment levels and working conditions and be also specifically designed to achieve environment preservation objectives or have indirect effects on them.

Alternative income sources – Green Pay as an incentive to reduce environmental impact

A first strategy with the objective of de-incentivizing over-production and the related environmental issues by providing new sources of income for employees consists in a partial decoupling of income from employment volume – and therefore production. These sources of income can be granted by the state (e.g.: Universal Basic Income), social security institutions or employers. An interesting case of such a solution is the so-called Green Pay, a bonus given to employees proportional to the environmental performance of the company. Studies from Paolo Tomassetti (2015) report applications of this incentive in three different companies located in Italy: Luxottica (manufacturing and wholesale distribution), Renner Italia (chemical sector) and Almaviva (ICT industry). All three of them introduced gain-sharing plans linked to green objectives (i.e.: energy efficiency and energy conservation) via negotiation of collective agreements with trade unions, although with different implementations methods. In *Box 1*, a summary of the plans and their outcomes is provided.

The three cases presented are examples of how alternative income sources can incentivize employees in learning and practicing environmental-friendly actions in their daily tasks, affecting both working conditions, income levels while directly influencing pollution rates.

Box 1: Luxottica, Almaviva and Renner Italia Green Pay plans

In 2011 Luxottica launched the Zero Waste Project, aimed at reducing the company's CO_2 emissions by 30% over a five-year period. The initiative included a life cycles assessment and several waste streams recycling programs. It also linked the gain-sharing system to a "zero waste" index related to both electricity and paper/toner consumption, in accordance with Italian trade unions Filctem-Cgil, Femca-Cisl and Uilta-Uil. Every year, percentage reductions in both the indicators were to give birth to corresponding monetary increases in the workers' payrolls.

The Almaviva Green project was launched in 2009 by a team made of both Almaviva workers' representatives and managers, along with the firm's CEO's public statement announcing that the group had decided to follow a new strategy with a strong commitment to "going green". This led to the inclusion of green objectives in the company's gain-sharing plan and the introduction of internal environmental awareness campaigns. The staff bonus schemes were also redesigned in order to be based on two components: financial performance (75%) and energy efficiency/conservation (25%). The latter would be evaluated and defined by works councils and management at plant level and dependent on electricity being used, in details, for air-conditioning, water-heating and light. Accomplishing the goals set would result in the total entitlement of the 25% share of the bonus amount.

Renner Italia decided to embark in a similar route in 2012 with the signature of an agreement between the management, the works council (RSU) and Filctem-Cgil, and the launch of the project "Energy saving in the pay packet". The objective of the agreement was to commit the company in rationalizing consumption and reducing waste through the implementation of sustainable policies and lifestyle and to save 10% of energy consumption costs over a 3-year timeframe. Half of the yearly savings would then be equally distributed among the employees in the form of bonuses. Internal information campaigns and an overseeing, bilateral committee were also introduced.

Each employee in the three firms received monetary compensation for his efforts to some extent – 61€, 3.8% of the bonus for Luxottica employees; 288.50€, 17.40 % of the bonus in Almaviva; 309.07€, 15.4% of total bonus in Renner Italia – while all the companies were able to save on energy/resources consumption – 5% of electricity and 15% of paper/toner consumption in Luxottica; 45% (over 3 years) in Almaviva; 7.5% in Renner Italia.

Socio-ecological Job Guarantee – Public Service Employment and Austrian Universal JG

Employment guarantees are programs promoted by the governments that can have effects similar to the ones of decommodification measures (described later on). Job guarantees are defined as *[…] economic policy proposals that aim to provide a sustainable solution to inflation and unemployment. Their aim is to create full employment and price stability by having the state promise to hire unemployed workers as an employer of last resort* (Wikipedia, Job Guarantee). Employment guarantees have been applied for years worldwide and are nowadays being often adopted to tackle the high levels of unemployment among young people (Tcherneva, 2020) and the consequences of the Covid-19 pandemic (Dhingra, 2020). In common applications, this type of intervention creates job positions to cover tasks that would not be paid on the traditional labour market, mainly supporting communities and/or social institutions, and do not usually focus on environment issues. Even so, it should be considered that these tasks are often focused on providing labour-intensive, resource-light services and can therefore participate in reducing the overall environmental impact of labour while on the other hand provide a potential solution to long-term unemployment, while contributing to reducing poverty and, by doing so, pursue the European Sustainable Development Goals (SDGs). A Job Guarantee can hence be seen as a subsidy for socially and ecologically beneficial initiatives and play a significant role in the carbon-neutral economies.

One of the main arguments raised against the introduction of forms of Job Guarantees lays on the assumption that a certain degree of unemployment is functional to the control of inflation: governments control unemployment by changing spending and taxation levels in order to be able to manage inflation and keep it at a reasonable level. To this extent, the NAIRU (Non-Accelerating Inflation Rate of Unemployment) concept has been widely adopted as a parameter that represents the *lowest rate of unemployment that can be sustained without causing wages growth and inflation to rise. It is a concept that helps us gauge how much 'spare capacity' there is in the economy.* (Reserve Bank of Australia)

However, several studies (Wray et. al., 2018; Parrique, 2019) found that employment guarantee programs could play an important role in achieving full employment without having repercussions on inflation and wage levels. For instance, the Public Service Employment (PSE) solution proposed by Wray in the U.S.A. has the potential to address and partially solve several social and employment issues that are widely spread and significantly costly for U.S. countries. The authors' proposal consists in the introduction of a form of Job Guarantee that is funded by

the federal government and managed by local institutions at the extent of providing social/environmental-care related occupations to unemployed, mostly low-skilled, people. The main advantages and features reported are the following:

- Increase in the minimum wage levels: setting a fixed hourly rate (15$/h) for people who would be employed under PSE activities, would force the private sector to adapt to the (decent and living) wage established by the program, reducing income inequality;
- The PSE would not create competition in the private sector's labour market since it would not attract regular workers who work at a higher wage level;
- The PSE would not create competition in the private sector profitable activities since it would not address markets already served by private firms;
- The PSE would target social and environmental problems by creating work opportunities specifically aimed at serving local communities' needs, therefore creating double advantages for communities;
- The PSE would contribute in reducing gender inequality by providing more work opportunities for unemployed women;
- The PSE would possibly pay itself over time by reducing public expenditures that are due/related to unemployment conditions (reduction of crime, better health, greater social and economic stability) and to environmental change (mitigation of local ecological problems and improvement of environmental conservation activities in communities).

The Public Service Employment plan has great potential in dealing with social problems and improving overall working and living conditions for people living in poverty and for local communities. However, although these objectives are in line with the Sustainable Development Goals and therefore are part of a system where, as seen before, environmental protection plays a crucial role, within the scope of this thesis we mainly focus on the ecological implications of policies implementation and their effects on employment. In these regards, the authors state that care for the environment would be one of the main cores of the proposal and the created jobs would tackle: soil erosion, flood control, environmental surveys, species monitoring, parks maintenance and renewal, removal of invasive species, sustainable agricultural practices, support for local fisheries, tree planting, disasters' prevention measures, weatherization of homes in poor overlooked communities, composting. Unfortunately, though, the study does not provide figures specifically concerning green employment increase and green jobs creation. A breakdown by type of job of the total number of occupations created – ranging from 10 to 15mln

over all U.S.A. countries with peaks after 3-4 years of implementation, according to authors' estimates – would be useful to measure the effective impact of PSE on green employment.

A practical implementation of a universal Job Guarantee program was started in October 2020 in Marienthal, Austria, as a response to the worsening of unemployment conditions over the last years, which is particularly due to the Covid-19 pandemic (Universal Job Guarantee Experiment, 2020). Designed by Oxford University researchers Lukas Lehner and Maximillian Kasy, the program aims at providing unconditional job opportunities for all people who have been unemployed for 12 or more months within the Marienthal area and pays a collectively bargained minimum wage (1,500€/month), taken from a €7.4mln total budget. The planned duration of this experiment is set to 3 years and foresees two waves of employment. Preliminary results published in 2021 (Lehner L., Kays M., 2021) promise a general improvement in several social areas, particularly incomes, mental health, wellbeing and social inclusion. Although this project does not specifically target green employment and environmental preservation activities, positive outcomes witnessed at the end of the implementation (2024) could lead the way to the proposal and institution of similar forms of Job Guarantee centred on the creation and promotion of green work opportunities that could both benefit social and ecological conditions. Furthermore, it would provide social and financial support to workers who could be displaced from brown sectors as a result of the Green Transition (Mastini et. al., 2021).

A possible indirect environmental downside of employment guarantee programs that should be considered is the possible increase in consumption, and therefore production and resource usage levels. Income provision to previously unemployed people, raise of minimum wages and general improvement of living conditions would probably lead to increases in products and services demand with consequential impacts on resource depletion due to rises in production of goods and services provision if not accompanied by other interventions to mitigate environmental impacts of such activities. Economics studies should be carried out to assess whether Green Jobs Guarantee proposals' ecological benefits could be offset by these implications or not.

Work-time reduction (or Work-time distribution)

Work-time reduction (WTR) has been object of debate for many years and many advocate its utility in fighting climate change. Although literature works about the application of WTR as an instrument of environmental preservation are quite heterogeneous, difficult to integrate and

few significant results have been achieved (Antal et. al., 2020), there exist studies stating that work-time reduction and distribution measures may prove beneficial in reducing GHG (greenhouse gasses) emissions: in *Environmental impacts of productivity-led working time reduction* (D'Alessandro et. al., 2021) the authors conducted an analysis of several scenarios where work-time distribution (in this case, synonym to work-time reduction, WTR) was applied, and observed the changes in several variables, especially labour income. They studied three scenarios of WTR implementation starting from a baseline case where no such measures were introduced. In the Baseline scenario, working hours were fixed by the industry and hourly wages increased with labour productivity, while in the first alternate scenario (simple *WTR* introduction scenario) labour productivity gains did not increase hourly wage (which, instead of fixed, was in this case a function of employment) but they were converted into less working hours per employee. The second variation of the baseline scenario (defined as *Global WTR* scenario) assumed that every other country mirrored the same WTR strategy. Lastly, the third scenario (*Constrained WTR*) furtherly added the assumption that the countries adhered to the current European Fiscal Stability Pact, cutting government expenditures when the deficit-to-GDP ratio exceeded 3%.

The authors witnessed that for a given GDP growth, in all three scenarios the growth rate of labour income was higher than the baseline case, leading to believe that a reduction in working hours favours workers in terms of income distribution. However, it was also demonstrated that, although both the indicators slightly improved with respect to the baseline, environmental performance and employment outcomes conflicted with each other in the implementation of such scenarios. In fact, the solely introduction of WTR (first scenario) led to a reduction in prices and a consequential increase in exports and hence offset the emissions reduction effect; the GWTR scenario solved the problem by assuming a general decrease in exports, which although negatively impacted economic competitiveness and worsened employment rates; the introduction of binding fiscal rules (CWTR) produced, according to the paper, the best environmental performances at the expense of creating the worst employment outcomes among the studied scenarios.

According to the analysis reported, it can be inferred that a work-time reduction strategy could either benefit the environmental impact of employment through the reduction of the resources and energy used due to the decrease in hours worked or, if labour is complemented by hiring resources to substitute for the working hours cuts, improve employment levels and workload and income distribution. However, WTR measures alone can hardly accomplish both results.

Work-time reduction strategies can although entail indirect downsides too. For instance, a reduction of work hours in wealthy countries that 'can afford it' may lead, as seen, to a decrease in prices with consequential increases in exports and decreases in imports. Poorer supplier countries may then suffer damages due to these changes, possibly at the expense of their employment levels. Moreover, a greater availability of free time to employees may entail an increase in the consumption of products or services that are highly polluting, such as travelling.

Vocational Education and Training

Future workers need to be taught that there exist businesses that are bound to be unsustainable in the future and that green alternatives do actually exist and, if not, they can be created. To this extent, it is important that basic education, vocational trainings and job orientation are able to provide knowledge of green transformation and its implications for the labour market future scenarios. Students and young workers may be more prone to consider careers in green occupations/sectors if they recognize the opportunity early on, while medium-long experienced employees in brown sectors may find it more challenging to pursue new career paths in the Green Economy until they are not faced with the dismantling of their current no-longer-sustainable occupation. For this reason, active labour market policies could focus on granting these employees access to retraining activities for the new green labour markets, possibly being supported by career counselling institutions and organizations in re-defining their path and identifying job opportunities where to employ the skills they already developed. Lack of this type of support does often reduce the success of retraining programs (Bohnenberger, 2022). The transition should also be supported by companies themselves, with the provision of short, manageable training periods and possibly the institution of "green education leaves" to facilitate and incentivize the workers in attending these activities without negative repercussions on their current job.

Although VET policies usually focus on the provision or enhancement of skills and will therefore be treated more in depth in Chapter 3, it is important to mention them as interventions that could participate in reducing the negative impacts of the green transition on employment, especially focusing on the tasks and workplace dimensions of sustainable labour.

1.3.2 Indirect effects of policy strategies and interventions on employment

We will now analyse the indirect effects on employment that could be created by the implementation of two policy interventions, one targeted at reducing the carbon emissions of a specific sector through the conversion of existing plants and business models, and the other aiming at providing support to workers who wish to abandon their job due to environmentally ethical reasons (decommodification), in order to facilitate the transition to a greener economy

Conversion of plants and businesses – The plant-based milk and the BEV cars' markets

One common strategy in dealing with greening necessities is the conversion of plants and businesses of brown (unsustainable) sectors into more sustainable businesses. Such transformations can be led by either workers or firms' managers who seek to anticipate future re-conversion needs, and can either focus on renovating the process – in terms of machineries, plants or inputs – or the business model itself. An example of a process renovation is the conversion from traditional to plant-based milk production, which brings enormous environmental benefits, especially in terms of water consumption, land space needed to farm and GHGs (Greenhouse gasses) emissions. This type of change requires the substitution of input resources, of the production process and of the machineries and spaces (e.g.: farms) used. *Box 2* reports an example of how the shift from dairy to plant-based milk impacted the U.S. market and how policies might affect the outcomes.

Sometimes however climate change and the related mitigation actions might also lead firms to not only convert their processes and inputs but also part (or the entirety) of their business model, for example by diversification. An instance of such conversion is the transformation from a car retail business to a mobility service or car rental one, or the switch to electric cars manufacturing. The latter strategy is especially diffused nowadays across the whole car industry, with gigantic market leaders such as Toyota, BMW and Tesla leading the way in the research and development of new low-impact technologies. In 2015 Toyota launched its "Toyota Environmental Challenge 2050", establishing 6 goals to be accomplished within 2050 consisting in: i) a drastic reduction of emission produced by their cars (-90% w.r.to 2010 levels); ii) a 25% drop (w.r.to 2013) of total emissions over products' lifecycle and iii) -35% in global plants emissions; iv) minimization and optimization of water usage and v) waste production (to accomplish through recycling activities); vi) preservation of forests and other ecosystems (Toyota's website). These ambitious objectives will require large investments in facilities

Box 2: The plant-based milk market in the U.S.

The shift in preferences regarding milk consumption of a large share of the consumers – around 10% in 2021 moved to plant-based products (M. Hale, FoodManufacturing article) – led over the last years to a consequential increase in the production of plant-based milk substitutes and the related conversion of production processes for many producers: from 2017 to 2019, sales of plant milks in the U.S. increased by 14%. On the other hand, traditional milk farmers are taking a severe hit from this transition to more environmentally friendly substitutes, witnessing a halving of dairy farms during the period 2003-2019 (USDA Milk production report, 2020). The dairy product sector has always been highly supported and regulated in the U.S. by forms of subsidies, incentives, price-protection policies and import limitations. Examples of such interventions are the Federal Milk Marketing Orders (FMMO) program, introduced during the 1930s and still in place today, which sets a price floor for the amount that processors can pay farmers for using their milk to produce derived goods, or the Dairy Export Incentive Program (E. Sanon, 2018). Despite these support measures, as reported above the white milk market is suffering from the expansion of plant-derived products and employment levels are bound to drop even further following the current trend. Conversion incentives and subsidies could ease the burden on dairy farmers and allow them to adapt to the change by totally or partly switching to plant milk products; however, no such forms of intervention seem to be adopted at the moment. On the other hand, the progressive deallocation/phase-out of white milk protection measures might force this greening process, although likely leading to disruption in the sectors' employment level, especially in absence of adequate forms of social protection, employment reallocation or process conversion.

adaptation and re-arrangement, R&D activities to improve products' and processes' efficiency, creation of recycling centres and significant re/up-skilling of currently employed workforce, along with possible talent acquisition.

However, electric cars manufacturing might not only have positive employment implications: according to a 2021 report by J. Barrett and J. Bivens analysing the current and future American car market, in a scenario where electric vehicles' (EVs) sales were to make up for 50% of total car sales in the U.S. by 2030 and in absence of adequate accompanying policy actions, U.S. automotive productions sectors would lose around 75.000 employees. This loss would mainly originate from lack of supports to domestic batteries and drivetrain producers needed for the Battery Electric Vehicles (BEVs) manufacturing supply chain and from a failure in regaining market shares in overall global vehicle sales. On the contrary, the authors sustain that a correct

and far-sighted line of strategic investments in manufacturing and job quality in the auto sector might give birth to a large number (up to 150.000) of jobs and enhance their quality, providing also a boost in BEVs production. They also advocate the need for the introduction of policies with the aim of increasing the U.S. capacity to produce EV and BEV powertrain components, which are currently mostly imported and therefore their contribution in job creation is rather limited.

These estimates were produced by modelling different scenarios varying the share of the vehicle market taken by BEVs, PHEVs (Plug-in Hybrid EV, hybrid vehicles that can be charged both by using a wall outlet or by the internal combustion engine) and internal combustion engines (ICE) vehicles. Barrett and Bivens found that, in the absence of manufacturing policy action, even a 30% share of BEV sales would create thousands of jobs losses both in automobile assembly and parts supply jobs (*Figure 2*). However, the introduction in this equation of policy interventions drastically changes the scenarios proposed: in fact, assuming that policymakers were able to enhance onshoring activities to the extent that EV components production would reach levels comparable with the ones of ICE components, job losses in auto parts manufacturing would be zeroed (*Figure 3*). Moreover, extreme positive effects on vehicle assembly employment would originate by the introduction of measures able to boost the market share detained by U.S.-based producers by 10% (*Figure 4*). (Barret, Bivens, 2021)

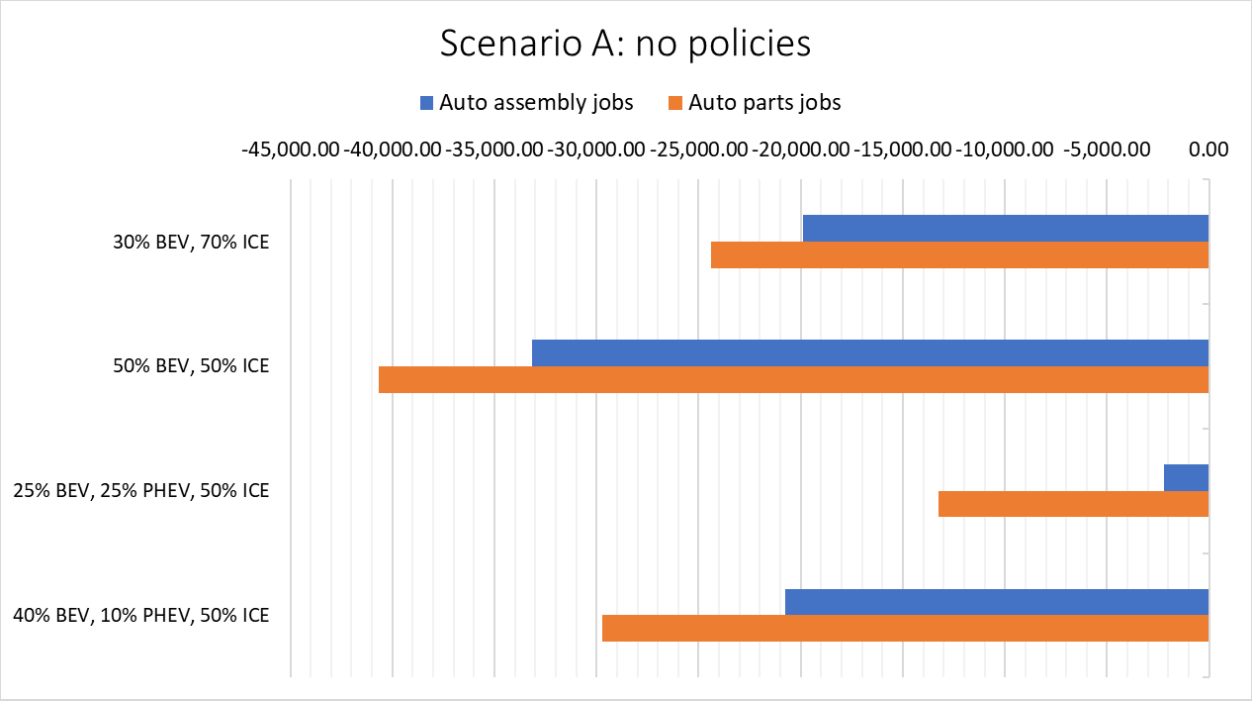

Figure 2: Variations in U.S. employment levels in auto assembly and auto parts production occupations under four EV market shares scenarios when no policies are implemented (data source: Barret, Bivens, 2021)

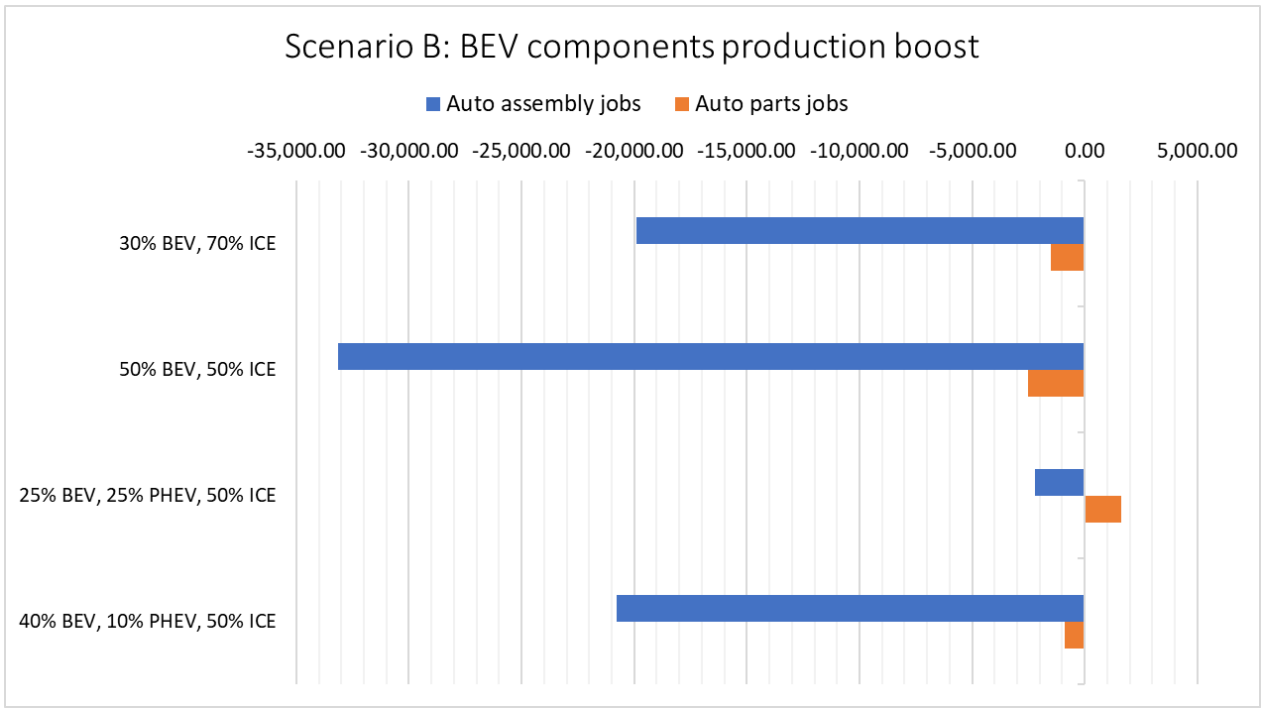

Figure 3: Variations in U.S. employment levels in auto assembly and auto parts production occupations under four electrical vehicle market shares scenarios when BEV components production is boosted by policies implementation (data source: Barret, Bivens, 2021)

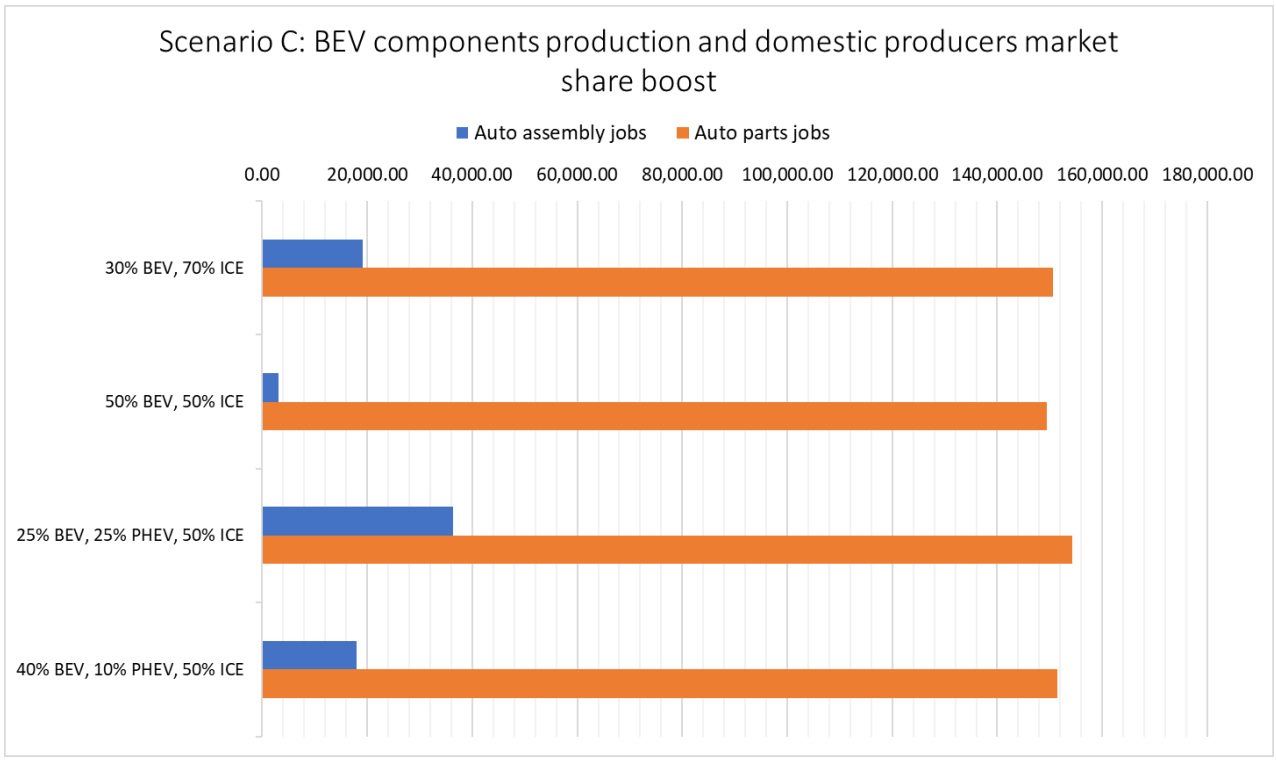

Figure 4: Variations in U.S. employment levels in auto assembly and auto parts production occupations under four electrical vehicle market shares scenarios when BEV components production and domestic producers market share are boosted by policies introduction (data source: Barret, Bivens, 2021)

In the cases presented, the application of policies plays a crucial role in supporting the transition to more environmentally friendly business models. Conversions of plants and business models are strategies that indirectly impact (sustainable) employment, affecting the number of brown and green jobs in a certain sector/industry, and in some way the greenness of tasks and activities carried out by employees on the workplace, since in these strategies the transformation revolves around the change of products, services and processes. Therefore, to make the transition successful and have positive employment outcomes, green conversion strategies should be supported by institutions via market protection policies, incentives for innovation and measures to ease and in some cases push the switch to sustainable models.

Environmental decommodification – Universal Basic Income as a facilitator of green transition

A different strategy for coping with the burden of climate change direct impacts on workers is to establish a work environment where employees are allowed to (and helped in) leaving their job when its activities, impacts and ethical implications do not fit with personal and shared environmental ethic principles. 'Decommodification' measures the degree to which citizens feel comfortable in refusing or leaving jobs for non-employment-related reasons and the type of social and financial support they receive if they choose to do so. The environmental crisis poses the question whether this concept should be applied to climate change related reasons and which actions should be taken to support these decisions. Instances of environmental concerns that could lead to leaving the job could be the incapacity to reconcile the industry in which one works and personal ethical beliefs (e.g.: working in coal extraction activities), being asked to perform nature damaging tasks (e.g.: deforestation activities, incorrect waste disposal) or working in environment-harmful or dangerous – due to climate reasons – locations (e.g.: working in agriculture, as discussed in section 1.1).

Examples of forms of protection that could allow workers to exert their right to work in a comfortable workplace appropriate to their own ethical standards are: regulations on the freedom of workers to refuse tasks they feel being environment-harmful and protection from possible work-life repercussions; social protection and help in relocation of employees quitting their job; universal and unconditional basic income; financial-level services allowing full participation in society. In this sense, the Unconditional Basic Income Europe (UBIE) citizens' initiative, a proposal made recently to the EU Commission for the introduction of a universal basic income, could contribute to moving towards an improvement of decommodification

levels in EU countries. The initiative, started in 2020, is although still far from becoming reality, since the signatures collection process is still on-going. It is important to point out that even though this measure would not specifically target employment issues related to climate change, it would still impact the levels and conditions of employment throughout Europe and inevitably have effects on all the areas involved.

1.4 Carbon pricing measures

Carbon pricing is an environmental preservation policy tool that is widely used among countries and local jurisdictions and is based on the introduction of taxes at several levels of the production chain, proportional to the share of carbon dioxide emissions (CO_2) for which the actors involved are responsible. The main origin of carbon dioxide emissions is the combustion of fossil fuels, which in turn is used for generating electricity, industrial production, transportation and generation of energy for households and businesses (Hafstead, 2019). Carbon pricing policies can be applied in several forms, two of which are more spread than others.

Carbon taxes work as a fixed price to be paid for each ton of CO_2 emissions produced, which is in fact proportional to the carbon amount combusted. Carbon tax advantages lay in its price-certainty feature: given a certain price per ton, emitters can precisely compute how much carbon they should use and the cost that will derive. It can act as a strong incentive to reduce emissions, but on the other hand it does not ensure or force a significant reduction unless the measure is particularly stringent, since companies could simply decide to maintain/slightly decrease their pollution levels and pay the related tax amount if this does not hinder them in maintaining/increasing their profits.

On the other hand, **cap-and-trade programs** work on setting a defined amount of CO_2 tons that can be emitted by specific facilities. Governments can issue limited numbers of 'emissions allowances', each of which gives the right to the given facility/company that awards it to emit one ton of carbon dioxide. Firms can obtain allowances in several ways, for instance by direct allocation – *free allocation of allowances* – or buying them in auction markets. These permissions are tradeable, meaning that companies can exchange them in a supply/demand market for allowances and this mechanism will set a yield market price for them. In this sense, as an opposite to carbon taxes, cap-and-trade policies have the advantage of setting the maximum level of CO_2 emissions allowed, although partially losing control on the fluctuations

of pollution prices. However, permits are not usually time-limited, therefore total control of yearly emissions quantity is not granted since allowances may be used in different years. Nonetheless, balancing of emission levels over time is expected.

Given the advantages and disadvantages of both carbon policy types, hybrid forms could be implemented to allow for a better performance of carbon pricing measures in both emission reduction and tax revenue generation. For instance, price ceilings/floors can be introduced in cap-and-trade programs to prevent fluctuations being too wide, or carbon taxes' prices can be adjusted conditionally on reaching predetermined emissions thresholds. Different approaches can also be used in terms of point of regulation, which specifically determines who will be required to submit permits – in cap-and-trade systems – or pay the carbon tax. Regulators could choose upstream points of regulation (taxing fossil fuels producers), target the purchasers of such resources (midstream) or directly go to the emitter (downstream). It is although important to specify that, regardless of the point of regulation identified, part of the burden will inevitably fall on the final consumer in the form of price increases or supply reductions.

When compared to other environmental protection policies, carbon pricing ones have some significant benefits for both businesses and institutions and ultimately individuals. While, for example, technological mandates may be too general (or too specific) to fit with all firms within an industry and therefore making it more difficult for companies to adapt and for regulators to control, carbon pricing measures give businesses more flexibility in deciding the cheaper and more effective approach to reduce their climate impact. Also, carbon taxes provide more equalization across industries and firms in terms of marginal emissions-abatement costs. Finally, carbon pricing measures create revenue streams that governments can, for example, re-invest in greening activities and programs.

According to the World Bank Carbon Pricing Dashboard (2022), as of 2022 there are 68 total carbon pricing initiatives implemented or scheduled for implementation around the globe, mainly concentrated in the U.S., Europe and Eastern Asia, covering 46 National Jurisdictions and targeting approximately 12 Gigatons of carbon dioxide emissions, accounting for 23% of global GHGs emissions. *Figure 5* depicts the current situation in the EU area, broken down by type of measure, i.e., emission trading systems (ETS, mechanism for the implementation of cap-and-trade solutions) and carbon taxes.

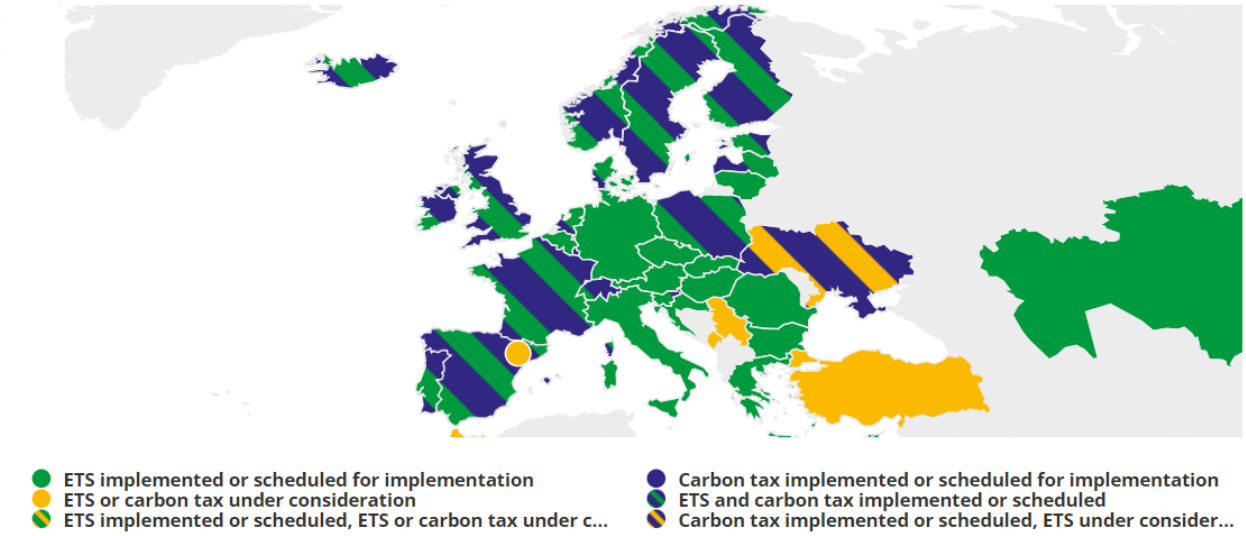

Figure 5: EU area map of carbon pricing measures implementation in 2022 (Source: World Bank Carbon Pricing Dashboard)

It is worth to mention that the European Union countries fall under the already implemented EU Emission Trade System, the world's first international ETS created in 2005. Participation is mandatory for all companies within the scope of the program – but also dependent on size or complementarity with other measures. The program covers the following sectors and greenhouse gases:

- *Carbon dioxide (CO_2) from*
  - *electricity and heat generation,*
  - *energy-intensive industry sectors including oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals,*
  - *commercial aviation within the European Economic Area;*
- *Nitrous oxide (N2O) from production of nitric, adipic and glyoxylic acids and glyoxal;*
- *Perfluorocarbons (PFCs) from production of aluminium.*

(source: European Commission website)

Nonetheless, according to the map shown, there are several countries which implemented – or scheduled the implementation of – complementary carbon tax measures. A report from Tax Foundation (2022) shows that since 1991 carbon taxes were/are being introduced in 21 countries, the first two (in chronological terms) being Sweden and Norway. The first one also detains the first position in terms of carbon tax rate, with a price of 117.30 € per ton of CO_2,

covering a 40% portion of all GHGs emissions in the country. As a reference, the 21 countries' carbon tax rates and GHGs emissions coverages are reported in *Table 1*, while a review of the Swedish carbon tax system can be found in *Box 3*.

Box 3: Sweden carbon tax – a 30-years history of carbon policies

In 1991, as a consequence of growing environmental concerns, the Swedish government introduced a carbon tax that is still active as of today. The aim of this measure was to target specific sectors' pollution issues and led over the last 30 years to a 27% reduction in GHGs emissions and allowed – as a part of the "green tax-switch" reform of 1990-1991 – for significant reductions in other fields' taxation rates, such as marginal income tax rate for individuals, corporate taxation and capital income (Jonsson et. al., 2020). The largest reductions were achieved in heating homes, industrial facilities and domestic transportation emissions. The point of regulation chosen for this measure is up-midstream, since the levy is applied to importers and distributors and not to final consumers.

During the years of application of this tax, Sweden registered a steady GDP growth, with a GDP per capita increase of more than 50% between 1990 and 2019, therefore partially relieving possible fears of economic threats caused by carbon pricing measures. Moreover, the government was able to collect large amounts of tax revenues due to this measure (roughly €2.17 billion in 2019, around 1% of total tax revenues), half of which went to replenish government's general funds while the other half was used to lower other tax burdens (e.g., income taxes) (Pomerleau, 2020).

Despite the positive results achieved by Sweden's carbon tax, the measure is not free from criticisms. First of all, the effect on emissions over the years has been below its potential because of the large extent of exemptions applied: Sweden's biggest polluters are in fact construction material manufactures who were not addressed by carbon tax measures until the introduction of the EU Emissions Trading System in 2005, and even after that a cap was applied to alleviate the tax burden for companies that would be put out of business if they were to pay for the total amount of their emissions. The same cap although provides an incentive for these companies not to decrease their pollution levels, in fact it counter-intuitively "allows" them to further increase emissions since they are already paying the maximum price. Concerns have also been raised on the high tax rate applied in comparison with other countries. Finally, Torbjörn Schiebe (2019) raised the issue of decreasing state revenues as a consequence of emissions reduction: if emission reductions were to be brought to zero, how would the government cover for the income provided by the carbon tax? The Swedish environmental research institute is currently researching the possibility to introduce a kilometre tax as a kind of road pricing to account for these future losses.

Country	Carbon Tax Rate EUR per ton of CO_2e	Carbon Tax Rate USD per ton of CO_2e	Share of Jurisdiction's Greenhouse Gas Emissions Covered	Year of Implementation
Austria (AT)	€ 30.00	$ 33.15	40%	2022
Denmark (DK)	€ 24.04	$ 26.62	35%	1992
Estonia (EE)	€ 2.00	$ 2.21	6%	2000
Finland (FI)	€ 76.00	$ 85.10	36%	1990
France (FR)	€ 45.00	$ 49.29	35%	2014
Iceland (IS)	€ 30.93	$ 34.25	55%	2010
Ireland (IE)	€ 41.00	$ 45.31	40%	2010
Latvia (LV)	€ 15.00	$ 16.58	3%	2004
Liechtenstein (LI)	€ 117.27	$ 129.86	81%	2008
Luxembourg (LU)	€ 39.15	$ 43.35	65%	2021
Netherlands (NL)	€ 42.00	$ 46.14	12%	2021
Norway (NO)	€ 79.12	$ 87.61	63%	1991
Poland (PL)	€ 0.07	$ 0.08	4%	1990
Portugal (PT)*	€ 23.88	$ 26.44	36%	2015
Slovenia (SI)	€ 17.27	$ 19.12	52%	1996
Spain (ES)	€ 15.00	$ 16.58	2%	2014
Sweden (SE)	€ 117.30	$ 129.89	40%	1991
Switzerland (CH)	€ 117.27	$ 129.86	33%	2008
Ukraine (UA)	€ 0.93	$ 1.03	71%	2011
United Kingdom (GB)	€ 21.36	$ 23.65	21%	2013

Table 1: 2022 carbon taxes data in Europea area (source: Bray S., 2022, Tax Foundation)

1.4.1 Carbon pricing impacts on employment

We investigated the main types of carbon pricing measures, how they are implemented and analysed the impacts on economic activities of the application of carbon taxes in the Swedish case. But what are the possible effects of carbon policies on employment and labour markets mechanisms?

Literature is quite divided about this topic: many advocate that an increase in the production costs brought by the introduction of carbon taxes affecting the price of inputs (that are not easily substitutable by labour) would lead to significant reductions in production levels, with related increases in prices and job losses (OECD, 2012) (Känzig, 2022). Other scholars' studies show that carbon pricing instruments are not bound to carry significant effects on aggregated employment rates if they are reasonable and the revenues they produce are invested in mitigating the downsides of carbon taxation policies (e.g. reducing labour or income taxation) (Hafstead, 2018), eventually with the support of complementary measures (Mohommad, 2021).

Furtherly sustaining the thesis by which carbon prices do not have significant impacts on employment, an OECD review (2015) of most prominent literature at the time showed that these pricing measure did not carry relevant negative impacts on any indicator of competitiveness, including employment, output and exports at various aggregation levels. The study focused also on the effects of the implementation of the EU Emissions Trading System mentioned before. Results showed that while some of the analysed literature reported slight decreases in employment rates especially related to the non-metallic minerals sector, most of the studies did not find evidence of negative impacts on employment derived by the introduction of the EU ETS. However, on the other hand, no evidence was found of significant job creation either, contrary to the expectations of some studies (Oberndorfer, Rennings, 2006).

In an analysis on employment rates in manufacturing conducted after the implementation of a carbon tax measure in Australia (introduced in 2012), ABC fact-checking team found no direct correlation between the job losses trend affecting Australian labour market and the policy introduced, contradicting the claims of Minister Angus Taylor (ABC Fact Check, 2022).

Although no relevant implications on employment were found related to the application of the European cap-and-trade system and the Swedish and Australian carbon tax policies, labour market impacts cannot be factored out from carbon pricing policies discussions. In fact, several studies show that in a carbon pricing implementation scenario, workers are more likely to face reallocation rather than displacement (Hafstead, Dunlap, 2020). Moreover, it is difficult to assess whether the reallocation from phasing-out brown industries to green ones will entail job losses in the firsts and creation in the latter – and therefore unemployment for the workers involved in unsustainable occupations while hiring of new green workers on the other side – or rather allow for a shift of most of the affected workers from one to the other. Both the options would explain for the observed net impacts on employment levels; however, they entail significant differences from a social point of view. Workers who would lose their job, who are likely to be low-skilled and have lower degree of formal education, would in fact face more difficulties than the currently unemployed ones since they could lack the right skills and qualifications to apply for green jobs. To the extent of understanding the requirements that would allow for a smoother transition for both workers and businesses from brown, unsustainable models to green, low-carbon systems, the concepts of skill mismatch and re-skilling could give important insights and will therefore be furtherly discussed in a separate chapter of this thesis.

1.5 Strategic planning of policy implementation for a Just Transition

As seen in the previous sections, policies and regulations play a fundamental role in allowing and smoothing the transition from a carbon-intensive, environment-depleting economy to a greener one. Changing the economic paradigms that govern the use we make of natural resources and the pollution we create with production and consuming activities requires deep structural modifications to our business and consumption models and entails important repercussions on both our living habits and working environments. These consequences can be highly disruptive if not carefully managed and controlled: the transition to a Green Economy should pursue all the Sustainable Development Goals and be 'fair' to all. In this sense, the International Trade Union Confederation (ITUC) defined the concept of:

Just Transition – A process that *secures the future and livelihoods of workers and their communities in the transition to a low-carbon economy. It is based on social dialogue between workers and their unions, employers, governments and communities. A plan for Just Transition provides and guarantees better and decent jobs, social protection, more training opportunities and greater job security for all workers affected by global warming and climate change policies.* (ITUC, 2019)

To the extent of promoting a fair and sustainable shift to a de-carbonized economy and protect the workers in doing so, ITUC, along with several partners, created the Just Transition Centre in 2016, whose activities focus on accelerating the process by empowering workers, documenting best practices, starting social dialogue processes and providing strategic inputs to national and global policy discussions. (ITUC, Just Transition Centre website, 2022)

On the same line, the International Labour Organization (ILO) defined in 2015 a guideline for policy implementation in the context of a Just Transition and advocated the need of social dialogue among relevant stakeholders at local, sectorial, international and global levels as a cornerstone enabler for fair policies definition, smooth sectors' de-carbonization and decent green jobs creation. They also identified nine key policy areas to address environmental, economic and social sustainability, which are: i) *macroeconomic and growth policies*; ii) *industrial and sectoral policies*; iii) *enterprises policies*; iv) *skills development*; v) *occupational safety and health*; vi) *social protection*; vii) *active labour market policies*; viii) *rights*; ix) *social dialogue and tripartism*. (ILO, 2015)

In the previous sections of this thesis, we analysed some of these areas by providing examples of policies implementations. Carbon pricing and tax reforms fall, for instance, under both the

macroeconomic *(i)* and sectoral dimensions *(ii)*, especially when targeting specific highly polluting industries or redirecting the cost of carbon emissions to reduce labour costs and income taxation. Environmental decommodification measures and socio-ecological Job Guarantees contribute to increasing occupational safety *(v)* and social protection *(vi)*, particularly when supported by alternative income sources, while work-time reduction policies and measures to target negative implications of climate-change natural phenomena provide health benefits to workers in highly productive, labour intense occupations. Business and plants conversion strategies can be implemented as forms of enterprises reforms *(iii)* targeting specific industries or sectors *(ii)*. They can also create significant growth opportunities *(i)* in greener markets and by doing so, prevent future losses due to phasing-out of brown activities. Skills development *(iv)* is also a fundamental policy area that will be specifically addressed in Chapter 3.

An interesting case of sectorial policies application is the Italian *Superbonus 110%*, an incentive measure introduced with law decree *Rilancio* in May 2020 that targets the reclassification of old buildings and the enhancement of their energy efficiency with greatly reduced (if not zeroed) costs for households and companies (Italian Government website, 2022). Although it presents some important drawbacks (like low availability of materials and labour and ineffective, unclear communication of the mechanism's principles to both population, construction firms and financial institutions), it is reported that the Superbonus led to the creation of 100.000 jobs per year in the construction, insurance, fiscal, legal and business consultancy sectors (Orienta – Agenzia per il lavoro, 2020). Moreover, it generated positive impacts in the construction industry in terms of investments (Mattarelli, 2021) and could allow for households' savings in energy expenditures and consequential environmental benefits thanks to energy demand reductions due to the consumption efficiency improvement feature of renovation interventions (Ellen McArthur Foundation, 2020) (European Commission, 2020b). Improvements to this initiative, whose application was extended to 2023, could entail fostering social dialogue inherent to the proposal, by including all stakeholders in the decision-making process to ensure extended comprehension of the possibilities, legal boundaries and requirements of the program and extended investments in labour – through training and skill provision activities – and resources supply.

On the Green Economy opportunity-creation side, ILO guidelines (ILO, 2015) state that the labour market can benefit from green growth in several ways: net employment gains deriving from investments into environmentally sustainable production, better management of natural

resources and green innovation; improvements in decency of jobs and incomes as a result of new and more productive green processes and more social inclusion through access to affordable, clean energy; payments for environmental services (e.g. Job Guarantees outputs). However, a Just Transition is not free from important challenges, particularly in terms of economic restructuring and consequential displacement of workers (which should be balanced by the creation of green jobs and, more importantly, minimized through shift-enabling reskilling and relocation programs), adaptation of communities, workplaces, and enterprises to climate-change to avoid involuntary migrations, and increments in energy and commodity prices that would increase the burden on households.

To prevent the possible disruptive effects of a green growth process and pursue the objectives of sustainable development in a just transition optic, policymakers should base green policy implementation on fundamental pillars that include strong and informed social consensus, equality principles and rights of workers, coherence and (positive reinforcing) synergy among policies at all levels of implementation (economic, environmental, education, training and labour) (ILO, 2017). Moreover, actions taken should be specific and designed on the needs of the targeted local community, sector or industry of scope, taking into account its particularities and stage of development with the final goal of contributing to the realization of the Sustainable Development Goals at a national, international and global dimension. Concerning the matter of coherence and synergies, the ILO identifies several reciprocal reinforcing ways in which business development and reforms can foster green growth and vice-versa (*Table 2*).

Green growth helps business development through	Business environment reform helps green growth through
Creation of and access to new markets, such as clean technology and renewable energy	*A focus on structural change through regulatory and policy reform, enhancing the sustainability and scalability of green growth initiatives*
A focus on long-term sustainability and access to resources, thus helping to provide medium-term security for firms	*Unlocking the resources, creativity and innovation power of the private sector*
Support and incentives for resource efficiency to lower costs and improve profitability for firms	*A sharper focus on the real alignment of incentives and better understanding of the pitfalls of poorly designed regulation*
A stronger perspective on the political economyof a country, bringing in externalities and potential new economic opportunities	*The reallocation of subsidies and adjusting taxes to reflect real costs to the environment for enhancing green growth*

Table 2: opportunities to develop synergies between business development and green growth programs (source: ILO, 2017)

Employment policies should then focus on exploiting the leverage offered by private sector-driven green growth in creating and maintaining decent work. Some ways to achieve this, among others, are:

1. Creation of green investments funds and credit lines;
2. Promotion of green practices among businesses through training and advisory initiatives concerning green standards and certifications;
3. Green-centred innovation and development, including the use of value chain intervention to incentivize and promote the adoption of new green products or production processes and fostering the evolution of green technology start-ups, possibly creating new environmental-friendly business models;
4. Promoting green entrepreneurship in secondary and tertiary training institutions, particularly addressed to young entrepreneurs.

These actions are central to the successful implementation of a Just Transition leading to a Green Economy that could maintain the high standards set by the Sustainable Development Goals in fostering green, carbon-neutral innovation, promoting social awareness and inclusion, reduce inequalities and head towards a green growth environment. Significant efforts in the development of a promising strategy for the transition have been made in Europe through the last decades, leading to the development of the European Commission Green Deal, a policy framework specifically structured as to favour the introduction of tools and strategies for the shift towards a green, regenerative economy which will be furtherly looked into in the Circular Economy chapter of this thesis.

1.6 Conclusions on labour markets impacts driven by climate change and green transition

In the course of this chapter, we identified several climate change-related tools and situations that carry either positive or negative consequences affecting employment at all levels and from different points of view.

Natural disasters, heat waves and temperature rise affect the labour market in many ways. They may destroy natural and built environments, leading to losses in production assets and resources (e.g., water, crops, land), displacement of workplaces or force changes in production systems and inputs. Unbearable living and working conditions caused by heat may negatively influence

workers' willingness to take up certain types of jobs (e.g., agricultural sector) or their productivity, leading to decreases in production levels, profits and therefore labour demand.

Natural phenomena and climate change may also lead to climate migration, which could reduce the labour supply in the leaving countries while producing over-skilling and over-qualification issues for migrant workers in the destination countries. However, migrations have proven to possess the potential for the creation of green innovation boosts via skills and knowledge exchanges, best practices implementation and international collaboration improvements.

The major implications for employment though derive from the implementation of climate-change related policies. De-carbonization measures can take many forms and they have different degrees of impact depending on the area of application (direct vs indirect effects on labour) and target level (sector/industry-wide vs occupation level). Depending on the scope of the initiative, policymakers may decide to implement strategies aimed at decarbonizing the output of businesses and processes (e.g., conversion of businesses and plants, environmental decommodification programs), follow direct occupational-influencing plans (e.g., alternative income sources and VET provisions), aim at changing work-lifestyle approaches via modifications of income and work (e.g., work-time reduction and distribution and income equalization strategies) or target the outcome efficiency of employment with policies that provide environmental positive outputs without affecting current levels of employment in private sectors (e.g., eco-social Job Guarantees).

Finally, carbon pricing measures are policy forms with great potential in carbon emissions abatement that do not entail significant impacts on employment rates – at least not observed until now. However, this type of regulation does affect the redistribution of employment between the unsustainable brown sectors and the newly created and incentivized green industries. The displacement of workers in highly polluting businesses due to the increase in carbon emission costs should be carefully managed by policymakers, who should introduce tools to enable their transition from old to green jobs and provide training and re-skilling programs, along with social assistance and financial support for those workers who will not "make the cut".

To conclude, a just transition to a Green Economy should be founded on social, inclusive and informed dialogue, and promote a fair labour market that aims at providing job opportunities to all through the synergic implementation of sustainable instruments and policies. Green growth and business reform initiatives can and should be aligned in order to create positive

reinforcement cycles that can contribute to improving the quality of jobs and life while leading to economic growth. This can be made easier by investing in sustainable innovation, promoting green practices among businesses and providing environmental education and green skills training to students and workers.

Chapter 2

Circular Economy

A relevant component of a green transition is the concept of Circular Economy, which was also included in the EU's sustainability strategy in 2015. Circular economy is an economy that is *restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles* (Ellen MacArthur foundation, 2015). Although this concept may resemble the one of green growth described earlier on, Circular Economy focuses on fostering growth *within*, promoting the extraction of more value and consumer utility by existing stocks of products and materials and addressing social aspects as well, while green growth models are more focused on achieving economic growth in an environmentally, but not necessarily socially fair, sustainable way. Despite the fact that the topic of circularity seems to have reached public debate only quite recently, its main dogmas have been object of discussion for almost seventy years, and they have constantly evolved during time.

The concept of Circular Economy was born as an opposite to our current capitalistic and consumeristic model that seeks profit over sustainability, based on a linear model that follows the pattern *extract – produce – consume – dispose*, and that was described in the early Fifties by the economist Victor Lebow as an:

> *[…] Enormously productive economy* [that] *demands that we make consumption our way of life, that we convert the buying and use of goods into rituals, that we seek our spiritual satisfactions, our ego satisfactions, in consumption. […] We need things consumed, burned up, replaced and discarded at an ever-accelerating rate.* (Lebow, 1955)

The raising concerns over the sustainability of our consumeristic lifestyle brought through the decades to several explorations of different models that could be sustainable over time, while still allowing for development and profitability of the industries. In 1961, program Symbiosis was launched in Kalundborg, Denmark, grounded on the concepts of waste and energy usage reduction. The program foresaw the creation of a complex network of secondary raw materials, production scraps and energy residuals exchange between firms operating in different sectors at the extent of improving processes' efficiency while reducing their environmental impacts. The program resulted in the creation of the first case of industrial symbiosis which has been active until today and expanded throughout the decades with new partners and firms joining the

symbiotic network (Kalundborg Symbiosis.dk, 2022). According to the program's website, the project saves the environment and the partners every year around 4 million m^3 of groundwater, 586,000 tons of CO_2 and 62,000 tons of residual materials. They also report reductions in their CO_2 emissions by 80% since 2015, having reached emissions neutrality in the use of energy. This and other cases of success in the implementation of sustainable industrial solutions led scholars all over the world to analyse possibilities in the field, leading to the creation of international organizations such as the Club of Rome, which, founded in 1968, groups scientists, businessmen and economists together under the scope of debating and proposing solutions and analysis to global-wide issues, including sustainability and development matters (Club of Rome website, 2022).

The "Father" of Circular Economy is by many considered to be Walter Stahel, who, in 1976, wrote the report *Potential for Substitution Manpower for Energy* for the European Commission in which he analysed the theme of wastes of resources due to the dismissal of goods and products instead of their reparation, and proposed a solution based on the extension of the lifecycle of long-term assets such as cars and buildings, to reduce wastes and garbage creation. His strategy consisted in replacing the old linear economic model – working on the pillars of value added, after-sales depreciation and dismissal after first use – with a circular model where, for the system to be regenerative, companies are supposed to maintain responsibility over the product even after they sold it. This concept is commonly known as Extended Producer Responsibility (EPR) and works on shifting the burden of the waste dismissal and pollution from the consumer to the producer. In his report, the author also shows how this type of economy can be encouraged by the right strategy, characterised by regionalization of workplaces and competences (e.g.: creating small factories for recycling of materials and re-manufacturing products) and sustained by planning, researching and managing structures. He advocates that a cyclic economy would consume less resources and would do it more efficiently, while having positive effects on employment due to the high rate of labour vs energy needs in activities of transformation of raw materials rather than extraction (which on the other hand are more energy-intensive). In this sense, Stahel observes that circularity has the potential to benefit the labour market by requiring competences and workers to employ in repairing, recycling, re-using and regenerating activities while on the other hand diminish the needs for high energy-consuming primary raw materials such as steel, cement or plastic.

Later on, in 1987, the report *Our Common Future* from the World Commission on Environment and Development (WCED) analysed the relationship between environment and development

and proposed solutions to its most problematic points that could be addressed by nations, organizations, companies and private citizens as well. The report promoted a new growth model based on *sustainable development*, which, as addressed previously in this thesis, represents the idea of a process of change in which resources exploitation, investments, technological development, and institutional changes are coherent and adequate with both present and future needs of society. During the Nineties this concept was further analysed and became central to development strategies all over the world. The United Nation Conference on Environment and Development (UNCED) – also known as the Earth Summit, held in Rio de Janeiro in 1992 – saw the recognition by the participating countries of the need for a collective effort in dealing with the environmental issues. The conference led the way to the approval, in the same year, of the Fifth plan of action of the European Union to turn into reality the agreements made by the attendant countries.

It is in this context that Amory and Lee Hunter Lovins first proposed the idea of a *bioeconomy*, in their book *Natural Capitalism: Creating the New Industrial Revolution* (Lovins A., Lovins L. H., 1999). The concept of bioeconomy was born as a solution to the limitations of the so-called *ecoefficiency*, a term used by many scholars at the time to represent the search of more efficiency in the use of resources rather than its diminishment. The authors pointed out that given the demographic increases foreseen for the following decades and the limited amount of resources available on the planet, a deep structural and cultural change in our commercial system was fundamental for the shift towards an actually sustainable economy. Starting from this position, they postulated that a new economic model should be created based on the recognition and wise use of human, financial, fixed and natural assets, suggesting four strategies:

- *Increase productivity of resources*: diminish utilization of resources at the beginning of the process and reduce pollution at its end, increase employment and the related qualification average level, with final reduced costs of production and emissions;
- *Biomimicry*: as nature is a closed cycle based on the re-utilization of resources and products, so it should be the logic of our industrial processes, which should be able to eliminate waste by constantly re-using materials in a closed cycle, eliminating toxic substances too;
- *Service economy*: move from a product-based economy to one that works on services, changing the consuming behaviours and orienting them towards quality, utility and performance instead of price;

- *Investments in natural capital*: protect the nature as it is a fundamental supplier of both raw materials and services needed for our survival (air, water, soil…).

The observations of the authors aim at suggesting a new economic model that is decoupled from the current *produce-consume-dispose* behaviour and instead works cyclically, by turning waste into raw materials for the process. These concepts will then be furtherly expanded in 2002 by William McDonough and Michael Braungart with their book *Cradle to Cradle* (McDonough, Braungart, 2002), criticizing the diffused attitude of 'limiting the damages' through preserving, limiting, reducing, degrowing, all actions that do not change our consumerist structure and are perceived in a negative way by public opinion. They pointed out that although the client is defined as a 'consumer', the real 'consume' is only a small part of the results of our economic model, where most of the products are bound to become waste after they are sold in an unnecessarily short time. They also addressed the idea of recycling (or *subcycling*, as they defined it), which on their opinion cannot be efficient if the products are not conceived from the beginning to be recycled and re-used, highlighting that in many cases the separation of complex and interdependent finite products can be expensive in terms of energy usage and pollution (e.g.: the recycle of an aluminium can). Finally, they noticed that the final products derived from recycled materials are usually less resistant and are processed with chemicals in order to be suitable for sale, leading to a decrease in the value of materials and products. They challenged this issue a decade later in *The Upcycle* (McDonough, Braungart, 2013), proposing the creation of production cycles where resources do not lose value but, on the contrary, acquire more of it after every re-processing.

These evolutions in the ideas and proposals revolving around the topic of sustainability and development led over the years to the consolidation of the concept of Circular Economy and the birth of several initiatives and organizations, one of the most prominent being the Ellen McArthur Foundation. The Foundation, created in 2010 by Ellen McArthur, has the objective of accelerating the transition towards a regenerative and Circular Economy and to make it effective and concrete. It also works as a collector of schools of thought trying to present a coherent and cohesive picture of the principles of circularity and sustainability. As of today, the Ellen McArthur Foundation is by many considered to be the main actor invested in the diffusion of the Circular Economy paradigm on an international scale.

2.1 Main pillars and advantages of the Circular Economy

The last decades increasing scarcity of resources is slowly leading economic markets to accept the unsustainability of the current linear economic model. Raw materials become increasingly costly and difficult to obtain while our continuous consumption and its consequent waste are devastating nature and its ecosystems at a rapidly increasing rate. All of this has consequences on the final prices of commodities, which was subject to significant raises in the last few years. From the identification of these problems, a question was raised: what if we could use the wastes that are polluting our environment as raw materials, reducing the demand for virgin raw materials and our environmental footprint at the same time?

The potential value of waste is not of easy computation: the World Bank estimated that by 2025 each of us could produce about 1.42 kilograms of waste a day (in terms of Municipal Solid Waste, MSW), for a total of 2.2 billion tons a year, while from an energetic point of view the solely alimentary waste produces around 3.3 billion of tons of CO_2 every year (The World Bank, 2012). We also throw away 250 km^2 of water, which would be enough to irrigate 1.4 billion hectares of land. But waste is not only what we dispose of: from an immobilization-of-value point of view, materials and products that are purchased and used only in limited situations and time can be considered as a waste too (e.g.: cars are products that most of us consider fundamental, but then are usually used for very limited amounts of time).

The recognition of these potential sources of materials, power and savings is one of the pillars of the Circular Economy, a model that is founded on the vision of an economy where materials flow following McDonough's and Braungart cradle-to-cradle philosophy rather than the cradle-to-grave one that we are used to. Re-inputting scraps, waste and unutilized products in the economy would lead to the abatement of raw material costs, higher employment rates (especially due to the creation of occupations linked to new rework processes based on the principles of circularity), reductions in sanitary costs (as a consequence of the related reductions in negative externalities on environment associated with waste) and a general release of pressure on the economic and political systems deriving from scarcities of resources (Bompan, 2016). Moreover, according to the definition given by the Ellen McArthur Foundation, a Circular Economy should be *restorative and regenerative by design*, meaning that this type of economic model has the potential of not only reducing negative impacts on the environment, but more importantly to positively influence it - e.g.: in Stockholm the employees of a restaurant

use aprons created with fibres and materials which can absorb CO_2 emissions, which are then transformed in nutrients for the restaurant's greenhouse plants (Katanich, 2022).

Circular economy rests on three main principles:

i) Preserve and enhance natural capital;

ii) Optimize yields from resources in use;

iii) Foster system effectiveness minimizing negative externalities.

These macro-principles entail a series of needs that must be fulfilled in order for an economy to be circular: first of all, natural capital should be preserved and enhanced by reducing our demand for natural non-renewable raw materials such as water, carbon and petrol and by creating processes that produce positive externalities on natural environments. At this extent, recycling and transforming waste to turn it into either source of energy or secondary raw material contributes to both reducing our demand for natural resources and limit the impact of waste on the environment. Innovation on the other hand should head towards the creation of new technologies capable of both increasing efficiency and yields but also creating positive, reinforcing benefits to nature. An example of such innovation is e-Kakashi, an Internet of Things (IoT) tool described in *Box 4*.

Concerning the second principle of Circular Economy, the optimization of the yields from the use of resources has multiple effects: on one side, it allows the extraction of "extra" value/profit from the materials and processes already in use, which is appealing to companies that would otherwise be less interested into sustainability. Meanwhile, this reduces the amounts of waste and scraps created, lowering their negative impact on environment. Finally, it also means changing our perception of waste as an inconvenience while it can be used as a vast, low-cost source of perfectly re-usable materials, parts and energy. Shifting towards an economy that transforms waste into its primary source of inputs for its productive processes would require moving from a globalized supply chain to a regional, local supply *cycle*, allowing for the creation of new occupations and jobs for local residents, and a maximization of the use of each product (Stahel, 1976) (Ellen McArthur Foundation, 2015) (Bompan, 2016). In this sense, Circular Economy discards the practice of "programmed obsolescence", which in contemporary markets is vastly diffused in order to encourage the replacement of products for slightly upgraded versions well before their lifecycle reaches its end, and instead focuses on the extension of the lifecycle of products by proposing upcycling mechanisms, such as the improvement of "old" products rather than substitution. In this way, a product that would be

Box 4: e-Kakashi, IoT for sustainable agriculture

e-Kakashi is an Internet of Things (IoT) tool designed by PS Solutions used in agriculture to collect environmental data through a network of sensors. The information is then integrated with farming data to provide crops farmers detailed insights on the best solutions to several field conditions. The data collected include water levels in the soil, air temperature and humidity, soil temperature and moisture, and solar irradiance. Data is collected at a specific field and combined with previous scientific data about cultivation to create ek-Recipe, a tool described by the company as a science-based e-farming manual that helps in optimizing cultivations, meaning that it also allows to optimize the amounts of water used and the greenhouse gasses emissions (e-Kakashi website, 2022).

The development of this IoT service, according to the words of one of the developers Takashi Togami, was based on the idea that market needs and scientific studies on cultivation techniques and metrics had to be combined with the implicit know-how detained and used by farmers to deliver a solution that combines everything from a "plant perspective". In a way recalling the idea of bioeconomy proposed by Amory and Lee Hunter Lovins (previously discussed in this chapter), e-Kakashi uses nature as both a role model and a kind of "feedback provider", allowing to increase the productivity of the farms and the resources (first strategy proposed by Lovins), improving the quality of work and the use of resources using scientific knowledge and intrinsic farmers' know-how to provide a service rather than a product (third strategy), while using the information derived from the observation and understanding of natural processes (biomimicry, second strategy) to improve soil conditions and reduce negative externalities on the environment (investments in natural capitals, fourth strategy), all of this leading to a better quality of the final products and higher profits due to savings.

Finally, the e-Kakashi platform works as a collector of knowledge and competences in cultivation activities that can be used to improve skills and know-how among several processes. In the words of one of the developers, Kyosuke Yamamoto, *[…] We [PS Solutions] are developing a platform that connects farmers in various layers. As a first step, we built the 'cultivation technology platform'. There exist many communications about cultivation skills and knowledges between farmers in various forms. Our platform aggregates them in one place, and provides various tools, data and analysis results to facilitate the information transfer. […] We will develop 'Agricultural information platform' that facilitates various transactions related to agriculture, such as farmer's operation history, plant growth information, material buying and selling, product distribution and sales etc. Our platform provides new values generated from the interactions to every users*.

(e-Kakashi website, 2022, *Vision*)

discarded after a limited use can ideally turn into a lifelong service that allows to both improve its quality over time, keep its features up-to-date and can be retired by the manufacturer and re-

sold or re-used as an input in the production process at the end of its usage. However, these possibilities are strongly dependent on the concepts on which products are designed: modern smartphones' components, for example, are often so deeply integrated that operations such as extraction of materials, upgrading or repairing are extremely expensive in monetary, energetic or GHGs (greenhouse gasses) emissions terms. For this reason, optimizing the use of resources in a Circular Economy entails that also the designing process should be aligned and coherent with the three R's: *recycle, reuse, repair*.

A company that was born embracing these ideas is Fairphone. Founded in 2013, the mission of the company is: *we care for people and planet. From the earth to your pocket, a smartphone's journey is filled with unfair practices. We believe a fairer electronics industry is possible*. (Fairphone website, 2022). Fairphone products are smartphones designed to be easily repairable in each of their components, a solution that is far distant from the traditional "black boxes" sold by big tech companies such as Apple, Huawei or Samsung. Each Fairphone is produced through an ethically designed process that is characterized by decent and fair work conditions, responsibly supplied materials and components and a product design centred on longevity and easy repairment of single components. In their yearly impact report of 2021, the company showed that for each Fairphone sold a smartphone gets recycled or other electronic waste (e-waste) collected, meaning that the production is e-waste neutral. (Fairphone, 2021) Moreover, Fairphone reports saving more than 650 tons of CO_2 through Fairphone products' longevity: this is due to the fact that, according to the company, the greatest amount of CO_2 emissions related to a smartphone are released during its production, meaning that extending its life and improving its repairability, great amounts of emissions can be avoided. They finally claim to put workers and their needs first, having increased their living wage bonus and selected suppliers who practice fair labour conditions.

Both the companies mentioned, PS Solutions and Fairphone, apply circularity tools and concepts to operate through the principles of Circular Economy, preserving and enhancing natural capitals while optimizing the use of resources and minimizing waste, therefore improving efficiency and maximizing the effectiveness of their products/services with almost null negative externalities on the environment. The business models proposed show that it is possible to re-design our consumerism-oriented processes to provide new solutions that can contribute to preserving natural environments and earn profits from it. Such transformations should also bring benefits to employment in terms of better working conditions and new job opportunities.

Circular Economy differs from other models such as Green Economy, degrowth and bioeconomy, which brought under the spotlight themes like emissions and consumption reductions, abandonment of fossil fuels and output re-utilization, in the sense that it encompasses all these concepts and integrates them in a single system that simultaneously seeks market goals (profit), social goals (full employment and decent work) and environmental goals (emissions and raw materials extraction minimization). Circular Economy does not only carry significant social benefits such as welfare, biodiversity, employment, security and development, it is also capable to generate important outcomes in economic terms: the Ellen McArthur Foundation presented a report in 2012 to the World Economic Forum in Davos that estimated that the application of Circular Economy principles to European manufacturing would allow for savings in the order of 600 billion euros after a decade from the adoption (Ellen McArthur Foundation, 2012), but they only considered five key sectors, representing roughly half of the European GDP coming from manufacturing. However, the Foundation furtherly expanded their analysis in 2015 with an extension of the first report (Ellen McArthur Foundation, 2015) and a separate investigation called *Growth Within: A Circular Economy vision for a competitive Europe* (Ellen McArthur Foundation, McKinsey Center for Business and Environment, 2015) and reported that a shift from a linear towards a circular model would allow for a 11% GDP growth by 2030 (7% higher than the expected growth in the linear case), a reduction of emissions by 48% (possibly increasing to 84% by 2050) and raises in personal income for households by 18%. They forecasted that a 5-year, scaling expansion of circular models among European businesses could have led to the creation of 100,000 jobs, saved 450 million euros in raw materials costs and avoided the disposal of 100 million tons of waste.

Emanuele Bompan, chief director of the magazine Renewable Matter (*Materia Rinnovabile*) and key figure in the definition of the project *Circular Re-Thinking*, case study analysed in Chapter 4 of this thesis, identifies nine key points that he defines as 'elemental particles' of a Circular Economy (Bompan, 2016):

1. <u>Renewable matter: the disappearance of waste</u>

After-use matter is no longer to be considered waste but instead should be seen as a mix of biological, chemical and material components that are supposed to remain within and fuel the cycle. Organic wastes go back to being organic materials and are redistributed over the territory, while material such as polymers, metals or fibres are designed so that they can be re-employed

with the minimum use of energy and water that provides the maximum level of materials extraction. Moreover, the concepts of maximization of value through usage (e.g.: car-sharing as a method to increase the usage of a car that could otherwise be seen as an immobilized asset) and extension of products' lives are part of the foundation on which Circular Economy stands.

2. System thinking

Circular economic models require a deep investigation of the interconnections among societies, industries and ecosystems. Thinking in a systemic way means being constantly looking for possibilities of recreating circular flows of matter, focusing on stocks and flows: the stocks of organic and non-organic matter should be constantly refilled in order for the systems to endure shocks in demands and this means that the collection of renewable matter should be organized and efficient. The flows of matter are instead more dynamic since they can potentially interconnect sectors and industries that were never supposed to meet: connections can be created among different cycles to interlock them, allowing for mutual influence and matter exchanges. This particle allows for the matter to actually be renewed.

3. Cascaded actions and closed loops

Using biomimicry (the imitation of natural features, i.e. the cycle of water), Gunter Pauli promoted the creation of cascading systems, where the scraps and waste produced by a process are used as inputs for other processes in order to generate productivity and profits (Pauli, 2010). Moreover, he pointed out that as water gets purified through the dynamization produced by waterfalls, so scraps and waste's value can be increased through further processing (upcycle). Stahel's idea of closed loops instead identifies in small, regional, circular industrial contexts – where materials and products are produced, used, repaired, recycled, regenerated and re-sold in a never-ending loop – the conditions for economic and environmental benefits to be optimized with the lower price for the consumer (Stahel, 1982). Although in our globalized world it is not always possible to locate entire production processes within a closed space (e.g. regional dimension) and repairing/regenerating tasks are not necessarily labour-intensive (thanks to automation) as Stahel expected, his theory of closed loops is still valuable for the implementation of circular economic models.

4. Cross-fertilization: inter-cyclic and inter-sectorial

Recognizing interconnections between sectors allows for the creation of possibilities of inter-cyclical mutual reinforcements: as an example, the Italian companies QuadroLegno and

OrangeFiber utilize the organic waste generated by oranges cultivations to create high-quality parquets (from the otherwise burnt orange wood) in the first case and clothes (made in a special fibre derived from oranges' peels) in the second.

5. Resilience

Resilience is not only a key factor in the transition from the linear to the Circular Economy, but it is also an intrinsic characteristic of the latter as this is a growing field based on inter-sectorial cooperation in the design of both production processes and policies for its development.

6. Relationship with the environment

The Circular Economy should operate within the boundaries imposed by our planet conditions for our survival and strive to diminish human impact on natural assets and ecosystems.

7. Temporality

While linear economy is based on short-term strategies aimed at the maximization of profits, circular thinking needs to be focused on long-term sustainability objectives and minimization of current and future negative externalities. This concept does not only apply to business strategies but also to products and services lifespan, constantly fighting the concept of obsolescence that is fuelled by modes, continuous incremental innovation (e.g.: slightly improving a smartphones' camera and sell it as a new product) and planned obsolescence. Finally, companies could progressively shift towards product-as-a-service models, taking responsibility for their products after they are sold and providing repairment, regeneration and end-of-life collection services to close the cycle.

8. Scale and economic geography

Products and services should be designed based on the right production scale and having an adequate physical collocation in geographic terms. Understanding and exploiting scale efficiencies in the supply of materials and energy, along with finding the correct dimension for the closed loop and the most efficient positioning strategy are therefore crucial points in a circular context.

9. People as fundamental assets

While practices of linear economy such as outsourcing, rationalization and restructuring see human resources as costs to be lowered, Circular Economy aims at improving social conditions by enabling the creation of new job opportunities that provide better work conditions. Green

Alliance UK estimated that a committed shift to Circular Economy would allow Great Britain to create hundreds of thousands of new jobs by 2035 (Green Alliance UK, 2021). Hopefully, the savings derived from cost optimization thanks to circular economic principles could be used to cover the cost of labour supply, supply that will be asked to provide to the market more high-level skills than before due to the high complexity intrinsic of circular models designing.

2.2 Circular economy policies and regulations and employment impacts

In the transition towards a circular economic model, public and private support and enablers play a key role. The concept of circularity can be disruptive for most of the established business models in our linear economic society, since it requires: *long term strategic vision*; *focus on environmental issues*; *restructuring of processes* in the search of ways of improvement in the utilization of resources; *changes in supply chain* flows, materials and design; to put *people and technologies at the centre* of the transition plan. This type of change is hindered by many factors, such as price sensitivity of customers (who might choose less sustainable products when green ones are applied a premium price, e.g.: biological food), costs of restructuring entire business processes, lack of expertise and guidance in the transition, motivation and full comprehension of the advantages and possibilities offered by Circular Economy. It is therefore important for policymakers to tackle the barriers and pave the way to a fully regenerative and profitable system. This necessity has also been clearly expressed by the European Commission in its proposal *A New Industrial Strategy for Europe*, highlighting the importance of looking closely at the opportunities and challenges facing industrial ecosystems. (European Commission, 2020a)

2.2.1 The European Green Deal and the Circular Economy Action Plan

Until today, several efforts have been made all over the world to reach such goals within different application areas. The European Green Deal is one of the most prominent examples of such efforts: proposed in December 2019, it sets a series of ambitious goals concerning environment protection and restoration, green transition and green employment. Although many documents and proposals were made previously (e.g.: the Circular Economy Package of 2015, as cited in European Parliament, 2016), the Green Deal entails new legally binding norms demanding the EU reaches emissions neutrality by 2050, with an intermediate milestone of a

55% emissions reduction by 2030. The Deal was then reinforced by many policy tools, primarily aimed at providing financial support and creating investment opportunities to allow a just transition, until in March 2020 the Circular Economy Action Plan was introduced.

[…] The European Green Deal launched a concerted strategy for a climate-neutral, resource-efficient and competitive economy. Scaling up the Circular Economy from front-runners to the mainstream economic players will make a decisive contribution to achieving climate neutrality by 2050 and decoupling economic growth from resource use. […] To fulfil this ambition, the EU needs to accelerate the transition towards a regenerative growth model that gives back to the planet more than it takes, advance towards keeping its resource consumption within planetary boundaries, and therefore strive to reduce its consumption footprint and double its circular material use rate in the coming decade. (European Commission, 2020b)

Building on Circular Economy actions implemented since 2015, the Circular Economy Action Plan describes a group of interrelated initiatives to allow for the creation of a well-structured, comprehensive policy framework aimed at transforming both the consumption patterns and business models in a sustainable, waste-free optic. These initiatives are based on the three main pillars of Circular Economy (*preserve and enhance natural capital; optimize yields from resources in use; foster system effectiveness minimizing negative externalities*) and address its main particles. In terms of system thinking and renewable matter, the Plan foresees the extension of the original Ecodesign Directive (introduced in 2009, set mandatory ecological requirements for energy-using and energy-related products) to make it applicable to the widest possible range of products with the following objectives:

- Improve durability, repairability, reusability and upgradeability;
- Increase energy efficiency of products and processes;
- Increase high-quality recycled content;
- Counter premature obsolescence and single-use practices;
- Reward sustainability performances;
- Widely spread digitalisation of product information concerning its lifecycle;
- Incentivise product-as-a-service models.

Particular attention is posed on the design phase of the product, which, according to the proposal, determines up to 80% of the environmental impacts derived from a product. The Plan especially focuses on fostering collaboration in defining and implementing actions to improve

sustainability in the key supply chains, identified as: *electronics and ICT*, for which less than 40% of e-waste is currently recycled due to complex design structures and components integration, and premature obsolescence is a significant issue; *batteries and vehicles*; *packaging*, which accounts for a massive share of plastic wastes; *plastics*, including microplastics; *textiles*, the fourth highest sector in consume of primary raw materials and water (after food, housing and transport) and the fifth in GHG emissions; *construction and buildings*, which account for 50% of total material extraction, 35% of total waste generated in the EU and 5-12% of total national GHG emissions; *food, water and nutrients*. For all these sectors, the Circular Economy Action Plan foresees for the near future the introduction of specific strategies and regulations to address the main sustainability barriers and issues.

2.2.2 A circular strategy after the Covid-19 pandemic

Almost counterintuitively, according to both the European Commission and studies from the Ellen McArthur Foundation (2020), the economic and social crisis created by the spread of the Covid-19 pandemic can represent a turning point in the transition to a Circular Economy: the aftermath on employment, consumption patterns, business models and society as a whole accelerated the recognition by citizens, industries and institutions of the limits of the current linear industrial model and contributed in spreading among population the demand for decent jobs and work conditions, fair economic practices, sustainable and accessible products and services. This is also partially because travel and shipments restrictions forced us to look for more local occupation and business opportunities based on closed, more reliable supply chain, which are key points in a Circular Economy. The Foundation's report highlights how the massive investments introduced all around the world in response to the pandemic consequences should be used not only as a tool for recovery but also as stimulus for the creation of a regenerative and resilient global economy that will prove more resistant to future global risks and will create more decent jobs. In this sense, the European Commission introduced in January 2020 the European Green Deal Investment Plan, which allocated 1,000 billion euros to support the Green Deal's objectives and that was then modified few months later in the context of NextGeneration EU, which is *more than a recovery plan – it is a once in a lifetime chance to emerge stronger from the pandemic, transform our economies and societies, and design a Europe that works for everyone* (EU, Next Generation EU, 2020).

While understanding and spreading the principles of a Circular Economy is important in order to design and implement enabling actions and policies, a significant focus has to be given to the opportunities that a regenerative and restorative system provides in terms of jobs creation and work improvement. The Covid-19 pandemic led to significant job losses all over the world and still threatens the sectors that were more affected by the shifts in consuming behaviours. Many see a solution in the possibilities offered by green employment, a concept that has been subject of many studies and initiatives through the last decades, one of them being the European Green Employment Initiative. Launched in 2014 – although proposed in a green growth optic (that, as discussed earlier on, does not necessarily meet all the Circular Economy principles) – the initiative provides encouraging estimates on the volumes of jobs creation (European Commission, 2014). As an example, according to the estimates of the initiative, improvements in waste prevention and management practices and the review of waste legislation could collectively create up to 580,000 new jobs across the EU, while additional 400,000 positions could be provided by renovation activities in the building and construction sector. These estimates are sustained by the McArthur Foundation strategy proposal for a Covid-19 recovery (Ellen McArthur Foundation, 2020), which explores the environmental, social and economic benefits that would be brought by adopting circular strategies in five main sectors similar to the ones tackled by the Circular Economy Action Plan, being *building and constructions, fashion, mobility, packaging and food.*

While in the construction sector modular building solutions represent an important step in the adoption of circularity concepts such as recycling-focused design and materials re-utilization, the Foundation's work finds in renovation activities a key factor in the abatement of environmental impacts and in the creation of employment opportunities, claiming that the retrofitting for energy efficiency of 2 million homes could lead to the creation of roughly 2 million new jobs. An example of such renovation initiatives is provided by the Italian Superbonus, previously cited in this thesis, that contributed to the creation of 100,000 jobs. Circular renovation projects will also improve durability, adaptability and energy-efficiency of buildings, using recycled materials in doing so, therefore protecting the environment in multiple ways. Including innovative digital solutions in construction and renovation projects has also been found to be significantly successful in reducing energy consumption: smart homes' features such as auto-regulating thermostats and lighting could lower a building use of energy by 10% by 2040, achieving a cumulative saving of 65PWh – the equivalent of the total energy consumed by all countries outside the OECD in one year (International Energy Agency, 2017).

In the fashion industry, the interest in rental, resale and refurbishment services has greatly increased in the last few years, with rental and resale business models expected to witness an increase in revenues by more than 800 million dollars by 2023 (ThredUp, 2019). These types of services have the potential to create new jobs in repairment, collection and refurbishment of used garments, while also contributing to the reduction of GHGs emissions in one of the most polluting industrial sectors. Rental and refurbishment strategies are also promoted by the Ellen McArthur Foundation in the mobility and transportation field, suggesting that the introduction of multimodal mobility systems based on vehicles sharing, resale, upgrade and repairment could contribute to reducing CO_2 emissions from materials by 70% by 2040 (Ellen McArthur Foundation et. al., 2019). Growth in these types of business models is expected to continue in the years to come, attracting investors and creating business opportunities with related new jobs.

Although greatly addressed by policies and initiatives attempting to reduce their environmental impact, the food and plastics sectors are still found to be among the main contributors to non-recyclable waste creation and GHGs emissions. Plastic packaging accounts for 30% of total plastic produced but only 14% of it is recycled (Ellen MacArthur Foundation, 2016), while each year around 1.6 billion tons of food is wasted, accounting for economic losses in the order of 1 trillion dollars (Food and Agriculture Organization of the United Nations, 2014). Efforts should be made in the adoption of reuse business model in the plastic sector: substituting single-use packaging with reusable products would contribute in generating enormous economic and waste savings, while reducing emissions by 3 million tons per year by 2050 (Material Economics, 2019). “A comprehensive Circular Economy approach could reduce the global annual volume of plastics entering our oceans by over 80%, generate savings of USD 200 billion per year, reduce GHG emissions by 25%, and create 700,000 net additional jobs by 2040” (Ellen McArthur Foundation, 2020). The agricultural sector on the other hand would substantially benefit from the adoption of regenerative farming models and the diversification of food grown, which would lead to greater resilience to shocks caused by environmental changes and demand fluctuations and to the creation of economic and work opportunities: by 2030, 190 million jobs and 3.65 trillion dollars could be generated by reforming food, land and ocean use, with regenerative agricultural practices being one of the main tools to do so (World Economic Forum and AlphaBeta, 2020).

However, significant investments are necessary to support these strategies. Besides the fundings needed to transform the already existing business models and allow for the design and

implementation of new, circular ones, massive monetary support should be poured by institutions in the creation of collection, sorting, recycling, reworking, repairing and redistribution infrastructures that will provide the secondary raw materials essential for the achievement of significant economic profits, pollution reduction and employment opportunities. The report (Ellen McArthur Foundation, 2020) clearly shows how an effectively supported transition towards such circular business models could create vast improvements in all sectors of society and industry, but in order to do so the new economy should be built on an efficient system that enables the full exploitation of materials and energy already in use or currently wasted.

2.3 Conclusions on Circular Economy

Enabling the transition towards a Circular Economy means addressing the structural issues and unsustainable practices of our current linear economic model. This should be done at every level of the production system: consumers should progressively cease financing unsustainable business models through their purchasing and consuming habits, favouring local, environmentally friendly and decarbonised products/services whenever possible, while access to such products and services should be simplified and made less expensive. Simplifying and lowering the cost of accessing sustainable products means on one side reducing the cost of production and delivery – which is often higher than standard, massively produced options since there's less benefit from economies of scale and higher technological and labour inputs, which carry higher costs. This could be made possible by introducing policy tools targeted at spreading and making convenient circular practices. Reuse and recycling of materials can significantly reduce the costs of supplies and their volatility in prices and availability, lowering production costs for the manufacturers, shortening and localizing the supply chain. Increased durability and quality of products derived from design and R&D activities aimed at extending the lifecycle of goods could justify the premium price that is often applied to sustainable products, especially in a world where concerns and interest in sustainability and circular models are increasingly rising from customers.

Circularity would also carry enormous advantages for the environment, saving billions of tons of GHGs emissions by making use of less polluting resources or recycled materials already extracted. This would allow for a regeneration and restoration of natural assets and a significant reduction in waste disposal, especially in the most wasteful sectors such as plastic packaging,

food, buildings and construction, ICT and electronics, mobility and transport or textiles. Recycling and reutilization practices could be furtherly fostered by the adoption of circular design thinking, which entails the creation of product designs that maximize repairability and substitutability of components and their extraction and re-introduction in the system at the end of the product lifecycle, as the Fairphone experience teaches. Moreover, the use of recycled materials and components with the minimum possible re-manufacturing can help in achieving great reductions in energy consumption. Finally, closed loops and local supplies of materials contribute to reducing the emissions created by global transportation of raw materials, a theme that is of primary importance for territories such as Europe that heavily rely on imports of metals, gasses and other production inputs.

From an employment perspective, a Circular Economy offers interesting opportunities for working conditions improvements and jobs creation. Significant efforts should be made to create a recognized, wide and well-structured system for the collection, sorting and redistribution of recyclable materials. As an example, it is estimated that around the world about 15-20 million people work as informal plastic waste pickers (The Worldwatch Institute, 2016): the shift to a circular economic model would sustain the recognition of such workers, allowing them to enter the regulated labour market and improve their working and living conditions. Jobs however would also be created by the new business opportunities provided by the introduction of new technologies and processes that make use of recycled materials and from the growth that the sharing, resale, refurbishment and repairment markets will have in the future. New skills and knowledge will be required for the design and implementation of successful circular business models and sustainable products and services, while monetary savings in energy and supplies costs could be used to improve salaries and hiring.

These benefits however will only be achievable if supported by effective, targeted policies and regulations. Interventions should focus on improving access to and incentivizing usage of recycled materials, while on the other hand penalizing virgin raw materials extraction and natural resources wastes. Rewards could be granted for the achievement of emissions reduction targets and improvements of working conditions, while taxation burdens could be progressively shifted from labour to energy consumption or waste generation. Investments will be needed in spreading knowledge and best practices concerning circularity, allowing for the creation of a collaborative network that shall hopefully lead to inter-sectorial exchanges of materials, competences and energy. Fortunately, several policy tools to accelerate the transition have already been deployed, especially in Europe, and more are programmed to be introduced in the

years to come, while progressively growing capitals are being made available to finance circularity projects and transformations.

Chapter 3

The role of skills in the green transition

In the transition towards a sustainable green/Circular Economy, a crucial role is played by skills: competences/knowledge availability is an essential factor to be taken into consideration in the definition of policies and environment preservation actions at the extent of preventing negative consequences on the labour market and to guarantee that interventions are effective. A comprehensive and constructive discussion over the implications on employment related to a green transition cannot be disaggregated from an analysis of the mutations of skills' requirements in the new sustainable economy. The transition to new de-carbonized economic models requires great efforts in the restructuring of business processes, resource extraction and control, technologies adopted and market mechanisms. These changes are difficult to implement if there is a lack of the skills that can enable them: new competences are required to expand the production and use of efficient renewable energy, to enact solutions for reducing water consumption, abate carbon dioxide emissions, preserve forests and natural – as much as built – environments from disruptive natural phenomena or to design sustainable innovation that can allow for a green growth that economy, environment and social communities can all benefit from.

However, recognizing skill gaps is often challenging and even when the identification is successful, tackling the problem can become expensive in terms of time and resources. Skills take long time to be acquired from scratch and their development is deeply tight to the individuals' abilities and willingness to learn. Moreover, skills, like technologies, are subject to obsolescence, especially in a fast-growing and dynamic sector such as green innovation. As new technologies are invented and new business models are applied, employees are required to keep up with the work-environment changes by adapting to the new competence requirements. As previously discussed, evolving skill needs can have deep impacts on the task-content of many occupations, but in worst cases can also lead to job displacement.

This chapter will focus on the concept of skill mismatch and its implications for current employment and sectorial or industrial labour shifts. It will therefore present a review of the most prominent green skill needs that are present or likely to be developed in Green Economy scenarios and address the occupations and sectors that are more probable to be heavily impacted by green skills scarcity and, on the other hand, the ones where brown competences demand is

declining. We will finally present an analysis of skill-targeting policy measures, accompanied by real cases of application of such policies.

3.1 Skill mismatch

The current trend of automation is leading to a job polarization that tends to shift labour towards the high- and low-skill/wage occupations, while slowly replacing middle-level workers – who perform tasks based on routine, codifiable cognitive skills – with capital assets (Autor et. al., 2020). While this polarization phenomenon might benefit to some extent high-skilled workers, low-skilled jobs provide littler income and social security, limited career growth opportunities and are often in carbon-intensive sectors such as transportation, cheap-products manufacturing, resources mining and so on.

With the on-going process of green transition, low-skill occupations in brown sectors are bound to pay a significant toll in terms of employment rates, partly due to the high level of skill-intensity associated with green-growth-related work opportunities. It is therefore important, as stated previously in this paper, that growth processes and innovation – both in general and 'green' terms – are developed with particular focus on the skills provided by the labour market and the ones required by the new occupations, tasks and processes that are implemented. A misalignment between the supply and the demand of competences is known as 'skill mismatch'.

Skills mismatch is a discrepancy between the skills that are sought by employers and the skills that are possessed by individuals. Simply put, it is a mismatch between skills and jobs. This means that education and training are not providing the skills demanded in the labour market, or that the economy does not create jobs that correspond to the skills of individuals. (ILO, 2020)

Skill mismatch is a well-known though hardly defined issue widely spread in contemporary labour markets. While the general idea is that the term refers mainly to skills 'missing' on the supply side with respect to the demand put by companies, several studies (European Investment Bank, 2019; Guvenen et. al., 2020; McGuinness et. al., 2017; OECD, 2021; Pellizzari – Fichen 2017; Vandeplas – Thum-Thysen, 2019) show that skill mismatch can have many forms which carry different impacts on the company and the worker as well as economically. The main types of skill issues identified by the cited literature can be grouped into:

- Macro-economic skill mismatch
- Labour market skill shortages
- On-the-job skill mismatch
    - Skill gaps
    - Over/under-qualification
    - Over/under-skilling
- Horizontal skill mismatch

Notice that there is however a difference between the main approaches used in discussions over skill mismatch. One point of view focuses on the gaps between unemployed people's competences and the vacant jobs' requirements and comprises the first two types of mismatches, while a second approach deals with the discrepancies between the individuals having a job and the set of competences required by that position (or by other similar jobs in the sector of interest), taking into account the latter forms of skills mismatches. Also, although the term 'skills' represents capabilities that an employee possesses and can apply on the job, which can be soft (interpersonal, social skills) or hard (technical), several studies reduce the complexity of the investigations by utilizing the term as a synonym to the concept of 'qualifications', which instead are the educational attainments an employee has reached during his academic career and are far easier to be analysed, allowing for simpler clustering activities.

Given the complexity of the matter at hand, several limitations come with every approach of analysis: proxying the skill level with the educational attainments of an individual ignores the experience and capabilities employees may acquire on the job and can only provide insights on the actions that can be taken at educational level to provide the market with new skills. On the other hand, focusing only on skill shortages at a macroeconomic level does not account for the productivity and economic consequences of over-/under-skilling issues on the job. Finally, not taking into consideration horizontal skill mismatches (i.e.: employees do not possess highly enough levels of certain skills to shift to similar level positions within or across sectors) prevents possibilities of filling the gaps in skills requirements by moving competences across similar sectors. Due to these complications in analysing the topic of skill mismatch, the literature is quite spread over several measurement approaches and reaches often controversial conclusions depending on the method of evaluation used and the pool of data analysed.

Although of difficult interpretation, it is important to account for skill mismatch frictions since they can carry several implications at various levels of the employment market and entail

consequences on the advancement of the economy towards greener models. The lack of competences needed to work in the fast-changing, technologically advanced green jobs may affect both currently unemployed workers and those who likely to face displacement in brown sectors. Also, the negative impact of skill obsolescence on labour productivity and job shifts across industries should also not be underestimated. Moreover, shortages in green and high technological level skills supply can potentially hinder or slow down the transformation of industries and their shift to environmentally friendly frameworks. This can either lead to delays in addressing global climate-change issues at a society level, with impacts on the achievement of the green goals set, or, if the green transition is imposed by policy or regulatory frameworks, imply important consequences on economic performances of local industries which will need to adapt their business activities. Reductions in profits for firms in such industries may eventually lead to further losses in employment, reinforcing the displacement effects directly created by skill mismatch situations.

3.1.1 Macro-economic skill mismatch

From a macro-economic point of view, skill mismatch is the discrepancy between the skill sets of the individuals available for work and the requirements of job vacancies. This type of mismatch is usually evaluated by computing the unemployment rates for a specific sector or skill level (i.e.: low, medium or high skill level). As an example, a high unemployment rate among low skilled workers in the construction sector would suggest that there exists a macro-economic skill mismatch derived from the difference between the competences required to fill low-skill jobs' vacancies in the sector and the ones possessed by the unemployed. Also, scholars tend to use the educational attainments (qualifications) as a proxy for the skill level of workers to simplify data collection and comparison.

The presence of a macro-economic skill mismatch in a sector would suggest that there is a demand for workers with different skill sets than the ones supplied by the labour market and therefore reflect inefficiencies in the match of job positions and competences supply, leading to structural unemployment. In fact, although some degree of job mismatch is frequent in labour markets and is usually temporary, it may in some cases result in a persistent state where there is a group of unemployed workers with a certain skill type in a relatively high-vacancy job market. Moreover, if this type of mismatch is computed based on the (un)employment rates of a certain working population, it can entail, besides structural, also cyclical dynamics, since low-

qualified workers' unemployment rates tend to be more sensitive to economic cycles, meaning that they are more likely to face difficulties in being employed during economic downturns.

Vandeplas and Thum-Thysen (2019) investigated the degrees of skill mismatches across European countries, using the simplifications described above (skills proxied to qualifications and computation based on unemployment rates) and compared unemployment data across three qualification levels – low, medium and high. According to their study, a high mismatch at macroeconomic level usually persists in countries where a small portion of workers possess high-level skills and is employed with relative ease, while the largest share is composed by low/medium-skill workers who face high unemployment rates. In their report the authors found a correlation between mismatch and employment rates' differences between qualification levels, showing that the European countries mostly affected by mismatch problems are Italy, Belgium, Croatia, Bulgaria and Slovakia, all of them having a 20% or greater difference in employment rates across qualification levels – meaning that low/medium-qualified workers' employment rates differ from high-qualified workers' ones by 20% or more. They also witnessed that since the economic crisis of 2008, 15 of the EU Member States were able to recover in terms of unemployment levels (which had worsened all over Europe with the economic downturn) and in terms of mismatch, showing that in countries such as Estonia and Hungary the differences in medium- and highly-qualified worker employment rates diminished constantly during the years: this, accompanied by the shrink in low-skilled workers shares (who however suffered greater losses in employment levels) allowed for better (un)employment dispersion rates. On the contrary, skill mismatch indicators have worsened among the countries who took major economical hits from the crisis, such as Portugal, Greece, Denmark, France or Spain.

Figure 8 shows the 10-year (2007-2017) variation in macroeconomic skill mismatch (*SMI*), where the latter is proxied as the relative dispersion of employment rates (across three qualification levels (*L* = Low, *M* = Medium, *H* = High) through the following formula:

$$SMI = \sum_{i=L,M,H} \left| \frac{E_i}{E_t} - \frac{P_i}{P_t} \right| = \frac{1}{e_t} \sum_{i=L,M,H} \left| \frac{P_i}{P_t} (e_i - e_t) \right|$$

where i stands for the three different qualification groups L, M and H, Ei, Pi and ei for total employment, the working age population and the employment rate of group i respectively; and

Et, Pt and et for aggregate (or total – indicated by the subscript t) employment, the aggregate population and the aggregate employment rate respectively. (Vandeplas, Thum-Thysen, 2019)

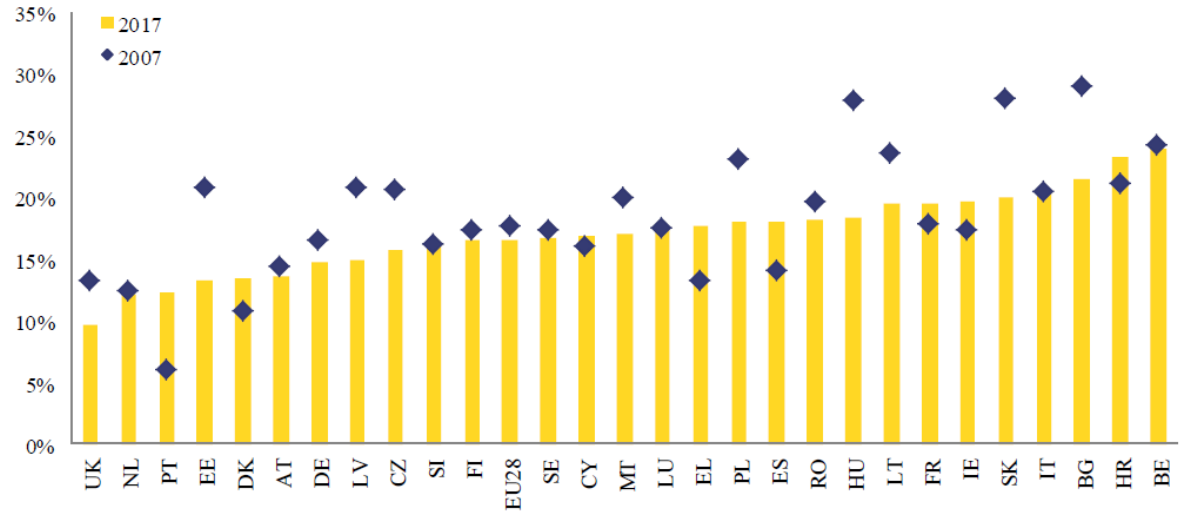

Figure 2: Comparison of macro-economic skills mismatch in terms of employment rates differences across occupational groups (%) in

EU Member States (source: Vandeplas and Thum-Thysen, 2019)

In terms of patterns, the authors found that in some countries macro-economic skill mismatch seems to be increasing in the high-skilled portion of employment too: this could be due to difference in pace between the gradual upgrading in occupations – which is the process of improving workers' skills/qualifications for them to be able to move to higher level jobs – and the evolving needs in high level skills, possibly also associated with the green innovation and the related integration of currently less-qualified workers in the "new" labour market. Generally, they witness that this type of mismatch's is lowering in the tertiary-educated population, suggesting that it is negatively related to the rise of employees' educational levels.

Due to the intrinsic difficulties of measuring the mismatch between the specific skills required by open job positions and the ones possessed by unemployed workforce, few studies were found to specifically address macroeconomic skill mismatch by providing magnitude of impact and relevant data. Those who did, like Vandeplas – Thum-Thysen (2019), mostly proxied skills with educational attainment in order to allow for a comparison of jobs' requirements and workforce capabilities, therefore not producing relevant evidence concerning the specific skills that should be learnt by unemployed workers in order to fill occupational vacancies.

3.1.2 Skill shortages

The term 'shortages' in the supply of skills identifies those situations in which employers encounter difficulties in filling their job vacancies due to a lack in the labour market of the skills needed to perform the tasks. This usually reflects imbalances between demand and supply of workers and can either show cyclical or structural traits (European Parliament, 2015). Indeed, employers seem to face more challenges in recruiting suitable workers in periods of economic growth and technological or organizational change (Desjardins – Rubenson, 2011), when the demand for skilled labour is higher. This may well be the case of a green transition, which should entail traits of economic growth and technological development, being therefore characterised by a high demand for skills, either new/green or already developed ones.

Skill shortages are usually measured through 'subjective' methods that link the perceived difficulty felt by employers in finding the right candidates with the pool of unemployed people available for work and the skills they possess. However, the issue with this method is that it is not often easy to separate the 'pure' skill shortages measure from other possible reasons that get in the way of the successful recruitment of resources, i.e., poor salary/working conditions offered to attract skilled workers, location (Cedefop, 2015). This may lead to overestimations of the phenomenon. One would expect a link to exist between the presence of skill shortage and reductions in productivity, since the lack of a competence within a firm can hinder some of the processes or the use of more efficient technologies, leading to a decrease in performances. Although this was found to be partially true under certain conditions, there is little literature demonstrating a significant relationship actually exists (McGuinness et. al., 2017) and in other cases empirical findings show no correlation at all between shortages in skill and labour productivity (Vandeplas – Thum-Thysen, 2019). This may be also due to the overestimation of the phenomenon given by biases in the collection of data, showing that the actual level of skill shortages is lower than the perceived one. Finally, the study from Vandeplas and Thum-Thysen cited before shows that the incidence of skill shortages is higher in countries with generally better labour market conditions and higher levels of educational attainment (e.g.: Germany, United Kingdom, Finland or Sweden) while it is lower in countries that face high unemployment rates and low labour productivity (e.g.: Greece, Italy, Spain or Portugal). *Figure 9* provides a visual representation of the magnitude of skill shortages in EU Member States and the changes over the period 2008-2018. The values shown represent the share of employers who reported that labour shortages are a major factor limiting their production in three macro

sectors (construction, industry and services) and are computed as a weighted average based on the aggregate value added of the three.

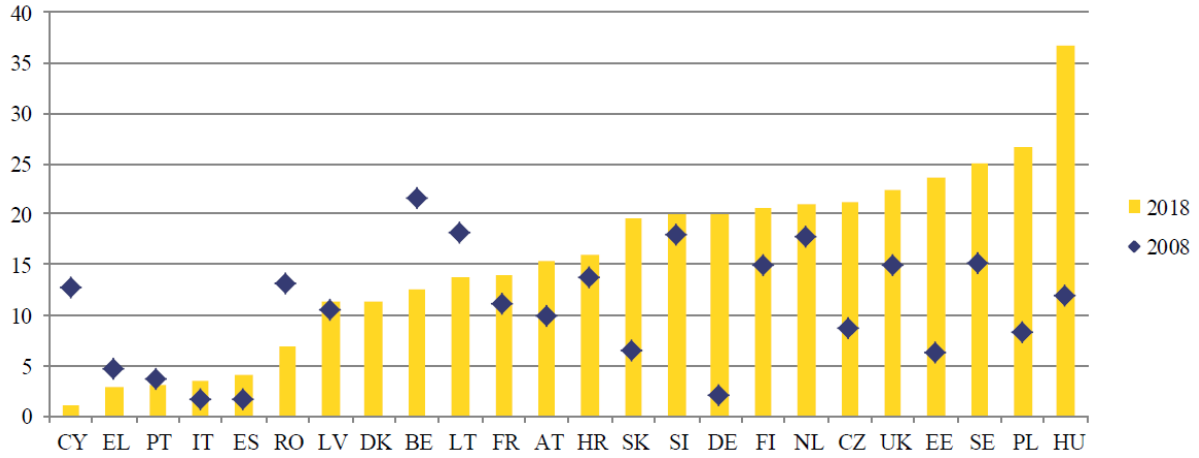

Figure 3: Share of employers in construction, industry and service sector reporting skill shortages (%) as a major threat to production across EU Member States (source: Vandeplas and Thum-Thysen, 2019)

3.1.3 On-the-job skill mismatch

On-the-job mismatches in skills are those (vertical) discrepancies between the skills or qualifications that a worker possesses and the skills or qualifications that their job requires. In addressing this issue, then, unemployed people are not taken into account. On-the-job skill mismatch can be studied under many approaches, depending on how skills are selected and proxied (i.e., difference between skills and qualifications/educational attainments), on the data sets available for the analysis and on the methods that are used for the evaluation. Generally speaking, on-the-job skill mismatch can be classified into three categories: *skill gaps, over-/under-qualification, over-/under-skilling.*

Skill gaps are usually encountered by employers who believe that their employees do not possess the right skills (or are not sufficiently proficient in them) in order to fulfil their role within the company. Skill gaps are considered harmful for the general labour productivity of a company since they require monetary and time investments in either training or recruitment activities to be filled and may result in slowing technological change and innovation in some cases. Data concerning skill gaps are usually qualitative rather than quantitative and are collected through employers' surveys, transition studies or surveys of self-reported usage of qualifications and skills.

Fitness into **qualification requirements** is generally easier to be assessed since data concerning employees' education and jobs' educational requirements are available and comparable with relative ease. Nonetheless, subjective or objective mismatches can arise in situations where employees believe to be over-educated (in this context, 'qualifications' and 'education' are used as synonyms) for the tasks they are in charge of, even though the field in which they work is the same of their studies. On the contrary, workers may also feel under-qualified, expressing concerns over the possibility that they have not achieved the right educational attainments in order to fulfil their job. Under-qualification is generally associated with lower labour productivity and lower wages, while over-qualification is initially reported to increase productivity, but in the long term it has negative effects both on it and on workers' satisfaction, possibly leading to defections if not addressed. It may also contribute to reducing wages, compared to those of well-matched employees with the same educational level (McGuinness et. al., 2017).

Differently from qualification-related measures of mismatch, the concepts of **over-skilling** and **under-skilling** take into account the personal skills developed by employees rather than their educational attainments. This provides deeper insights into the competences developed by workers and allows for a better understanding of the enrichment of their skill sets through job experience and non-educational/non-work activities (e.g.: volunteering activities, sports, non-certified courses) but also entails greater complexity in the modalities of data collection and comparison as well as in the interpretation of the results.

Qualifications vs Skills

Although the conclusions on the effects of over-/under-skilling on work-life and productivity are similar to the ones found for qualification mismatches (Vandeplas – Thum-Thysen, 2019), studies found that the two concepts are only slightly overlapping: in a study from Quintini (2011) is shown that only 36% of workers found to be overqualified reported being also over-skilled, and similarly, 12% of under-educated employees felt also to be under-skilled. Similar results have been recently found by OECD (2021), whose analysis on multi-dimensional skill mismatch based on PIAAC surveys' data for France showed that qualifications do not represent a suitable proxy for skills, crossing the mismatch data within the occupation – obtained through comparison of the survey's scores of workers with median values of the total data concerning that job/occupation – with their 'training profile', which combined the maximum educational

qualification and fields of study. By taking into consideration data concerning several aspects, including proficiency in numeracy, literacy and problem solving as well as education and professional trainings, the authors found that 29% of the individuals surveyed were apparently mismatched within their occupation, meaning that they were either over- or under-skilled with respect to the median. Of them, more than half (17.6% of the total individuals) were found to be also over-/under-educated for their job, while 11.4% were not. For the latter group, the implication would be that the training profile (i.e., the qualification or educational attainment) did not represent a valid proxy for the employees' skill levels. Complementarily, the authors showed that 9.4% of the respondents showed a mismatch in their training profile but were instead well-matched within their occupation, meaning that despite their apparently unsuitable qualifications for the job, they possessed the correct set and level of skills to perform it. *Table 3* summarizes the results of people with apparent mismatches in relation to either training profile or occupation data. The study finally compares skill mismatch estimates in the workforce for some of the countries surveyed by the PIAAC, showing that a significant degree of mismatch is present both within occupations and in relation to educational attainments. Figure 9 provides a summary of the estimates, highlighting that each country analysed (Belgium, UK, Germany, Spain, Netherlands, France and Denmark) witnesses skill mismatch affecting around 25-30% of the workforce, whether it is in terms of qualifications or skills.

	Mismatch in skills in relation to training profile	*No mismatch in skills in relation to training profile*
Mismatch in skills in relation to occupation	17.6%	11.4%
No mismatch in skills in relation to occupation	9.4%	61.6%

Table 3: Percentages of respondents falling in the four combinations of skill mismatch in relation to occupation medians and training profile, according to analysis of 2012 PIAAC survey data (source: OECD, 2021)

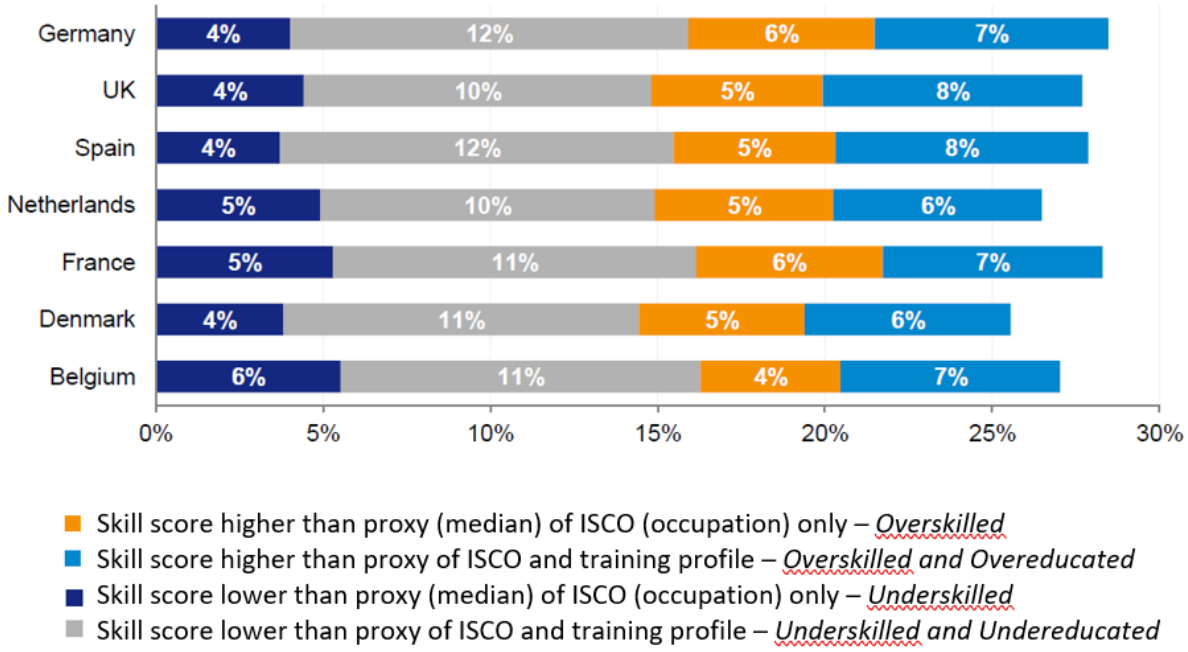

Figure 4: Proportions of individuals with scores above and below proxies for occupation and training profile according to PIAAC survey (source: OECD, 2021)

3.1.4 Horizontal skill mismatch

Horizontal mismatch measures the extent to which workers' main field of study (e.g.: philosophy, mechanical engineering, biology etc.) is related to their occupation. It does not usually refer to skills per se but instead compares educational paths, in order to identify sub-optimal uses of human resources in fields that are not entirely matching with their qualifications. Although being a far less studied subject compared to vertical forms of mismatches, researchers (Nordin et. al., 2010; Robst, 2007) found that horizontal mismatch can lead to wage penalties for workers, especially when the field of education is very occupation-specific (Somers, 2019), as in the case of Vocational Education and Training (VET) courses. The downside of analysing the match between formal education fields and occupations is that this approach tends to overlook the skills and occupational knowledge learnt in the years between the interruption of studies (e.g.: by obtaining a degree) and the current moment, biasing results especially for middle-aged and older workers. To overcome this limitation, Schweri et. al. (2020) take into consideration a more dynamic study background when analysing horizontal mismatch of workers in Switzerland coming from VET paths, recognizing formal education courses as well as life-long learning derived from informal training on the job and courses without federally recognized certificates. The authors also highlighted that while a static definition of horizontal mismatch may identify some of the workers that are not matched in

their occupation, it fails in recognizing that workers may encounter matching difficulties due to technological innovation and changes in business models or production processes. As an example, Swiss watchmakers who were forced to change occupation when their products lost substantial market shares to foreign quartz watches in the Seventies faced horizontal mismatch on a study-field definition – i.e.: they studied to produce a certain type of watches and the market was moving towards different types. However, changes in production technologies of watches over the years (and therefore in the task content of the job) brought to changes in the skill requirements for the traditional Swiss watches production as well, therefore potentially leading to horizontal mismatch in skills that could not be identified solely on a study-field basis.

Unfortunately, raising the level of detail in the analysis like so requires self-assessed measures from workers to a certain extent and may therefore be subject to some of the over/underestimation biases discussed previously. Nonetheless, Schweri et. al. (2020) used both objective (based on occupation-study field match) and subjective (from self-assessment workers survey) data to verify whether horizontal mismatch in Swiss workers coming from VET institutions is higher with respect to people with different backgrounds – due to the high percentage of students choosing occupation-specific VET courses – and whether these discrepancies show penalty effects on wages. They found that not only both the objective and subjective horizontal mismatch levels are low, but also that VET students seem to be more likely to have successful career paths, in contrast with the findings of Kracke et. al. (2018) who performed similar analysis on German workforce. They attribute the difference in findings to the transferability of vocational skills learned in Swiss VET courses that allows workers to change occupation more easily and to the many possibilities offered by work environments, training institutions and non-formal continuing education to upgrade qualifications and skills.

3.2 Skills for the green transition

We saw that skill mismatches carry important consequences on employment and on the quality of work. In a labour market that requires highly skilled workforce to keep up with the fast-paced technological change, individuals who possess outdated or unrequested competences face skill mismatch at a macroeconomic level and may therefore witness growing difficulties in finding suitable jobs for their abilities, therefore possibly ending up in a pool of persistently unemployed people with obsolete skills. Some may decide to settle with jobs requiring lower qualifications or competences than the ones they possess, leading to overqualification/over-

skilling situations that may on one hand result in lower salary levels and on the other negatively impact productivity and work-life satisfaction. Meanwhile, companies that wish to undertake innovative projects that involve new technologies or business models are likely to require new skills or to upgrade the ones within the firm to fill the skill gaps. However, such competences, especially if relatively 'new', are usually hardly available on the labour market and these skill shortages may hinder firms in fulfilling their goals. Employers may then settle with less qualified job applicants or decide to develop the skills in-house with internal training, which may result in employees feeling underqualified/under-skilled for the tasks if trainings are not carried out extensively.

Skill mismatches are extremely diffused issues that have been widely recognized and studied by the literature as potential impediments to innovation process and work-life improvement. Being the transition to a green (or circular) sustainable economy a process that requires deep structural and economical changes by definitions, the availability of the 'right' skills is a crucial cornerstone. But what are the right skills for the jobs of a green or Circular Economy? Scholars have tried to identify the so-called *green skills* by starting from the definition of *green jobs*, which however is often very wide and allows for high degrees of subjectiveness. There are many valid definitions and criteria to identify green jobs and they often coexist, making it harder for policymakers to develop common identification strategies in this field. The different approaches can be differentiated by paradigms based on *output* and *occupations (task-based)* (Janser M., 2018).

From an **output** point of view, one may take into consideration the Eurostat definition of Environmental Goods and Service (EGS) sector and consider as "green" those jobs that are related to the provision of EGS at a firm or sectoral level. EGS sector *comprises all entities in their capacity as 'environmental producers', i.e., undertaking the economic activities that result in products for environmental protection and resource management. Producers in the EGS sectors may or may not be specialised in the production of environmental goods and services and may produce them as principal or secondary activities or produce these products for own use* (Eurostat, 2016). The output approach is currently the most diffused as it allows for an easier identification and measurement of green jobs, although entailing some significant biases. As an example, an important distinction should be made between end-of-pipe, regulation-driven technologies, which are introduced to the extent of minimizing and fixing environmental issues, and clean, market-driven technologies created with the objective of prevention. Nonetheless, from an output point of view, both technologies contribute to creating green jobs. Another

downside of this approach is that firms do not usually provide only EGSs but rather follow a multi-product/service strategy, therefore making it harder to separate 'green' jobs from multi-purpose one. Concerns are also raised when questioning about whether suppliers of generic components for both green and brown production lines should or should not be considered as creators of green jobs. As a consequence, the definition of shares of environmental-friendly employment under the output approach has to be based on wide assumptions and simplifications, leading to less precise esteems.

A different approach proposed by authors such as Peters (2014) and Consoli (2016) is based on the **task content of an occupation**. Starting from data collected from U.S. occupational database O*NET they use the concept of 'task' – defined as a unit of works activity that produces an output in terms of goods or services (Acemoglu, Autor, 2011) – to develop a task-based approach that allows to narrow the focus of the research from a firm point of view to a more detailed occupational/job level. This level of detail can be useful to more precisely analyse the effective greenness of a job by taking into consideration the environmental positive/negative effects of the single tasks forming it. The task-based approach is a powerful instrument that however requires significant efforts in data collection and analysis and entails a greater degree of freedom in the interpretation of the tasks' greenness apport to a job. Despite the intrinsic difficulties of this approach, this type of analyses allows not only to examine the environmental impact of single tasks, but also to identify the skills involved in the green activities and present a broader view of the competence requirements of green jobs and of possible matches within the workforce. While traditional human capital literature suggests that job displacement due to the transition towards a Green Economy has costs – on both workers and societies – inversely proportional to the transferability of skills across sectors, task-based studies may provide insights on what know-how and competences may become or stay relevant in a sustainable productive system, complementing by facilitating the assessment of cross-occupational skill proximity (Gathmann, Schönberg, 2010). In trying to identify the differences in skill and qualifications requirements between jobs in a sustainable economy and the 'traditional' ones using this type of approach, Consoli (2016) highlighted the shortcomings of the binary definition of green and non-green jobs and used the O*NET Green Economy program's data to separate green jobs in three groups, namely:

*i) Existing occupations that are expected to experience significant employment growth due to the greening of the economy (**Green Demand**);*

*ii) Existing occupations that are expected to undergo significant changes in terms of task content (**Green Enhanced Skills**);*

*iii) New occupations that emerge as a response to specific needs of the Green Economy (**Green Emerging**).*

This classification allowed the author to operate a separation between occupations that are likely to undergo significantly different changes related to the green transition, as they will be differently impacted by new requirements

Since occupations within the **Green Demand** group may be considered only indirectly green, Consoli (2016) focused on analysing the other two groups, **Green Enhanced Skills (GES)** and **Green Emerging (GE)** jobs, and found that:

- Both the groups tend to be concentrated in occupations that are intensive in abstract non-routine cognitive skills. Examples of such skills are *problem-solving, management, coordination*;
- Out of 111 green occupations identified within the US O*NET data, 76 belong to typically high-skill macro-groups such as Management, Business and Financial Operations or Architecture and Engineering, while the remaining were found in mid-skill occupational groups like Construction and Extraction or Production workers;
    - At the time of data collection, with a level of detail of 6-digit occupations in the Standard Occupational Employment (SOC) and excluding agricultural occupations, green jobs accounted for roughly 9.8% of total private sector in the US.
- The author identified significant differences in the level of cognitive skills required by green vs non-green jobs, finding that the former (both GES and GE jobs) require stronger non-routine cognitive skills than comparable non-green occupations, which instead make more use of routine tasks with low cognitive skills requirements;
- The qualifications requirements appear to be higher for green occupations, especially for GES jobs: according to the analysis, they require more years of education, stronger on-the-job experience and significantly longer periods of training with respect to comparable non-green occupations.

The findings above seem to imply that the new jobs that will be created as a result of a transition to a greener economy will likely require abstract high-level skills from the labour market and will tend to be concentrated in the upper-level occupational sectors, such as management or engineering. However, it is worth noticing that the study does not provide numerical estimations in terms of *workers* affected, but only focuses on the occupations, therefore not providing insights on the number of people moving between occupations in high/mid-levels. In other words, while there are more high-level occupations that require green skills, these may impact a minor share of the workforce since typically mid-/low-level occupations employ significantly more people. Also, the study highlights that formal education will play an important role since green workers are required, on average, to attend longer study courses than other individuals in comparable non-green occupations (about 1.9% longer for GES, roughly 13 weeks). The same – although more pronounced – difference was found in the training requirements (about 41% longer training for GES, roughly 15 weeks; about 7 weeks for GE) that workers are asked, implying that such activities will be necessary to allow the transition of the workforce towards green jobs.

These results are supported by Botta (2018), who furthermore highlights that workers displaced by the low-carbon transition may face worse working conditions in their future employments, making a case for coal miners in the US who are likely to suffer significant reductions in their salary levels due to their averagely lower educational attainments with respect to the sectors to which they are likely to move. However, he also points out that extensive and efficient training may lower these negative effects and provides examples of how workers in different countries have managed to move to greener building-sector occupations through upskilling-oriented trainings and education. These examples are reported in *Table 4*.

Country	Occupation	Core Training	Up-Skilling	New Occupation
Denmark	Industry electrician/ energy technologist	VET qualifications/ tertiary engineering qualifications	Knowledge of energy sources, ability to integrate energy systems, project management	Manager in renewable energy
	Industrial operator/ industry electrician	VET qualifications/ upper secondary qualifications	Assembly, installation of parts, use of tools	Wind turbine operator
Estonia	Construction worker	No professional standards	Knowledge of energy systems, data analysis, project management	Energy auditor

France	Recycling sector worker	General certificate of vocational education	Sorting and reception techniques, knowledge of conditioning and storage	Waste recycling operator
	Product design and services	22 initial training courses with varying specialization	Integrating environmental	Eco-designer
United Kingdom	Commodity trader/ broker	Tertiary qualification	Practical skills on functioning of carbon market, understanding of trading tools	Carbon trader/ broker

Table 4: Example of transferability of skills in green building (source: Botta, 2018)

The author (Botta, 2018) also states that a significant portion of green jobs may simply require a 'topping-up' of the skills employed in corresponding brown occupations to allow for a smooth shift, as evidenced in some of the cases reported in *Table 4*. Moreover, workers employed in brown fading out sectors may gain competitive advantage in the labour market thanks to the skills and expertise developed in previous employments. As an example, professionals in petroleum drilling technologies may exploit their competences in the geothermal sector, while the skills of electrical engineers and technicians who worked in fossil fuel power station may be required in renewable energy plants. For these occupations, little training should be provided to fill the gaps between the green technologies and processes and the traditional ones, with relatively low costs for companies/governments.

The European Centre for the Development of Vocational Training conducted an analysis (CEDEFOP, 2012) of the skill needs, present and future, related to nine different green occupations spread across different sectors and skill levels, namely:

a) High-skilled occupations – *Nanotechnologist, engineering technologist* and *environmental engineers*;
b) Medium-skilled occupations – *Energy auditor, transport vehicle emissions inspectors, insulation workers, electrician, solar photovoltaic (SPV) installer* and *sheet-metal worker*;
c) Low-skilled occupation – *Refuse/Recycling collector*.

The study was conducted over eight Member States representing different stages of the development of a sustainable economy: Germany, Greece, Italy, Hungary, the Netherlands,

Slovakia, Finland and the UK. They tried identifying skill shortages and skill gaps among the occupations and found, generally speaking, fewer shortages than expected, attributing the reason to the economic downturn faced by European countries during that time. The authors found however several skill gaps, especially concentrated in medium-skill occupations and relatively new jobs (e.g.: nanotechnologist). The research shows that skill gaps tend to be more common in technical and practical competences rather than in generic skills, but that also some of the latter (sales and customer service skills, communication, problem solving, adaptability) are becoming increasingly important in green jobs.

Concerning future skill requirements, CEDEFOP's study (2012) highlights the need in the high-skilled occupations for technical job-specific skills such as regulatory awareness, life-cycle analysis, knowledge of energy consumption best practices or green design and planning, complemented by more generic skills like teamwork, communication or documenting. Middle- and low-skilled occupations will instead witness little changes in the technical competences required but instead demand for higher generic skills such as knowledge of environmental regulations, understanding of recycling practices, IT, numeracy, financial or risk management. This is mainly due to the fact that, according to the research, employers in middle-skill occupations tend to prefer re-skilling employees on the job through training programmes tailored to their needs instead of relying on formal education to provide the necessary skills. On the other hand, soft and generic skills are more difficult to develop on the job and more difficult to define, although playing a significant role in green jobs.

A complementary discussion has to be made over Circular Economy. As discussed in the previous chapters, the concepts of green and Circular Economy are not necessarily overlapping. The transition towards circularity adds to the set of skills needed in a Green Economy the competences that are involved in the development of a system that is fully regenerative and restorative. The paradigm will revolve around *core circular jobs* ensuring the closure of raw materials cycles, in fields such as renewable energy, repair and restore, waste and resource management, and these jobs will require technical as well as generic knowledge in areas like sustainable procurement, waste management normative, renewable energy production, environmental preservation or agronomics. Meanwhile, *enabling jobs* will foster the transition and upscale it by creating new business and consumption models such as leasing, sharing or product-as-a-service. Such enabling jobs will probably be concentrated in engineering and digital technology sectors and require strong skills in product/building/system design, data management, communication or software development, complemented by strong

environmental awareness (at social, economic and regulatory level) that can turn 'classic' jobs into circular. As an example, product design can become circular by utilizing concepts such as modularity, life-cycle analysis, materials recycling and reusage, repairing and so on. Finally, other occupations would be indirectly impacted by a circular transition: for instance, a higher demand for circular and green skills may lead to the creation or change of study courses designed to provide such competences, changing knowledge and possibly qualification requirements of teachers (Circle Economy, 2020).

Although the definition of green and circular skills can be sometimes controversial and debated across literature, research agrees that a green/circular transition cannot be successful unless the right competences and knowledge are widely spread and available on the market. According to this, it is therefore important to investigate the ways in which such skills can be developed and how the interventions in this direction will affect the labour market. Since the efforts of governments and institutions are oriented towards the creation of an economically, environmentally and socially sustainable economy to be achieved through what is commonly defined as a 'Just Transition', the actions that will be taken by all actors will need to address several aspects of employment at once and considerate a wide range of possible positive and negative externalities. In the next section of this thesis, we will analyse different areas of intervention – i.e.: public policies and regulations, private training, vocational education, labour migration – and provide examples of such applications.

3.3 Actions and policy interventions to tackle skill mismatch in a Green Economy

Due to its multi-dimensional features, the concept of skills and the mismatches existing in the labour market can be difficult to tackle with specific policies or interventions. On one hand, the focus could be on fostering the educational system as to address the qualifications gaps currently reported by employers and employees. This objective could also be pursued by providing additional training and certifications. On the other hand, as described in section 3.2, the concept of skill is not always equivalent to the one of qualification: several competencies may be developed through non-academic activities, such as job experience, non-certified trainings and courses, personal studies and interests, volunteering experiences, sports and so on. These types of skills – e.g.: problem solving, communication, system-thinking – are harder to measure and define and are rarely addressed directly through formal education, but may prove essential in the context of a green transition characterised by fast-changing and

developing technologies and business models. Moreover, while it is important to tackle current mismatches and skill shortages to allow the transition to 'begin', one should also focus on providing future workers the necessary abilities and tools to develop the competences that will be required by the jobs and sectors that will be born out of the new economic model, so as not to 'stop' the transition few steps forward. It is then evident that depending on the type of skill issue to be addressed, different (and often complementary) actions should be taken to grant a better adherence of the solution with the goals and people involved. Therefore, we will provide examples of policies and interventions that could be made to tackle the different skill issues highlighted in section 3.1, accompanied by the analysis of similar real-case applications. In this section we will focus on a context of Green Economy, while for an example of project aimed at developing circular skills we refer the reader to chapter 4. Since on-the-job skill mismatches (*skill gaps, over-/under-qualification, over-/under-skilling*) are not of significant relevance in the context of transition to a Green Economy, we will not address them in the analysis below.

3.3.1 Macroeconomic skill mismatch interventions and policies

Macroeconomic skill mismatch consists in discrepancies between the skills required by the labour market and the ones possessed by unemployed workers. If structured, it can result in a persistent pool of people who are not able to access job positions due to their long-life learnt skills being no longer required by the industry. In a context of green transition, this situation may happen when employees of phasing-out industries are laid off, as it might be the case for coal mining, petrol extraction, non-renewable energy production or carbon fuelled vehicles activities. If not assisted during the transition, workers, especially older or less educated ones, may face prolonged unemployment due to the lowering demand for their sets of skills. Actions to mitigate or prevent this issue can be made both at private and public level.

One way to tackle macroeconomic skill mismatches is to prevent job displacements in phasing-out industries to happen by supporting employees of such sectors in developing the necessary skills to relocate in other industries and helping them in finding a new job in relatively short time. An example of such prevention system is given by the Swedish Job Security Council, a system based on collective agreements covering the majority of workers in Sweden, assisting them in the transition to new workplaces after being laid-off (*Box 5*). This kind of intervention can entail several benefits on different actors, as it might exploit already developed skills (with lower costs related to training), avoid the negative externalities of unemployment such as social

costs and economic burdens of subsidies and provide multidisciplinary experienced workers to fill new job positions and tasks in emerging green sectors.

Box 5: Swedish Job Security Counsils

Created in the 1970s as a complement to Public Employment Services (considered to provide insufficient support to displaced workers), the Swedish Job Security Councils (JSCs) are an example of a mechanism to ensure resilient labour markets capable of providing employment protection based on collective agreements and bargaining. Through the consultancy with trade unions and the early intervention in the restructuring process of firms, JSCs are able to assist workers as soon as they received redundancy notice. Their support activities include counselling and coaching, activity plans and skills development activities provided through personal advisors assigned to individual workers. The JSCs model has proven to be especially successful, with a rate of 88% of reallocated workers in 2016.

Being pure bilateral bodies with no state involvement, Swedish JSCs proved to be more robust, meaning they are not affected by political shifts or public financial issues. While the model could theoretically be exported to other countries, there are significant enabling condition to be met in order for it to be as successful. Strong and well spread trade unions are essential, and they should possess sufficient leverage to engage in negotiations with employers that should result in win-win outcomes (since the companies will economically maintain JSCs activities by paying a fee proportional to their total payroll). A high collective bargaining coverage and unionisation rate across several sectors are also necessary.

Sources: Botta, 2018; Engblom, 2017.

Since preventing displacement in the first place might be challenging, a second strategy in addressing displacement caused by macroeconomic mismatches could be to rely on the entrepreneurial potential of laid-off workers. OECD (2017) studies found that when redundant workers master market-competitive skills and tacit knowledge in a field, they are more likely to succeed in starting entrepreneurial ventures. At the extent of allowing the development of such skills and knowledge and their transformation into work opportunities, policy packages could include tools for entrepreneurship training, mentoring, intellectual resources and material sharing, services for enabling networking, administration courses and facilitated access to financial instruments to support new businesses. An example of such support comes, again, from Sweden: the 'Support for starting a business' (*Stöd till start av Näringsverksamhet*) programme offers adults over 25 who are unemployed or facing lay-off assistance in starting their own business activity. Future entrepreneurs are selected based on their business plan

proposal and its expected profitability and are offered a 6-month integrated package including counselling, advise, participation in webinars, workshops and networking opportunities, along with a grant based on individual unemployment insurance entitlements, all provided by the Public Employment Service (Arbetsformedlingen, 2022). While receiving support, appliers shall also continue seeking for jobs, increasing their possibilities to work in the near future: in 2015, of the 5,300 participants who accessed the programme, 77% were back to work within 180 days after participating, either self-employed or as employees (Botta, 2018).

While some may be saved from displacement and others may start their own business, workers laid-off due to shrinking of their industry sector should not be left out of policy interventions. When facing difficulties due to poor skill match with labour market needs, jobseekers could be granted access to training and post-formal-education opportunities to develop new or complementary competencies and be supported in re-location based on an evaluation of their skill sets and needs. In the context of a green transition, the observation of evolving skill requirements and supply plays a significant role in mitigating negative externalities on employment. Such monitoring can be done at national level through institutes such as the French National Observatory for Green Economy Jobs and Skills (*Observatoire national des emplois et métiers de l'économie verte*) – created in 2010 as a part of the National Transition Strategy Towards a Green Economy – and can provide important insights on how to develop policy interventions tailored on the specific needs of the labour market on both supply and demand side. An example of such application is the TrasversSAL programme deployed in Alsace in response to the shrinking of the automobile, chemical, food processing, construction and electronics industries between 2003 and 2011. Launched by the *Maison de l'Emploi et de la Formation* (MEF) Mulhouse, the local employment and training centre, the project was based on a strong and continuous dialogue among several regional stakeholders – e.g.: the State, municipalities, skills operators, social partners, consular chambers, professional branches, centres of expertise and trade unions – which allowed to take into account all the aspects and interests involved. The focus of the initiative was the reallocation of displaced workers in emerging low-carbon sectors based on their skills affinities and possibilities of development. For example, the MEF was asked by trade unions in 2008 to develop a skill database for the textile industry with a particular focus on transferrable skills, after a large jobs loss in a local textile firm, in order to identify possible reallocation opportunities with few to none training for the displaced workers.

Moreover, governments could provide direct subsidies to employers for hiring and training unemployed people in-house. This method has been proven to generate strong employment outcomes and to be very effective in aligning training with employers' needs (Botta, 2018), as in the cases of UK's Jobcentre Plus, a public employment service matching employers' needs with suitable candidates and covering short-time training costs, and France's *Préparation Opérationnelle à l'Emploi*, which covers up to 400 hours of training for hired people lacking some of the skills requested for the job. A similar concept was applied in Italy with the Professional Apprenticeship (*Apprendistato Professionalizzante*), a permanent work contract aimed at providing training to young employees over a 2-to-5-year period. Although tailored on sectoral peculiarities, however, this type of solution is less adherent with the specific needs of the worker or the company, since the mandatory training are more general and usually related to the sector rather than the company or business per se. Nonetheless, the contract does provide the employee with a qualification at the end of the training period and grants the employer lower tax burdens.

Finally, particular attention should be placed on those workers who are more likely to face severe difficulties in job shifting due to older age or low-level educational qualifications. As the average working age tends to shift towards higher values due to increasing life expectancy, early retirement plans for '50-plus' laid-off workers are no longer an economically feasible solution, especially considering the number of people who will possibly be displaced in phasing-out sectors in the green transition. At the same time, the shrinking of low-qualification jobs share will offer less work opportunities to less educated workers. Policy interventions should then consider these situations and provide tools and programmes to enhance employability of such categories of workers, such as recognition of post-educational courses and informal certifications or facilitated access to trainings and formal education for working people. Older workers can be granted the same opportunities, but the outcomes of the German 'Perspective 50plus' programme suggests that the more the policy intervention is tailored on the target population, the better are the results and the lower the costs. Introduced in 2005 to contribute to reducing the early retirement age in Germany, the programme gave ample discretionary power to regional administrations in the utilization of the fundings: the funds could be used to purchase externally provided services, to provide them internally or even to distribute employment subsidies. A wide set of different interventions was adopted, including profiling, special training, internships promotion, placement subsidies for employers and others, resulting in outcomes better than the ones achieved with standard operations and with

lower costs per person. This success was attributed to the strong interaction between jobseekers and employment services, the focus on training and to personalized services, among other factors. (OECD, 2014).

3.3.2 Skill shortages interventions and policies

The lack of the right skills availability on the labour market is a problem that can entail severe consequences on the attempts of firms to start new projects and develop new products or services based on innovative technologies or business models. Therefore, in a context of green innovation and growth, with often unpredictable, fast-changing technologies and production processes requiring advanced and up-to-date competences, the risk of a slowdown in the transition due to skill shortages is significant. Since skills take long time to be developed, and even more to be understood and taught effectively (especially through formal education channels, which usually need more time to incorporate specific competences in their teaching courses), gaps between education systems and the labour market are likely to expand. For this reason, training programmes and education related to the needs of the low-carbon transition should disaggregate for different skill and qualification levels, age groups and sectors, targeting them with interventions aimed at providing the competences needed now, as well as the ones that will be required in the future. At this extent, analysis and prediction of the labour market requirements plays a fundamental role: while trainings and VET institutions can focus on filling the gaps that hinder the transition today, education can work on delivering the right tools and attitude to adapt to the changes of tomorrow, as well as transmitting the fundamental knowledge needed to work in the Green Economy.

At the extent of obtaining a clear picture over the current and future skill needs of the low-carbon transition, social dialogue and interactions are needed among different stakeholders – i.e.: States, trade unions, employers, education systems, training institutions. As discussed in the previous section, skill shortages are sometimes difficult to recognize and measure since they are often under-/over-estimated by the parties interviewed, like in the case of employers reporting difficulties in finding job applicants which are instead due to problems in the job offer itself (e.g.: low salary). For this reason, a comprehensive view of the situation should be obtained through the involvement of all the interested parties, as should be the plan to address such shortages, present and future. An example of such collaboration is given by the strong relationship that usually is created between VET systems/professional education institutions

and local businesses – as in the Swiss case discussed in section 3.1.4 (Schweri et. al., 2020) – which enables a better match between skills supply and demand.

While education plays a vital role in the provision of competences for the future, labour migration and exchange programmes may represent a complement to on-the-job training and skill development. Some workers *will need to move to adapt to the changing circumstances and requirements of emerging occupations. In some sectors there will be skills gaps that the existing workforce cannot fill, because of demographic trends or competing demands within the economy. In some countries, education and training systems may not be in place or sufficiently accessible to meet the rapidly changing needs of the low-carbon transition. For all these reasons, labour mobility within and between countries will have a part to play in enabling and facilitating the low-carbon transition. […] Policies for the low-carbon transition must, as part of the labour market solution, consider migration in all its forms – i.e. migration both domestically and internationally, short- and long-term, of people with different skill levels, and in all directions between and within countries at all levels of development.* (ODI, 2020) The effective implementation of low-carbon transition strategies supported by labour migration will although require significant collaboration efforts between the institutions dealing with policies in terms of sectoral green transition, migration reform and skills development in labour markets. Facilitating mobility across countries is a first essential step in this direction and entails: recognition of certificates and educational attainments acquired in other countries; fostered information exchange between jobseekers and employers across the world; financial support in relocation and mobility; mutual benefits for migrant workers, firms and communities – i.e.: regulation of working conditions and support for integration, portability of benefits across countries (e.g.: pensions), improved collaboration between host and of origin countries.

An example of how international mobility can be useful for the development of green skills to close shortages is given by the project *Move Green*, a circular mobility scheme between Andalusia (Spain) and Northern Morocco (ODI, 2022). Started in 2021, the project – a 3-year diploma course at the International University of Andalusia – aims at providing professional qualifications to selected Moroccan students in the renewable energy and Green Economy sector. Pre-departure language courses are given to the students to facilitate communication and integration in the destination country, where the participants will attend courses to develop and improve their competences in green areas, complemented by practical exchanges and visits to Andalusian companies and entrepreneurs. These activities should also help participants, companies and countries to develop networking opportunities and establish collaboration

channels. The students are then going to receive support in re-integrating into the Moroccan labour market, either through job placement opportunities or help in creating a personal business. According to the Migration Partnership Facility (MFP) – the EU organization co-financing the project along with Fondo Andaluz de Municipios para la Solidaridad Internacional (FAMSI, working on international human development) and CLANER (a renewable energy association) - t*he project seeks to strengthen partnerships between public institutions and private actors through seminars, experience exchange visits and awareness raising campaigns to promote circular migration and co-development processes between Andalusia and Morocco. Local and regional governments' partnership with companies and business groups will be reinforced, deepening possible trade relations and employment generation in the Green Economy sector* (MFP, 2022).

3.3.3 Horizontal skill mismatches interventions and policies

Although being far less addressed by the literature with respect to the vertical mismatch, horizontal skill mismatch is a widely diffused problem that might affect up to 25% of the working population (McGuinnes et. al., 2018), and can entail negative impacts on wages levels and work satisfaction. However, recalling the definition given in section 3.1, *horizontal mismatch measures the extent to which workers' main field of study is related to their occupation*. As underlined previously, the issue with the adoption of this definition is that it associates the static concept of *qualification* (i.e.: the educational attainment in a specific field) with the dynamic concept of *skills* (i.e.: the cumulated abilities and competences gained in activities which can range from education, work, leisure time or any other experience). In this way, the impact of horizontal skill mismatch on the working population could be overestimated, not taking into account that people may develop competences and fit into their job position in terms of skills, even though they might be mismatched from a qualification point of view.

It is therefore important for policymakers to develop in-deep analyses of the phenomenon and respond to it based on specific information, such as: the study fields or sectors mostly affected by horizontal mismatches; the sets of skills obtained by workers outside of formally recognized education and training courses; on-the-job acquired knowledge and competence; transferability of such knowledge, skills and experience across sectors. From this point of view, the transition to a Green Economy may offer interesting opportunities to address horizontal mismatches. The creation of new green jobs in different field – e.g.: agriculture, engineering, renewable energy,

green consulting, etc. – requires new competences which are often based on well-known skills, complemented or slightly modified by sustainability concepts, practices and standards. It is in this way that 'classic' power plant engineers may move to renewable energy plants, or architects may start developing green buildings projects. While sustainable jobs will slowly phase out polluting brown sectors, workers who studied specific skills appliable in green jobs may find a chance to move from unmatched sectors – in which they could have ended up for several reasons, one of which is saturation of the labour market in the initial field of preference – to well-matched ones, possibly by topping-up and refreshing their acquired knowledge. At this extent, policymakers and employers should focus on identifying possible horizontal skill mismatches – maybe utilizing task-based approaches as suggested in section 3.1 since they have been proven to provide more accurate measures of skills mismatch – and develop a training framework to help workers moving to a sector closer to their field of study. A better recognition of long-life learned competences will also help tailoring the training opportunities on the workforce involved and the destination jobs. Finally, the development of transferrable skills could facilitate employees in moving across sectors when needed, as the Swiss VET system case cited in section 3.1 showed (Schweri et. al., 2020).

On the other hand, prevention of future horizontal mismatches plays a crucial role. The first issue to be tackled is the misalignment between market needs and education: fostering communication and collaboration between employers, schools and universities is a key aspect to guarantee that students are taught skills and knowledge that is coherent with the demands of their future employers, especially for sector-specific educational paths such as VETs, tertiary education courses (e.g.: universities) and professional schools. Since, as seen in section 3.2, green professions are more likely to require higher educational attainment and strong abstract cognitive capabilities, policymakers and educational institutions should also promote the development of such skills and guarantee the possibility to obtain tertiary education achievements to everyone. However, an analysis of the Italian labour force (Esposito, Scicchitano, 2020) found that tertiary educated workers with field of study mismatches (i.e.: horizontal qualification mismatch) face higher unemployment risks, especially if their field is a non-STEM one (Science, Technology, Engineering and Math), therefore deeper connections between labour market and universities to align demand and supply are extremely valuable. In this sense, intensive and effective job guidance, counselling and support in job-seeking may prove necessary to ease the entrance in the job market for future graduates.

The same suggestions are expressed in the European Pillar of Social Rights, which states that e*veryone has the right to quality and inclusive education, training and life-long learning in order to maintain and acquire skills that enable them to participate fully in society and manage successfully transitions in the labour market* (European Commission, 2020c, *First principle: Education, training and life-long learning*). Within its ambit, according to the European Parliament (2019) the New Skills Agenda addresses a common set of challenges faced by Member States to the extent of:

- improving quality and relevance of training, as well as recognizing other ways of acquiring skills (e.g.: strengthen basic skill provision, competences development in higher/more complex skills, promote VET, etc.);
- make skills more visible and comparable (e.g.: improve transparency and comparability of skills and qualifications, early profiling of migrants' competences, etc.);
- improve information and understanding of skills and jobs demand patterns to enable better career choices, high quality jobs and expand workers' possibilities.

The accomplishment of these objective may create a solid labour environment able to overcome horizontal skill mismatches and provide decent work to the population, however at the moment few actions appear to have been taken by governments of the Member States.

3.4 Conclusions on the role of skills in the green transition

In this chapter we analysed the role of skills in the labour market and their importance in relation to employment levels and work conditions by focusing on the main types of mismatches that can affect workers' lives. These mismatches can be summarized into:

- Macro-economic skill mismatch: a discrepancy between the skill supply vs demand on the labour market;
- Skill shortages: the skills demanded by the labour market are not available;
- On-the-job skill mismatch, divided into:
    - Skill gaps: employers feel their employees' skills do not match their jobs' requirements;
    - Over-/Under-qualification: employees feel their qualification level does not match the one required for the job;

    - Over-/Under-skilling: employees feel their competences level does not match the one required for the job;
- Horizontal skill mismatch: discrepancy between the field of study/set of skills of the worker and the sector she is employed in.

Skill mismatch issues are widely spread across countries and have been extensively discussed by literature and institutions, although the tackling of these phenomena seems to be less diffused and concentrated on one type of mismatch, namely the skill shortage, which paradoxically is also the one found to be less impacting on workers' as well as companies' performances. Since skills are a cornerstone in any innovation or transition process and in the definition of new business models, their role in the transition towards a Green Economy should not be overlooked o underestimated and skill mismatches should be recognised and dealt with by governments, firms and regulatory institutions. In fact, in the context of a green transition, several types of mismatches in skills may present at once, therefore it is crucial for policymakers and employers to obtain realistic and specific estimates of the different situations and provide an adequate response to them. Assessments should take into account both workers' qualifications and skills in order to give a more complex and detailed picture of the issues and allow for appropriate strategies to be implemented.

These policy strategies may go from exploiting labour mobility to fill skill shortages, to fostering Vocational Education and Training and aligning educational programmes with the market needs to tackle horizontal skill mismatches. Prevention and solutions to unemployment caused by the transition to sustainable models should be given in the form of trainings, financial support, relocation and job-seeking assistance, social protection and incentives to continuous education and re-skilling. Actually, while green jobs are likely to require higher level cognitive skills, there exist many cases in which workers from similar brown jobs might only need to top-up their current skills with sustainability concepts, practices and standards to bridge the gaps. For this reason, monitoring and re-skilling of the workforce in a decarbonized-economy optic will play a crucial role in the immediate future, while it should be complemented by extensive support and innovation in educational systems, which should provide students high level skills, especially in areas such as system-thinking, green design, renewable energies, recycling, bio-agricolture etc., to prepare them for the new Green Economy. The focus of VET institutions should be posed on fostering the collaboration and alignment with the labour market and on the provision of highly transferrable skills, to favour labour mobility and sectoral shifts.

Chapter 4

Case study: Circular Re-Thinking

The recognition of the importance of addressing the skill gaps that hinder the transition to a Circular Economy calls for the creation of initiatives that can favour the acquisition of the skills and knowledge required by circular models. An example of such projects is Circular Re-Thinking, an academy launched by Trentino Sviluppo S.p.a. in 2020 within the area of Progetto Manifattura, in Rovereto (TN). The project was originally designed as a course aimed at transmitting the fundamental concepts of circularity through classes and exploration of successful implementation cases of circularity in Europe and involved participants from companies within the area of Progetto Manifattura. It was then furtherly developed for its second edition (2021) to allow for a more practical application of the knowledge acquired. This was done by introducing real case studies proposed coming from an external partner to challenge participants in the application of circularity skills and concepts in addressing a real business situation. Besides its educational goals, Circular Re-Thinking aimed also at establishing a network of experts in Circular Economy that could develop new business solutions and tackle firms' challenges through cooperation and exchange of competences in a multi-disciplinary environment. For this reason, the second edition opened to the participation of freelancers from several sectors and with different levels of expertise in circularity matters, at the extent of creating a group involving different skills backgrounds that could grow over time, both in terms of people and competences, through the collaboration with partner companies within the Trentino Sviluppo's innovation and think-tank hubs.

The creation of the project involved several partners. It was mainly sponsored by three companies, controlled by a private equity investment company, Ardian: *Energy Management and Services (EMS)*, an investment and asset management platform addressing the renewable energy sector; *Daunia Wind S.r.l.*, which produces, sells and maintains wind turbines and solar panels; *Margherita S.r.l.*, a company that develops, realizes and manages renewable energy generation plants. These partners sponsored the project in the optic of entering the sustainability network of Progetto Manifattura. On the other hand, Trentino Sviluppo partnered with Terra Institute and Renewable Matter (*Materia Rinnovabile*) in order to benefit of their strong knowledge in circularity topics in the definition of the academy courses, in the selection of teachers and key themes and in the connection with the external companies and circular realities that were discussed during the project. An additional partner, T-Trade Group, was involved in

the second edition of Circular Re-Thinking and provided real case scenarios for the participants to engage in. The roles of these partners will be addressed more in detail through the following sections since they are strongly related to the academy's contents and development. A review of the project's structure, of its contents and outcomes is provided in this thesis through interviews conducted with the key figures of the project, being the main partners listed above, and the attendants of the courses.

4.1 The Circular Re-Thinking Academy and the T-Trade case study

Circular Re-Thinking was developed in 2019 from the cooperation between Trentino Sviluppo, Materia Rinnovabile and Terra Institute, who had the vision to create a "winter school" for professionals to favour the development of new skills in the circularity field and to allow for the collaboration among different realities in the pursuit of Circular Economy agendas. In its first 2020 edition, the program addressed the employees of companies already operating within the area of Progetto Manifattura, in order to inspire the cross-pollination of circularity knowledge and competences inside the companies and expand the collaborative network among business realities. The course was structured as an academy with lessons held by partners' consultants and experts (i.e.: Emanuela Vedovati and Mauro Vaia for Terra Institute and Emanuele Bompan for Renewable Matter), but also from scholars and experts in circularity matters who were invited to attend (e.g.: Walter Stahel, whose work has been cited several times when talking about Circular Economy throughout this thesis). The program also entailed study visits to incubators and innovation centres in Europe.

Building on the success of the first class of the Academy, the project was furtherly developed in its 2021 edition, opening participation to freelancers from different sectors and partially re-defining its structure and approach towards learning and teaching. During its 1-month full-time intensive course, class lessons were accompanied by testimonials from companies who embraced sustainability and circularity patterns such as Patagonia – historic clothes and bags manufacturer who recently (2018) changed its mission statement to "A business to save our home planet" – and EcorNaturaSì – a bio-food company that makes of circularity and sustainability in agriculture its main core. Through classes, the participants were taught the principles of circularity: starting from the definition of a Circular Economy, the first module of the course was focused on understanding and applying **systemic thinking** to businesses in the context of a regenerative and restorative system. The topic of **value chain** was then central to

the second and third modules of the academy: how to supply sustainable raw materials and components, assembling them consciously through eco-design, applying the concept of bioeconomy, exploiting the benefits of open source information and production, addressing consumption issues via re-utilization, recycling, repairment and upcycling activities, to produce durable, fully re-exploitable products with lower impacts on environment and production costs. Finally, the last section of the classes shifted the focus on how to manage a business in a Circular Economy, proposing different **business models** examples, detailing the enabling conditions for a successful management and highlighting the role of cooperation in a deeply interconnected system of regenerative industries. A summary of the lessons' contents is provided in *Figure 8*. As in the first edition of the project, the theoretical classes were also integrated with a **study visit** to Cariplo Factory's Circular Economy Lab in Milan, an initiative that aims at involving big companies and transformative agents such as start-ups, innovative SMEs, universities and research centres in the acceleration of the transition towards a Circular Economy (Cariplo Factory, 2022).

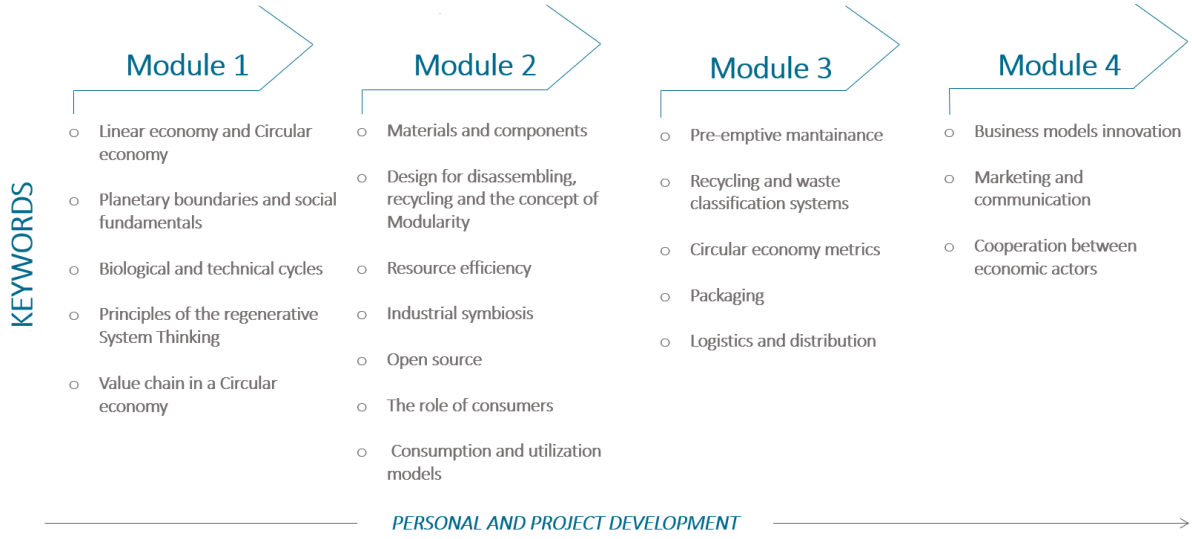

Figure 5: Contents of the Circular Re-Thinking Academy 2nd edition classes (slides provided by Terra Institute during interview, then translated)

The second edition of the project however was also characterized by the possibility for the attendants to engage in practical applications of the skills and knowledge they were acquiring during theoretical lessons. The involvement of T-Trade Group introduced **real business cases** that the participants were required to address in a Circular Economy context at the extent of providing analysis of the situation, identifying potential obstacles to the realization of the proposal and suggest approaches based on the circularity foundations. The company – leader

in the creation of sustainable industrial labelling solutions, producing everything from printers to thermal transfer ribbons, self-adhesive labels, linerless rolls, RFID labels and thermal rolls – challenged the class with two different business cases.

The **first case** revolved around a proprietary app developed by T-Trade called TT-No Waste. The app is meant to be used by consumers to obtain all sorts of information on the product of interest by scanning a QR code that is printed on its label by the patented system TT-PSafe. This system records data useful in terms of safety (e.g.: alimentary or pharmaceutical) and logistic information such as place of labelling, packaging materials, source, and so on. The app then elaborates the data associated with both the product scanned and the consumer who bought it, providing insights such as closeness to expiration dates of foods and drugs, predictive groceries lists based on recurrency of buying, consumption reports or advice on products to buy. Ideally, the app would also work as a connector between the consumer and organizations preventing waste: as an example, the app could connect the owner of expired/close to expiration alimentary or pharmaceutical products with food banks or medical centres which can make use of them. Finally, T-Trade claims that an extensive and structured use of the app and its information could fill the gap of communication between the producer and the final consumer, allowing the first to obtain precise information on consumption and the latter to have a deeper level of detail concerning the product, avoiding the filter provided by the intermediation of the large-scale retail trade (e.g.: grocery stores). Circular Re-Thinking participants were asked to work on developing a business model for spreading the TT-No Waste app and informing consumers on its benefits, while supporting the utilization of TT-PSafe labelling system in combination with it.

The **second case** proposed by the Group was instead related to bio-labelling. The company's focus on sustainability materializes in the constant research for new productive solutions that can lower the impacts of the labelling process on environment. For this reason, T-Trade asked the attendants of Circular Re-Thinking to explore new possibilities int terms of biomaterials suitable for labels creation, especially the ones that have to be resistant natural phenomena out in the field, which are usually made in plastic since the paper would become unreadable under stressful weather conditions (e.g.: rain, strong wind, oily/wet contents of packages). At that moment, the company was testing the usage of a bio-degradable corn-derived film for the production of tags for labelling plants in the agricultural fields. They demonstrated that a 100%-bio substitute to the diffused polypropylene tag was feasible and would avoid the release of plastic in the environment as a result of crops collection activities. Starting from this example,

the students were challenged to identify similar solutions and to investigate their feasibility in terms of materials requirements, supply chain, production process and integration with the packaging.

The second edition of Circular Re-Thinking was also designed as to become the start of **a new Circular Economy hub** that would connect former participants with firms interested in working in circularity contexts within the area of Progetto Manifattura and under the scope of Trentino Sviluppo and Terra Institute, providing expertise, tools and guidance in the creation of new projects and business opportunities for both attendants and external companies. The hub would have on one hand allowed to continue the education process for the participants on circularity topics and tools, while on the other become a centre of connection and exchange of competences, favoured by the multidisciplinary backgrounds of the people involved. Unfortunately, this phase of the project never came to realization due to recent changes in the corporate strategy within Trentino Sviluppo, although it would have represented an interesting case of implementation of the skills and knowledge transmitted during the Academy.

4.2 Circular Re-Thinking main partners and key figures

As previously stated, Circular Re-Thinking is a project that was born from the cooperation of three main partners, being Trentino Sviluppo S.p.a., Terra Institute and Renewable Matter. Each of them participated in the design process of the project through expert figures, who then proceeded in conducting the course through classes, selecting speakers and teachers, contacting the other partners and providing support during laboratory phases. This section gives an overview of the partners' activities and roles in the project, as well as information over the main actors involved. All of them have been interviewed at the extent of providing a more comprehensive view of the work performed and the expectations over Circular Re-Thinking. The transcripts and notes concerning the interviews done are provided in the Annex A at the end of this thesis.

4.2.1 Trentino Sviluppo and Progetto Manifattura – Andrea Cuoghi

In 1986 Tecnofin Structure was founded by the Autonomous Province of Trento as a Business Innovation Centre (BIC) in Rovereto, TN. The company, which offered productive spaces and services to other firms and research centres, later evolved in a Group, incorporating a holding

company operating a real estate fund and a company working in the firm innovation sector, partnering with technological research centres and Trento University. It was in 2007 that the company shape was renewed and the name changed in Trentino Sviluppo, making the firm the main actor in the implementation of sustainment, development and promotion of economic activities in the Trentino region with respect to the Italian and international markets. Over the last ten years Trentino Sviluppo S.p.A. incorporated several functions and companies, such as Trentino Marketing S.p.A. (promotion and development of tourism in the region), CEII Trentino (*Centro Europeo d'Impresa e Innovazione*, European Centre for Business and Innovation) and Trentino Sprint (support services for internationalization). In 2014, the company also incorporated a firm that was already controlled by Trentino Sviluppo, named Progetto Manifattura.

Progetto Manifattura is particularly interesting within the scope of this thesis since it represents one of the biggest European Green Economy incubators (Trentino Sviluppo, 2017). Created in 2009 through the renewal of the historic Manifattura Tabacchi in Rovereto, the hub nowadays offers educational services, consulting and personalized assistance. It also takes part in important international networks such as Climate-KIC (Knowledge and Innovation Community), which is the biggest public-private partnership on climate change in the EU. *The project provides companies with a production platform complete with services, skills, and specialized know-how. The rebirth of the old Manifattura is the result of the combined actions of companies, research laboratories, services targeted to business, and other actors with the common goal of growing ecosustainable enterprise.* (Progetto Manifattura – Vision, 2022)

Designed and built as a showcase for clean technology solutions and projects, Progetto Manifattura meets the highest standards of sustainability in terms of energy efficiency and reduced environmental impact and operates under the standards of the Italian LEED (Leadership in Energy and Environmental Design) certification, a voluntary certification program that recognizes the achievement of goals in green building performances based on eight categories, being: Location and Transport, Site Sustainability, Water usage Efficiency, Energy and Atmosphere, Materials and Resources, Internal Environments Quality, Innovation and Regional Priority. Over the years the Project was able to attract and incubate 78 companies and start-ups (Progetto Manifattura – Aziende insediate, 2022), becoming an extremely wide ecosystem where firms and new projects can benefit from cooperation opportunities, knowledge sharing, and expertise provided by Trentino Sviluppo's and other consulting firms.

This allows for new sustainability projects, green innovation activities and circular economies opportunities to be created and sustained over time.

It is within the area of Progetto Manifattura that the second edition of Circular Re-Thinking was carried out under the supervision of Andrea Cuoghi, who has been working for the past 5 years as a consultant in Progetto Manifattura for new projects and start-ups in Trentino Sviluppo's Business Innovation Centres. Cuoghi, as a representative of the company in Circular Re-Thinking, cooperated with Terra Institute and Renewable Matter key figures in the definition of the scope of the project and its structure, working on the creation of contacts with other partners and companies and participating in the selection of the students for the Academy. He then joined the course as a participant himself in order to expand his knowledge on circularity themes and support the group during the laboratory and study visit phases. He would then have become the main reference point of the Circular Re-Thinking consulting hub that was meant to be born after the end of the academic path if the project were to be continued.

4.2.2 Terra Institute – Emanuela Vedovati

Founded in 2010, Terra Institute (TI) is a company specialized in providing consultancy to firms who wish to develop sustainable growth strategies. According to the company's vision, TI's employees are *innovative, courageous and empathetic consultants that work on the internal and external growth of individuals and companies. Because sustainability, for us, means first and foremost striving for balance and bringing awareness to the different fields of work. We accompany companies that look for of a sense of purpose and feel the responsibility to transform themselves and contribute to global change.* (Terra-Institute.eu, 2022) The company helps its clients in the process of transformation of their business model in one that is based on sustainability fundamentals, by working at each and every level of the organization to allow the change to be felt, embraced and proactively pursued by every member of the company. In the words of Emanuela Vedovati – consultant who, together with Mauro Vaia, country manager for the Italian market and trainer in Terra Institute, developed the programme of the Circular Re-Thinking Academy – *sustainability must be sponsored by the management of a company and include all organizational levels.* TI's work starts from changing the vision that surrounds the idea of sustainability within a client's firm, working on the comprehension of the ground concepts of circularity and the reasons beneath the changes required in the daily approach to business. Once the members of the company have started to embrace the potential

benefits in performances and lifestyle and the responsibilities associated with circularity, TI's consultants can work on identifying, analysing and filling the skill and knowledge gaps that can hinder the transition, modifying roles and responsibilities when necessary. This process is done on the basis of the peculiarities of each client, since the heterogeneity of business models, productive processes and industrial sectors calls for specificity in the approach to Circular Economy and sustainability projects. TI's consultants make also use of tool developed by Terra Institute, the Smart Terra Solution tools, that allow them and clients' employees to learn and improve their green skills providing deep analysis of CO_2 emissions at firm and product level, suggesting strategies for the reduction of environmental impacts, creating sustainability reports and connecting all stakeholders in the sustainability strategy.

During the interview, we asked Emanuela Vedovati about the role of Terra Institute in the project Circular Re-Thinking and what was the methodology applied in the creation of the Academy. *Terra Institute developed the didactic plan and outlined the contents, that were then furtherly reviewed with Renewable Matter's Director Emanuele Bompan. We created the "shell", identified the contents to be put in it and defined the "rules" to connect everything together.* (Emanuela Vedovati, interview, July 5th, 2022, Annex A) She and Mauro Vaia then proceeded in accompanying the class throughout the entire process, participating in the selection of relators and external guests, interviewing them in order to outline lectures that could specifically address the most important points of focus in the academy (tailored on the experience, competences and interests of the participants as a group, as well as on the specificities of the project) while also holding some of the classes themselves. In defining the modules of the course, TI's consultants applied an approach focused on fostering personal development and growth (*my personal project*) with a systemic view (*how do I interpret with my role in the system*). They explored three different levels, which, according to Vedovati, are crucial for the development of consciousness and knowledge in circularity themes: the *project level* – what is our personal goal, how do we achieve it, who do we need to cooperate with; the *systemic level* – how do we operate in the system, what are the relationships, what are the consequences and benefits of actions; the *cognitive level* – how to approach circularity, what is the mindset needed to develop an efficient and effective sustainability strategy. This approach at the definition of the educational modules of Circular Re-Thinking reflects the idea of Terra Institute of what is needed to achieve Circular Economy successes in today's society: *we are missing the "push "*, *we do not feel the urge to believe in being sustainable, in making the change at every level. Without this, Circular Economy can become a trap, because beside the*

productive model it is important that we change our consumption behaviour. (Emanuela Vedovati, interview, July 5th, 2022, Annex A)

4.2.3 Renewable Matter – Emanuele Bompan

The name of the magazine Renewable Matter comes from the fundamental concept of Circular Economy that sees Matter as something that is not to be discarded after use, but that can instead generate value through re-usage and restoration, in a cycle that protects and enhances the environment while satisfying human utilization needs. Deeply involved in the themes of circularity and sustainable innovation, the magazine works as a collector, promoter and informer of anything related to them, from publishing analysis and reports concerning the usage of natural resources, climate negotiations and deals, to promoting public and private proactive and successful initiatives, promising innovations and opinion articles on circularity matters. The first magazine of Renewable Matter was released in November 2014 and the last trimestral edition currently available is the 40th, issued in June 2022 and dedicated to water, *the most precious of resources, the most important of 'materials'. Water is at the heart of any thought on sustainable development: a source of life, energy, and biodiversity, it is both a victim and weapon of climate change. This is why its sustainable, circular, and equitable management will be increasingly fundamental for the future of the Planet.* (Renewable Matter, issue 40 abstract, 2022)

As an expert in Circular Economy and Director of the magazine, Emanuele Bompan participated in the design of the Circular Re-Thinking academic path, collaborating with Terra Institute and Trentino Sviluppo in the definition of the contents of the course, providing insights on interesting projects and initiatives in the Circular Economy and creating connections with eminent figures from the academic as well as industrial world (one of them being Walter Stahel, "father" of the Circular Economy, also interviewed by Bompan in his book *What is Circular Economy*, 2016). He also held some of the lectures himself during the classes and contributed to supporting the class along the academic path.

4.2.4 T-Trade Group – Daniela Giacchetti

Tranfer-Trade Group (abbreviated in T-Trade Group) is a leader company in the field of industrial labelling solutions. Within the group of three companies, Tranfer-Trade operates as

the parent company and is dedicated to production and development activities. In T-Trade, complete solutions for industrial labelling are conceived, designed, researched and developed: the company produces and sells everything that is related to labelling activities, from consumables such as label rolls and liners, to end-of-line machineries such as thermal-transfer ribbons (used, for example, to print expiration dates on labels or packaging) or label printers. They also provide assistance services concerning their and also some third parties' products. The world of labelling, and the world of packaging by extension, is an incredibly complex system that touches every single product sold on every market: no product can be sold without a label, and usually comes within a package that is labelled itself and it is also contained in a different box with a different label. It is therefore logical that huge amounts of resources are utilized everyday in packaging and labelling activities all around the world, with enormous potential harm to environment and significant waste derived from production activities. Moreover, the materials used to produce labels are usually highly impacting on environment, being paper and plastic in most of the cases. But this does not necessarily have to be the case.

Since its foundation in 2005, T-Trade has always put sustainability – at environmental, economic and social levels – at the heart of its strategies and business activities. From the beginning then, the company has concentrated significant efforts in the development of innovative technologies that could reduce its environmental footprint and deliver high quality products and solutions. Through internal research and development activities T-Trade Group was able to patent many technologies that proved to significantly reduce the use of paper and plastic in labelling processes, managing in the last years to create industrial solutions that are able to print labels that are 100% bio, zeroing wastes in both paper and plastic usages. Concerning biomaterials, T-Trade Group experimented on agricultural fields the use of corn/rice-derived paper bands for tying up plants, substituting plastic bands which contribute to polluting the field when the crop is harvested. They proved that this type of material is resistant to weather and can be left in the field when harvesting since it turns over time into nutrients for the crop, in a circular model that benefits both the environment and the business.

Through its R&D centres, one of which is located in Progetto Manifattura, in Rovereto (TN), and taking advantage of the push towards sustainable and circular business models given by raising environmental awareness during the Covid-19 pandemic, T-Trade developed a bio film derived from corn and rice that can be used to produce both labels and liners (the strings on which label rolls are attached, usually made in silicone paper, which is considered a special waste and cannot be recycled). Moreover, T-Trade developed IoT solutions that can print liner-

less labels, produce data extractions concerning energy and resource usage for sustainability reporting purposes and generate QR codes containing huge amounts of information regarding product traceability and environmental footprint and other useful data such as the product expiration date. This information is stored in a digital ecosystem (also developed by T-Trade) and is accessible via an app called TT-No Waste directly by the final consumer, who is then fully aware of everything concerning the product and can be suggested multiple options to avoid wasting it when close to expiration date (e.g.: in the case of food, the app can connect the consumer with food banks willing to collect excesses).

When asked about the efforts that the company puts in the internal development of new skills and in the expansion of knowledge concerning sustainability and circularity matters, Daniela Giacchetti – Quality, Communication and Marketing Manager at T-Trade – stated that the company handles the continuous improvement of competences in three main ways: *first of all, through on the job experience: when we analyse markets and find new requirements, it is the market itself that partially returns the set of skills that are needed. Working on new projects and cooperating with new suppliers we evolve and learn […], especially through understanding how new materials are produced and how they can be used. Secondly, […] we rely on qualified external consultants to train employees […] under both technical and attitude aspects. We are constantly and systematically organizing trainings by sectors, skills or transversely. Finally, we also make use of external consultancy* [for legal and bureaucratic aspects] *because it is impossible to know everything that is needed. As an example, we acquired certification ISO 14001,[…] a process that has to go through an audit with the certification authorities and has therefore to be prepared very carefully.* (Daniela Giacchetti, translation of interview, July 21st, 2022, Annex A)

Transfer-Trade joined the second edition of Circular Re-Thinking to propose challenges for the participants of the Academy. The company showcased the class two main projects, being the research and development of new eco-materials to substitute plastic and paper in labels and its digital ecosystem, which is accessible from users of the app TT-No Waste and connects the labelling solutions used by T-Trade customers with the final consumers of the products, allowing for better transparency and communication B2C. The firm asked the participants of the project to analyse the business cases presented and to research alternatives and new possibilities to furtherly improve T-Trade solutions, highlighting eventual points of risk and evaluating the circularity of the system and its advantages. Particularly, they were asked to explore existing industrial processes to create suitable materials for bio-labelling resulting from

the processing of alimentary waste, in order to substitute the dedicated use of consumable food such as rice and corn with matter that would otherwise be discarded, furtherly reducing environmental impacts. Concerning the app TT-No Waste, Circular Re-Thinking students were asked to develop a business strategy to favour the utilization of the app among consumers and provide an evaluation from an external point of view of the possibilities and limits of the digital ecosystem developed by T-Trade.

4.3 Project outcomes

In this thesis work, at the extent of evaluating the impact that Circular Re-Thinking had on the participants' skills in Circular Economy subjects, interviews were conducted with the main partners of the project and a questionnaire (Annex B) was submitted to the participants through Trentino Sviluppo's channels. Unfortunately, due to the limited number of attendants of the Circular Re-Thinking Academy (around twenty across the two editions) and the even more limited number of responses to the questionnaire submitted (3 responses), it was not possible to collect sufficient data to elaborate a quantitative analysis of the outcomes of the project from a skill development perspective. Nonetheless, we report in this section a qualitative analysis based on the feedback provided by the promoters of the project (Trentino Sviluppo, Terra Institute and Renewable Matter), the business case partner (T-Trade) and the participants who answered the questionnaire. Video interviews published on the initiative's YouTube playlist on Trentino Sviluppo's social channel (Circular Re-Thinking YouTube, 2021) and feedbacks collected by the company few months after the end of the course will be reported in order to provide a more complete view.

Circular Re-Thinking was an intensive 1-month academic course that aimed at providing fundamental knowledge and tools to advance few steps in the complex world of Circular Economy. As such, it crossed several vast and interconnected topics that would require far more time to be decompressed and explored in deep. Nonetheless, the feedback received by each party involved in the project concerning the course outcomes is enthusiastic. According to Emanuela Vedovati (Terra Institute), who conducted several of the Academy's classes and followed the project in every aspect, the receptivity showed by the students with respect to the topics proposed was impressive in both the edition, but the second-year's class showed even better comprehension since they were given the chance to practice notions and tools with real case scenarios. Moreover, the heterogeneity in the participants working backgrounds allowed

for the exploration of different point of views and Circular Economy possibilities, leading to the expansion of dialogue and exchange of information during classes and laboratories. This feedback is supported by Andrea Cuoghi (Trentino Sviluppo), who saw in the collaboration with external partners as testimonials, class guests and business case proposers a great enabler for learning and enriching the experience. He also collected the opinions of the project participants few months after the end of the course and reports that more than a half of them (in both editions) were able to transform the notions acquired during the project into practical skills and activities at work. This result is partially reflected in the responses to the questionnaire proposed in this thesis (Annex B): two out three respondents stated that prior to the project they were not involved in sustainability/circularity activities at work, being a freelance energy engineer and an employee (no further information given), but their careers have changed over the last year, becoming respectively an Energy and Sustainability Specialist and a Corporate Social Responsibility (CSR) Manager. The first of the two is now involved in activities such as energy auditing, life-cycle assessment (LCA), carbon footprint evaluations, sustainability reporting and consultancy in Circular Economy matters, while the latter affirms to work on several projects aimed at re-shaping the current business model of his firm in a circular view with the support of Terra Institute consultants. The two respondents participated in two different editions of the project, showing that positive results were achieved by some of the participants in both the courses.

All the respondents to the questionnaire declared to have joined the project out of willingness to expand their knowledge over circularity and sustainability themes, while one of them expressed also initial interest in learning new technical and interpersonal skills in the area, specifically System and Eco-design, Remanufacturing and Industrial Symbiosis concepts. All of them felt their expectations were met and reported gaining more consciousness and interest in deepening their knowledge on circularity from the project. Moreover, all of them state they were able to learn/improve their skills in the circular design of products and services, on of the main themes in the definitions of a circular business model, and system thinking, the ability that, according to Emanuela Vedovati, is at the core of a Circular Economy transformation. Two of them developed more understanding of circular business model possibilities, while one affirms to have gained more confidence in several green competences such as green procurement, open-source design, general knowledge of sustainability standards and metrics, recycling and marketing of sustainable and circular initiatives.

None of the respondents highlighted negative aspects on the project, but one of them suggested that the course should try and give more continuity to the path, organizing updates and enabling working synergies among participants and companies. This feeling is shared by Cuoghi and Vedovati, who both remarked that the initiative would have greatly benefited by the creation of the Circular Re-Thinking hub that was foreseen during the design phase, which would have worked as an incubator for new circular projects within Progetto Manifattura, representing a collector of expertise and know-how and a place for inter-sectorial collaboration and continuous training to be fostered. When asked about how the project could be furtherly improved for a new edition, Cuoghi suggested that the course activities could be spread over a wider timeframe, to allow participants to effectively assimilate and practice the contents instead of working on them full-time, a feeling that was also shared by one of the respondents to the questionnaire. On the content side, Vedovati would probably work more on the collaboration among economic actors in a Circular Economy context with a particular focus on the enablers to the transition, which she groups into *legislative, systemic and behavioural/educational*.

From a business case point of view, T-Trade expressed deep satisfaction for the results presented by the students at the end of the Circular Re-Thinking Academy. Upon delivering a summary of the notions learnt during the course in relation to the industrial sector of the client (T-Trade) and illustrating their comprehension of the client's vision and business model, the participants proceeded in analysing the opportunities for the company in the achievement of new sustainability certifications, such as the Afnor certification, which integrates with ISO 14001 (a certification that T-Trade was on the path to acquire at the time of the project). This new certification represented an opportunity to furtherly value the transition to circular models by defining objectives and setting up metrics for the evaluation of circularity performances, while allowing for savings in Green Sustainable Procurement at European level and access to private fundings for certified firms. The students also presented an analysis of the alternatives to biofilm produced from corn and rice: they highlighted that while waste material coming from fruit-derived products industries (e.g.: apple juice producers) would represent an interesting possibility for the creation of bio-paper, on the other hand the supply of these materials should be made as resistant to shocks and seasonality as possible. They suggested that the company should focus on developing a process able to operate with scraps of several cultivations and types of fruit and that the supply should be organized locally in order to lower both emissions and costs. Moreover, a significant focus should be placed on the legislation governing the utilization of scraps and wastes as input materials: the difference between subproducts (scraps

resulting from production processes that can be used as inputs without being furtherly processed or treated) and products is fundamental since it can generate legal issues if wrongfully interpreted.

Concerning T-Trade Digital Ecosystem, the students of the course highlighted some blind spots in the company's idea. Analysing the ecosystem and the usage foreseen for the app TT-No Waste, they raised concerns over the possible negative externalities that the features of the app could involuntarily generate. First, the reminder of the expiration date of food combined with the connection to food banks for the collection of it could on one hand diminish alimentary waste, but on the other de-responsibilize the consumer and lead him to increase general levels of consumption, therefore potentially leading to increases in food production instead of decreases. Moreover, food banks cannot easily collect food from private consumers for safety and sanitary reasons, and even if not so, organizing door-to-door collection could be very expensive for non-profit organizations, who usually establish collection agreements with GDO (*Grande Distribuzione Organizzata*) facilities. Besides these potential issues, Circular Re-Thinking participants recognized in the T-Trade Digital Ecosystem an interesting tool for the promotion of sustainable business models such as sharing economy, life extension, regeneration, Product as a Service (PaaS) models and upcycling in B2B, B2C, communities and retail networks scenarios. They suggested that an IoT platform where labels vehicle information could allow for great synergies to be created among businesses, giving access to so-called *material passports* and educating consumers on product journeys, life-cycle-end possibilities and more. In this sense, they saw in opensource solutions a strong reputational and societal value that could attract open innovation possibilities.

The feedback received created for T-Trade a place for dialogue and exchange of ideas in a multi-cultural environment and represented a significant opportunity to gather different opinions and external critics on its projects. Daniela Giacchetti reported great satisfaction for the discussion that was born around the topics and for the interest and capabilities that the students put in the project. According to the interviews with all the main partners of the project, it seems that T-Trade was able to receive the feedbacks to a certain extent, slightly modifying some parts of their activities, especially involving the Digital Ecosystem, although only partially based on the participants concerns and more on the internal evaluations made in the course of development. Further changes and collaboration opportunities could have maybe been created in the Circular Re-Thinking hub if it were to be continued.

4.4 Conclusions on Circular Re-Thinking

In conclusion, Circular Re-Thinking Academy succeeded in meeting most of the targets that were set at the beginning of the project, especially in the development of skills for the Circular Economy. During the second edition of the Academy, the participants showed a great involvement in sustainability matters and proved to have acquired both competences and knowledge sufficient to provide strong feedbacks on circularity initiatives under several points of view. They applied the notions acquired during the course in the analysis of various aspects of T-Trade's projects, ranging from the individuation of legal and certificatory opportunities and boundaries to strategic proposals for business development. They also developed skills in green procurement, system thinking and circularity-oriented design, identifying biomaterials alternatives and suggesting approaches to provision and supply chain management.

A significant share of the attendants of both editions of the project reported to have experienced/brought changes into their work activities and responsibilities, sometimes advancing in their career or taking up new roles and tasks in sustainability areas. Moreover, some of them started collaborating with the partners of the Circular Re-Thinking (e.g.: Terra Institute) on circularity and sustainability development projects, showing that the Academy also succeeded in fostering collaboration and partially developing a network to address sustainability themes. This objective would have been totally fulfilled if the original plan was to be continued with the creation of the Circular Re-Thinking hub, which would have increasingly expanded the connections and added structure to the network, possibly extending and widening the skill-development and the opportunities-creation features of the project.

The main strengths of Circular Re-Thinking resided in the expertise and knowledge brought by its network of partners and collaborators. The variety of backgrounds and approaches brought into the design and development of the project allowed for the creation of a multidisciplinary, practice-oriented, teamwork-based course that resulted in an effective teaching environment capable of delivering skill-development opportunities, as well as fostering collaboration within and across different fields. Although being still a "young" project, the quality results obtained by the first two editions are promising and lead to believe that further work on the contents and structure of the Academy could have brought to the creation of an important hub for everything related to Circular Economy in Progetto Manifattura. Unfortunately, the project was dismissed, but if it ever was to be restarted, advices (according to the interviews conducted) would be to give less sector-specificity to some of the classes, focusing more on topics such as the enablers

for the transition to a Circular Economy or the metrics for the evaluation of circularity initiatives, working on the collaboration between economic actors and providing more examples of circular business models. Finally, extending the timeframe of the academy and providing more continuity to the project with the creation of the Circular Re-Thinking Hub would significantly increase the educational, social and economic value delivered by the project.

Conclusions

The **first objective** of this thesis was to investigate the following research question:

What are the employment implications of climate change and decarbonization policies?

We therefore analysed the main policy strategies and interventions that tackle the issue of climate change, with a particular focus on their effects on workers, both in terms of employment rates and working conditions. At this extent, we identified four main clusters of climate-change-related causes of impacts on employment, being: climate change natural phenomena, climate and labour migrations, policies and regulations on labour and business and carbon pricing measures.

Through the review of prominent literature and the analysis of several real case scenarios, we found that the increasing extreme natural phenomena happening all around the world are causing disruption in labour markets in several ways. The destruction of natural and built environments caused by natural disasters leads to severe losses in production assets and resources in different sectors, such as land and crops for agriculture, natural resources (like water, on which several industrial and farming activities are heavily dependent), buildings and working sites. Due to this, workers may lose their jobs as a direct consequence of disasters or indirectly from the decreased profits connected to the productivity drops, generating lower labour demand. Rises in temperature and heat waves are also creating health risks in some occupations such as agriculture, farming or construction, especially in countries severely hit by high temperatures. These sometimes unbearable working conditions may discourage workers from taking up jobs in such sectors, creating shortages in labour markets and jeopardizing businesses, or on the other hand induce drops in productivity as a result of increasing temperatures, especially in situations where working facilities are not sufficiently equipped (e.g.: lack of air conditioning, open field work under the sun, etc.).

Appropriate policy responses to employment and environmental issues generated by climate change natural phenomena should include on one side important measures to abate carbon emissions, on the other social and work protection for workers who risk suffering a worsening in their working conditions. Buildings and facilities should be fully equipped to provide comfortable working environments when abrupt drops or rises in temperatures happen, and they should be designed in order to resist natural disaster and provide safety to both employees and people living in the area. Workers should be granted paid leave permits when weather

conditions are extreme, and they should also be allowed to have breaks and refreshment when working under hot temperatures, in order not to incur in health problems and maintain productivity. In this sense, policymakers should address these issues by providing incentives and financial support to renovation of buildings and working places, as well as social protection for workers who are not able to work due to weather-related conditions and on the other hand push towards the abatement of carbon emissions.

Natural phenomena and climate change may also lead to climate migration, which consist in significant portions of populations who move from countries where living and working conditions are threatened or worsened by adverse climate environments to other countries, seeking for job opportunities and new places to live. Climate may both represent a loss in the workforce and labour skills for the country of origin and a burden worsening unemployment levels in the destination areas, if not well addressed. On the other hand, labour migration represents an important opportunity for the facilitation of the transition to a de-carbonized economy, since migrants represent a significant portion of the workforce in several sectors related to the green transition, two of them being agriculture and building constructions, and may favour the exchange of skills and knowledge between countries, fostering international collaboration and alignment on sustainability objectives.

Policy responses play a fundamental role in shaping the effects that climate labour migration has on the pursuit of a green transition. If well managed, migration can foster sustainable activities by providing skilled workforce in sectors afflicted by skill shortages or low labour supply. Efforts in the legalization of migrant workers and in the validation of their previous experiences and qualifications in their countries should be made in order to properly employ them in suitable jobs, with the support of counselling and placement services as well. Thee legalization of the workforce is an objective in line with the Sustainable Development Goals, since it contributes to the provision of decent and better jobs, reducing inequalities and fighting poverty and health issues related to poor, non-regulated working conditions. On the other hand, improving international collaboration on migration themes is key to the development of common strategies for the achievement of sustainability objectives and the alignment of such goals. In this sense, the improvement and expansion of student mobility and international training opportunities might participate in reducing cultural barriers and favour skills and knowledge exchanges, providing benefits for all countries involved, while the creation of stronger legal migration channels would contribute to making migration easier and more effective.

Although natural phenomena and climate migration carry significant impacts on both the achievement of a green transition and the related employment effects, de-carbonization policy strategies and interventions are significantly more influential on both carbon emission levels and labour markets mechanisms. Tackling climate change through policy responses can imply different paths of action, depending on the target of the intervention: governments may on one side address de-carbonization objectives through measures that have indirect effects on employment such as green conversion of plants and businesses, a strategy that may induce profound changes in the target sectors with significant implications for the skills and labour supply requirements. Actions may also be implemented with a dual scope of both improving working conditions and employment while reducing environmental impact: in this thesis we analysed strategies such as the provision of alternative sources of income and socio-ecological Job Guarantees, showing the benefits that would be granted to employees in terms of alignment with corporate sustainability objectives, unemployment levels diminishment, poverty reduction and social rights, while providing also labour force for socio-ecological sectors helping in reducing environmental negative externalities. On the other hand, interventions that focus on providing better working conditions and alignment of job seekers with market demands such as the improvement and promotion of VET institutions and agreements on work-time distribution may have positive effects on environment protection and restoration in the medium-long term.

Finally, we showed that carbon pricing measures are policy forms with great potential in carbon emissions abatement that do not entail significant impacts on employment rates – at least not observed until now. However, this type of regulation does affect the redistribution of employment between the unsustainable brown sectors and the newly created and incentivized green industries. The displacement of workers in highly polluting businesses due to the increase in carbon emission costs should be carefully managed by policymakers, who should introduce tools to enable their transition from old to green jobs and provide training and re-skilling programs, along with social assistance and financial support for those workers who will not "make the cut".

We then looked into the concept of Circular Economy and its differences from the one of Green Economy, as well as the policy tools and strategies that favour the achievement of circularity

and the enablers to be put in place to allow for the transition to happen. Moreover, we focused on the potential effects on employment generated from the adoption of circular business models.

Enabling the transition towards a Circular Economy means addressing the structural issues and unsustainable practices of our current linear economic model. This should be done at every level of the production system: consumers should progressively cease financing unsustainable business models through their purchasing and consuming habits, favouring local, environmentally friendly and decarbonised products/services whenever possible, while access to such products and services should be simplified and made less expensive. Simplifying and lowering the cost of accessing sustainable products means on one side reducing the cost of production and delivery – which is often higher than standard, massively produced options since there's less benefit from economies of scale and higher technological and labour inputs, which carry higher costs. This could be made possible by introducing policy tools targeted at spreading and making convenient circular practices. Reuse and recycling of materials can significantly reduce the costs of supplies and their volatility in prices and availability, lowering production costs for the manufacturers, shortening and localizing the supply chain. Increased durability and quality of products derived from design and R&D activities aimed at extending the lifecycle of goods could justify the premium price that is often applied to sustainable products, especially in a world where concerns and interest in sustainability and circular models are increasingly rising from customers.

Circularity would also carry enormous advantages for the environment, saving billions of tons of GHGs emissions by making use of less polluting resources or recycled materials already extracted. This would allow for a regeneration and restoration of natural assets and a significant reduction in waste disposal, especially in the most wasteful sectors such as plastic packaging, food, buildings and construction, ICT and electronics, mobility and transport or textiles. Recycling and reutilization practices could be furtherly fostered by the adoption of circular design thinking, which entails the creation of product designs that maximize repairability and substitutability of components and their extraction and re-introduction in the system at the end of the product lifecycle, as the Fairphone experience teaches. Moreover, the use of recycled materials and components with the minimum possible re-manufacturing can help in achieving great reductions in energy consumption. Finally, closed loops and local supplies of materials contribute to reducing the emissions created by global transportation of raw materials, a theme that is of primary importance for territories such as Europe that heavily rely on imports of metals, gasses and other production inputs.

From an employment perspective, a Circular Economy offers interesting opportunities for working conditions improvements and jobs creation. Significant efforts should be made to create a recognized, wide and well-structured system for the collection, sorting and redistribution of recyclable materials. Jobs however would also be created by the new business opportunities provided by the introduction of new technologies and processes that make use of recycled materials and from the growth that the sharing, resale, refurbishment and repairment markets will have in the future. New skills and knowledge will be required for the design and implementation of successful circular business models and sustainable products and services, while monetary savings in energy and supplies costs could be used to improve salaries and hiring.

These benefits however will only be achievable if supported by effective, targeted policies and regulations. Interventions should focus on improving access to and incentivizing usage of recycled materials, while on the other hand penalizing virgin raw materials extraction and natural resources wastes. Rewards could be granted for the achievement of emissions reduction targets and improvements of working conditions, while taxation burdens could be progressively shifted from labour to energy consumption or waste generation. Investments will be needed in spreading knowledge and best practices concerning circularity, allowing for the creation of a collaborative network that shall hopefully lead to inter-sectorial exchanges of materials, competences and energy. Fortunately, several policy tools to accelerate the transition have already been deployed, especially in Europe, and more are programmed to be introduced in the years to come, while progressively growing capitals are being made available to finance circularity projects and transformations.

To conclude on our first objective, we insist that a just transition to a Green/Circular economy should be founded on social, inclusive and informed dialogue, and promote a fair labour market that aims at providing job opportunities to all through the synergic implementation of sustainable instruments and policies. Green growth and business reform initiatives can and should be aligned in order to create positive reinforcement cycles that can contribute to improving the quality of jobs and life while leading to economic growth. This can be made easier by investing in sustainable innovation, promoting green practices among businesses and providing environmental education and green skills training to students and workers.

The **second objective** of this thesis was to investigate more in deep the role of skills in the transition towards a Green Economy and the support needed at policy level to avoid losses in jobs and productivity related to changes in skill requirements and provision, by researching the following question:

What skills should workers develop in a Green or Circular Economy?

At this extent, we first discussed the concept of skill mismatch, which represents a discrepancy between the competences demanded by the labour market and the ones supplied by the workforce, and its many forms, analysing its negative effects on working conditions and employment levels.

We identified 4 macro-types of skill mismatch, namely:

- Macro-economic skill mismatch: a discrepancy between the skill supply vs demand on the labour market;
- Skill shortages: the skills demanded by the labour market are not available;
- On-the-job skill mismatch, divided into:
    - Skill gaps: employers feel their employees' skills do not match their jobs' requirements;
    - Over-/Under-qualification: employees feel their qualification level does not match the one required for the job;
    - Over-/Under-skilling: employees feel their competences level does not match the one required for the job;
- Horizontal skill mismatch: discrepancy between the field of study/set of skills of the worker and the sector she is employed in.

Through the review of prominent literature and the analysis of real case studies, we found that skill mismatch issues are widely spread across countries and have been extensively discussed by scholars and institutions. Paradoxically, the type of skill mismatch that seems to carry the lower impacts on employment, the shortage in skills, is also the one that is mainly tackled by institutions and policymakers. This may be due to an overestimation of the phenomenon and a wrong interpretation of skill needs within companies and industries. Another reason that seems to delay the intervention of policymakers and businesses on skill mismatch issues is the difficulty in the proper identification of skills and its differentiation from the concept of qualification. In this thesis, we provide a review of the most diffused methods for the identification of mismatches in skills and education and suggest the use of task-based

approaches to analyse more complex and comprehensive sets of employment data (e.g.: PIAAC survey, O*NET database etc.) to separate skill and qualification evaluations.

Concerning projections over the future needs for skills in a Green Economy, literature shows that there exist significant differences with respect to current labour markets. As an example, green jobs are more likely to require high-level, non-routine, abstract cognitive skills with respect to brown jobs. Moreover, employees are required higher qualifications and relatively longer education/training to fulfil green jobs' requirements. However, a significant portion of green jobs may simply require a 'topping-up' of the skills employed in corresponding brown occupations to allow for a smooth shift and workers employed in brown fading out sectors may gain competitive advantage in the labour market thanks to the skills and expertise developed in previous employments. Concerning future skill requirements, it is likely that there will be need in the high-skilled occupations for technical job-specific skills such as regulatory awareness, life-cycle analysis, knowledge of energy consumption best practices or green design and planning, complemented by more generic skills like teamwork, communication or documenting.

The **last research question** investigated in this thesis was:

What can be done to foster green and circular skills development?

We therefore proceeded in identifying and analysing policy measures that could specifically address the different types of skill mismatch previously described, supporting our proposals with examples of application in different sectors and countries.

Due to its multi-dimensional features, the concept of skills and the mismatches existing in the labour market can be difficult to tackle with specific policies or interventions. On one hand, the focus could be on fostering the educational system as to address the qualifications gaps currently reported by employers and employees. This objective could also be pursued by providing additional training and certifications. On the other hand, the concept of skill is not always equivalent to the one of qualification: several competencies may be developed through non-academic activities, such as job experience, non-certified trainings and courses, personal studies and interests, volunteering experiences, sports and so on. These types of skills – e.g.: problem solving, communication, system-thinking – are harder to measure and define and are rarely addressed directly through formal education but may prove essential in the context of a

green transition characterised by fast-changing and developing technologies and business models. Moreover, while it is important to tackle current mismatches and skill shortages to allow the transition to 'begin', one should also focus on providing future workers the necessary abilities and tools to develop the competences that will be required by the jobs and sectors that will be born out of the new economic model, so as not to 'stop' the transition prematurely. It is then evident that depending on the type of skill issue to be addressed, different (and often complementary) actions should be taken to grant a better adherence of the solution with the goals and people involved.

Policy strategies may go from exploiting labour mobility to fill skill shortages, to fostering Vocational Education and Training and aligning educational programmes with the market needs to tackle horizontal skill mismatches. Prevention and solutions to unemployment caused by the transition to sustainable models should be given in the form of trainings, financial support, relocation and job-seeking assistance, social protection and incentives to continuous education and re-skilling. There also exist many cases in which workers from similar brown jobs might only need to top-up their current skills with sustainability concepts, practices and standards to bridge the gaps. For this reason, monitoring and re-skilling of the workforce in a decarbonized-economy optic will play a crucial role in the immediate future, while it should be complemented by extensive support and innovation in educational systems, which should provide students high level skills, especially in areas such as system-thinking, green design, renewable energies, recycling, bio-agricolture etc., to prepare them for the new Green Economy. The focus of VET institutions should be posed on fostering the collaboration and alignment with the labour market and on the provision of highly transferrable skills, to favour labour mobility and sectoral shifts.

Finally, this thesis provides an analysis of the Italian project 'Circular Re-Thinking', a Circular Economy academy created by Trentino Sviluppo in Rovereto, in partnership with Terra Institute and Renewable Matter. The project was originally designed as a course aimed at transmitting the fundamental concepts of circularity through classes and exploration of successful implementation cases of circularity in Europe and involved participants from companies within the area of Progetto Manifattura and freelancers. Besides its educational goals, Circular Re-Thinking aimed also at establishing a network of experts in Circular Economy that could develop new business solutions and tackle firms' challenges through cooperation and exchange of competences in a multi-disciplinary environment. We propose it as a case of a public and private initiative aimed at developing circular skills and move a step towards the creation of a

local circular business model, by analysing the project's strengths and liabilities through interviews with the main stakeholders and actors.

Circular Re-Thinking Academy succeeded in meeting most of the targets that were set at the beginning of the project, especially in the development of skills for the Circular Economy. During the second edition of the Academy, the participants showed a great involvement in sustainability matters and proved to have acquired both competences and knowledge sufficient to provide strong feedbacks on circularity initiatives under several points of view. They applied the notions acquired during the course in the analysis of various aspects of T-Trade's projects, ranging from the individuation of legal and certificatory opportunities and boundaries, to strategic proposals for business development. They also developed skills in green procurement, system thinking and circularity-oriented design, identifying biomaterials alternatives and suggesting approaches to provision and supply chain management.

A significant share of the attendants of both editions of the project reported to have experienced/brought changes into their work activities and responsibilities, sometimes advancing in their career or taking up new roles and tasks in sustainability areas. Moreover, some of them started collaborating with the partners of Circular Re-Thinking (e.g.: Terra Institute) on circularity and sustainability development projects, showing that the Academy also succeeded in fostering collaboration and partially developing a network to address sustainability themes. This objective would have been totally fulfilled if the original plan was to be continued with the creation of the Circular Re-Thinking hub, which would have increasingly expanded the connections and added structure to the network, possibly extending and widening the skill-development and the opportunities-creation features of the project.

The main strengths of Circular Re-Thinking resided in the expertise and knowledge brought by its network of partners and collaborators. The variety of backgrounds and approaches brought into the design and development of the project allowed for the creation of a multidisciplinary, practice-oriented, teamwork-based course that resulted in an effective teaching environment capable of delivering skill-development opportunities, as well as fostering collaboration within and across different fields. Although still being a 'young' project, the quality results obtained by the first two editions are promising and lead to believe that further work on the contents and structure of the Academy could have brought to the creation of an important hub for everything related to Circular Economy in Progetto Manifattura. Unfortunately, the project was dismissed, but if it ever was to be restarted, advices (according to the interviews conducted) would be to

give less sector-specificity to some of the classes, focusing more on topics such as the enablers for the transition to a Circular Economy or the metrics for the evaluation of circularity initiatives, working on the collaboration between economic actors and providing more examples of circular business models. Finally, extending the timeframe of the academy and providing more continuity to the project with the creation of the Circular Re-Thinking Hub would significantly increase the educational, social and economic value delivered by the project.

In conclusion, the transition towards a Green Economy is a complex process that requires strong collaboration among all the actors involved – Governments, policymakers, local authorities, businesses, industries, unions, workers and citizens – to be successful. This process is no longer delayable: de-carbonization is an urgent as well as vital theme to which we all should give much more commitment than ever. While the transition is possible and slowly progressing, in this thesis we underline the importance of not overlooking the externalities that the shift to a Green Economy may entail for labour markets and working conditions. We stress the key role played by skills in facilitating the transition and smoothing negative effects on employment, while also creating new opportunities for current and future workers and entrepreneurs. For this reason, it is essential that policymakers and firms dedicate more resources and focus on identifying skill needs and gaps and provide tools for addressing and preventing the issues. Finally, while the utopia of a restorative and regenerative Circular Economy is still far to be reached, real cases of application show that it is possible to create circular ecosystems that benefit both the environment, the population and the businesses.

Further developments on this work could include in-deep research over the extension of skill mismatch issues based on tasks-related data – such as the ones contained in the PIAAC 2nd-cycle survey, whose results will be published in 2024 – and provide numerical estimates of the phenomenon, investigating the mitigation effects of the policy tools and strategies proposed in this thesis and delving deep into other application cases.

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Annex A – Interviews notes and transcripts

Interview with Andrea Cuoghi, Trentino Sviluppo

Videocall, not recorded, notes from March 26th, 2022

Note: this is not a word-by-word transcription, but a summary of the interview content

Q = Question

AC = Andrea Cuoghi

Q: Please introduce yourself and your role in Trentino Sviluppo

AC: I am Andrea Cuoghi and for the last 4-5 years I have been supporting new projects and start-ups within Progetto Manifattura and I also work on the Business Innovation Centres (BIC)

Q: Please tell me about the project Circular Re-Thinking and your role in it

AC: I started working on the project in 2021, substituting a colleague who had worked on the first edition, started in 2019-2020. The project was born as a response to two needs: developing new competences in sustainable projects and allowing the beginning of a collaboration with Terra Institute, a consulting company in sustainability areas. I acted as a coordinator for the laboratory part of the course and helped in the definition of the second edition of the Academy. I was also supposed to become the contact person for the community hub that would have been created at the end of the course.

The project was born to address the need for new professional figures who could take part in sustainability and circularity initiatives in Progetto Manifattura: from that, the original idea of creating a "winter school" to bring new skills and knowledge into the companies within the area. After the first course, we focused more on bringing freelancers into the Academy, to allow for a more heterogeneous class in terms of knowledge and background. We also decided to insert a business case study so that participants could practice the concepts they were taught.

Q: What partners were involved in the project?

AC: We had companies which sponsored the project as a way to settle in Progetto Manifattura and enter the sustainability network. These are mainly firms that produce energy from sustainable sources. Then we had Terra Institute and Renewable Matter (a magazine that for years has been focused on sustainability and circularity themes) and T-Trade (only in the second edition of the course). The latter

joined bringing the case study on which the students worked during laboratory activities, while the first ones designed the course structure and contents, selected most of the guests and lecturers and hold some of the classes, curating the lessons. We also organized study visits to Circular Economy initiatives, the first year in Berlin and the second year at Cariplo Factory in Milan.

Q: What were the objectives of the participants that joined the course and what metric/KPI were used to evaluate the outcomes? What results did you witness?

AC: Some of the attendants wanted to develop more consciousness over circularity and sustainability matters, some others wished to re-orient themselves in the labour market. The goal was then to include them in sustainability projects within Trentino Sviluppo thanks to the hub we planned to create, but then that part of the project was not carried on because of changes in the management decisions. We did a qualitative evaluation of the results of the project by interviewing the participants in two rounds, at the end of the course and some months later. We found out that half of the participants were able to turn the skills learnt into practical activities on the job. Concerning the impacts on T-Trade as a result of the case study, although during the project the class identified some blindspots and potential issues, the company already had a strategy and probably followed through it, but they were satisfied by the discussion that was born. I am not sure if they changed something in their original project after the course and the presentation of the case study since we had no contacts after the interruption of Circular Re-Thinking.

Q: What are the positive aspects of the project and what would you do differently if the project was to be continued?

AC: The replicability is a strong advantage of this project. Year after year it is possible to smooth the angles and refine the structure in order to deliver more value than the previous edition and extend the network of partners who join the project. Meeting real business and study application cases is also extremely important and should be fostered even more, in order to finally create the Circular Re-Thinking hub. Also, having Trentino Sviluppo acting as an incubator for the project allowed to attract more partners. Probably in the future I would suggest diluting the course lectures and activities over a longer period instead of concentrating them in one full-time month. Monitoring and assessing the outcomes would also require a longer follow-up, which although was originally planned.

Interview with Emanuela Vedovati, Terra Institute

Videocall, not recorded, notes from July 5th, 2022

Note: this is not a word-by-word transcription, but a summary of the interview content

Q = Question

EV = Emanuela Vedovati

Q: Please introduce yourself and Terra Institute

EV: I am Emanuela Vedovati and I work as a Consultant in Terra Institute, a consulting firm that accompanies business in the transition towards sustainable business models, involving all levels and functions of the firm.

Q: What is the approach of Terra Institute in allowing this transition?

EV: Sustainability must be sponsored from the top and shall include all business levels. We start from changing the view they have on sustainability, from comprehending the concepts at the foundation of circularity and the reasons to change our lifestyle. Without the "push" to believe in it, there is no way to reach the goals desired. Once the members of the company have understood the ground notions of sustainability and how it can positively impact on work-life and business performances, analysing positive and negative impacts, we work on the single skills that can enhance the positive effects and mitigate the negative ones, eventually modifying roles and responsibilities within the work context when needed.

Q: What was Terra Institute's role in Circular Re-Thinking?

EV: Terra Institute developed the didactic plan and outlined the contents, that were then furtherly reviewed with Renewable Matter's Director Emanuele Bompan. We created the "shell", identified the contents to be put in it and defined the "rules" to connect everything together. We then accompanied the class day-by-day both at a process and at a content level, interviewing and preparing the speakers and lecturers to make sure the contents of the lessons adhered to the needs of the group and the project. Our approach was to fond personal growth ("my" project, as a person) and systemic learning (how to interface with our role). We focused on three levels: project, systemic and cognitive. We believe this school has to be a path of development and not merely a collection of notions.

Q: How did you evaluate/measure the outcomes of the project?

EV: We believe that parameters are the weakest leverage for change, since "parameter" does not necessarily equate "information". It is important to develop a systemic view, were several factors are involved. Altogether, we are greatly satisfied about the results of the project, especially concerning the second edition. I believe we could have focused a little bit more on some themes (but this was actually planned to happen later, in the Circular Re-Thinking Hub), for example on circular business models examples or on the collaboration between economic actors. We could have given a little bit less space to production processes, which can be very specific, and favour the topic of metrics to evaluate Circular Economy and the legislative, systemic and behavioural/educational enablers.

Q: What do you believe is needed at a legislative/political level to enable the transition to circularity?

EV: For sure product design standards and alignment on waste treatment at European level are fundamental. But the real problem is that we are missing the "push ", we do not feel the urge to believe in being sustainable, in making the change at every level. Without this, Circular Economy can become a trap, because beside the productive model it is important that we change our consumption behaviour.

Interview with Emanuele Bompan, Renewable Matter

Telephone call, not recorded, notes from July 5th, 2022

Note: this is not a word-by-word transcription, but a summary of the interview content

Q = Question

EB = Emanuele Bompan

Q: Please introduce yourself and Renewable Matter

EB: I am Emanuele Bompan and since 2018 I am the Director of Renewable Matter, a global magazine that focuses on economy, circularity and innovation to create a sustainable future.

Q: What was your role in Circular Re-Thinking?

EB: I helped in selecting and contacting the guests and lecturers focusing on the topics and contents we decided to cover over the course of the classes. We selected the lecturers based on previous collaborations and experience in particular fields. I also reviewed the contents with Terra Institute.

Interview with Daniela Giacchetti, T-Trade Group

Telephone call, recorded on July 26th, 2022

SA = Simone Anzelini

DG = Daniela Giacchetti

SA: Please introduce yourself and T-Trade Group

DG: I am Daniela Giacchetti and I am in charge of everything related to marketing and quality within the company. The two things seem unrelated but in fact they are very much linked, because when we talk about quality we talk about certifications, about checking that the company's processes are working in a certain way, and that clearly ties in with marketing as well. What does our company do? First of all, T-Trade Group is a group, the parent company of which is Transfer Trade. Inside the group there are also two other companies, but the lead company is the one in charge of production. Here they design, study, research and develop complete solutions for industrial labelling.

What does that mean for those outside the industry? Whatever product ends up in the hands of a consumer, as you and I can be as people, cannot end up there without a label. But the label is not only the one that is attached to the product, but also, trivializing to simplify the process, the one that is in the box that contains a series of products. Connected to labelling is the whole issue of product traceability, which has become increasingly important today. We produce everything that is labelling, from consumables such as the label, thermal transfer ribbon (which is used to print, for example, the expiration date on labels or on the pasta package), end-of-line printing solutions that are totally green and digitized industry 4.0. Plus, as a product/service we offer technical assistance on all products, including those not of our own production, and we commercialize everything needed for packaging, from machines to consumables.

The company was founded in Padua, where its registered office now stands, while the production site is in Falconara Marittima in the province of Ancona. There are several locations, for example the one in Rovereto dedicated to R&D and a digital sum function. Since its inception, the company has had a strong interest in sustainability, understood as environmental, economic and social sustainability, and this led to patenting twenty years ago printing solutions that were going to decrease by 50 percent or even eliminate the use of paper in the labelling process, when the time was not yet ripe to understand such green processes. All of this was studied and developed in-house. When I talk about printing solutions at the end of the line, I am talking about printing solutions that act on the packaging box, on the pallet, that is, before the departure and transport of the goods. This process of studying and continually researching what can be sustainable has never stopped, so much so that the pandemic has developed a greater

common feeling towards these issues, accelerated the pace on this point of view, digitized more, and pushed to understand the importance of solutions that can move towards a truly Circular Economy. Our group has not stopped and has gone on to develop more solutions that embrace circularity. We have opened an in-house bio lab where we are studying the possibility of making entirely bio labels that come from vegetable waste, for example, from fruits and vegetables, from which we make an extrudate that through an extruder produces a bio film, This, through other machinery such as the laminator and the adhesiveizer, can be turned into reels of adhesive or non-adhesive materials, totally bio. This for us is the ultimate expression of the concept of circularity, because a label that is created in this way comes from waste and not from raw materials such as rice or corn, which come from a "soil strain" anyway. These labels then, applied on organic packs that are also organic, go back to nature. For example, large agricultural crops put plastic bands around each plant. At harvest time, these bands (which are quite rigid to withstand the weather) are either harvested by hand or, as in most cases, are milled and plowed in with the soil, going over time to pollute the field. Therefore, the first thing we did, through the collaboration of large groups as field testers, was to make clamps/tags out of organic material with a loop, like those in nurseries, to be used to band plants and on which any data can be printed. We tested them for a year and found that at harvest time these ties can remain in the field without producing damage, dissolving over time, even going some way to fertilize the soil.

SA: This is the expression of the concept of circularity, when scraps become not only a new product but also raw materials to nurture the field to generate new agricultural materials, in a loop.

DG: Yes, absolutely, and if I remember correctly this project is one of the case studies we proposed in Circular Re-Thinking. But the other project was T-Trade Digital Ecosystem, which involved the use of an app, which we launched and is in operation. In contrast to what was proposed in the project, however, the machine is no longer the one originally thought of but another one, which came out of a further vision of Dr. Friziero (ed. President and managing director of T-Trade Group).

Linking this to the theme of your thesis, the skills of all company personnel must continue to evolve through times, ways and needs of markets and consumers change.

SA: Speaking of skills, you are very careful as a company to sustainability and circularity. How do you handle the continuous improvement and expansion of competences among the personnel?

DG: In several ways. First and foremost, experience in the field: as you survey the markets and understand their new needs (a fundamental activity), your skills automatically grow because the market, when studied, gives back new skills that you did not have before. As you work, following new projects, you evolve, including through contact with suppliers, especially those who produce materials that were

not used before. Understanding where the raw material comes from, how it is processed, what the fields of application are, allows skills to evolve. The second aspect that I think should be an obligation of every company, and which we really do here, is continuing education. We have very qualified external consultants that we use to train staff in every aspect, from technical aspects to attitude/behaviour towards new things and new customers. We do training systematically and continuously, we organize training moments divided by sectors, by skills or crosswise. The third point is always about the help of external consultants, because you cannot know everything. A few days ago, for example, we certified ourselves ISO 14001, a certification with considerable weight regarding environmental aspects. Such a process, before going through the audit with the certifiers, is done with the help of consultants who specialize in the main issues such as legislative aspects. We use very good consultants, for example as far as I am concerned the coaching I have received in the last two years has been a very profound and valuable continuing education. In this company then there is also a lot of cooperation, in fact here I have found a very collaborative environment, where no-one knows everything but there is always a colleague who can help you.

SA: Moving to Circular Re-Thinking, when did T-Trade enter the project and which were the objectives of the company related to the programme?

DG: Comparing with minds other than our own, who had knowledge in the area of circularity, also due to the fact that the participants came from experiences however inherent to the area, all for the purpose of growth. The business cases given to the participants represented at the same time a "school" for us as well, a school of ideas, a school of comparison, we also learned from them some things that could come in handy. They gave us a work developed by them on what they had done during the course. For us, the intent, which we think is always very important, is always the confrontation on topics that need to take root.

SA: You also proposed two projects/business cases to the class, can you please tell me more about them?

DG: One of the projects was related to bio-based labels. The production process starts with an organic compound (derived from corn, rice, or other), which an outside laboratory then turns into compounds, sort of "grains," smaller than a grain of rice, which the extruder turns into a reel of bio-based plastic film that is then fed into a laminating machine that adds adhesive (if necessary) and a liner (i.e., the part of the roll of labels to which they are attached), normally made of yellow silicon paper. This liner is a special waste, precisely because it is siliconized. In our laminating plant, the liner is organic, as is the label material. Then a machine prints the die, that is, cuts the label into the desired shape. This originates the reel of adhesive labels in bio film, or a reel of linerless adhesive in bio film, that is, the linerless

label, which, however, can only work in special printers. After that, intelligent printing systems (patented by T-Trade) are able to print the label by autonomously generating a QR code that contains unique and unrepeatable information. These are then printed on the label and also sent through a cloud to the recipient of the parcel, because we are always talking about end-of-line process, who with the QR code can verify that the parcel belongs to them upon arrival (traceability and security) or they can use the TT-No Waste app, which from the QR code records the products purchased. In addition, the app, besides being an important data warehouse, informs about the expiration date and proposes options to donate the product, relying on an entity registered in the TT-No Waste circuit with which to arrange for pickup (ed. For example, food banks). This avoids waste with a view to circularity. Our end-of-line solutions are also industry 4.0 certified and communicate data in and out: in addition to giving information on maintenance, etc., they also give information on environmental impact. Starting from a set of official data about the paper use that is made with "normal" printers, our machines give feedback on the amounts of natural resources (water, trees...) and energy that are saved with this type of labelling. This saving is obviously maximum in the case of labelling with organic materials, but in the case where classic paper and/or liner should be used for some reason, the machine gives the user important insights into the savings (also in terms of pollution) based on the volumes produced. In addition, the manufacturer using the printer may decide to "resell" the information to the customer by printing it on the label, so the customer may have a sense of the environmental impact produced by the packaging of the product he or she purchased. For example, some Danish customers explained to us that in Denmark sustainability is not only a matter of boast but a legal requirement, so they are driven to purchase machinery that has an eco-friendly impact.

SA: Going back to the Circular Re-Thinking Academy, how do you evaluate the feedback received from the class about the cases analysed, the points highlighted by the students and the results shown?

DG: They provided us with a paper on the final day, explaining their findings. They explained their ideas and gave invaluable advice, even talking about standards that are less known. For them however, the world of labelling was an unknown world, so it was not easy to develop something extremely in-depth, not being from the industry, but the discussion was very positive.

SA: From a practical point of view, did you receive suggestions that made you change your original plans about the two projects proposed?

DG: Things always evolve, compared to the project there has been further development, that is, the initial machinery was changed. This is also partly due to the discussion that arose from the project. On organic labels there was also a discussion that had arisen about the need to pay attention to the origin of

plant waste, for example that it came from organic fields where no pesticides are used, to avoid producing labels that contain traces of pesticides. This, however, cannot happen because the material is processed and purified, but it is difficult to get into technicalities when one does not work in the field. In any case, the work done in the Circular Re-Thinking Academy has been helpful in changing a few curves, a few paths, within our work, which is constantly evolving anyway. We believe a lot in confrontation, also with our suppliers, and this experience was one of the most useful we have had, this also because of the different background of subjects that characterized the course participants, which enriched the dialogue.

Annex B – Circular Re-Thinking questionnaire answers

How old are you?

3 responses

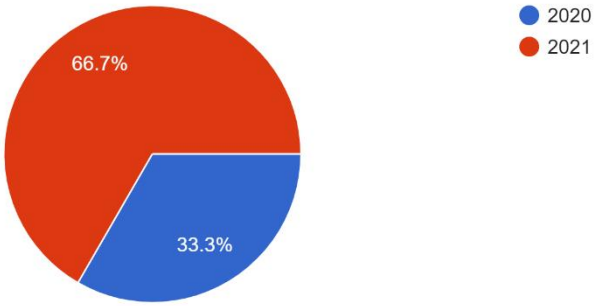
54

37

25

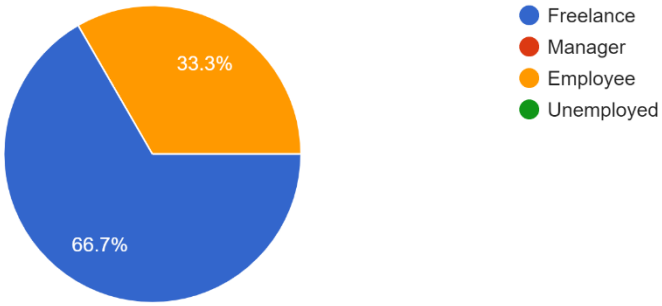
In which year did you participate in Circular Re-Thinking?

3 responses



What was your position when you joined the academy?

3 responses



What was your occupation?

3 responses

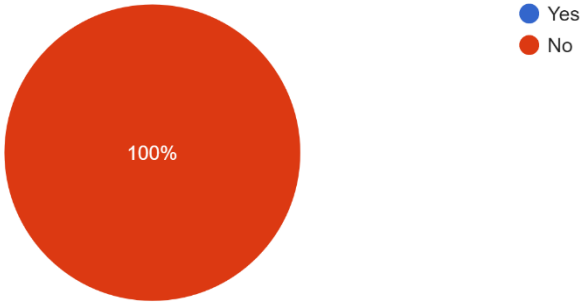
Marketing Consultant

Energy engineer

Employee

Were you involved in sustainability/circularity-related activities before joining the project?

3 responses



If you answered yes, which sustainability/circularity-related activities were you involved in?

0 responses

No responses yet for this question.

What is your current occupation?

3 responses

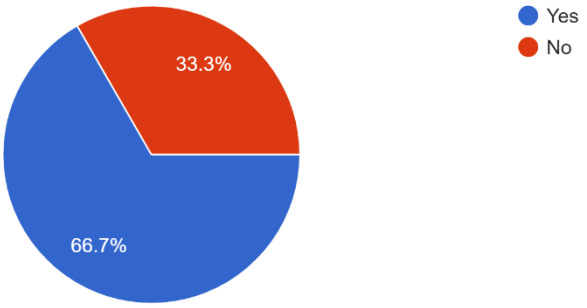
Marketing Campaign Manager

Energy and Sustainability Specialist

CSR Manager

Are you currently involved in sustainability/circularity-related work activities?

3 responses



If you answered yes, what sustainability/circularity-related activities are you involved in?

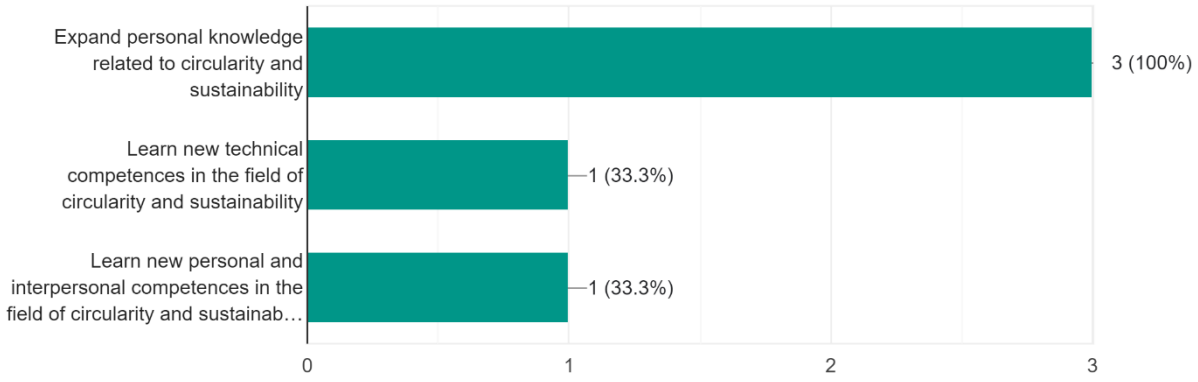
2 responses

Energy Audit, LCA, GHG, Carbon Footprint, Sustainability Reporting, circular economy consultancy

Sono coinvolto in parecchi progetti con l'aiuto di Terra Institute, in modo da poter rimodellare/cambiare il sistema attuale della nostra azienda verso un sistema sostenibile e circolare.

What was the motivation that brought you into this project?

3 responses



If you answered "Learn new technical competences in the field of circularity and sustainability", please detail the technical competences you wished to learn during the course

1 response

System Design, Ecodesign, Remanufacturing, Industrial symbiosis

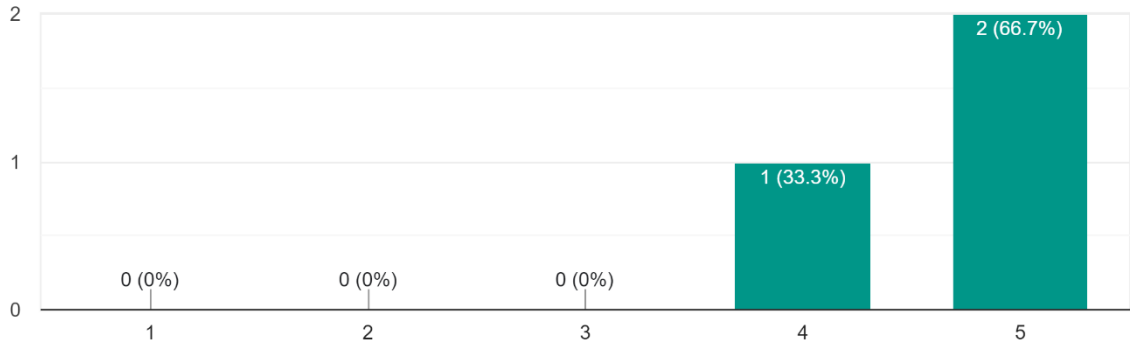
If you answered "Learn new personal and interpersonal competences in the field of circularity and sustainability", please detail the personal and interpersonal competences you wished to learn during the course

1 response

System Design, Ecodesign, Remanufacturing, Industrial symbiosis

On a scale from 1(not at all) to 5 (fully satisfied) how much do you feel your expectations on the course were satisfied?

3 responses



Please briefly motivate your answer to the previous question

3 responses

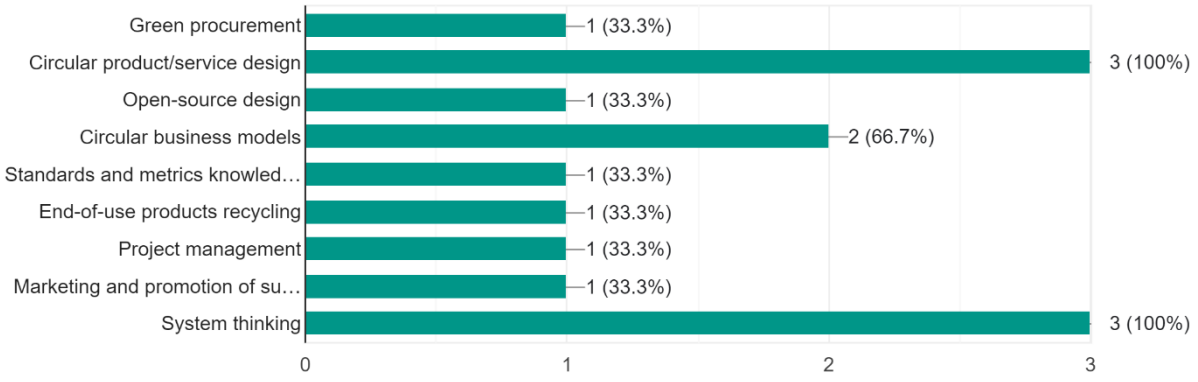
Expectations satisfied in full

I was looking for a course / school whose contents mainly concerned the
design and systemic thinking. I can say that my expectations have been met.
Certainly the organization and structure of the course with the constant involvement of
participants from the first day, the informal and collaborative atmosphere. I really enjoyed the possibility
given to the participants to have an active role in the development of the path.
The choice of having a class made up of participants with different skills and experiences.
The free time for the challenge was not much but a good part of the study was
conceived in class thanks to the way in which the school is conducted.
The availability of the organizers and attention to everyone's needs.

Ho imparato davvero molte cose che prima del corso davo per scontato, inoltre mi è servito molto per poter cambiare il mio comportamento/approccio nei confronti dell'ambiente, ma anche nei confronti delle risorse che la Terra ci offre e dei prodotti commerciali che abbiamo sotto mano tutti i giorni.

What skills (both technical and non-technical) and knowledge do you feel you were able to learn/improve?

3 responses



What are the changes (if any) that you brought in your daily work-life after Circular Re-Thinking?

3 responses

-

Greater awareness and overall vision

Sono molto più attento al mondo dei rifiuti che generiamo tutti i giorni, cercando di massimizzare al massimo lo spazio necessario per lo stoccaggio e organizzando al meglio il conferimento dei rifiuti , cercando anche delle potenziali vie per un eventuale riutilizzo di essi.

What are the critics (if any) that you would like to highlight about Circular Re-Thinking?

3 responses

-

None in particular

Non ho nessuna critica da fare.

What are the positive aspects that you would like to highlight about Circular Re-Thinking?

3 responses

Program, team-building, commitment

Participation and multidisciplinarity

Il corso è stato organizzato molto bene ed è servito inoltre a conoscere nuove persone ed interagire con loro riguardo ai temi della sostenibilità ed economia circolare.

Please feel free to use this space to express any additional comment on the project and your participation

1 response

it would be nice to be able to give continuity to the path with new updates and working synergies