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Anticipating and managing the impact of change

Impact of climate change and climate policies on living conditions, working conditions, employment and social dialogue: A conceptual framework

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Eurofound research paper

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European Foundation for the Improvement of Living and Working Conditions

When citing this report, please use the following wording:
Eurofound (2023), *Impact of climate change and climate policies on living conditions, working conditions, employment and social dialogue: A conceptual framework*, Eurofound research paper, Publications Office of the European Union, Luxembourg.

Authors: Dragoș Adăscăliței, Tina Weber (Eurofound) and Davide Consoli (contractor)

Research manager: Dragoș Adăscăliței and Tina Weber

Research project: Concept paper on impact of climate change and environmental degradation (210509)

Luxembourg: Publications Office of the European Union, 2023

PDF ISBN 978-92-897-2318-3 doi:10.2806/442099 TJ-05-23-085-EN-N

This report and any associated materials are available online at http://eurofound.link/EF22036

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The European Foundation for the Improvement of Living and Working Conditions (Eurofound) is a tripartite European Union Agency established in 1975. Its role is to provide knowledge in the area of social, employment and work-related policies according to Regulation (EU) 2019/127.

European Foundation for the Improvement of Living and Working Conditions

Telephone: (+353 1) 204 31 00
Email: information@eurofound.europa.eu
Web: www.eurofound.europa.eu

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Introduction

Policy relevance of climate change and environmental developments

In the 2020s, there is widespread discussion of the idea that the economy and labour market in Europe and beyond are influenced by megatrends including climate change, digitalisation and demographic change. While they are far from new phenomena, having been developing for decades, nowadays (some of) these trends are observed to be accelerating and having a greater impact on society, the economy, the labour market and institutions. This is caused not least by their combination and mutual influence, and most recently by the impact of the COVID-19 pandemic.

Accordingly, the megatrends are receiving increasing policy attention and research interest, with the aim of understanding their impact better as a precondition for designing and implementing policies to ensure long-term inclusive and sustainable growth delivering high-quality employment and well-being. In Europe – not least in the context of the recovery from the pandemic – related discussions are emphasising the need to successfully master the twin transition to a globally competitive, innovative, climate-neutral and digital economy, contributing to an inclusive society and labour market, and to ensure that institutions are fit for purpose to effectively guide and support this transition.

The purpose of this paper is to provide a conceptual framework for research and analysis suitable to guide Eurofound's future research linked to the impact of climate change and climate change policy. This framework is based on a review of existing literature addressing the impact of climate change, and climate change policies, on living conditions, employment, working conditions and social dialogue.

The increasingly evident implications of climate change, with more frequent summer heatwaves and extreme weather events, and the context of the energy crisis associated with the war in Ukraine have placed increasing emphasis on the urgency of addressing this issue. The war has reopened the debate on energy security with stakeholders searching for various medium-term measures to achieve long-term goals.

Box 1: Climate change projections in the European Union

The recent report by the Intergovernmental Panel on Climate Change (IPCC, 2022) estimates that anthropogenic activities are responsible for approximately 1.0°C of global warming above pre-industrial levels, and that at the current rate warming is projected to reach 1.5°C between 2030 and 2052. Recent projections also indicate that Europe is warming faster than the global average, with temperature increases expected to be more than 2°C by 2050 if the Paris Agreement targets are met (this increase would be 4°C otherwise) (EEA, 2022a). The effects of these changes would differ significantly across geographical areas, with southern European regions and cities expected to be more severely affected by heat, with an associated risk of wildfires (primarily in the Mediterranean basin) (Vitolo et al, 2019). Furthermore, winter precipitation is projected to increase over most of central, eastern and northern Europe, with the potential for river and coastal floods, and to decline in Mediterranean countries (Flouris et al, 2018).

Policymakers across Europe and beyond have started to engage in three broad strands of intervention.

- **Mitigation policies** aim to make the impacts of climate change less severe by preventing or reducing the emission of greenhouse gases (GHGs) into the atmosphere. Mitigation is achieved either by reducing the sources of these gases (e.g. by increasing the share of renewable energies, improving energy efficiency or establishing a cleaner mobility system) or by increasing the storage of these gases (e.g. by increasing the size of forests or investing in carbon capture technologies). In short, mitigation is a human intervention that reduces GHG emissions and/or increases sink effects.
- **Adaptation policies** seek to anticipate or address the adverse effects of climate change. Examples of adaptation measures include large-scale infrastructure changes, such as building defences to protect against sea level rise, and behavioural shifts, such as individuals reducing their food waste or changing their travel behaviour. In essence, adaptation can be understood as the process of adjusting to the current and future effects of climate change (see also EEA, undated-a).
- In addition, what will be termed '**compensation policies**' in this report aim to offset the distributional impacts of climate change on societies by targeting the groups most affected by the transition to a carbon-neutral economy. Their goal is to embed social fairness and social justice goals into climate policies. Examples include direct subsidies to help communities and workers adjust to a carbon-neutral economy, public support for investments in innovative and sustainable projects that can generate employment, public investment in retraining and upskilling programmes, employment subsidies and targeted job-search assistance. Such policies can be intracountry or transnational, given the global nature of the climate challenge and the imbalance

between where most carbon emissions are generated (i.e. more developed wealthier nations) and where the impact is most severely felt. Such measures align with the concept of ensuring distributive climate justice. Another aspect of distributive climate justice is procedural justice, which relates to who participates in decision-making and is able to influence outcomes, which will also be addressed in this paper. Having compensation policies does not mean that no attention should be paid to mainstreaming climate justice considerations in adaptation and mitigation policies.

Mitigation and adaptation are complementary strategies that are needed in combination to manage the risks of climate change and to reach climate objectives. Experts are convinced that a one-tier approach by itself is not sufficient to tackle the severe, widespread and irreversible global impact of climate change and environmental developments (see, for example, IPCC, undated). As a result, a variety of types of interventions has been emerging in the portfolio of climate policies and measures. In its collection of instruments, the European Environmental Agency (EEA), for example, illustrates measures related to information, research, planning, economic incentives, regulations (including on standards and taxation), voluntary agreements, etc.[1] In relation to adaptation policies, the EEA works with five key type measures at the highest level, summarised as policy measures, economic instruments, technical interventions, nature-based solutions and behavioural measures, all of which have a number of sub-measures.[2] Some policies identified include several types of intervention, which highlights the relevance of combined approaches. As well as the direct impact of climate change, choices regarding the specific nature of climate change policies have implications for different groups in society, the economy, labour markets, working conditions and policy actors, including social partners. It is generally considered that vulnerability to the harmful consequences of climate change, and to some of the implications of climate change policy, is unevenly distributed, with adverse impacts likely to affect more vulnerable groups in society. Therefore, on their own and depending on their design, mitigation and adaptation policies can be insufficient to address the distributional impact of climate change policies, and either not introducing them or designing them poorly can have a negative impact on the acceptance of climate change policy and social cohesion. This necessitates the implementation of targeted compensation policies as described above.

Definitions

One of the challenges in the discussion around the impact of climate change and climate change policies is a proliferation of different terminologies and concepts, sometimes lacking agreed definitions. The box below presents a summary of the key concepts and definitions used in the debate that are of greatest relevance for the purposes of this paper.

Box 2: Concepts and definitions

Climate change is the 'statistically significant variation in the mean state of the climate or in its variability, persisting for an extended period' (IUCN, 2011). It can be caused by natural processes and/or human activity.

The **greenhouse effect** occurs when GHGs released by humans, by burning fossil fuels, deforestation, livestock production, waste management or industrial processes, prevent heat from escaping Earth's atmosphere into space, which results in global warming (and hence climate change).

Environmental degradation is the process of negatively affecting the quality of the natural environment, notably through air, water and soil pollution and the intensity of land use, resulting in an undesirable reduction in biodiversity (Johnson et al, 1997), and could have a harmful impact on human health.

A **zero-/low-carbon economy** is based on using sources of energy that minimise GHG emissions. Related to that is the concept of **decarbonisation**. Mainly in the context of the power sector, policy (such as the European Decarbonisation Pathways Initiative) is directed towards the reduction of carbon intensity by reducing emissions (London School of Economics, 2020).

The concept of the **circular economy** describes a business model that deviates from the traditional 'take–make–waste' linear production and consumption model by being regenerative by design and decoupling growth from the consumption of finite resources (Ellen MacArthur Foundation, 2019). It promotes the use of renewable resources, waste prevention through repair and reuse, and recycling.

Various concepts use the term '**green**'. These tend to have a broader approach, including prevention/alleviation/mitigation of impacts of both climate change and environmental degradation.

- The green economy is an economic system that generates increasing prosperity while maintaining the natural systems that sustain society (EEA, undated-b).

[1] See EEA (2022b); a similar typology is mentioned by Gupta et al (2007).
[2] For more information see Leitner et al (2020).

- Green entrepreneurship relates to business activities either in green sectors (such as renewable energy) (Volery, 2002) or in traditional sectors but applying 'green' business models, processes or technologies (for example, organic farming) (Isaak, 2005).
- Green innovation is the invention or adaptation of production, products or services, or business management practices that result in a reduction of environmental risk, pollution and other negative impacts on resources used (including energy) (Kemp and Pearson, 2008; EIO, 2012).
- Green jobs contribute to preserving or restoring the environment, in both traditional and newly emerging green sectors such as renewable energy or energy efficiency (ILO, 2016).
- Greening of jobs describes increasing the level of environmentally friendly requirements within occupations (Janser, 2018).
- Skills for green jobs are the capabilities needed to fill a green or greening job (ILO, 2016).
- Green skills, in contrast, refer to the 'knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society' (UNIDO, 2020). Hence, this concept is broader than that of skills for green jobs. Linked to the concept of green skills is the concept of green tasks, which involves a variety of activities related to reducing the use of fossil fuels, increasing the efficiency of energy usage, recycling materials and adopting new sources of energy (ONS, 2022).

The widest policy approach in which climate and environmental issues play a central role is that of **sustainable development**. Against the understanding that 'sustainability' is the capacity for the Earth's biosphere and human civilisation to co-exist, sustainable development seeks a balance between economic, social and environmental dimensions by considering all three, as well as their mutual influence in any action (European Environmental Bureau, undated). The UN 2030 Agenda (which set 17 Sustainable Development Goals (SDGs)) and the European Commission in its Green Deal apply this understanding (European Commission, 2020a).

Related to climate change, **climate/carbon neutrality** aims to achieve a balance between the emission and absorption of carbon from the atmosphere in carbon sinks,[3] ideally to realise net zero emissions.

Another policy concept related to climate change is **climate justice**. It focuses on citizens by aiming to safeguard the rights of the most vulnerable people and to share the burdens of climate change equally and fairly between and within countries in the transition to a climate-neutral society (European Economic and Social Committee, 2017). It is also a significant issue at transnational level between developed and developing countries.

The policy concept of **just transition** tends to have a specific orientation, in this context, to the labour market, and particularly to workers displaced by economic developments related to climate change or environmental protection policies (Labor Network for Sustainability, 2016; Smith, 2017). Workers should not be disproportionally burdened by such developments by losing their jobs, but should be provided with decent alternative employment (ILO Actrav, 2018), including through job creation and timely anticipation of skills needs (Heyen et al, 2020). An important pathway to achieving this is to give workers and their representatives an active role in policy debates (ITUC-TUDCN, 2019). More recently, however, a broader understanding of just transition tends to be applied. Based on a more regional approach towards climate and environmental developments, the social dimension in just transition debates is being expanded from workers to also include their families and the society more generally (Atteridge and Strambo, 2020; Laurent, 2021) – that is, to consider avoiding or reducing environmental inequalities overall, thereby overlapping with the concept of climate justice described above.

The concept of **just resilience** also takes on board that the most vulnerable people (on account of their age, place of residence or socioeconomic status, among other things) are most at risk from climate change impacts, have the least capacity to adapt and are least likely to have their voice heard. Just resilience approaches seek to take this into account to avoid creating winners and losers, by reducing the unequal burden of climate risks and ensuring equity in the distribution of benefits of adaptation.[4]

European Union policy context

European Union (EU) policies related to climate change are not new, and over time a variety of mitigation and adaptation approaches have been developed to tackle the issue. In more recent years, EU policy ambitions and mitigation policies aimed at reducing GHG emissions have been considerably ramped up and have been combined with significant financial investment to support a green (and digital) transition and growth strategy, including in the context of the pandemic recovery package. In recognition of the complexity of climate change and its all-encompassing impact on society, the economy, labour market and institutions, policy approaches are not limited to direct climate mitigation and adaptation policies, but are also increasingly seeking consistency, coherence and

[3] To date, no artificial carbon sinks are able to remove carbon from the atmosphere on a satisfactory scale. Natural sinks are soil, forests and oceans.
[4] Definition adapted from Climate-ADAPT (undated-a).

complementarity across the policy spectrum in a way that can reinforce ambitions relating to the reduction of GHG emissions, while also recognising the potentially unequal impact of climate change policies themselves (OECD, 2021). Increasingly, EU policy measures are therefore also incorporating what were described above as compensation policies that aim to address negative distributional effects of climate change policies.

In line with these considerations, to confront the challenge of climate change and environmental degradation, the EU has committed to a series of targets and linked policy measures. Taken together, these policies are referred to as the **European Green Deal (EGD)**, adopted in 2019.[5] They have the objective of transforming the EU into a modern, resource-efficient and competitive economy based on the binding target of achieving carbon neutrality by 2050. As an intermediate step towards climate neutrality, the EU has raised its 2030 climate ambition, committing itself to cutting emissions by at least 55% relative to 1990 by 2030. Under the **Fit for 55 package**, the EU is revising its climate-, energy- and transport-related legislation in order to align current laws with the 2030 and 2050 ambitions. The new EU Climate Law was published and entered into force in July 2021.[6] It requires current GHG emission levels to drop substantially in the coming decades. The regulation strengthens emission reduction targets for buildings, transport, agriculture, waste and small industries; requires restructuring of the car industry and energy sector to meet climate targets; and envisages setting a carbon price on imports into the Single Market and the use of revenues (through a Social Climate Fund) to address the social impact on vulnerable households, microenterprises and transport users. In addition, the EU has established a Just Transition Mechanism with the goal of leaving no one behind. A core pillar of the mechanism is the Just Transition Fund, which will provide support to the regions most affected by the green transition. Actions financed by the Just Transition Fund include investments in projects that will generate employment in green industries, support for covering the costs of redundancies resulting from the closure of carbon-intensive industries, investments in small and medium-sized enterprises, research and development, and innovation, and support for training. The priority of these policies is evident in the EU's budgetary allocation. The Green Deal will absorb one-third of the €1.8 trillion investments from the NextGenerationEU Recovery Plan.

Within an international context, the EGD is an integral part of the European Commission's strategy to implement the **SDGs** of the United Nations.

All EU actions are expected to contribute to the Green Deal objectives in a holistic way (European Parliament, 2020a, 2020b). The deal also relates to the endeavour of linking climate policies with interventions driven by other megatrends, notably digitalisation (for example, developing an energy sector that is not only largely based on renewable sources but also digitalised to better ensure accessibility and affordability for consumers) and societal developments (for example, by integrating climate policies and social aspects, such as those related to mobility, housing, health or poverty). Climate policies should be considered in combination with other policy areas, such as economic and industrial policy (for example, related to the circular economy or specific sectors), consumer policy (such as empowering consumers to play an active role in the ecological transition through informed choices), labour market policy (for example, job creation, skills, transitions) or regional policy.

A centrepiece of the EGD is that the transition to a climate-neutral economy and society must be 'just and inclusive'. While this is not further defined, it is emphasised that the strategy must put people first and pay attention to the regions, industries and types of workers that face the greatest challenges. Active public participation and confidence in the transition are discussed as important pre-conditions for the policies derived from it to be accepted and effective.

Among the various measures, in 2020, the European Commission released its communication **'A new circular economy action plan for a cleaner and more competitive Europe'** as part of the EGD and the new industrial strategy (European Commission, 2020b). The action plan aims to reduce the EU's consumption footprint and increase the material reuse rate through legislation on sustainable product policy, encouraging industry to reuse, repair and recycle; through targeted initiatives for the sectors that use most resources and where the potential for circularity is high (electronics and information and communications technology, batteries and vehicles, packaging and plastics, textiles, construction and buildings, food); or through improved accessibility of consumer information on the reparability and durability of products.

Another relevant EU activity is the **8th Environmental Action Programme**,[7] which entered into force in May 2022. It defines six thematic priority objectives with a time horizon of up to 2050:

- reducing GHG emissions
- enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change
- advancing towards a regenerative growth model that gives back to the planet more than it takes, decoupling economic growth from resource use and environmental degradation, and accelerating the transition to a circular economy
- zero pollution of air, water and soil, and protecting the health and well-being of citizens from environment-related risks and impacts
- protecting, preserving and restoring biodiversity and enhancing natural capital

5 COM(2019) 640 final.
6 See more details at https://ec.europa.eu/clima/eu-action/european-green-deal/european-climate-law_en#formal-adoption
7 See more details at https://environment.ec.europa.eu/strategy/environment-action-programme-2030_en

- promoting environmental sustainability and reducing key environmental and climate pressures related to production and consumption, in particular in the areas of energy, industrial development, buildings and infrastructure, mobility and the food system

The integrated approach to policy development and implementation should be strengthened by considering synergies and trade-offs between economic, environmental and social objectives and by effectively integrating environmental and climate sustainability in the **European Semester** of economic governance, including in the national reform programmes and national recovery and resilience plans.

In 2021, the European Commission established the **EU action plan 'Towards zero pollution for air, water and soil'**.[8] It envisages that by 2050 air, water and soil pollution will be reduced to a level that no longer causes harm to health and natural ecosystems. Operational objectives to be reached by 2030 have been set as regards air, water and soil quality, noise pollution and waste reduction. It advocates preventive action and the 'polluter pays' principle.

Also in 2021, the European Commission adopted its new **Strategy on Adaptation to Climate Change**.[9] It calls for more evidence-based, smarter, faster, more comprehensive and systematic adaptation taking into account the impacts of climate change at all levels of society and across all sectors of the economy.

In response to the Russian invasion of Ukraine, in 2022, the European Commission launched the **REPowerEU Plan**, which aims to reduce dependence on Russian fossil fuels and fast-forward the green transition.[10] The plan complements the Fit for 55 package and puts forward a range of additional actions aimed at saving energy, diversifying energy supplies, replacing fossil fuels with green alternatives and coordinating national investments in green projects.

In recognition of the all-encompassing impact of climate change policy and its implications for different parts of society, the economy and the labour market, as mentioned above, these considerations are increasingly being mainstreamed into other EU policies, such as industrial policy, research frameworks, education and skills strategies and indeed the ambitions of the **European Pillar of Social Rights**. The pillar has a key role to play in supporting transition through adequate social protection systems, inclusive education, training and lifelong learning. Skills development will be particularly important in this transition, as people's reskilling and upskilling will be essential to ensure that no one is left behind. Among other principles set out in the European Pillar of Social Rights, the principle of access to essential services is relevant, as it states that everyone has the right to access energy and transport services, among others, and specifies that support for access to such services will be available for those in need.

Overview of theoretical framework

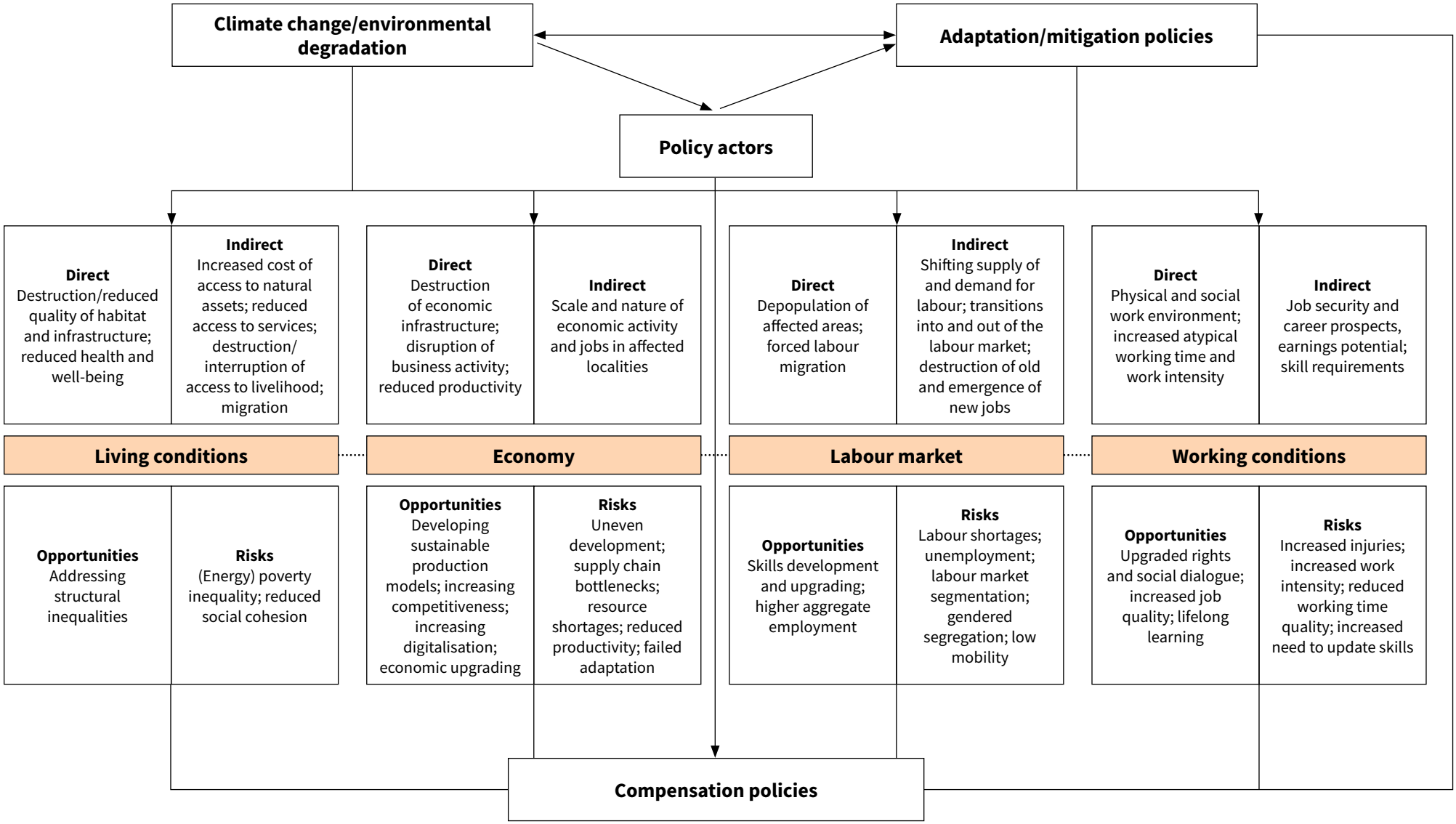
When engaging with the topic of climate change and environmental degradation it is understood that its impact is substantial and wide-ranging and affects all areas of human activity in Europe and beyond. This poses a challenge when discussing and researching its implications, and for the design and implementation of adaptation, mitigation and compensation policies. While the full gamut of climate change effects is impossible to account for in a single theoretical framework, this paper narrows down the observed and potential effects across four domains: living conditions, economic activity, the labour market and working conditions.

As depicted in Figure 1, climate change can have both direct and indirect consequences across the four domains. For example, climate change can directly affect labour markets by making some areas inhospitable to humans and therefore lead to depopulation and forced migration. Indirectly, the effects of climate change on the labour markets are mediated by the policies adopted to mitigate its potential negative effects. These policies have an impact on the labour market by shifting the supply and demand for labour inputs, by supporting the creation of new jobs and the destruction of old ones. The potential effects of climate change on the labour market are also mediated by compensation policies, that is, policies aimed at addressing the distributional effects or risks generated by climate change. In effect, policy responses to climate change can generate opportunities to increase the resilience of labour markets through, for example, sustained investments in skill developments and skill upgrading, stimulating transitions from inactivity into employment, increasing aggregate employment or addressing existing labour market inequalities.

The framework also implies that, given the cross-cutting effects of climate change, policies aimed at addressing its impacts require coordination across different domains. For example, while mitigation policies in particular are likely to result in the cessation of some human activities (and should be designed with potential distributional impacts in mind), compensation policies can address the distributional consequences of such cessations through the development of safety nets, mobility schemes and pathways to access the labour market. Since the different building blocks of the framework are not independent of one another, the impact of climate change in one is likely to ripple across different domains. For example, economic effects of climate change and climate change policies have consequences for both labour markets and social conditions. Similarly, changes in labour markets are likely to have impacts on working conditions, generating both risks and opportunities for firms and workers, not least as a result of compositional impacts.

[8] COM(2021) 400 final.
[9] See more details at https://ec.europa.eu/clima/eu-action/adaptation-climate-change/eu-adaptation-strategy_en
[10] COM(2022) 230 final.

Figure 1: Theoretical framework to assess the impact of climate change and climate change policy



Source: *Authors*

The following sections discuss in turn the impacts of climate change and climate change policies on each of the areas outlined in the present theoretical framework. They review the key findings in academic and policy literature against the backdrop of this framework and seek to summarise the mechanisms affected by climate change and climate change policy, potential impacts and the groups most likely to be affected. The term 'mechanisms' is used here to describe areas, domains or relationships most likely to be affected (either positively or negatively).

The final sections of the paper analyse the impacts on policymaking and on policy actors, including social partners, and discuss the implications for future research.

1 Socioeconomic effects of climate change and environmental degradation

Introduction

Climate change directly impacts on human activity through the degradation of the natural ecosystem, which undermines access to a good-quality habitat for essential needs such as health, nutrition and housing. By altering the frequency and range of abnormal weather phenomena, climate change can pose a direct threat to life and imperils the availability of fresh water, biodiversity, livestock renewal and therefore the viability of activities that essentially depend on the environment for subsistence and by extension many other activities. Events related to climate change that are of concern for public health and their wider socioeconomic impact include increasingly frequent, intense and long-lasting extreme heat, which worsens drought, wildfire and air pollution risks; increasingly frequent extreme precipitation, intense storms and changes in precipitation patterns that lead to drought and ecosystem changes; and rising sea levels that intensify coastal flooding and storm surges.[11]

These hazards affect societal groups unevenly, by age, sex, socioeconomic status and race, as well as by geographical locations: floodplains, coastal zones, urban areas. Environmental degradation triggers more negative socioeconomic outcomes among vulnerable individuals, for example, women, migrant workers, persons with disabilities and other disadvantaged groups (Breil et al, 2021; IPCC, 2022). Moreover, these mechanisms can trigger a self-reinforcing spiral of inequality and poverty in communities wherein repeated extreme weather events undermine resilience and capacity to put in place or rebuild emergency measures (Cappelli et al, 2022). Crucially, in an interconnected world, the hardships of more exposed territories, often in less developed parts of the world, are transferred to other countries through social and economic channels (EEA, 2017). The focus of this paper is on implications at EU level.

Impacts on living conditions

Climate change and environmental degradation affect the existence of a healthy natural ecosystem, with effects on people's access to a good-quality natural habitat as a place for living, work and recreation, but also as a resource for essential goods required for nutrition or housing, and for services of public interest (such as water, energy, public transport and medical services). The provision of essential services can also be affected if damage occurs to such infrastructure or supply chains or if labour supply is affected.

Climate change can affect health through the adverse effects of exposure to prolonged periods of extreme heat, the direct dangers to health associated with flooding and environmental damage associated with fires and floods, changes in the geographical distribution of food and the spread of waterborne diseases. Environmental degradation contributes to increases in allergies, pathogenic diseases, respiratory sicknesses, cardiovascular diseases, blood and liver issues, malnutrition or cancer (Fears et al, 2020; European Parliament, 2021; Romanello et al, 2021; WHO, 2021; Mora et al, 2022).

When discussing the health impacts of climate change, it is important to consider not only the physical dimension but also mental health (Whitcomb, 2021). A good natural environment can have beneficial psychosocial effects on individuals, for example when outdoor activities are conducted to reduce stress. Negative developments, however, including for example noise pollution or rising temperatures, can decrease people's mental well-being (such as by increasing stress levels due to bad weather or noise) (National Geographic, undated; EEA, 2020). As temperatures across Europe rise, increasing evidence points to the negative mental health effects of prolonged high temperatures. Furthermore, emerging phenomena specifically related to climate change and environmental degradation should also be monitored. For example, 'eco-anxiety', observed particularly in younger people, manifests through the fear of having children, as they will be exposed to living in a world affected by climate change (Lawrance et al, 2021).

These effects, in combination with the impact on the economy and labour market (see 'Impacts on the economy and the labour market' below), can have a direct impact on social protection, health, education and welfare systems, as well as other essential services, in terms of their ability to provide continuity of service and access to these services for all groups of society. Such services may also have to be adjusted to meet new requirements (ILO, 2018; Orru et al, 2018; Aleksandrova, 2019).

[11] A detailed classification of climate-related hazards can be found in the Annex to the Commission Delegated Regulation (EU) 2021/2139 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives, available at https://ec.europa.eu/finance/docs/level-2-measures/taxonomy-regulation-delegated-act-2021-2800-annex-2_en.pdf

Box 3: Climate change and energy poverty

Among the individual impacts most discussed in the literature is the impact of climate change on those experiencing energy poverty, which is defined as the 'inability to afford proper indoor thermal comfort' (Energy Poverty Advisory Hub, undated). According to Eurostat estimations, in 2020 about 8% of the population in Europe lived in energy poverty while 18% were considered at risk, with higher vulnerability in the Mediterranean basin (European Commission, undated-a). Energy poverty stems from a combination of low income, high energy bills relative to disposable income and poor energy efficiency, all of which climate change is known to exacerbate (Randazzo et al, 2020). There is no common definition of this phenomenon, and individual EU Member States use different terms to identify the affected individuals: fuel poor, energy poor, vulnerable energy consumers or, in a larger sense, people who are at risk of poverty or on a low income (European Commission, 2020c).[12] As a result, official data collection programmes use different methods and different criteria, which complicates the elaboration of systematic analyses and may lead to overlooking specific vulnerable groups (Bouzarovski et al, 2021). Eurofound (2022a) argues that the inherited notion of energy poverty, framed as an issue of affordability, is narrow and leads to ad hoc responses with limited scope, such as subsidies and price regulation. A broader approach rooted in reducing households' external energy dependence on fossil fuels would go a long way towards shaping the design and implementation of structural and long-term policy responses, in line with the EGD.[13]

As mentioned above, the impacts on communities and individuals across Europe and beyond will differ (EEA, 2018; WHO, 2019; Breil et al, 2021), depending on, for example, regional or sociodemographic characteristics. In general, however, it can be expected that the traditional vulnerable groups in society will be affected more, and most likely more negatively. To give an example, it is expected that those who can afford it will leave housing areas that are regularly affected by floods, leaving less well-off tenants to live in water-damaged structures posing long-term health risks to the individuals and the potential for them to end up homeless (Defra, 2012). This, in turn, is likely to result in a vicious circle as regards access to sustainable and higher-quality employment that would allow them to opt for better accommodation. Research by the EEA (Breil et al, 2021) indicates that challenges in coping with heatwaves will have more impact on vulnerable groups in Europe than flooding.

Box 4: Climate change and migration

In terms of impacts on groups and regions, the effect of climate change on migration is increasingly discussed. Evidence from the Global South indicates that unfavourable climatic conditions lead to fast and uncontrolled growth of urban populations, as well as movements between countries, both of which have direct consequences for the receiving communities (Henderson et al, 2017). Crucially, while migration intentions could predict migration outcomes (Docquier et al, 2014; Bertoli and Ruyssen, 2018), adverse climatic conditions are likely to limit the financial possibility of migrating (Beine and Parsons, 2017). A study by Docquier et al (2014) reports a reduced link between migration intentions and migration outcomes for the less educated and residents of rural areas. Likewise, the literature on the costs and wealth effects of migration finds that financial constraints are a major barrier to migration among individuals in the lower to middle part of the income distribution (McKenzie and Rapoport, 2007; Dustmann and Okatenko, 2014; Angelucci, 2015; Bazzi, 2017). This again indicates that the most vulnerable groups are likely to remain trapped in the regions most affected by climate change.

In this context it should also be mentioned that social cohesion plays an important role in mitigating the effects of climate change (thanks to the dissemination of information about developments in the natural environment and about the behaviour expected from citizens), while at the same time those effects can have an impact on social cohesion (for example, if different population groups have different conceptions regarding the gravity of the developments and the actions required, or if, as in the above example on flooding and housing, some population groups have the opportunity to leave environmentally devastating areas while others are left behind) (Klinenberg, 1999; Walker et al, 2006; Whitmarsh, 2008; Wolf et al, 2010; Zsamboky et al, 2011). Climate change can therefore contribute to social instability at community level, for instance if climate pressure leads to conflicts by undermining the availability of essential resources (Froese and Schilling, 2019).

[12] For a thorough overview of different definitions and nuances of concepts related to energy poverty, see Eurofound (2022a).

[13] To illustrate this, as a result of the crisis in Ukraine, the European Commission has set in motion a plan for saving energy, producing clean energy and diversifying Europe's energy supplies, which is in line with the principles of long-term structural transformations underlying the EGD. See European Commission (undated-b) and Eurofound (2022b).

Table 1: Main mechanisms affected and impacts of climate change and environmental degradation on living conditions

Affected mechanisms	Potential impacts	Potentially most affected groups
• Access to, costs of and quality of the natural habitat and products of it (including food and water) • Access to, costs of and quality of housing • Access to livelihood (due to destruction of premises, means of production, etc.) • Access to, costs of and quality of services of public interest (for example, healthcare, fire/emergency/rescue services, education, energy, transport, waste management) due to destruction/ damage/limitation of access to premises and supplies • Access to basic goods including food supplies due to damage and disruption of supply chains	• Reduced quality of life, including homelessness and availability, costs and quality of public services; reduced access to work/means of subsistence • Reduced purchasing power and wealth, increased poverty • Energy poverty • Disruption in access to and lower quality of social protection, health and welfare systems; need for health and welfare systems to adapt to new requirements • Reduced physical and mental health and well-being • Migration placing strain on receiving regions and depopulation of affected areas, with impacts on essential services in both • Rising inequalities between social groups • Increased social tensions	• People living in areas more prone to flooding/fire risk • Vulnerable groups including sick people, people with disabilities, ethnic minorities, older people, young children, pregnant women • Unemployed people • People with lower levels of education • Low income groups

Source: *Authors*

Impacts on the economy and the labour market

Climate change and environmental degradation directly affect the use of land, labour and capital while also having an impact on the productivity of inputs to economic activity (OECD, 2015a). Some sectors such as agriculture will be directly hit by climate change through land and capital destruction and through lower labour productivity due to health impacts. Yet other core sectors of the economy, such as the service and manufacturing sectors, will also sustain direct negative impacts of climate change. These effects are likely to be compounded by considerable indirect impacts stemming from changes in the prices of input factors and from changes in demand for goods and services.

In the past, the loss of productivity resulting from the impact of climate change was considered to be, on average, relatively limited and mostly concentrated in low-income countries (Yohe and Schlesinger, 2002). However, as summer heatwaves are becoming more regular occurrences, including in the previously more temperate regions, the impact of extreme heat on productivity is being increasingly recognised as an issue for European labour markets to tackle (Narocki, 2021).

The loss of labour productivity, through the impact of temperatures above 24°C on human performance and working hours lost, is estimated to range from 0.8% to 5% (ILO, 2019; Watts et al, 2019). Research in the manufacturing sector has demonstrated that temperatures in excess of 25°C resulting in reduced productivity may also require recovery times in excess of one week following extreme heat events (Ciuha et al, 2019). A study by Triple E Consulting (2014) estimated that a business-as-usual scenario could lead to 240,000 potential job losses in the EU by 2020 and 410,000 by 2050 due to declining labour productivity associated with heat stress. More recent estimates by the ILO (2019) quantify productivity losses due to heat stress in northern Europe at about 0.01% of working hours (the equivalent of 502 full-time jobs). The impact is larger in southern Europe, at 0.02% of working hours (6,300 full-time jobs), and is expected to rise to 0.03% (14,400 full-time jobs) by 2030.

Extreme weather and climate-related events also exert significant economic and fiscal costs by having a negative impact on growth drivers and through unforeseen shocks to the economy (European Commission, 2022a). Although no consensus exists with respect to the exact size of the effects of climate change on growth, there is agreement that climate disasters are taking a toll on public finances. This in turn has implications for the policies aimed at dealing with the climate emergency. Estimates by the European Commission put the economic losses caused by climate-related events at around 3% of GDP on average across EU countries between 1980 and 2020. The size of GDP losses varies by country, from 8% in Spain through 5% in Portugal and Romania to 1% in Belgium, Estonia, Ireland, Lithuania, the Netherlands and Sweden (European Commission, 2022a, p. 150). Depending on the different adjustment scenarios, these losses are likely to increase by a factor of two to three by mid-century.

Box 5: Impact of climate change in agriculture

Sector-specific research on the effects of climate change on the agriculture sector has traditionally focused on crop productivity (OECD, 2015b) and the negative labour market outcomes for farm workers (Mendelsohn et al, 1994; Schlenker et al, 2005). These aspects are relevant to Europe, considering that, although employment in the agricultural sector has been steadily declining for decades, agriculture still accounts for large shares of the workforce in Bulgaria, Greece, Latvia, Lithuania, Poland and Romania. In addition, evidence shows that employment in the agricultural sector remains high in several regions in western Europe, including the regions of Extremadura and Murcia in Spain (Eurofound, 2019a). According to Eurostat (2018), farming in Europe remains a family activity managed predominantly by males aged 55 years or more. Accordingly, work in the sector depends on individuals who are on average vulnerable to heat stress and are also unlikely to accommodate territorial shifts of fertile soils by migrating (Eurostat, 2022a).

Research on crop productivity demonstrates that regional differences are likely to be heightened as a result of changes in rainfall, carbon dioxide and ozone concentrations. These changes will have direct impacts both on crop productivity and on the way in which agricultural activities are conducted. For example, farmers may alter crop selection to deal with new climate conditions (Mendelsohn et al, 1994), may innovate to develop new varieties robust to adverse climates (Olmstead and Rhode, 2011) or may simply migrate away from deteriorating climates, which erodes the community's future capacity to adapt to climate change (Hornbeck, 2012). In other contexts, farmers may make defensive investments that minimise the impact of climate change such as increase in pesticide use, with further adverse effects on environmental vulnerability.

Overall, these challenges compound the fragile nature of family farming businesses, which may struggle to adapt to the pressure of climate change, for example, by switching to drought-resistant crops that require decades of investments before yields become profitable (Pingali, 2012). Recent literature also points out that other primary activities such as fisheries and forestry are also under threat. For example, global warming and sea level rise can lead to displacement of fish stocks, species decline and an uncontrolled increase in other species that can increase environmental stress by reducing oxygen concentration and ocean acidification (Barbarossa et al, 2021). The effects of climate change on fisheries will also increase differences between regions, with negative effects likely to be concentrated in tropical areas while developed countries in northern areas are likely to benefit (IPCC, 2014a).

While, as noted above, primary sectors such as agriculture will be directly affected by climate change, other sectors will also be affected. First, negative effects on agricultural activities will spill over into other sectors that depend on them, such as retail and transport (Jones and Olken, 2010). Second, a warming climate and changes in precipitation patterns bear on other sectors that depend on the natural environment, such as tourism and recreational activities, and therefore on the communities whose livelihoods depend on them (Dell et al, 2012; Carleton and Hsiang, 2016). Recent studies estimate that the associated job losses in these sectors will be significant in Europe, ranging between 400,000 and 650,000 by 2025, especially in Austria, Bulgaria, Croatia, Cyprus, Estonia, Greece, Italy, Latvia, Lithuania and Romania (Triple E Consulting, 2014; ILO, 2018). Third, productivity shocks due to thermal stress are likely in non-farm activities that entail physical work, or that require workers to wear heavy clothing and technical equipment, such as work in indoor industrial settings (Acharya et al, 2018), in construction or in service sectors such as refuse collection, emergency repair work, transport, tourism and sports (Nunfam et al, 2018). Finally, heat stress also affects office jobs that entail working indoors in warm spaces where the insulation or cooling/ventilation system is inadequate (Hancock et al, 2007; Hooyberghs et al, 2017).

The economic consequences of climate change will also increase the vulnerability of European labour markets by having an impact on the levels of employment and unemployment, inactivity rates, labour market transitions and the overall quality of employment. Through both supply- and demand-side effects, labour shortages are expected in certain occupations, sectors and regions. Furthermore, given existing labour market inequalities, climate change is also likely to increase polarisation and inequalities in the labour market. This also poses the risk of further labour market segmentation, limiting the mobility of some types of workers from low-quality to better employment. Despite these potential short- and medium-term negative outcomes, little information is yet available on the labour market impacts of climate change across relevant subgroups.

Table 2: Main mechanisms affected and impacts of climate change and environmental degradation on the economy and the labour market

Affected mechanisms	Potential impacts	Potentially most affected groups
• Scale of economic activity and jobs in certain sectors and regions (direct and indirect sector effects) • Adaptation of characteristics of economic activity in certain sectors and regions • Structure of regional economic systems • Job creation and destruction • Productivity in sectors with exposure to more extreme heat, including where protective equipment needs to be worn • Change of task profiles within jobs • Public finances	• Transitions into, out of and within the labour market • Unemployment, employment and inactivity • Labour shortages and surpluses • Employment quality • New skill needs • Geographical labour mobility • Labour market polarisation, segmentation and inequalities	• Sectors such as agriculture, forestry, fishery, tourism, transport, construction and some manufacturing and service sectors • Workers employed in the most affected sectors • Populations of regions dominated by the most affected sectors • Vulnerable groups in the labour market, such as low-qualified workers and workers on irregular contracts

Source: *Authors*

Impacts on working conditions and job quality

Working conditions and job quality can differ significantly between sectors and occupations (Eurofound, 2017, 2020). Therefore, an indirect effect on working conditions and job quality can be expected from the above-described compositional effect of climate change on the economy and labour markets. The economic (sector) structure, business models and labour market characteristics (notably surplus versus scarcity of human resources, but also linked to jobs and tasks) influence the contractual relationships between businesses and workers as well as work organisation, which has an impact on elements such as job security, wages, working time (flexibility), social protection, access to training or career prospects (Dierdorff et al, 2009). In addition to these fundamental working and contractual conditions, climate change can clearly affect other aspects such as (Eurofound, 2017):

- the physical working environment (e.g. exposure to different environmental conditions or biological and physical hazards)
- the social environment (e.g. management and social support, adverse social behaviour)
- work intensity (e.g. pace, or quantitative and emotional demands)
- working time quality (e.g. atypical working time, duration).

As well as being professional/occupational and sectoral, these impacts of climate change are set to be highly regionalised and have varying implications for different groups in the labour market.

Physical and social environment

As regards the impact of climate change and environmental degradation on working conditions and job quality, the most direct effect is likely to be on the physical work environment – and as a result can also have negative implications for the social environment. The place of work can be affected in terms of temperature, humidity, water, air quality, noise, and exposure to chemical and biological hazards. Furthermore, the impact of adverse climate events can affect work location, for example, when existing work sites become inaccessible because of flooding or are destroyed by fire resulting from climate events. Such impacts on the physical environment can affect the social environment in terms of proximity to management and colleagues, level of support from them and exposure to new social risk factors, for instance, adverse social behaviour from clients who are under stress due to climate events. The physical and social work environment has a decisive impact on workers' health and well-being, affecting the likelihood of accidents, illnesses caused or aggravated by workplace factors, and stress-related conditions. Work–life balance can also be affected, for example, if commuting times change due to changes in location (or are reduced because of environmental considerations) (Nilsson and Kjellstrom, 2010; ANSES, 2018).

Box 6: Impact of heat on working conditions

As global temperatures increase and summer heatwaves become more prevalent, there is an increasing recognition of the detrimental impact that heat exposure at the workplace has on human health, as greater heat exposure can increase internal metabolic heat production, which can lead to heat stress. This can in turn trigger physical and physiological changes that affect performance, and contribute to detrimental health outcomes, accidents and occupational injuries. In the worst-case scenarios this can lead to temporary or chronic ill-health or death, with negative impacts on not only the individual but population health and the wider economy (Lucas et al, 2014; Narocki, 2021).

Heat exposure poses the greatest risk to those workers whose tasks require physical exertion or the use of protective clothing or personal protective equipment, which can hamper natural heat dissipation. This is particularly the case in outdoor settings (e.g. in agriculture and construction; Levy and Roelofs, 2019) and in poorly ventilated or poorly temperature-controlled indoor settings, particularly where machinery can contribute to raising temperatures. Similarly, workers paid based on output can be more vulnerable, as they are less likely to be able to take breaks without an impact on their pay. Vulnerable workers on precarious contracts are more likely to face high-risk conditions, thus further deepening social inequalities.

Health impacts can be short term or contribute to the emergence or acceleration of chronic illnesses. Heat stress can lead to harmful physiological changes in the body and psychological consequences that can also affect the social working environment and contribute to adverse social behaviour. High temperatures have been shown to have a particularly adverse impact on pregnant women and can cause congenital defects and contribute to the risk of miscarriage, low birth weight and other defects (Zhang et al, 2019).

According to the World Health Organization, the ideal temperature for working is between 16°C and 24°C. Another study shows that when the temperature exceeds 30°C the risk of workplace accidents goes up by between 5% and 7%, while above 38°C the probability of accidents increases by 10% to 15% (Narocki, 2021). A Eurofound survey shows that 23% of workers across the EU are exposed to high temperatures, rising to 36% in agriculture and industry and 38% in the construction sector (Eurofound, 2017).

High temperatures have also been shown to increase the risk of certain chemical substances/pollutants that can be present in the workplace. An appraisal report by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES, 2018) points to alterations of the biological and chemical environment as an emerging, if under-studied, work-related hazard.

As well as affecting productivity (see 'Impacts on the economy and the labour market' above), this combination of harmful factors can affect cognitive performance, which can contribute to workplace accidents (Schulte and Chun, 2009; Schulte et al, 2016; Andrews et al, 2018). Depending on their severity, work-related injuries may in turn affect individuals' work capacity.

Heat stress is a social hazard, which affects not only individuals but also local communities and, through its impact on productivity, the economy (Kjellstrom et al, 2016).

In July 2022, recognising the adverse effects of heat stress on workers' health, the European Trade Union Confederation (ETUC, 2022) called on the European Commission to bring forward a directive imposing a maximum temperature limit for work. This follows on from a resolution adopted by ETUC in 2018 calling for workers to be protected from high temperatures in the workplace (ETUC, 2019). According to ETUC, to date only a few European countries have legislation to protect workers during heat waves. This is the case in Belgium, Hungary, Latvia, Montenegro, Slovenia and Spain.

Work intensity and working time quality

Some studies point to individual indirect effects, namely growing pressure on public services such as social services, education, public transport and disaster management exerted by extreme- weather events. Galgóczi (2021) finds that a higher frequency of climate-related events has significant negative impacts on the work intensity and working time quality of rescue services and healthcare workers.[14] On the one hand, increasing numbers of forest fires put rescue services under strain, thus leading to greater workloads, a deterioration of the firefighters' working conditions, and greater health and safety risks due to higher exposure to heat stress and injuries and unpredictable working hours. Likewise, the risk of droughts can affect brigades' training capabilities because of water scarcity (Fire Brigades Union, 2010). Similar considerations apply to the healthcare sector, wherein the indirect effects of climate change add to existing pressures due to ageing populations and budgetary constraints.[15] The projected increase in health-related issues will bear once again on the work intensity and working time quality of health staff, already under pressure from irregular schedules. These phenomena will also increase the risk of inefficiencies in understaffed and, in many Member States, underfinanced medical and health services – especially in rural, isolated areas and deprived urban areas. The negative impact on working conditions will affect nurses, doctors, administrative employees and

[14] The same report also points out that data collection on weather-related loss and damage, which is critical for disaster risk management, is inadequate in Europe.

[15] https://ec.europa.eu/eurostat/statistics-explained/index.php/Healthcare_expenditure_statistics (accessed April 2022).

rescue services workers (Kjellstrom et al, 2016) and can have an impact on the quality of the services delivered to citizens.[16]

Skills and discretion, prospects and earnings

As well as affecting the above factors, changes in sectoral, occupational and task profiles linked to the compositional effects of climate change on the economy and the labour market can result in positive or adverse effects on job and career prospects, earnings potential and access to (and the requirement for) training. In the short term, these impacts could be perceived to be negative, as individuals may be required to move between geographical areas, sectors, occupations or tasks, which could lead to (temporary) spells of unemployment. Depending on the success and nature of the sectoral or occupational shift performed and the level and quality of support received, this could lead to improvements or deterioration in prospects and earnings. Longer-term labour market trends in Europe demonstrate a shift away from the primary sectors (including agriculture in particular). Since these sectors tend to be characterised by insecure contracts and challenging working conditions, this could be indicative of a trend towards overall improvements in conditions. However, the casualisation of contracts, including in the service sectors, means that not all workers will benefit from the impacts of sectoral shifts.

Overall, the direct or indirect impact of climate change beyond the implications for the physical working environment remains poorly understood.

Table 3: Main mechanisms affected and impacts of climate change and environmental degradation on working conditions

Affected mechanisms	Potential impacts	Potentially most affected groups
• Various indicators of job quality, but primarily physical work environment, social environment and prospects • Working time, work intensity and earnings • Risk of accidents	• Health • Job security • Employability • Career prospects • Working time and work–life balance • Training, skills use • Social protection • Wages	• Workers in specific occupations in specific sectors (such as agriculture, forestry, fishery, tourism, transport, construction, energy, mining, some manufacturing sectors) and regions most affected • Workers affected by sectoral/occupational and task shifts • Those working outdoors and in hot indoor environments; jobs requiring the use of personal protective equipment • Those in occupations dealing with the environmental and societal effects of climate change and environmental degradation (health, emergency services, immigration services, etc.)

Source: *Authors*

[16] The healthcare sector is responsible for almost 5% of global GHG emissions, and has a carbon footprint equivalent to 514 coal-fired power plants (Health Care without Harm and Arup, 2019; Health Care without Harm, 2021). If the sector were a country, it would be the fifth largest polluter on Earth.

2 Socioeconomic effects of climate change policy

Introduction

The economy and labour markets, working conditions, broader society and institutions can be affected by climate change mitigation and adaptation policies, in addition to the direct effects of climate change. These policies can have different distributional impacts and therefore have the potential to enhance or negatively affect social cohesion (Breil et al, 2021; EEA and Eurofound, 2021). Such implications depend on the precise nature of specific policies and can differ in the short, medium and longer terms.

As indicated above, there is widespread agreement in the policy debate that achieving sustainable economic growth depends not on the efficacy of any individual instrument but, rather, on whether or not the policy mix is comprehensive and coherent (OECD, 2019). As a result, policy design would ideally strive to be comprehensive in treating multiple dimensions as complementary rather than competing (Sovacool, 2009). On the other hand, policy design should strive for coherence, whereby the concurrent implementation of multiple instruments should ideally prevent efforts in one area from undermining other domains (Parsons and Hawkes, 2019).

As indicated above, the EGD is conceived as a holistic growth strategy aimed at accelerating the transition to climate neutrality in Europe by 2050. The first step in this ambitious undertaking is a portfolio of actions to cut GHG emissions by at least 55% by 2030. While environmental policy has been traditionally defined in terms of the problem it was designed to address – controlling pollution – the design logic has recently shifted towards integrative approaches to ensure consistency and coherence across the policy spectrum, and with greater emphasis on socioeconomic issues (OECD, 2021). In line with this, delivering the EGD will entail straddling boundaries across production, consumption, large-scale infrastructure, transport, food and agriculture, construction, taxation and social investments. Such comprehensive approaches, while likely to be beneficial, can also increase the complexity of seeking to assess short-, medium- and long-term implications for different groups.

After briefly summarising key policy approaches employed to tackle climate change, this section will discuss the effects and impacts of climate change policy on living conditions, the economy and labour markets, working conditions and policy institutions, including social dialogue.

Box 7: Growth and natural resource use: Alternative narratives

Economic growth is at the core of national policy agendas that aim to plan, finance and implement measures to address development challenges. Being closely linked to increases in production, consumption and natural resource use, growth – the way it has been pursued so far – has inevitable detrimental effects on the environment and, ultimately, on long-term human well-being. Some commentators consider that the decoupling of economic growth from natural resource depletion at global scale seems increasingly unfeasible, certainly at the speed that is necessary to avoid irreversible global temperature rise (Parrique et al, 2019; Hickel and Kallis, 2020; Wiedmann et al, 2020; Keyßer and Lenzen, 2021). Based on this outlook, experts and policymakers have explored alternative avenues to balance societal well-being with environmental sustainability.

Another narrative at the heart of the policy agenda in much of the developed world focuses on decoupling, with less energy-intensive production and an emphasis on the preservation of natural resources, including through a more circular economy. The emphasis of public policy remains on growth.

An alternative paradigm to the above policy agenda is the proposal to decouple GDP growth from its ecological impact. Known as the 'degrowth' paradigm, it argues that traditional economic development goals are fundamentally incompatible with ecological sustainability. Instead, developed countries should decrease the pace of material production by reducing energy demand and the use of raw materials. This would ensure an 'ecologically coherent' growth strategy that harmonises the developmental model with the need to reduce pressure on the environment (Hickel, 2021). While the menu of policy proposals to achieve degrowth is vast, proponents of the paradigm broadly argue for reductions in working time and wage labour, redistribution of resources between and within countries, decommodification of labour through universal policies that ensure fundamental human rights, and decentralised and democratic governance of societies and economic systems (Fitzpatrick et al, 2022).

Mitigation, adaptation and compensation policies

Policy instruments vary in terms of the underlying governance principles and behavioural assumptions. In general, responding to climate change involves a two-pronged approach. The first, mitigation, involves reducing the flow of GHGs either by reducing sources (the burning of fossil fuels for electricity, heat or transport) or by enhancing the sinks that store these gases (oceans and forests). According to the IPCC (2014b, p. 4) the goal of mitigation is to 'stabilize greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened and enable economic development to proceed in a sustainable manner'. The second approach is adaptation, which involves adjusting to the actual or expected future climate to reduce vulnerability and increase adaptive capacities and resilience. As indicated above, examples of adaptation measures include large-scale infrastructure changes, such as building defences to protect against sea level rise, and behavioural shifts, such as individuals reducing their food waste and changing consumption patterns. It should be noted that such policies can be cross-sectoral and wide ranging.[17] As a result of the uneven distributional impacts of climate change and climate change policy, a third policy approach is required to ensure just transition and continued societal support and cohesion; for the purposes of this paper, such an approach is termed 'compensation policies'.

The literature identifies four main mechanisms through which policies aimed at dealing with climate change trigger socioeconomic outcomes (OECD, 2017a).

- The first is changes in **production or delivery** processes. When adapting to green growth regulation, firms will be mandated or incentivised to use fewer polluting inputs and processes. European policy pursues these changes by either targeting broad goals that cut across all sectors or targeting specific sectors. To illustrate, an example of targeting broad goals is the Energy Taxation Directive, a broad instrument to align the taxation of energy products with EU energy and climate policies, which will affect a wide range of activities including agriculture, industry and construction. Conversely, a tightly targeted intervention such as the phasing out of free emission allowances for aviation is an instance of targeting specific sectors.
- The second mechanism includes changes in **price signals to affect consumer demand**. These can be achieved through hard policies that aim to lower the prices of clean goods relative to polluting products, thus making it cheaper to purchase cleaner goods than polluting goods. In contrast, soft interventions rely on voluntary information-based instruments such as environmental management systems, environmental product labelling, industry codes of practice and voluntary agreements. They can also stimulate environmental awareness and nudge consumers towards more sustainable lifestyles.
- The third mechanism of interest is changes in **trade**, which can be affected by similar price signals. Climate change policies can have a direct impact on the competitiveness of firms by raising the costs of producing in a specific location or providing incentives for producing a certain class of goods and services. Existing research demonstrates that in the short run environmental regulations can lead to adverse effects on trade and productivity, albeit these effects remain small relative to general trends in production (Dechezleprêtre and Sato, 2020). However, others find that carbon-pricing regulation has no effects on employment, value added or imports of intermediate goods but does lead to reductions in emissions by stimulating targeted investments (Colmer et al, 2020). Further research on the effects of the EU Emissions Trading System (ETS) on firm location decisions shows that the policy did not result in additional significant costs, nor did it induce a fundamental shift in strategy (Martin et al, 2016).
- The fourth mechanism consists of changes in **resource redistribution**. The implementation of environmental policies affects macroeconomic conditions and aggregate income, which in turn have an impact on governments' budgets and fiscal policies. The commitment stipulated in the EGD to finance the newly created Social Climate Fund by using 25% of the expected revenues of emissions trading for building and road transport fuels is a good case in point. The goal of this and other funds is to support vulnerable households and microenterprises by supporting investments in energy efficiency, new heating and cooling systems, and cleaner mobility. Similar goals are targeted by the Just Transition Fund, which dedicates €7.5 billion to the economic revitalisation of regions particularly affected by the decline in coal mining and other resource extraction activities (e.g. peat, oil shale) and energy-intensive industries. The fund also grants social support for reskilling/upskilling and job transfers, and assistance for land restoration. A significant share of the Recovery and Resilience Facility is also dedicated to measures to address the unequal social and labour market impact of the twin transition. The EU Cohesion Fund also provides relevant support.

The main focus in the subsequent sections will be on mitigation and compensation policies.

Impacts on living conditions

When looking at the broader impact of climate policies on living conditions, the main issues considered relate to impacts on health and general well-being, incomes and poverty, housing, energy poverty and access to essential services. Furthermore, the implications of these impacts on (perceived) fairness and social cohesion also need to be considered, as clearly demonstrated by the rise of the

[17] See for example Climate-ADAPT (undated-b) for more details on relevant policy measures.

'yellow vest' movement in France. As indicated above, efforts are increasingly being made to address such distributional impacts through compensation policies.

Low-carbon energy policies mitigating the impact of climate change should have implications for health and well-being by reducing the likely consequences of climate change outlined above. The benefits to health and well-being arising in the shorter term due to reduced pollution and in the longer term as a result of forestalling the consequences of climate change and environmental degradation – for example, extreme weather events – are considered to lead to particularly health co-benefits to low-income households, which are more likely to be concentrated in highly polluted urban areas and poorer rural regions most affected by drought. In this context, it could, however, be worth exploring the noise impact of green activities, as for example the first discussions of the noise produced by wind turbines are emerging (Jianu et al, 2012), not at least in relation to establishing rules on the distance required between turbines and housing/working areas.

By acting on energy prices, the wide range of policies supporting the deployment of renewable energy, energy efficiency improvements and the promotion of low-carbon technologies as outlined above can have very different implications for different households depending on geographical location, age, income level and employment, among other things.

Box 8: Examples of distributional effects of energy, carbon taxes and subsidies

Although the distributional impact of low-carbon energy policies depends very much on their design, Table 4 summarises the most likely implications of different types of energy policies.

Table 4: Impacts of energy policies

Mostly progressive	Mostly regressive
Subsidies to households to improve energy efficiency (but depends on design of scheme and range of costs covered)	Taxes on heating fuels and electricity, because low-income households spend a larger share of income on energy and are less likely to live in energy-efficient dwellings
Public transport subsidies, as low-income households are less likely to have access to private means of transport	Subsidies for retrofitting or electric vehicles, as low-income households remain less likely to be able to afford them
Public transport subsidies, as low-income households are less likely to have access to private means of transport Subsidies for retrofitting or electric vehicles, as low-income households remain less likely to be able to afford them	

Source: *EEA and Eurofound (2021)*

Several of the EGD policy instruments have clear connections with the improvement of living conditions. At a general level, any policy aimed at containing or preventing pollution or exposure to thermal imbalances has obvious positive implications for health and well-being. This is the case, for example, with the Modernisation Fund to support investments in the energy efficiency of new buildings, or the Energy Performance of Buildings Directive for retrofitting old buildings to meet new efficiency standards. Other relevant instances are proposals to increase the stringency of fuel and noise emission regulations (e.g. the Effort Sharing Regulation and the Sustainable and Smart Mobility Strategy).

However, the direct or indirect benefits of subsidies may not be available to everyone. For instance, low-income households may be unable to invest in energy-efficient buildings or purchase energy-efficient technologies, and thus take advantage of the resources available through the instruments mentioned above (Eurofound, 2022a).

Box 9: Initiatives to address energy poverty

Most European countries have no official definition of the term 'energy poverty'. This condition is often described as the 'inability to keep homes adequately warm'.[18]

The EGD also includes provisions related to domestic energy use, which are relevant to energy poverty. The new policy framework seeks to extend prior actions such as the Clean Energy for All Europeans package (European Commission, 2019a), which was designed to promote a just energy transition, especially for vulnerable citizens.

Several pieces of legislation before the EGD were relevant to tackling energy poverty. For example, the Electricity Directive requires Member States that identify energy poverty as a salient social challenge to define criteria for the identification of energy-poor households, and to put in place appropriate measures to avoid disconnection. Likewise, the Energy Performance of Buildings Directive makes EU countries responsible for outlining national actions to alleviate

[18] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumer-rights/energy-poverty-eu_en

energy poverty and for prioritising the worst-performing buildings in their long-term renovation strategies. Furthermore, the Energy Efficiency Directive mandates Member States to implement a share of energy efficiency savings as a priority in energy-poor households and social housing. Lastly, the Regulation on the Governance of the Energy Union and Climate Action defines a governance process to monitor and report on energy poverty, and to set quantifiable national targets for its alleviation.

In this framework, Member States' national energy and climate plans are instrumental to monitor and report on energy poverty. Besides these actions, the European Commission also set up an Energy Poverty Observatory in December 2016 to facilitate Member States' actions addressing this issue. Last but not least, a recent report on country-specific experiences indicates that various Member States do not inform the target population effectively about the benefits available to them; that is a major barrier to the use of resources that can alleviate vulnerability (Eurofound, 2015, 2022a).

This speaks to the broader point of if and to what extent climate policies trigger distributional consequences, and how these can be best prevented or contained (Vona, 2022). Existing evidence shows that carbon and energy taxation in developed countries has a small and slightly regressive effect on households' spending (Dorband et al, 2019). This is because the share of energy costs has an inverted U-shape relative to income levels: it is small at low income levels and around the energy deprivation threshold (which is coherent with the notion of 'hidden energy poverty'; see for example Eurofound, 2022a), it increases for low to middle income levels, where energy becomes affordable, and it decreases again for high-income households, for which energy costs represent a small share of overall spending. A study on UK households finds that a tighter ETS regime led to systematic reduction in emissions and significant increases in energy costs, with stronger negative effects for lower-income families (Känzig, 2022). At the same time, the effects of regressiveness depend on the type of energy source. Existing studies conclude that electricity taxation in developed countries impinges more on low-income households because residential energy is a necessity (Hassett et al, 2009; Pizer and Sexton, 2020). In contrast, petrol taxes are progressive at the bottom, because poorer households use public transport, and regressive for high-income households that can afford new, energy-efficient vehicles (West and Williams, 2004; Sterner and Köhlin, 2012). These concerns add to shortcomings in the current policy framework, whereby access to essential services, including energy and transportation, is often insufficient and does not account properly for non-financial dimensions.[19] In relation to this, a recent report emphasises that there is much scope for improvement in the domains of poverty prevention and provision of advice and support to potentially vulnerable individuals (Eurofound, 2022a).

Another area of societal life that is affected by climate change and environmental degradation is the provision of public services, including education and healthcare (including public–private collaboration in these areas). The healthcare sector will probably need to be reviewed to establish if the current service provision is fit for purpose. This is not only limited to services to remedy the impact, but also refers to establishing and running early warning systems that monitor, for example, water quality, spread of infectious diseases and airborne mould (Orru et al, 2018). The education sector will also need to adapt, not only to provide the skills needed in the labour market in the transition to a climate-neutral economy (see 'Impacts on the economy and the labour market' below), but also to take into account the health impact of climate change and environmental degradation on learners (such as learning disabilities, severity of attention deficit hyperactivity disorder or physical health issues). Climate-friendly policies can also affect waste management, water supply and sanitation strategies, which, in turn, have an impact on the quality of life of the individuals (for example, related to costs, noise and smell) (AEA Technology, 2020; OECD, 2020). Furthermore, consumer protection probably needs to adapt to inform individuals about the characteristics of 'green' products and services, to help them make informed decisions in purchasing or renting.

Table 5: Main mechanisms affected and impacts of climate policies on living conditions

Mechanisms affected	Potential impacts	Groups potentially most affected
• Quality of the natural environment as a result of implementation of new technologies • Delivery of essential services including energy, health, water, waste treatment and transport • Delivery of education and training • Consumer protection	• Reduced purchasing power and wealth, increased poverty • Energy poverty • Rising inequalities • Increased social tensions	• Individuals in regions most affected by compositional effects of climate change policies • Low-skilled and other vulnerable groups

Source: *Authors*

[19] The right to access to essential services is outlined in principle 20 of the European Pillar of Social Rights, and is also relevant in the context of advancing digital transformation, the green transition and the objectives of social Europe. See European Commission (2020c).

3 Impacts on the economy and the labour market

The far-reaching goals of the EU's climate adaptation and mitigation policies as set out above will have profound impacts in the areas of work and employment in terms of the compositional effects and associated skills requirements, which will play out differently across sectors and on different timescales. They will also probably affect business models.

Aggregate assessments and the importance of timescale

In 2019, the Future of Manufacturing in Europe project published findings projecting that a successful transition towards a low-carbon economy, as defined by the Paris Climate Agreement, would result in a 1.1% growth in GDP and a 0.5% growth in employment in the EU by 2030 (Eurofound, 2019b). This was in comparison with a business-as-usual baseline forecast. The modest positive benefits for the EU of policies to meet the Paris Climate Agreement targets were attributable in large part to the energy efficiency investment required and the reduction in fossil fuel imports relative to GDP. Even if the overall impacts of meeting the climate challenge may be positive, the specific impacts are likely to differ substantially across economic activities, skill types and regions. In Q1 2022, the economic sectors responsible for most emissions of GHGs were households (24%), electricity and gas supply (21%) and manufacturing (20%), followed by agriculture (12%) and transportation and storage (10%) (Eurostat, 2022b).

Some jobs will be lost or require different skill sets as they are 'greened'. Others will be created. In particular, energy-intensive and high-carbon areas with limited economic diversification could be severely hit during the transition process. In some regions, this transition has already begun, with varying levels of transition support available for affected parties (workers, businesses, communities in which businesses or workers' residences are based, etc.). Therefore, the geographical dimension of the labour market changes brought about by the green transition is a fundamental aspect, as 'green' jobs will not necessarily be created in regions where 'brown' jobs will be lost. This may be particularly significant for communities where brown jobs are utilised as an income supplement (perhaps for multiple generations, indicating other attachments as well), with workers partaking in seasonal or part-time work alongside, for instance, agriculture. In these cases, having to relocate would mean sacrificing other income streams, as well as having detrimental impacts on community cohesion. Adjustments arising from decarbonisation are likely to affect workers along the wage distribution differently. While there is no consensus in the literature, several studies suggest that the transition will require a higher-skilled workforce, pointing towards increased inequality risks (Markkanen and Anger-Kraavi, 2019). At the same time, employment gains are expected in low-carbon construction projects and in the supply chains for renewables and energy-efficient equipment and installation processes, which would mostly benefit manual jobs in the middle and bottom parts of the wage distribution. Analysis by Eurofound (2018) also foresaw more growth in low-skilled employment compared with the baseline as an indirect effect linked to increased consumer spending.

An accelerated schedule for decarbonisation is foreseen in the Fit for 55 package agreed in 2021. This requires that an interim target for 2030 of a 55% reduction in GHG emissions compared with 1990 levels be met as a staging post to meet the goal of carbon neutrality by 2050 (the previous target for 2030 had been 40%). In the light of this accelerated schedule, but also taking into account the COVID-19 pandemic shock, new assessments of employment impacts will be needed.

The time perspective plays a significant role in the calculation of the net employment impact of a transition to a green economy. Fankhauser et al (2008) identify the following three types.

1. **Short-term** effects are the results of changes in demand for goods or services. Policies that aim to increase the price of emissions or of using resources will have an immediate negative impact on resource-intensive sectors. Indeed, according to the impact assessment of the EGD, the implementation of the nationally determined contributions under the Paris Agreement would generate a small negative effect on employment in the EU (-0.26% or 494,000 jobs in 2030). However, these losses can be offset by the use of carbon revenues to reduce labour taxation, which would result in a positive impact on aggregate employment of about 110,000 jobs (0.06%) in 2030. While aggregate employment effects are relatively small, green policies are likely to produce significant negative effects. This is especially the case for employment in the coal and other fossil fuel sectors (European Commission, 2020a).
2. **Medium-term** employment effects are ascribed to indirect adjustments, for example, driven by behavioural changes and the progressive emergence of new industries and markets. On the one hand, changes in energy prices and new fiscal rules due to restrictions regarding carbon dioxide emissions may hamper, at least temporarily, labour demand. Conversely, new opportunities to export environmentally friendly technologies, particularly when other countries adopt similar environmental regulations, are expected to yield positive employment effects.
3. Finally, **long-term** effects usually result from structural adaptations, such as organisational and technological innovations accompanied by intersectoral structural change. According to the impact assessment of the

Commission, almost all of the actions within the EGD will generate positive long-term employment effects, but if and to what extent these predictions materialise depends on country-specific transformations in complementary domains such as education, training, job mobility and industrial relations (OECD, 2017a; Cedefop and OECD, 2022).

Sectoral and domain-specific assessments

Sector-specific studies focusing on the employment effects of climate change policies note that, on aggregate, employment effects tend to be small because jobs move between sectors. However, at the level of sectors, climate change policies are predicted to have substantial effects. For example, Fragkos and Paroussos (2018) find that the low-carbon transition will lead to the net creation of about 200,000 jobs in energy sectors by 2050. This represents around 1% of the total EU workforce in 2050. Pollin et al (2009) find between 2.5 and 4 times as many jobs would be created by investing in energy efficiency in the EU as by investing in oil and gas. In a similar vein, according to E3Mlab (2016), achieving the ambitious EU climate targets up to 2030 and 2050 would lead to more than 0.6% job growth. Studies based on forecast models (GEM-E3 and E3ME) confirm critical shifts of jobs across sectors due to decarbonisation policies, with limited impacts on aggregate EU employment of between -0.2% and 1% depending on the model used and scenario assumptions (E3Mlab, 2016).

Also, looking specifically at energy generation and distribution, the World Employment Social Outlook (ILO, 2018) forecasts the creation of about 24 million jobs globally by 2030 through increased uptake of renewable energy and low-carbon vehicles, adoption of sustainable practices and increased efficiency in buildings. This will be offset by losses of up to 6 million in carbon- and resource-intensive industries by 2030, resulting in the global net creation of 18 million new jobs (0.3% more than in the business-as-usual scenario). Most of the existing evidence from the EU concurs that the impact of low-carbon transition mechanisms and decarbonisation policies on employment will be around -2.4% in the period to 2050 (ESDE, 2019). These losses will, however, be offset by emerging sectors based on low-carbon and energy-efficient technology, which are central to the EGD, especially the Renewable Energy Directive. Positive outcomes are also expected from the diffusion of green jobs in the manufacturing, installation and operation of clean energy technologies, and new jobs in the associated supply chains (see next section). The evidence indicates that jobs are projected to grow in various sectors, such as construction, low-carbon electricity and agriculture, with jobs in the European renewable energy sector increasing rapidly from 0.7 million in 2015 to 1.8 million in 2050 (Fragkos and Paroussos, 2018). New jobs are also expected to be created in sectors that are not directly linked to preserving environmental quality, including construction, engineering and the manufacturing of electrical equipment and efficient appliances. The long-term changes implied by decarbonisation may be greater than the models predict because carbon-neutral economies depend more on knowledge-based outputs and human capital and less on the use of material resources (OECD, 2014).

A study sponsored by the European Commission specifically on the job creation potential of climate change adaptation reveals that, in a reference scenario, around 500,000 additional jobs (approximately 0.2% of the working population) could be directly and indirectly created in the EU by 2050 thanks to the increased expenditures under the EU Adaptation Strategy, and some 136,000 jobs could be saved from the negative impacts of climate change as a result of these adaptation measures (Triple E Consulting, 2014). Should the amount of expenditure increase to 1% of GDP by 2050, around 1 million jobs could be directly and indirectly created and around 330,000 jobs saved in the EU by 2050 (Triple E Consulting, 2014). The sectors primarily affected by adaptation strategies are infrastructure (e.g. energy infrastructure), water (including flood prevention measures), agriculture (e.g. forestry, fisheries and husbandry), biodiversity conservation and health (Harsdorff et al, 2011; Triple E Consulting, 2014; ILO, 2015). Most of the adaptation projects are related to infrastructure, while most of the jobs created in both the reference and ambitious scenarios are in business, public services and the construction sector (Triple E Consulting, 2014). Finally, an assessment of potential impacts of the 2010 Energy Performance of Buildings Directive during 2011–2050 estimates that a fast pace of renovation could generate 0.5–1.1 million (gross) jobs annually (Buildings Performance Institute Europe, 2011).

Although the focus of the empirical literature is primarily on industry, transport and energy, a few scholars maintain that the types of policies implemented through the EGD can have a solid impact on job creation and quality in agricultural activities too (Pociovălișteanu et al, 2015; Viola et al, 2016). Organic farming is one of the fastest growing sectors in Europe, thanks to booming demand after 2010 and to the accompanying institutional support of the Common Agricultural Policy during 2014–2020 (European Commission, 2019b). Based on these premises, the EGD includes specific provisions to harmonise trade rules, which will simplify procedures (e.g. certification of origin) as well as ensuring consistency in compliance with new standards for the use of chemicals. According to a World Bank report (Sova et al, 2018), European legislation has created propitious conditions for smart growth in the agricultural sector by fostering education, knowledge, innovation and digitalisation. That said, the sustainable growth of agriculture depends on whether policy instruments keep up with the reality of the sector, primarily the ageing working population, which could be a bottleneck for technology adoption, labour market participation and skills upgrading (Schuh et al, 2019).

Summing up, the transition to a resilient and low-carbon EU economy will have substantial labour market impacts in sectors that are more likely to be affected by green policies on account of the intensity of resource use. These may be positive or negative, as they encompass new opportunities for workers in existing (e.g. construction or

agriculture) or new (e.g. manufacturing of clean energy technologies) sectors or risk displacing them in polluting sectors (ILO, 2018). As energy prices change, investments are redirected and the use of green technologies increases in the transition to carbon neutrality, workers in all occupations and sectors will be affected (ILO and OECD, 2012), and not only those working in sectors directly affected by decarbonisation.

Green jobs, greening jobs and green skills

Taking a broader perspective on the impact of climate policies therefore calls for careful assessment of complementary domains, especially labour market and social policies (ILO and IILS, 2011), as well as education and training policies, to ensure that the transition benefits both existing workers (by ensuring adequate working conditions) and displaced workers who transition to new jobs or undergo significant changes in their work tasks (Cedefop and ILO, 2010; Cedefop and OECD, 2021). Crucially, however, although negative labour market outcomes may be offset by instruments such as tax-recycling schemes (Yamazaki, 2017) or direct subsidies to the green economy (Popp et al, 2020), climate policies may still trigger significant distributional consequences across groups of workers that would ultimately undermine their political acceptability (Vona, 2019). The issue of possible winners or losers in the transition shifts the focus to qualitative changes in employment.

The key ingredient for the success of the EGD is the implementation of institutional mechanisms that facilitate the reallocation of displaced workers away from carbon-intensive activities. Regardless of whether these consist of within- or between-sector changes, the low-carbon economy calls for qualitative changes in the content of occupations across the board. This is because, besides the mere absorption of short-term employment shocks, investments in appropriate skills are strategic in view of the competitive advantage that mastering the design and operation of new technology can accrue in emerging markets, such as green batteries, solar panels or electric vehicles, to name a few (Vona et al, 2018; IMF, 2022).

Despite broad agreement on these principles, both the definition of green jobs and green skills and the empirical approach to operationalising these concepts remain contentious. The main difficulty lies in separating green jobs from other jobs. Often such a distinction relies on either an output perspective or a process perspective. From an output perspective, green jobs are those in companies and sectors that produce goods and services that are either environmental in the strictest sense or relatively environmentally friendly. For example, a study focusing specifically on green jobs, defined as employment in the EU environmental goods and services sector, finds that their share grew by around 37% between 2002 and 2011 (Pociovălișteanu et al, 2015).[20] In 2012, around 4.2 million people were employed full time in these sectors, with significant representation of jobs in natural resource management activities. A review on a panel of EU countries from 2005 to 2013 shows that the environmental goods and services sector had grown in almost all countries over that time, with an overall employment share of about 2%. A particularly rapidly growing activity is waste recycling, with an increase of 45% between 2000 and 2007 (Altenburg and Assmann, 2017).

From a process perspective, the definition of green jobs goes beyond this and covers employment that seeks to improve the environmental impact of companies that do not produce environmental goods in any sense (Jarvis et al, 2011).

The empirical identification of green employment is challenging for two reasons. First, it is not easy to define what a green job is, considering the broad spectrum of actions devoted to environmental sustainability, from reducing pollution and resource exploitation, for example, to preventing pollution by reducing the use of energy and materials. Second, and partly as result of the former, uncoordinated data collection on the part of national statistical offices has given rise to inconsistent empirical accounts. To illustrate, the OECD and Eurostat indicators focus on employment in 'environmental industries', which produce goods and services that reduce environmental risks, emissions and consumption of resources (Bowen, 2012). Critically, the number of green jobs is inferred indirectly from industry characteristics. The main criticism levelled at this approach is that, by focusing on a fairly aggregate level of analysis, it does not capture adequately the degree of engagement with sustainable work activities. This leads to inaccuracies such as the inclusion of false positives (i.e. labelling jobs as green just because they are in green sectors) or false negatives (i.e. missing green jobs because they operate in non-green sectors) (Consoli et al, 2016; Vona, 2021).

In contrast, the US Bureau of Labor Statistics employs a process perspective and distinguishes 'jobs in businesses that produce goods and provide services that benefit the environment or conserve natural resources' from 'jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources' (Bruvoll et al, 2012). Using data from the US Green Economy programme of the Occupational Information Network (O*NET), Vona et al (2019) propose an alternative accounting method based on the identification of groups of work tasks and on an occupation-specific index of 'greenness', which is based on the share of green tasks in each job. This differs from other approaches on two counts: first, the unit of analysis is tasks nested within occupations; second, prior methods are based on the premise of a dichotomy between green and non-green jobs, whereas greenness is a continuous measure, which implies that potentially all occupations

[20] Environmental goods and services are products manufactured or services rendered for the purposes of (i) preventing or minimising pollution, degradation or natural resource depletion; and (ii) related activities such as measurement and monitoring, research and development, education, training and communication about environmental protection or resource management. Given the broad scope, environmental goods and services are spread over various industries and sectors.

are becoming greener, albeit to differing extents. Such an exercise yields three categories of occupations ranked by greenness: (i) jobs that carry out primarily green tasks (e.g. environmental engineers, solar photovoltaic installers or biomass plant technicians); (ii) jobs in which green work tasks are part of a broader set of activities (e.g. electrical engineers, metal sheet workers or roofers); and, importantly, (iii) jobs that engage environmental tasks only occasionally (e.g. traditional engineering occupations, marketing managers and construction workers). Critically, the applicability of such an approach depends on the existence of detailed data on work tasks by occupation, which are unfortunately still not widely available for Europe.

Dierdorff et al (2009) use O*NET data to distinguish between four types of occupations as shown in Table 6.

Table 6: Classification of greening occupations

Label	Description
No-greening	Occupations with limited or no impact of greening
New and emergent	New and emerging occupations that do not exist in ISCO08 (the current international classification system for occupations) and are classified in one of the old codes despite having new characteristics and might require separate classification
Enhanced skills	Existing occupations that will potentially require changes in tasks, skills and knowledge as a result of the transition to a carbon-neutral economy, although the essential purpose of the occupation remains unchanged
Increased demand	Existing occupations that will not require changes in the tasks, skills and knowledge but will potentially see increased demand due to the transition to a carbon-neutral economy

According to 2021 data from the European Working Conditions Telephone Survey (EWCTS), nearly 65% of workers in the EU27 were employed in occupations that will experience only a small impact or none at all from the green transition. Close to 10% of workers are in new and emergent occupations, while close to 15% are either in sectors requiring enhanced skills or likely to witness growing demand (Eurofound, 2022c). As indicated above, given the nature of the sectors, occupations and tasks affected (in agriculture, mining and quarrying, construction, and transportation and storage), the affected workforce is predominantly male.

By moving away from the traditional dichotomy of green economy versus the rest, this approach implies that the green transition is not the exclusive remit of renowned flagship activities (e.g. wind energy generation) but is rather a widespread transformation. The key policy implication is therefore no longer to increase the supply of high-skilled workers but, rather, to precisely identify which types of qualifications and educational and training programmes, including on-the-job training, are best suited to provide the skills specifically required in expanding green activities (Vona and Consoli, 2015). Green technologies are no exception to this pattern: identifying the skills specific to the various green technologies is of the utmost importance to design the appropriate educational responses and integrate green policies with existing educational and training policies (Cedefop, 2019).

Despite growing debate, the lack of skilled labour is still a significant barrier to the low-carbon transition (ILO, 2016; OECD, 2017a; Relly et al, 2022).[21] New work requirements in the green economy are driven by four mutually reinforcing factors: environmental change; environmental policy; new green technologies; and innovations, including changing cultural values, related lifestyles and consumer behaviour. In industrialised countries, this change is strongly promoted by technology and consumer demand. In developing countries, however, the future demand for green skills is dominated by adaptation to changing environmental conditions and the requirements of a stable energy supply (ILO, 2010; ILO and Cedefop, 2011).

Related to the latter, the only large-scale study of EU countries available so far reveals that climate policies induce a skills bias that favours technical and, to a lesser extent, professional workers to the detriment of manual workers (Marin and Vona, 2021). Evidence of stronger demand for technical and scientific occupations – e.g. science technicians, process control technicians or regulatory associate professionals – indicates that climate policies have distributional consequences beyond the arguably narrow focus of the current debate on the net employment effect. Rather, this speaks to broader issues about a just transition in the workforce (Rosemberg, 2010) and reasserts the need for an integrated view of environmental, innovation and educational policies based on tighter coordination between the political actors, social partners and regulatory institutions (Cedefop and OECD, 2021).

Changes in business models: The circular economy

The developments outlined above, and particularly changes in consumer behaviour, also have an impact on business models, processes of production and service provision as well as the structure and characteristics of the supply chain (Table 7). The most prominently discussed concept is the circular economy, which shifts the more traditional production–consumption–waste approach towards models based on maintenance, sharing, reusing, repairing and recycling, thus contributing to extending the life cycles of products and reducing waste

[21] See also recent industry reports by LinkedIn Economic Graph (2022) and Green Alliance (Alvis et al, 2022).

and carbon emissions resulting from production. As a result the security of the supply of raw materials can also be enhanced. It has also been argued that the circular economy can boost economic growth and contribute to the creation of around 700,000 jobs in the EU alone by 2030 (European Parliament, 2020c). To support the development of the circular economy, the European Commission adopted a Circular Economy Action Plan in 2020, which was followed by a first package of measures to speed up the transition to a circular economy in March 2022. The proposals include measures to boost sustainable products and empower consumers, including by providing clearer information, reviewing construction product regulation and creating a strategy on sustainable textiles (European Commission, 2022b).

In addition, the emergence of green entrepreneurship is an example of the impact of climate change on the economy. Alongside new developments in the start-up scene, the potential for far-reaching business restructuring, including 'green innovation' or the introduction/enhancement of digitalisation and (advanced) technologies, needs to be highlighted in this context (Frishammar and Parida, 2019).

Table 7: Main mechanisms affected and impacts of climate policies on the economy and labour markets

Mechanisms affected	Potential impacts	Groups potentially most affected
• Scale of economic activity and jobs in certain sectors and regions (direct and indirect sector effects) • Adaptation of characteristics of economic activity in certain sectors and regions • Structure of regional economic systems • Job creation and destruction • Change of task profiles within jobs	• Transitions into, out of and within the labour market • Unemployment, employment and inactivity • Labour shortages and surpluses • Employment quality • Business models and processes • Supply chain composition and working methods • Sustainability and competitiveness • Company restructuring • Company obligations relating to administrative processes • Labour market polarisation, segmentation and inequalities	• Sectors such as agriculture, forestry, fishery, tourism, transport, construction, energy, mining and some manufacturing sectors • Regions dominated by the most affected sectors • Vulnerable groups in the labour market, such as low-qualified workers

Source: *Authors*

4 Impacts on working conditions and job quality

Policies on climate change can have far-reaching consequences for working conditions and job quality, not only because of their implications for sectoral, occupation and task shifts on the above-mentioned job quality indicators, but also because of the adjustment of existing business models and the emergence of new ones, the potential for new managerial approaches, and changes in commuting behaviour and associated implications for other factors, such as work–life balance. These implications are likely to impinge unequally on workers in different sectors and occupations, on different types of contract and with different characteristics (e.g. age, gender, ethnic background, skills level).

While mitigation policies are likely to affect job prospects, job security, earnings and training requirements as a result of the required job shifts in the sectors most affected by these approaches, adaptation policies – on the face of it – are more likely to engender labour demand, new and additional training requirements and changes in business models. However, these impacts will depend on the mix of policies and the precise nature of each policy, the sectors/occupations/tasks affected in terms of decline, growth or task change, and the availability, quality and effectiveness of any associated compensation measures. For example, emission-limiting mitigation policies that contribute to the phasing out of coal- or peat-fired power will have implications for different occupations and sectors from emission-trading schemes or the Renewables Directive, and each will lead to different shifts in employment and in occupational and sector profiles, with related implications for working conditions and job quality. Similarly, in terms of adaptation policies, large-scale infrastructure investments to prevent flooding will have different sectoral and occupational impacts from measures to nudge consumer behaviour, including support for the circular economy. These implications need to be assessed in detail to grasp their impacts on working conditions.

Indirect indications can be extrapolated from global analyses. They show that sectors where job opportunities are expected to emerge in the transition to low-carbon economies remain highly male-dominated sectors and some aspects of working conditions are still of (relatively) poor quality (ILO and Eurofound, 2019).

Comprehensive analyses of different aspects of job quality in relevant subsectors are lacking, with only broad sectoral-level analyses (e.g. agriculture, industry, construction, commerce and hospitality, transport, financial services, public administration, education, health and other services) available based on Eurofound's 2015 European Working Conditions Survey (EWCS) (Eurofound, 2020). Given the factors outlined above, any assessment of the impacts of different climate change policies on working conditions and job quality therefore needs to be highly granular and take into account the impact of available compensation measures. Such measures aim to address the distributional consequences of climate change policies and, on the whole, are in principle directed towards limiting negative employment impacts and seeking to generate high-quality new job opportunities. However, detailed implications of such polices have to be understood on a case-by-case basis in the context of the national and regional policy mix in order to assess their implications not only for employment but for working conditions and job quality.

In the following, the available evidence and the potential impacts of climate change policies on various aspects of working conditions and job quality are discussed.

Physical environment

The sectors that are most likely to face decline or significant change particularly as a result of climate mitigation policies include mining, petrochemicals, energy-intensive industries and intensive agriculture. On the face of it, many of them are characterised by challenging physical working conditions because they are physically demanding and subject to exposure to hazardous substances or to hot or ergonomically difficult working environments. Reducing such tasks could be beneficial, depending on the nature of new employment opportunities. In this regard, studies of the impacts of sectoral shifts towards decarbonisation emphasise the new and emerging risks associated with new technologies, which need to be fully understood to assess the risks. These can be linked to specific chemical, biological, ambient and ergonomic hazards. Such new hazards, in turn, require new combinations of skills (Schulte et al, 2016). For instance, installing solar water heaters involves combining the skills of a roofer, a plumber and an electrician. The shift to renewable energy may minimise health hazards associated with coal mining but may generate new ones that affect the physical working environment. Examples are workers producing solar photovoltaic panels who are exposed to toxic substances and electrical hazards (UNEP et al, 2008; Poschen and Renner, 2015) and workers in factories that produce thin-film and emerging nanotechnology-based solar technologies, which imply new chemical and bio-hazards (Silicon Valley Toxics Coalition, 2009, 2014; EU-OSHA, 2011). Furthermore, solar panel installers or wind turbine maintenance workers may suffer from an increase in work intensity in addition to heat stress or danger of falling (EU-OSHA, 2014), just as handlers of recycled material or waste material may be harmed by toxic substances (EU-OSHA, 2021, undated). The same could be true of workers cleaning and revitalising areas previously used for mining or other declining industries, which could suffer from significant contamination issues. Such risks are greater if insufficient training about them is provided, especially

for less highly skilled workers, who are less likely to have access to training.

This needs to be viewed against the benefits to working conditions from a reduction in hazardous mining activities, or the indirect benefits from the enhanced thermal performance of buildings (Bueno et al, 2021).

It is worth noting that changes in physical hazards tend to be concentrated in sectors and occupations dominated by largely male workforces. Those sectors are often in decline.

The impact of adaptation measures on physical hazards is more diffuse and less studied. Among the implications could be an increase in public infrastructure projects boosting the construction sector (the same is true of mitigation measures aimed at enhancing the energy efficiency of buildings). EWCS data from 2015 show that this sector tends to be characterised by a relatively poor physical working environment and could be faced with new hazards requiring risk assessment and training as outlined above. Measures nudging consumers towards more sustainable behaviours can affect a variety of sectors, some of which can also feature more challenging physical working conditions, e.g. the textiles and agriculture sectors. Having said that, the shift to organic farming and green textiles is more likely to be associated with reduced exposure to hazardous chemicals, and to some extent is less likely to involve mass production, which can bring its own ergonomic and other hazards.

Another consideration with a bearing on the scale of physical hazards (but also other elements of job quality) is the size of the establishments affected. Evidence from EU-OSHA's European Survey of Enterprises on New and Emerging Risks shows that larger companies tend to have more capacity to conduct risk assessments, implement preventative and remedial measures, and provide access to occupational physicians. Small and medium-sized enterprises, on the other hand, can lack the resources and staff for such investments (EU-OSHA, 2016). Any shift in the balance of company size and structure could therefore have a particular impact on physical (and psychological) workplace hazards. The extent to which such impacts are mitigated by increasing management-level awareness and efforts to establish good-quality working environments among organisations with higher levels of ethical and environmental awareness (due either to their circular economy business model or to the greater overall awareness resulting from new sustainability reporting requirements) remains to be assessed.

Using the categorisation of new and emergent, enhanced skills, increased demand and no-greening, analysis of EWCTS 2021 data indicates that, while new and emergent jobs and those with enhanced skills are likely to perform better in terms of physical risks, jobs with increased demand (and to some extent those on which greening has little or no impact) tend to fare worse in relation to these indicators (Eurofound, 2022c).

Social environment

Indicators informing the quality of the social work environment include the quality of management and social support from managers and colleagues as well as the level of exposure to adverse social behaviour. Overall, agriculture, construction and industry (which includes the extractive industries) tend to score higher in relation to the quality of the social environment than sectors such as transport and health, not least because the latter tend to be more public facing, carrying the risk of exposure to harassment, intimidation or third-party violence (Eurofound, 2020). Therefore, any sectoral shifts in employment could affect the performance of this indicator. It remains unclear if shifts towards greening in these sectors will have a significant impact on the experience of the social environment in the workplace. An interesting case study might be the construction sector, where the shift towards more prefabricated elements built off site could have implications for the social environment (as well as aspects of the physical environment).

Eurofound's analysis of EWCTS 2021 data again points to new and emergent occupations performing better on some of the key indicators for this aspect of job quality.

Work intensity and working time quality

Pace determinants, interdependency and quantitative demands tend to be particularly high in sectors such as industry and construction, and lower in sectors such as education and public administration. The implications of a qualitative shift towards greening in these sectors could to some extent be dependent on the scale of operations and therefore on the level of task interdependency and the use of automation and digitalisation, which influence pace determinants.

Poor working time quality, in terms of duration, atypical working time, unsocial working time arrangements and a lack of flexibility, tends to be more of a feature of employment in agriculture, commerce, hospitality and transport. Any employment shifts away from these sectors (as has happened in agriculture in the EU over recent decades) could therefore improve this indicator. The rise in organic farming could have implications for working hours if the scale of intensive farming or the use of pesticides and fertilisers is reduced or eliminated. A number of farms have diversified, including into the tourism and hospitality sector, which can again have a bearing on working hours. The working time implications of a shift towards more sustainable tourism and eco-tourism remain unexplored.

As previously indicated, greater demands on healthcare and emergency service workers resulting from the impact of climate change (if not met by policies adjusting resources in this area) will probably have a negative impact on working time quality.

Similarly, labour and skill shortages in the short and medium terms could affect working time quality in green and greening sectors and occupations. Ongoing research by Eurofound (2023) points to the existence of such shortages, for example, in relation to renewable energy and building practices, but also with regard to new tasks such as those linked to new environmental reporting requirements. In the short to medium term, this could

not only hamper progress towards environmental goals but also increase workloads for individuals active in these sectors, occupations and tasks who are faced with high levels of demand.

Working time quality is also the result of how people organise themselves in population agglomerates (urban and rural). If climate policies lead to a rethinking of how societies organise their time, this will have an impact on working time quality. Such discussions are, for instance, reflected in debates around the four-day working work and the redistribution of labour.

Skills and discretion

This aspect of job quality, which encompasses among other things decision latitude, organisational participation and training, tends to be lowest among workers in the agriculture and transport sectors, followed by commerce, hospitality and industry. Among the reasons for this is the relatively limited access to training for low-skilled workers, who make up a significant part of the workforce in these sectors. Therefore, any quantitative employment shifts away from these sectors are likely to have a positive effect on job quality, particularly if newly created jobs are more likely to be found in the service sectors and higher-skilled occupations. This also depends to some extent on the contractual nature of newly created job opportunities, as past experience has shown that workers on temporary and part-time contracts are less likely to have access to employer-funded training (Eurofound, 2021a). Workload and working time pressures associated with labour and skill shortages could affect the possibility of delivering and accessing training in the short term in sectors and occupations where this is an issue, with potential implications for health and safety (as discussed in the section above) and prospects (see next section).

As mentioned in 'Impacts on the economy and the labour market' above, while jobs in developing and growing green sectors and tasks are generally considered to be higher skilled, this is by no means the case for all job opportunities. It has also been argued that, although job demand may be high in the short to medium term, some renewable technologies (e.g. electric vehicles) are associated with less ongoing maintenance, which might restrict job demand in some occupations in the medium to long term, with an associated impact on prospects and earnings (Eurofound, 2021b).

Training and task autonomy are also assessed to be greater among new and emergent jobs (Eurofound, 2022c). The same is true of prospects, which are also greater for workers in occupations requiring enhanced skills.

Prospects and earnings

Based on an analysis of 2015 EWCS data, job security, career prospects and the quality of employment status were lowest in agriculture (owing to the high level of seasonal work and self-employment), followed by construction, commerce and hospitality. The latter group of sectors also feature a high number of low-skilled workers on temporary or part-time contracts, with construction employment in particular being highly sensitive to economic cycles. Earnings in these sectors tend to be in the medium range. The projected high demand for construction labour resulting from investments in large-scale infrastructure adaptation projects and the conversion of domestic dwellings to be energy efficient could improve prospects in terms of job security and offer opportunities for upskilling and reskilling.

Prospects for workers in sectors likely to decline will of course be significantly affected. Such workers will be most reliant on EU and national measures aimed at retraining and successful transitions into new employment. Past experience has shown that such transitions can be challenging, particularly in regions where a large share of the working population was previously reliant on sectors in decline. The EU's Just Transition Fund was devised with a particular focus on this type of region. In this context, it must clearly be assessed what types of prospects and earnings newly created occupations offer.

In conclusion, this section has demonstrated that there is still significant potential to improve the evidence base on the impact of climate change policies on working conditions.

Table 8: Main mechanisms affected and impacts of climate change and environmental degradation on working conditions

Mechanisms affected	Potential impacts	Groups potentially most affected
• Sectoral shifts in employment affecting job quality indicators • Emergence of new sectors, occupations and tasks with different working conditions/job quality profiles • Emergence of new business models • Increasing awareness of sustainability challenges and new reporting requirements	• Job security, prospects and earnings • Physical and social environment • Work intensity and working time quality • Accessibility of training and skills use • Social protection	• Workers in sectors (such as agriculture, forestry, fishery, tourism, transport, construction, energy, mining and some manufacturing sectors) and regions most affected • Those in occupations dealing with the environmental and societal effects of climate change and environmental degradation (health, emergency services, immigration services, etc.) • Those in occupations experiencing increasing demand

Source: *Authors*

5 Impacts on policymaking

A new approach for more holistic and multiagency policymaking

Climate change and environmental degradation increase the need for coordination between a wide range of (policy) areas and a comprehensive policy approach that aligns them rather than isolated action. Accordingly, multistakeholder approaches to the design and implementation of climate policies and their operational initiatives are emerging. Further efforts in this area are required. These include all-encompassing approaches within a type of actor (for example, whole of government, multiministry) (Channel News Asia, 2021; White House, 2021), but also span different types of actors (such as joint identification of potential solutions by governments, social partners and civil society) and administrative levels (national, regional, local). One of the reasons for such an inclusive policy process is the recognised need for buy-in from all stakeholders, including citizens, to ensure the success and effectiveness of any policy or operational instrument. In this context, the concept of 'deliberative democracy' is referred to (Wilson, 2011). That aims to provide long-term solutions in instances that affect large and diverse populations, for example, through including citizens' assemblies in the decision-making process.

Developing successful multiagency approaches is also all the more important given the above-mentioned unequal impacts of climate change and climate change policies on different geographical regions, sectors, labour market groups and individual profiles, and given that those who are already disadvantaged are more likely to be negatively affected. In a situation where surveys and protest actions demonstrate increasing fault lines within society and reduced trust in government (Eurofound, 2022b), the urgency of coordinated policy approaches striving for fairness in the (twin) transition process is all the more evident.

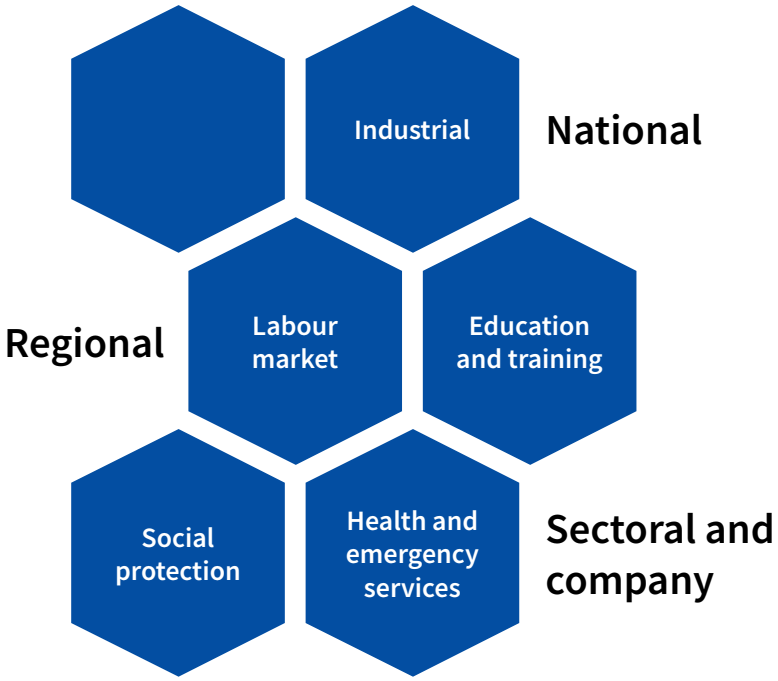
This affects the processes of policymaking and implementation, such as which actors are involved in the different stages (including less traditional ones such as environmental non-governmental organisations, non-profit organisations, citizens' assemblies, etc.) (Pandey, 2015), mechanisms for coordination and communication among them, or monitoring and evaluation practices. At micro level, this is likely to influence the capacity needs in the institutions, in terms of the number of staff devoted to these activities, but also their skills and competences in the subject matter (the complexity of climate change impact) (ILO, 2018; IndustriAll, 2020) and the process (understanding the different stakeholder perspectives and mechanisms). These institutions are not only those involved in policymaking but also those contributing to the implementation of policies. An example of this is labour inspectorates; they need to be equipped for the changes in the labour market driven by climate change, such as health and safety issues related to 'green jobs', first responders to natural catastrophes or the above-mentioned workplace aspects such as rising temperatures or biohazards, which are likely to have the greatest impact on vulnerable groups such as migrants (Nordic Future of Work Group, 2020).

Similarly, the policy toolbox employed is also affected. Impacts are, for example, already materialising in the form of initiatives to establish and strengthen social ties among the multitude of different policymakers in the process but also within communities. This is deemed to be an important pre-condition for effective sustainability policies (Markantonia et al, 2018). It is becoming increasingly important to consider in advance the influence of individual policies and instruments on other areas than those directly targeted, such as exploring if mitigation policies aiming to reduce emission sources create social inequalities (Laurent, 2021) or what effect innovation related to decarbonisation has on workplaces (Medium, 2020). This is best achieved by enhancing the active role of policy actors working together; for example, including climate or environmental criteria in public procurement (White House, 2021) or 'green collective bargaining' (EPSU, 2017). At the more detailed level of considering the choice of policy tools, ex ante assessments of the progressive or regressive nature of different climate mitigation and adaptation instruments need to be considered in order to optimise outcomes and protect the most vulnerable in society (EEA and Eurofound, 2021b). It is also worth bearing in mind the tension that often exists between competition/state aid rules and environmental protection policy.

Policy areas to adjust for the impact of climate change policies

Climate change itself arguably has an impact on most areas of policymaking. However, this section focuses specifically on the impact of climate mitigation and to a certain extent adaptation policies and the compensation measures required to contribute to a 'just' or 'socially equitable' transition (see Figure 2). Such policies cover industry, the labour market, education and training, social protection, and health/care and emergency services, all of which need to be considered in tandem.

Figure 2: Policy areas and levels critical to compensation policies



Source: *Authors*

Industrial policy and regional planning

Holistic planning of industrial policy at both national and regional levels will be required to support the shift from carbon-intensive to low-carbon and renewable sectors. This is of the greatest significance for the regions most affected by the move to renewables, away from carbon-intensive production, and those where an adjustment to different types of production is needed within the same sector. Such strategies should encompass not only the main large producers but also the whole associated supply chain, and ideally be coordinated between regions.

Labour market policy

Research shows that labour market policy is most likely to achieve positive labour market outcomes for workers affected by shifts between and within sectors if it anticipates change and restructuring and aims for job-to-job transition (keeping periods of unemployment as short as possible). This should be combined with early and ongoing anticipation of skills needs, informed by institutionalised consultations with social partners and other local economic stakeholders (e.g. chambers of commerce). Eurofound research shows that more remains to be done to anticipate greening skills needs and deliver appropriate training at all levels of education, including vocational training and lifelong learning (see next section and Eurofound, 2023). If social partners are involved in the design of active labour market policies, combining recognition of existing competences with delivering upskilling and reskilling that include elements of work experience, they can contribute to the rapid and effective transition of workers from declining sectors to those experiencing growth.

Education and training policy

The education system will need to be reviewed and, if applicable, adapted to provide 'green curricula' (Hopkins, 2018) to equip the (future) workforce with the required skills, but also more generally to create awareness among citizens so that they will reduce environmental degradation and resource depletion (Chakraborty et al, 2018). As mentioned in the previous section, the same is true of the vocational training system, with lifelong learning becoming ever more important in the context of the twin transition.

Social protection

Social protection systems are important to highlight in this context. Notably, they need to be adapted to cover the needs of people affected by natural disasters or climate-related events (for example, impacts on their health, income loss, loss of housing) (Davies et al, 2008; ILO, 2018; United Nations University, 2020). A challenge will be the accommodation of both short-term and long-term protection in such systems, as some forms of short-term interventions hinder long-term household adaptation to climate change; for example, they may fail to drive the diversification of livelihoods in manners that are not/less dependent on natural resources (Tenzing, 2019). In some countries, 'universal basic service' models are being implemented or considered to mitigate inequalities or address cost of living issues (e.g. free or reduced-price public transport).

Health and emergency services

Health and emergency services need to be reviewed to take account of increased and changing demand resulting from the direct and immediate health impacts of climate

change and the potential implications for the health service infrastructure. Over the medium term, services delivered and delivery mechanisms will need to adjust to the impact of climate change and climate change policies.

Key role of the social partners

Social partners have a critical role to play in developing and implementing responses to the implications of climate change and climate change policies, including in the context of the other megatrends outlined in the introduction. This is recognised by the European-level cross-industry social partners in their 2022–2024 joint work programme adopted in June 2022:

> *Green transition, decarbonisation and circular economy along with digitalisation contributes to changing jobs, tasks, and to creating new occupations while others disappear. These transitions are interlinked and mutually reinforcing. … greening of the economy requires more advanced technologies and digital solutions to accompany structural changes. … Social partners should play an active role to ensure that a just transition, underpinned by appropriate public funding and investments, creates quality jobs and supports enterprises and workers adapting to change, including new skills needs, upskilling, redesign of jobs, organising job-to-job transitions and work organisation improvements.*
>
> (BusinessEurope et al, 2022, p. 5)

Encompassed in these goals for priority action is recognition of the dual role of social partners in, on the one hand, contributing to and helping to shape policy action and funding measures, while on the other hand contributing to just transition at workplace level through collective bargaining and negotiations at European, national, regional, sectoral and company levels. Social partners can influence the determination of EU policy priorities through the role accorded to them by Articles 152, 154 and 155 of the Treaty on European Union, utilising a variety of policy instruments ranging from framework agreements, leading to the adoption of EU legislation, through to joint recommendations, guidelines and other types of policy texts, which are subsequently implemented at national level. Similarly, they should be involved in the national-level implementation of EU policy priorities in the national policy dialogue through the European Semester process (including implementation of the priorities of the European Pillar of Social Rights and implementation of the SDGs).

Across policy priorities, but particularly in the field of employment and social protection policy, the European Commission strongly emphasises the role of social partner organisations. A review of case studies on governance structures for the green transition concludes that wide participation of different stakeholders is a critical pre-condition for achieving environmental innovation (Carrillo-Hermosilla et al, 2010). In a similar vein, Lannelongue and González-Benito (2012) find that greater involvement of stakeholders – including shareholders, employees and community organisations – increases the likelihood of implementation of environmental management systems. More recently, Antonioli and Mazzanti (2017) find that Italian firms with union representatives are more likely to adopt low-carbon technologies and other complex innovations. A qualitative study by the ILO (2010) assesses the experience of the social dialogue round tables initiative in Spain, a mechanism of participation aimed at monitoring both compliance with the Kyoto Protocol and the effect on employment, competitiveness and social cohesion. The main conclusion is that tripartite social dialogue has proved a valid instrument for analysing the effects on competitiveness, employment and social cohesion of policies related to climate change. In particular, the government declared that emissions in most of the sectors under analysis stayed within the ETS emission allowance, unions reported improvements in employment stability and business firms agreed that round tables were important to prepare for possible market distortions. However, the evidence on this remains scattered and incomplete.

When assessing the role of social partners in this context, however, it is important to be aware of the varying roles and capacities of social partner organisations at national level, resulting from the evolution of different industrial relations systems. Research on industrial relations in Europe has proposed different classifications of systems for different country clusters. A recent classification of different industrial democracy clusters is proposed by Eurofound (2018). Clusters are based on a number of indicators, including those related to social dialogue and participation rights at company level.

Table 9: Industrial democracy clusters in the EU27

Cluster	Countries
1: Corporatist-framed governance	Austria, Belgium, Luxembourg, Netherlands
2: Voluntary associational governance	Denmark, Finland, Germany, Sweden
3: State-framed governance	France, Italy, Portugal, Slovenia, Spain (and Greece from 2008 to 2012)
4: Statutory company-based governance	Croatia, Hungary, Slovakia
5: Voluntary company-based governance	Bulgaria, Cyprus, Czechia, Ireland, Latvia, Lithuania, Malta, Romania (and Greece since 2013)
6: Market-oriented governance	Estonia, Poland

Source: *Eurofound (2018)*

Although there are clearly differences between clusters (and sectors within these clusters), the type of industrial relations system affects the nature, frequency and quality of involvement of social partner organisations in policymaking, as well as the role played by collective bargaining at different levels (coverage, applicability, etc.). Both have an impact on the potential influence of social partner organisations, including their involvement in climate change policies and collective bargaining to address such issues and the impact of climate change policies at various levels. Involvement in government policymaking tends to be most institutionalised and significant in clusters 1, 2 and 3. In these clusters, sectoral collective bargaining also tends to exert the greatest influence, while company-level negotiations predominate particularly in clusters 5 and 6. In countries where social partners currently play a more limited role, governments and other agencies can support the good functioning of social dialogue institutions by promoting agreed solutions in climate policies, providing capacity building, developing knowledge platforms at industry level and jointly monitoring that efficiency gains are distributed in a just manner.

As mentioned above, of particular importance in the context of the impact of climate change and climate change policy is the role of social partners in designing and implementing the content and delivery of active labour market policy and training, as well as social policies. At company (or in some cases sectoral) level, social partners also play a critical role in negotiating working conditions and implementing restructuring, including compensating affected workers and supporting job-to-job transitions (EEA and Eurofound, 2021b).

In relation to all of the above, the role of social partners is clearly not limited to the impact of climate change and climate change policy, but their involvement in and experience of dealing with other change processes are vital in shaping their increasing involvement with climate-related challenges.

At a very operational level, climate change and environmental degradation are already observed to have an impact on instruments such as the reporting obligations of companies or support instruments such as financial tools. For example, environmental, social and governance reporting means the disclosure of data on a company's impact on environmental, social and corporate governance issues, aiming to foster good practices to attract investors (Sphera, 2021); and the European Investment Bank has made a commitment to no longer finance fossil fuel energy projects but instead to support renewable energy, energy efficiency, alternative fuels, etc. (EIB, 2021).

At EU level, over the last 30 years, close to 40 joint opinions and other declarations and documents focusing on green/sustainability issues have been issued by European sectoral and cross-sectoral social partner organisations. Many of them are in response to European or international legislation, targets and standard setting, and focus on the employment and social impacts of such policies. A quarter of these joint documents have been issued since 2020 alone, highlighting the increasing importance accorded to the issue by social partners at European level, as well as the acceleration of policy actions in the sphere. Not surprisingly, many of these texts emanate from the energy and extractive industries and tackle the impact of climate change policy targets on businesses and employment.

As mentioned earlier in this section, at national level, social partners should be involved in planning the implementation and monitoring of the UN's SDGs and in making post-COVID-19 recovery plans through the European Semester process. However, the nature and quality of this involvement vary significantly from country to country, often in line with the country's experience of social partner involvement in broader policymaking processes (Eurofound, 2021c). In regions and sectors that are particularly affected, there are examples of social partners playing a role in shaping restructuring processes, but this involvement is insufficiently structural in nature. Further capacity building to deal with green transition processes is needed in countries with more limited traditions of social dialogue and collective bargaining.

Although social partners have been proactive on various issues, and preliminary agreements in different sectors have been discussed, a recent report by Eurofound (2021b) concludes that the wealth of case studies and evidence available on social dialogue supporting the green transition in terms of practical examples is still 'scarce' (p. 36). Where these exist, they are primarily in the energy sector. Such agreements seek to address the implications that changes in the energy mix have for workers.

Table 10: Main mechanisms affected and impacts of climate change and environmental degradation and climate change policy on institutions

Mechanisms affected	Potential impacts	Groups potentially most affected
• Involvement of social partners in macropolicies to address climate change • Negotiation of pay and working conditions at company level • Restructuring processes • Multistakeholder approach to policy design and implementation • Adaptation of policy toolbox	• Policy processes (coordination, communication, monitoring and evaluation) • Institutional capacities (staff endowment and skills) • Mutual impact of policies in different areas • Industrial policy • Active labour market policy • Social protection schemes • Education and training systems • Implementing restructuring to ensure rapid job-to-job transition • Environmental reporting obligations and finance	• Governments; regional governments of geographical locations most affected • Social partners • Environmental non-governmental organisations • Implementing authorities (such as labour inspectorates)

Source: *Authors*

6 Future perspectives for research and analysis

The scientific community is in agreement that the impact of climate change and environmental degradation is substantial and wide ranging. However, people may not yet be fully aware of how complex the impacts of climate change and of climate change policy are on the aspects at the core of Eurofound's research, or of the interrelationships between them. This paper has contributed to raising awareness by introducing a conceptual framework to assess the impacts of climate change and climate change policies on living conditions, the economy and labour market, working conditions, policymaking and industrial relations, and by outlining the main mechanisms through which impacts arise and the groups most likely to be affected. It provides examples of these mechanisms, impacts and groups without claiming comprehensiveness, since these need to be assessed in more detail in relation to specific climate events or policies.

Despite the complexity of climate impacts, an array of common dimensions emerges and are important for guiding policy analysis and discussion on climate change and climate change policies:

- the importance of differentiating between sectors and occupations and the impact on different jobs and tasks within jobs
- the importance of differentiating between countries and regions (in combination with sectors)
- the potential of climate change and environmental degradation to aggravate inequalities among different groups of citizens, groups in the labour market, companies, regions and countries – partly as a result of the differences in impacts of climate change and climate change policies by sector, occupation and region

From a policy perspective, it is critical to understand these different distributional, compositional and geographical effects and the impact on procedural justice in order to design both mitigation and adaptation policies, and also to devise effective compensation policies where unequal distribution consequences cannot be avoided in efforts to achieve climate goals.

This paper highlights a wide range of areas where the differential and distributional impacts of climate change, climate change policies and compensation policies remain poorly understood. Thus it provides guidance for potential future Eurofound research. Guidelines include the following.

- To add to the various quantitative estimates and forecasts of the net balance between job creation and job loss against the background of climate targets, further research is needed on what the compositional impacts of climate change and climate change policies will mean for **job quality and working conditions**. This includes research on the likely impact on the balance between employment and self-employment, different contractual arrangements, transitions into and out of unemployment, full- and part-time work, the identification of new physical hazards, and implications for working time, work intensity, job security and other job quality indicators. Furthermore, impacts on different groups of workers (by gender, age and qualification level) need to be better understood. A particular focus is needed on the impact of mitigation policies, which will have ripple effects across many occupations across almost all sectors but remain poorly understood.
- Further research is also needed on the impact of climate change on working conditions and job quality.
- The implications of **compensation policies** for job quality, working conditions and employment need to be better understood.
- Evidence is also needed on the **effects of climate change policies on labour markets**. This includes better evidence on the interaction between labour market institutions and climate change policies, the impact of climate change policies on mobility and labour market transitions, the link between aggregate employment and climate change policies, and firm-level strategies to adjust to climate change.
- Available learning from previous restructuring processes and sectoral shifts needs to be maximised alongside research on the **social dialogue processes and policy tools** that can best ensure effective and just transitions at sectoral, regional and company levels.
- Although there is an existing stream of research on green and greening jobs and associated skills needs and skills gaps, more work is needed to clearly identify the **changing task profiles and associated generalist and specific skills needs** and the balance in quality between polluting tasks and occupations, on the one hand, and green and greening ones, on the other. This will require a number of empirical obstacles to be overcome in the classification of tasks and occupations. Accordingly, the policy priority is not just to increase the supply of high-skilled workers but, rather, to identify which types of qualifications, educational and training programmes are best suited to provide the skills specifically required to meet the structural changes brought about by greening.
- Achieving a **just transition** requires compensation policies and instruments tailored to the specific circumstances of **regions** and **sectors**, as well as to different groups of workers. While the outcomes of the transition are clearly spelled out (i.e. promoting

sustainable production, transport, addressing inequalities), the procedural aspects of how to meet those goals remain unclear. More first-hand evidence on the implementation of (un)successful policy is needed to enhance the understanding of what works and what does not, where and why.

- The **distributional** effects of both climate change and climate policies at societal level also warrant further investigation. In particular, there is little research on the extent to which (i) low-carbon fiscal policies are regressive or not and (ii) pecuniary and environmental benefits due to these policies improve the living conditions of vulnerable communities and individuals.
- The multitude of new policy instruments within the EGD will raise challenges for the **consistency** and **coherence** of countries' policy mixes. But what of between-country effects? There is little research on the extent to which coordination in implementing policy instruments across countries can generate inefficiencies or accrue positive environmental and social spillovers, which is both a relevant and an imminent challenge for European society. A suitable monitoring framework to assess the socioeconomic impacts of climate change and climate change policies should be devised. The strains between the overarching concerns of strategic autonomy, energy security and the decarbonisation agenda has become very evident in the context of the war in Ukraine.
- The **involvement and contribution of different stakeholders and the role of social dialogue** in devising policy solutions at various levels also deserve more attention. This includes the role of collective bargaining at various levels, and the involvement of social partners and other policy actors in policymaking at regional, national and EU levels. Since dealing with the climate challenge will require striking a balance between economic, social and environmental agendas, engaging all the key stakeholders is essential to create a collaborative climate for negotiations between parties with different interests. Social partners have a key role to play in helping to manage change at company level and to influence relevant policies, especially in relation to their impact on employment and on the need for training and new skills. Evidence on this is still rather scanty and, given the variety of industrial relations traditions across and within countries, there is scope for systematic case studies to understand what each social partner can contribute in each socioeconomic setting.
- At structural level, further attention should also be paid to the impact of changing public frameworks (including regulations) and consumer behaviour on **production systems** (within individual enterprises but also along supply chains, such as in the circular economy), business organisation, management practices and working conditions.
- Lastly, there is increasing interest in **cross-fertilisation opportunities and risks across the megatrends**, but limited information on them. A notable example is digitalisation as a tool for transition to a climate-neutral economy, such as exploring the possibilities of big data or artificial intelligence facilitating 'greening' at company, sector or regional level, and indeed the opportunities and risks that digitalisation presents to a greener economy and society. Links between demographic change and climate change also remain underexplored.

References

All Eurofound publications are available at www.eurofound.europa.eu

Acharya, P., Boggess, B. and Zhang, K. (2018), 'Assessing heat stress and health among construction workers in a changing climate: A review', *International Journal of Environmental Research and Public Health*, Vol. 15, No. 2, 247.

AEA Technology (2020), 'Waste management options and climate change – Executive summary', available at https://ec.europa.eu/environment/pdf/waste/studies/climate_change_xsum.pdf, accessed 6 June 2021.

Aleksandrova, M. (2019), *Social protection as a tool to address slow onset climate events: Emerging issues for research and policy*, Discussion Paper No. 16/2019, Deutsches Institut für Entwicklungspolitik, Bonn.

Altenburg, T. and Assmann, C. (eds.) (2017), *Green industrial policy: Concept, policies, country experiences*, UN Environment and Deutsches Institut für Entwicklungspolitik, Geneva and Bonn.

Alvis, S., Fotherby, J., Bennett, H., Avison, Z. and Evans, J. (2022), *Closing the UK's green skills gap*, Green Alliance, London.

Andrews, O., Le Quéré, C., Kjellstrom, T., Lemke, B. and Haines, A. (2018), 'Implications for workability and survivability in populations exposed to extreme heat under climate change: A modelling study', *Lancet Planetary Health*, Vol. 2, No. 12, E540–E547.

Angelucci, M. (2015), 'Migration and financial constraints: Evidence from Mexico', *Review of Economics and Statistics*, Vol. 97, No. 1, pp. 224–228.

ANSES (2018), *Opinion of the French Agency for Food, Environmental and Occupational Health & Safety on the assessment of the risks to worker health posed by climate change*, Report No. 2013-SA-0216.

Antonioli, D. and Mazzanti, M. (2017), 'Towards a green economy through innovations: The role of trade union involvement', *Ecological Economics*, Vol. 131, pp. 286–299.

Atteridge, A. and Strambo, C. (2020), *Seven principles to realize a just transition to a low-carbon economy*, SEI policy report June 2020, Stockholm Environment Institute, Stockholm.

Barbarossa, V., Bosmans, J., Wanders, N., King, H., Bierkens, M. F. P., Huijbregts, M. A. J. et al (2021), 'Threats of global warming to the world's freshwater fishes', *Nature Communications*, Vol. 12, 1701.

Bazzi, S. (2017), 'Wealth heterogeneity and the income elasticity of migration', *American Economic Journal: Applied Economics*, Vol. 9, No. 2, pp. 219–255.

Beine, M. and Parsons, C. R. (2017), 'Climatic factors as determinants of international migration: Redux', *CESifo Economic Studies*, Vol. 63, No. 4, pp. 386–402.

Bertoli, S. and Ruyssen, I. (2018), 'Networks and migrants' intended destination', *Journal of Economic Geography*, Vol. 18, No. 4, pp. 705–728.

Bouzarovski, S., Thomson, H. and Cornelis, M. (2021), 'Confronting energy poverty in Europe: A research and policy agenda', *Energies*, Vol. 14, No. 4, 858.

Bowen, A. (2012), *'Green' growth, 'green' jobs and labor markets*, Policy Research Working Paper No. 5990, World Bank.

Breil, M., Zandersen, M., Pishmisheva, P., Pedersen, A. B., Romanovska, L., Coninx, I. et al (2021), *'Leaving no one behind' in climate resilience policy and practice in Europe: Overview of knowledge and practice for just resilience*, ETC/CCA Technical Paper 2021/2, EEA, Bologna.

Bruvoll, A., Ibenholt, K., Ahvenharju, S., Bröckl, M., Martinsen, L. and Zandersen, M. (2012), *Measuring green jobs? An evaluation of definitions and statistics for green activities*, Nordic Council of Ministers, Copenhagen.

Bueno, A. M., de Paula Xavier, A. A. and Broday, E. E. (2021), 'Evaluating the connection between thermal comfort and productivity in buildings: A systematic literature review', *Buildings*, Vol. 11, No. 6, 244.

Buildings Performance Institute Europe (2011), *Europe's buildings under the microscope: A country-by-country review of the energy performance of buildings*, Brussels.

BusinessEurope, ETUC, SGIEurope and SMEUnited (2022), *EU social partners work programme 2022–2024*, BusinessEurope, Brussels.

Cappelli, F., Conigliani, C., Consoli, D. and Paglialunga, E. (2022), 'Climate change and armed conflicts in Africa: Temporal persistence, non-linear climate impact and geographical spillovers', *Economia Politica*.

Carleton, T. A. and Hsiang, S. M. (2016), 'Social and economic impacts of climate', *Science*, Vol. 353, No. 6304, aad9837.

Carrillo-Hermosilla, J., Del Río, P. and Könnölä, T. (2010), 'Diversity of eco-innovations: Reflections from selected case studies', *Journal of Cleaner Production*, Vol. 18, No. 10–11, pp. 1073–1083.

Cedefop (2019), *Skills for green jobs: 2018 update*, Publications Office of the European Union, Luxembourg.

Cedefop and ILO (2010), *Skills for green jobs: European synthesis report*, Publications Office of the European Union, Luxembourg.

Cedefop and OECD (2021), *The next steps for apprenticeship*, Cedefop reference series No. 118, Publications Office of the European Union, Luxembourg.

Cedefop and OECD (2022), *Apprenticeships for greener economies and societies*, Cedefop reference series No. 122, Publications Office of the European Union, Luxembourg.

Chakraborty, A., Singh, M. P. and Roy, M. (2018), 'Green curriculum analysis in technological education', *International Journal of Progressive Education*, Vol. 14, No. 1, pp. 122–129.

Channel News Asia (2021), 'Singapore to launch multi-ministry Green Plan to tackle climate change challenges', web page, accessed 29 June 2021.

Ciuha, U., Pogačar, T., Bogataj, L. K., Gliha, M., Nybo, L., Flouris, A. D. et al (2019), 'Interaction between indoor occupational heat stress and environmental temperature elevations during heat waves', *Weather, Climate, and Society*, Vol. 11, No. 4, pp. 755–762.

Climate-ADAPT (undated-a), *Just resilience*, web page, accessed 23 November 2022.

Climate-ADAPT (undated-b), *Adaptation options*, web page, accessed 28 November 2022.

Colmer, J., Martin, R., Muûls, M. and Wagner, U. J. (2020), *Does pricing carbon mitigate climate change? Firm-level evidence from the European Union emissions trading scheme*, Discussion Paper No. 1728, Centre for Economic Performance.

Consoli, D., Marin, G., Marzucchi, A. and Vona, F. (2016), 'Do green jobs differ from non-green jobs in terms of skills and human capital?' *Research Policy*, Vol. 45, No. 5, pp. 1046–1060.

Davies, M., Oswald, K., Mitchell, T. and Tanner, T. (2008), *Climate change adaptation, disaster risk reduction and social protection*, briefing note, Centre for Social Protection, Climate Change and Development Centre, Brighton.

Dechezleprêtre, A. and Sato, M. (2020), 'The impacts of environmental regulations on competitiveness', *Review of Environmental Economics and Policy*, Vol. 11, No. 2.

Defra (2012), *UK climate change risk assessment: Government report*, London.

Dell, M., Jones, B. F. and Olken, B. A. (2012), 'Temperature shocks and economic growth: Evidence from the last half century', *American Economic Journal: Macroeconomics*, Vol. 4, No. 3, pp. 66–95.

Dierdorff, E., Norton, J., Drewes, D., Kroustalis, C., Rivkin, D. and Lewis, P. (2009), *Greening of the world of work: Implications for O*NET-SOC and new and emerging occupations*, National Center for O*Net Development, Raleigh, North Carolina.

Docquier, F., Peri, G. and Ruyssen, I. (2014), 'The cross-country determinants of potential and actual migration', *International Migration Review*, Vol. 48, No. 1_suppl, pp. 37–99.

Dorband, I. I., Jakob, M., Kalkuhl, M. and Steckel, J. C. (2019), 'Poverty and distributional effects of carbon pricing in low-and middle-income countries – A global comparative analysis', *World Development*, Vol. 115, pp. 246–257.

Dustmann, C. and Okatenko, A. (2014), 'Out-migration, wealth constraints, and the quality of local amenities', *Journal of Development Economics*, Vol. 110, pp. 52–63.

E3mLab (2016), *EU reference scenario 2016: Energy, transport and GHG emissions trends to 2050*, Publications Office of the European Union, Luxembourg.

EEA (2017), *Climate change adaptation and disaster risk reduction in Europe*, EEA Report No. 15/2017, Luxembourg: Publications Office of the European Union.

EEA (2018), *Unequal exposure and unequal impacts: Social vulnerability to air pollution, noise and extreme temperatures in Europe*, EEA Report No. 22/2018, Copenhagen.

EEA (2020), *Health and environment, including air and noise pollution – Putting EEA's work in the spotlight*, web page, accessed 4 June 2021.

EEA (2021), *Just transition in the context of adaptation to climate change*, Eionet Portal, available at https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_2-2021

EEA (2022a), *Projected change in annual (left) and summer (right) precipitation, 2071–2100*, web page, accessed April 2022.

EEA (2022b), *How is Europe fighting against climate change?* web page, accessed 22 November 2022.

EEA (undated-a), *Policies and actions*, web page, available at https://www.eea.europa.eu/themes/climate-change-adaptation/adaptation-policies, accessed 22 November 2022.

EEA (undated-b), *Climate change mitigation*, web page, available at https://www.eea.europa.eu/themes/climate, accessed 13 March 2023.

EEA and Eurofound (2021), *Exploring the social challenges of low-carbon energy policies in Europe*, Briefing No. 11/2021, Publications Office of the European Union, Luxembourg.

EIB (2021), *Climate action and environmental sustainability: Overview 2021*, Luxembourg.

EIO (2012), *Closing the innovation gap: An economic opportunity for business. Annual report 2011*, European Commission, Brussels.

Ellen MacArthur Foundation (2019), *The butterfly diagram: Visualising the circular economy*, web page, accessed 30 November, 2022.

ESDE (Employment and social developments in Europe) (2019), *Sustainable growth for all: Choices for the future of social Europe*, Publications Office of the European Union, Luxembourg.

Energy Poverty Advisory Hub (undated), *National indicators*, web page, accessed April 2022.

EPSU (2017), *What is green collective bargaining?* web page, accessed 1 December 2022.

ETUC (2019), *ETUC resolution on the need for EU action to protect workers from high temperatures*, web page, accessed 24 November 2022.

ETUC (2022), 'Climate crisis requires EU law on maximum working temperatures', press release, 25 July.

EU-OSHA (European Agency for Safety and Health at Work) (2011), *Foresight of new and emerging risks to occupational safety and health associated with new technologies in green jobs by 2020: Phase II – Key technologies*, Publications Office of the European Union, Luxembourg.

EU-OSHA (2014), *Green Jobs, new risks? New and emerging risks to occupational safety and health in the electricity sector*, Publications Office of the European Union, Luxembourg.

EU-OSHA (2016), *Contexts and arrangements for occupational safety and health in micro and small enterprises in the EU – SESAME project*, Publications Office of the European Union, Luxembourg

EU-OSHA (2021), *Consolidated Annual Activity Report 2021*, Publications Office of the European Union, Luxembourg.

EU-OSHA (undated), *Workers' safety and health in green jobs*, web page, accessed 29 November 2022.

Eurofound (2015), *Access to social benefits: Reducing non-take-up*, Publications Office of the European Union, Luxembourg.

Eurofound (2017), *Sixth European Working Conditions Survey – Overview report (2017 update)*, Publications Office of the European Union, Luxembourg.

Eurofound (2018), *Measuring varieties of industrial relations in Europe: A quantitative analysis*, Publications Office of the European Union, Luxembourg.

Eurofound (2019a), *European Jobs Monitor 2019: Shifts in the employment structure at regional level*, Publications Office of the European Union, Luxembourg.

Eurofound (2019b), *Energy scenario: Employment implications of the Paris Climate Agreement*, Publications Office of the European Union, Luxembourg.

Eurofound (2020), *Working conditions in sectors*, Publications Office of the European Union, Luxembourg.

Eurofound (2021a), *Working conditions and sustainable work: An analysis using the job quality framework*, Challenges and prospects in the EU series, Publications Office of the European Union, Luxembourg.

Eurofound (2021b), *Distributional impacts of climate policies in Europe*, Publications Office of the European Union, Luxembourg.

Eurofound (2021c), *Involvement of social partners in policymaking during the COVID-19 outbreak*, Publications Office of the European Union, Luxembourg.

Eurofound (2022a), *Access to essential services for people on low incomes: Energy, public transport and digital communications*, Publications Office of the European Union, Luxembourg.

Eurofound (2022b), 'Shifting the focus from energy subsidies to reducing energy dependence', blog post, 10 June 2022.

Eurofound (2022c), *Working conditions in the time of COVID-19: Implications for the future,* Publications Office of the European Union, Luxembourg.

Eurofound (2023), *Measures to tackle labour shortages: Lessons for future policy,* Publications Office of the European Union, Luxembourg.

European Commission (2019a), *Clean energy for all Europeans*, Publications Office of the European Union, Luxembourg.

European Commission (2019b), *Organic farming in the EU: A fast growing sector*, EU Agricultural Markets Briefs No. 13.

European Commission (2020a), *Impact assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Stepping up Europe's 2030 climate ambition: Investing in a climate-neutral future for the benefit of our people*, SWD(2020) 176 final, Brussels.

European Commission (2020b), *A new Circular Economy Action Plan: For a cleaner and more competitive Europe*, COM(2020) 98 final, Brussels.

European Commission (2020c), *Access to essential services for people on low incomes in Europe: An analysis of policies in 35 countries: 2020*, Publications Office of the European Union, Luxembourg.

European Commission (2022a), *Economic losses and fatalities from weather- and climate-related events in Europe*, web page, accessed 29 November 2022.

European Commission (2022b), *Green Deal: New proposals to make sustainable products the norm and boost Europe's resource independence*, web page, accessed 1 December 2022.

European Commission (undated-a), *Energy poverty in the EU*, web page, accessed July 2022.

European Commission (undated-b), *REPowerEU: Affordable, secure and sustainable energy for Europe*, web page, accessed July 2022.

European Economic and Social Committee (2017), *Climate justice (own-initiative opinion)*, web page, accessed 23 November 2022.

European Environmental Bureau (undated), *Sustainable development*, web page, accessed 23 November 2022.

European Parliament (2020a), *Resolution on the European Green Deal*, 2019/2956(RSP).

European Parliament (2020b), *Draft motion for a resolution on EU Strategy on adaptation to climate change*, 2020/2532(RSP).

European Parliament (2020c), *Report on a strong social Europe for Just Transitions*, 2020/2084(INI).

European Parliament (2021), *The effects of climate change on human rights and the role of environmental defenders on this matter*, P9_TA(2021)0245.

Eurostat (2018), *Agriculture, forestry and fishing statistics, 2018 edition*, Publications Office of the European Union, Luxembourg.

Eurostat (2022a), *Farmers and the agricultural labour force – statistics*, web page, accessed 29 November.

Eurostat (2022b), *Quarterly greenhouse gas emissions in the EU*, web page, accessed 1 December 2022.

Fankhauser, S., Sehlleier, F., Stern, N. (2008), 'Climate change, innovation and jobs', *Climate Policy*, Vol. 8, pp. 421–429.

Fears, R., Gillett, W., Haines, A., Norton, M. and ter Meulen, V. (2020), 'Post-pandemic recovery: Use of scientific advice to achieve social equity, planetary health, and economic benefits', *Lancet Planetary Health*, Vol. 4, No. 9, pp. e383–e384.

Fire Brigades Union (2010), *Climate change: Key issues for the fire and rescue service*, Kingston upon Thames, UK.

Fitzpatrick, N., Parrique, T. and Cosme, I. (2022), 'Exploring degrowth policy proposals: A systematic mapping with thematic synthesis', *Journal of Cleaner Production*, Vol. 365, No. 2, 132764.

Flouris, A. D., Dinas, P. C., Ioannou, L. G., Nybo, L., Havenith, G., Kenny, G. P. et al (2018), 'Workers' health and productivity under occupational heat strain: A systematic review and meta-analysis', *Lancet Planetary Health*, Vol. 2, No. 12, pp. e521–e531.

Fragkos, P. and Paroussos, L. (2018), 'Employment creation in EU related to renewables expansion', *Applied Energy*, Vol. 230, pp. 935–945.

Frishammar, J. and Parida, V. (2019), 'Circular business model transformation: A roadmap for incumbent firms', *California Management Review*, Vol. 61, No. 2, pp. 5–29.

Froese, R. and Schilling, J. (2019), 'The nexus of climate change, land use, and conflicts', *Current Climate Change Reports*, Vol. 5, No. 1, pp. 24–35.

Galgóczi, B. (2021), 'From "just transition" to the "eco-social state"', in Räthzel, N., Stevis, D. and Uzzell, D. (eds.), *The Palgrave handbook of environmental labour studies*, Palgrave Macmillan, Cham, Switzerland, pp. 539–562.

Gupta, S., Tirpak, D. A., Burger, N., Gupta, J., Höhne, N., Boncheva, A. I. et al (2007), 'Policies, instruments and co-operative arrangements', in Metz, B., Davidson, O. R., Bosch, P. R., Dave, R. and Meyer, L. A. (eds), *Climate change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

Hancock, P. A., Ross, J. M. and Szalma, J. L. (2007), 'A meta-analysis of performance response under thermal stressors', *Human Factors*, Vol. 49, No. 5, pp. 851–877.

Harsdorff, M., Lieuw-Kie-Song, M. and Tsukamoto, M. (2011), *Towards an ILO approach to climate change adaptation*, International Labour Organization employment working paper No. 104, Employment Sector, Geneva.

Hassett, K. A., Mathur, A. and Metcalf, G. E. (2009), 'The incidence of a US carbon tax: A lifetime and regional analysis', *Energy Journal*, Vol. 30, No. 2, pp. 155–178.

Health Care without Harm (2021), *Our new road map for zero emissions health care*, web page, accessed 29 November 2022.

Health Care without Harm and Arup (2019), *Health care's climate footprint*, Climate-smart health care series, Green Paper No. 1.

Henderson, J. V., Storeygard, A. and Deichman, U. (2017), 'Has climate change driven urbanization in Africa?' *Journal of Development Economics*, Vol. 124, pp. 60–82.

Heyen, D. A., Menzemer, L., Wolff, F., Beznea, A. and Williams, R. (2020), *Just transition in the context of EU environmental policy and the European Green Deal*, Issue paper under Task 3 of the service contract on future EU environment policy, Öko-institut e.V., Freiburg.

Hickel, J. (2021), 'What does degrowth mean? A few points of clarification', *Globalizations*, Vol. 18, No. 7, pp. 1105–1111.

Hickel, J. and Kallis, G. (2020), 'Is green growth possible?' *New Political Economy*, Vol. 25, No. 4, pp. 469–486.

Hooyberghs, H., Verbeke, S., Lauwaet, D., Costa, H., Floater, G. and De Ridder, K. (2017), 'Influence of climate change on summer cooling costs and heat stress in urban office buildings', *Climatic Change*, Vol. 144, No. 4, pp. 721–735.

Hopkins, R. (2018), *Karen MacLean on Den Grønne Friskole, where imagination flourishes*, web page, available at https://www.robhopkins.net/2018/12/10/karen-maclean/, accessed 15 July 2021.

Hornbeck, R. (2012), 'The enduring impact of the American Dust Bowl: Short- and long-run adjustments to environmental catastrophe', *American Economic Review*, Vol. 102, No. 4, pp. 1477–1507.

ILO (International Labour Organization) (2010), *Social dialogue roundtables on the effects of compliance with the Kyoto Protocol on competitiveness, employment and social cohesion in Spain*, International Labour Office, Geneva.

ILO (2015), *Employment protection legislation: Summary indicators in the area of terminating regular contracts*, International Labour Office, Inclusive Labour Markets, Labour Relations and Working Conditions Branch, Geneva.

ILO (2016), *Green jobs progress report*, International Labour Office, Geneva.

ILO (2018), *The employment impact of climate change adaptation: Input document for the G20 Climate Sustainability Working Group*, International Labour Office, Geneva.

ILO (2019), *Working on a warmer planet: The impact of heat stress on labour productivity and decent work*, International Labour Office, Geneva.

ILO and Cedefop (2011), *Skills for green jobs: A global view*, International Labour Office, Geneva.

ILO and Eurofound (2019), *Working conditions in a global perspective*, Publications Office of the European Union, Luxembourg, and International Labour Organization, Geneva.

ILO and IILS (2011), *Towards a greener economy: The social dimensions*, International Labour Office, Geneva.

ILO and OECD (2012), 'Sustainable development, green growth and quality employment: Realizing the potential

for mutually reinforcing policies', background paper for the meeting of G20 labour and employment ministers, Guadalajara, 17–18 May 2012.

ILO Actrav (International Labour Organization Bureau for Workers' Activities) (2018), *Just transition towards environmentally sustainable economies and societies for all*, ILO Actrav Policy Brief.

IMF (International Monetary Fund) (2022), *Stress testing the global economy to climate change-related shocks in large and interconnected economies*, IMF Working Papers No. 189.

IndustriAll (2020), *Carbon Border Adjustment Mechanism – IndustriAll Europe answer to the public consultation,* Brussels.

IPCC (Intergovernmental Panel on Climate Change) (2014a), *Climate change 2014: Mitigation of climate change – Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

IPCC (2014b), *Climate change 2014: Synthesis report*, Geneva.

IPCC (2022), *Climate change 2022: Impacts, adaptation and vulnerability – Working Group II contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

IPCC (undated), *Global warming of 1.5°C*, web page, accessed 22 November 2022.

Isaak, R. (2005), 'The making of the ecopreneur', in Schaper, M. (ed.), *Making ecopreneurs: Developing sustainable entrepreneurship*, Gower Publishing, Farnham UK, pp. 13–25.

ITUC-TUDCN (International Trade Union Confederation Trade Union Development Cooperation Network) (2019), *The contribution of social dialogue to the 2030 Agenda – Promoting a just transition towards sustainable economies and societies for all*, Brussels.

IUCN (2011), *Terminologies used in climate change*, Kathmandu, Nepal.

Janser, M. (2018), *The greening of jobs in Germany: First evidence from a text mining based index and employment register data*, IAB Discussion Paper No. 14/2018, Institut für Arbeitsmarkt- und Berufsforschung, Nuremberg.

Jarvis, A., Varma, A. and Ram, J. (2011), *Assessing green jobs potential in developing countries: A practitioner's guide*, International Labour Office, Geneva.

Jianu, O. A., Rosen, M. A. and Naterer, G. (2012), 'Noise pollution prevention in wind turbines: Status and recent advances', *Sustainability*, Vol. 4, No. 12, pp. 1104–1117.

Johnson, D. L., Ambrose, S. H., Bassett, T. J., Bowen, M. L., Crummey, D. E., Isaacson, J. S. et al (1997), 'Meanings of environmental terms', *Journal of Environmental Quality*, Vol. 26, pp. 581–589.

Jones, B. F. and Olken, B. A. (2010), 'Climate shocks and exports', *American Economic Review*, Vol. 100, No. 2, pp. 454–459.

Känzig, D. (2022) *The unequal economic consequences of carbon pricing*, working paper.

Kemp, R. and Pearson, P. (2008), *MEI project about measuring eco-innovation: Final report*, Maastricht.

Keyßer, L. T. and Lenzen, M. (2021), '1.5 °C degrowth scenarios suggest the need for new mitigation pathways', *Nature Communications*, Vol. 12, No. 1, 2676.

Kjellstrom, T., Briggs, D., Freyberg, C., Lemke, B., Otto, M. and Hyatt, O. (2016), 'Heat, human performance, and occupational health: A key issue for the assessment of global climate change impacts', *Annual Review of Public Health*, Vol. 37, No. 1, pp. 97–112.

Klinenberg, E. (1999), 'Denaturalizing disaster: A social autopsy of the 1995 Chicago heat wave', *Theory and Society*, Vol. 28, No. 2, pp. 239–295.

Labor Network for Sustainability (2016), *'Just transition' – Just what is it?* web page, accessed 29 November 2022.

Lannelongue, G. and González-Benito, J. (2012), 'Opportunism and environmental management systems: Certification as a smokescreen for stakeholders', *Ecological Economics*, Elsevier, vol. 82(C), pp. 11–22.

Laurent E. (2021), The *well-being transition: Analysis and policy*, Palgrave Macmillan, Basingstoke.

Lawrance, E., Thompson, R., Fontana, G. and Jennings, N. (2021), *The impact of climate change on mental health and emotional wellbeing: Current evidence and implications for policy and practice*, Grantham Institute Briefing Paper No. 36.

Leitner, M., Dworak, T., Capela Lourenço, T., Lexer, W., Prutsch, A. and Vanneuville, W. (2020), *Rationale, approach and added value of key type of measures for adaptation to climate change*, European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA) Technical Paper 2020/2, Bologna.

Levy, B. and Roelofs, C. (2019), 'Impacts of climate change on workers' health and safety', *Oxford Research Encyclopedia of Global Public Health*.

LinkedIn Economic Graph (2022), *Global green skills report 2022*.

London School of Economics (2020), *What is 'decarbonisation' of the power sector? Why do we need to decarbonise the power sector in the UK?* web page, accessed 1 December 2022.

Lucas, R. A. I., Epstein, Y. and Kjellstrom, T. (2014), 'Excessive occupational heat exposure: A significant ergonomic challenge and health risk for current and future workers', *Extreme Physiology & Medicine*, Vol. 3, 14.

Marin, G. and Vona, F. (2021), 'The impact of energy prices on socioeconomic and environmental performance: Evidence from French manufacturing establishments, 1997–2015', *European Economic Review*, Vol. 135, No. C, 103739.

Markantonia, M., Steiner, A., Meador, J. E. and Farmer, J. (2018), 'Do community empowerment and enabling state policies work in practice? Insights from a community

development intervention in rural Scotland', *Geoforum*, Vol. 97, pp. 142–154.

Markkanen, S. and Anger-Kraavi, A. (2019), 'Social impacts of climate change mitigation policies and their implications for inequality', *Climate Policy*, Vol. 19, No. 7, pp. 827–844.

Martin, R., Muûls, M. and Wagner, U. J. (2016), 'The impact of the European Union Emissions Trading Scheme on regulated firms: What is the evidence after ten years?' *Review of Environmental Economics and Policy*, Vol. 10, No. 1, pp. 129–148.

McKenzie, D. and Rapoport, H. (2007), 'Network effects and the dynamics of migration and inequality: Theory and evidence from Mexico', *Journal of Development Economics*, Vol. 84, No. 1, pp. 1–24.

Medium (2020), 'Mississippi thinking for climate innovation', UCL Institute for Innovation and Public Purpose blog post, 9 October.

Mendelsohn, R., Nordhaus, W. D. and Shaw, D. (1994), 'The impact of global warming on agriculture: A Ricardian analysis', *American Economic Review*, Vol. 84, No. 4, pp. 753–771.

Mora, C., McKenzie, T., Gaw, I. M., Dean, J. M., von Hammerstein, H., Knudson, T. A. et al (2022), 'Over half of known human pathogenic diseases can be aggravated by climate change', *Nature Climate Change*, Vol. 12, pp. 869–875.

Narocki, C. (2021), *Heatwaves as an occupational hazard*, Report 2021.01, European Trade Union Institute, Brussels.

National Geographic (undated), 'Noise pollution', web page, accessed 4 June 2021.

Nilsson M. and Kjellstrom T. (2010), 'Climate change impacts on working people: How to develop prevention policies', *Global Health Action*, Vol. 3, No. 1, 5774.

Nordic Future of Work Group (2020), *Work today and in the future: Perspectives on occupational safety and health challenges and opportunities for the Nordic labour inspectorates*, Finnish Ministry of Social Affairs and Health, Norwegian Labour Inspection Authority, Swedish Work Environment Authority, Danish Working Environment Authority, Administration of Occupational Safety and Health in Iceland.

Nunfam, V. F., Adusei-Asante, K., Van Etten, E. J., Oosthuizen, J. and Frimpong, K. (2018), 'Social impacts of occupational heat stress and adaptation strategies of workers: A narrative synthesis of the literature', *Science of the Total Environment*, Vol. 643, pp. 1542–1552.

OECD (2014), *Integrated assessment of climate change impacts: Conceptual frameworks, modelling approaches and research needs*, OECD Environment Working Paper No. 66, OECD Publishing, Paris.

OECD (2015a), *The economic consequences of climate change*, OECD Publishing, Paris.

OECD (2015b), *Aligning policies for a low-carbon economy*, OECD Publishing, Paris.

OECD (2017a), *Employment implications of green growth: Linking jobs, growth, and green policies*, OECD Publishing, Paris.

OECD (2017b), *The pursuit of gender equality: An uphill battle*, OECD Publishing, Paris.

OECD (2019), *Waste management and the circular economy in selected OECD countries: Evidence from environmental performance reviews*, OECD Environmental Performance Reviews, OECD Publishing, Paris.

OECD (2020), *Addressing the social consequences of tariffs for water supply and sanitation*, OECD Environment Working Papers No. 166, OECD Publishing, Paris.

OECD (2021), *The inequalities–environment nexus: Towards a people-centred green transition*, OECD Green Growth Papers No. 2021/01, Paris.

Olmstead, A. L. and Rhode, P. W. (2011), 'Responding to climatic challenges: Lessons from US agricultural development', in Libecap, G. D. and Steckel, R. H. (eds.), *The economics of climate change: Adaptations past and present*, University of Chicago Press, Chicago, pp. 169–194.

ONS (Office for National Statistics) (2022), 'Research into "green jobs": Time spent doing green tasks, UK: 1997 to 2019'.

Orru, K., Tillmann, M., Ebi, K. L. and Orru, H. (2018), 'Making administrative systems adaptive to emerging climate change-related health effects: Case of Estonia', *Atmosphere*, Vol. 9, No. 6, 221.

Pandey, C. L. (2015), 'Managing climate change: Shifting roles for NGOs in the climate negotiations', *Environmental Values*, Vol. 24, No. 6, pp. 799–824.

Parrique, T., Barth, J., Briens, F., Kerschner, C., Kraus-Polk, A., Kuokkanen, A. and Spangenberg J. H. (2019), *Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability*, European Environment Bureau, Brussels.

Parsons, K. and Hawkes, C. (2019), *Connecting food systems for co-benefits: How can food systems combine diet-related health with environmental and economic policy goals?* European Observatory on Health Systems and Policies, Copenhagen.

Pingali, P. L. (2012), Green revolution: Impacts, limits, and the path ahead', *Proceedings of the National Academy of Sciences*, Vol. 109, No. 31, pp. 12302–12308.

Pizer, W. A. and Sexton, S. (2020), 'The distributional impacts of energy taxes', *Review of Environmental Economics and Policy*, Vol. 13, No. 1, pp. 104–123.

Pociovălișteanu, D. M., Novo-Corti, I., Aceleanu, M. I., Șerban, A. C. and Grecu, E. (2015), 'Employment policies for a green economy at the European Union level', *Sustainability*, Vol. 7, No. 7, pp. 9231–9250.

Pollin, R., Heintz, J. and Garrett-Peltier, H. (2009), *The economic benefits of investing in clean energy: How the economic stimulus program and new legislation can boost US economic growth and employment*, Political Economy

Research Institute, University of Massachusetts, Amherst, Massachusetts.

Popp, D., Vona, F., Marin, G. and Chen, Z. (2020), *The employment impact of green fiscal push: Evidence from the American Recovery Act*, NBER Working Paper No. w27321.

Poschen, P. and Renner, M. (2015), 'Green jobs: Protecting the environment can go hand in hand with economic prosperity and job opportunities', *Finance and Development*, Vol. 52, No. 4, pp. 14–17.

Randazzo, T., De Cian, E. and Mistry, M. N. (2020), 'Air conditioning and electricity expenditure: The role of climate in temperate countries', *Economic Modelling*, Vol. 90, pp. 273–287.

Relly, S. J., Killip, G., Robson, J., Emms, K., Klassen, M. and Laczik, A. (2022), 'Greening construction: A complex challenge for jobs, skills and training', Edge Foundation, London.

Romanello, M., McGushin, A., Di Napoli, C., Drummond, P., Hughes, N., Jamart, L. et al (2021), 'The 2021 report of the *Lancet* Countdown on health and climate change: Code red for a healthy future', *The Lancet*, Vol. 398, No. 10311, pp. 1619–1662.

Rosemberg, A. (2010), 'Building a just transition: The linkages between climate change and employment', *International Journal of Labour Research*, Vol. 2, No. 2, pp. 125–161.

Schlenker, W., Hanemann, W. M. and Fisher, A. C. (2005), 'Will US agriculture really benefit from global warming? Accounting for irrigation in the hedonic approach', *American Economic Review*, Vol. 95, No. 1, pp. 395–406.

Schuh, B., Maucorps, A., Münch, A., Brkanovic, S., Dwyer, J., Vigani, M. et al (2019), *The EU farming employment: Current challenges and future prospects*, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels.

Schulte, P. A. and Chun, H. (2009), 'Climate change and occupational safety and health: Establishing a preliminary framework', *Journal of Occupational and Environmental Hygiene*, Vol. 6, No. 9, pp. 542–554.

Schulte, P. A., Bhattacharya, A., Butler, C. R., Chun, H. K., Jacklitsch, B., Jacobs, T. et al (2016), 'Advancing the framework for considering the effects of climate change on worker safety and health', *Journal of Occupational and Environmental Hygiene*, Vol. 13, No. 11, pp. 847–865.

Schulte, P. A., Pana-Cryan, R., Schnorr, T., Schill, A. L., Guerin, R., Felknor, S. et al (2017), 'An approach to assess the burden of work-related injury, disease, and distress', *American Journal of Public Health*, Vol. 107, No. 7, pp. 1051–1057.

Silicon Valley Toxics Coalition (2009), *Toward a just and sustainable solar energy industry*.

Silicon Valley Toxics Coalition (2014), *2014 solar scorecard*, San Francisco.

Smith, S. (2017), *Just transition: A report for the OECD*, Just Transition Centre.

Sova, C. A., Grosjean, G., Baedeker, T., Nguyen, T. N., Wallner, M., Nowak, A. et al (2018), *Bringing the concept of climate-smart agriculture to life: Insights from CSA country profiles across Africa, Asia, and Latin America (English)*, World Bank Group, Washington, DC.

Sovacool, B. K. (2009), 'The importance of comprehensiveness in renewable electricity and energy-efficiency policy', *Energy Policy*, Vol. 37, No. 4, pp. 1529–1541.

Sphera (2021), *What is ESG reporting, and why is it important?* web page, accessed 28 June 2021.

Sterner, T., Damon, M., Köhlin, G. and Visser, M. (2012), 'Capacity building to deal with climate challenges today and in the future', *Journal of Environment and Development*, Vol. 21, No. 1, pp. 71–75.

Tenzing, J. (2019), 'Integrating social protection and climate change adaptation: A review', *WIREs Climate Change*, Vol. 11, No. 2, e626.

Triple E Consulting (2014), *Assessing the implications of climate change adaptation on employment in the EU*, European Commission.

UNEP (United Nations Environment Programme), ILO, IOE (International Organisation of Employers) and ITUC (International Trade Union Confederation) (2008), *Green jobs: Towards decent work in a sustainable, low-carbon world*, UNEP, Nairobi.

UNIDO (United Nations Industrial Development Organization) (2020), *Green industrial skills for a sustainable future*, Vienna.

United Nations University (2020), *Five facts on Adaptive Social Protection (ASP)*, web page, accessed 9 July 2021.

Viola, I., Pontrandolfi, A. and Manelli, A. (2016), 'The employment crisis and green orientation in agriculture: New educational models', *Agriculture and Agricultural Science Procedia*, Vol. 8, pp. 560–565.

Vitolo, C., Di Napoli, C., Di Giuseppe, F., Cloke, H. L. and Pappenberger, F. (2019), 'Mapping combined wildfire and heat stress hazards to improve evidence-based decision making', *Environment International*, Vol. 127, pp. 21–34.

Volery, T. (2002), 'Ecopreneurship: Rationale, current issues and future challenges', paper presented at the biennial conference of the Swiss Research Institute of Small Business and Entrepreneurship, St. Gallen, Switzerland.

Vona, F. (2019), 'Job losses and political acceptability of climate policies: Why the "job-killing" argument is so persistent and how to overturn it', *Climate Policy*, Vol. 19, No. 4, pp. 524–532.

Vona, F. (2021), *Labour markets and the green transition: A practitioner's guide to the task-based approach*, Publications Office of the European Union, Luxembourg.

Vona, F. (2022), *Managing the distributional effects of environmental and climate policies: The narrow path for a triple dividend*, OECD Environment Working Paper No. 188.

Vona, F. and Consoli, D. (2015), 'Innovation and skill dynamics: A life-cycle approach', *Industrial and Corporate Change*, Vol. 24, No. 6, pp. 1393–1415.

Vona, F., Marin, G., Consoli, D. and Popp, D. (2018), 'Environmental regulation and green skills: An empirical exploration', *Journal of the Association of Environmental and Resource Economists*, Vol. 5, No. 4, pp. 713–753.

Vona, F., Marin, G. and Consoli, D. (2019), 'Measures, drivers and effects of green employment: Evidence from US local labor markets, 2006–2014', *Journal of Economic Geography*, Vol. 19, No. 5, pp. 1021–1048.

Walker, G., Burningham, K., Fielding, J., Smith, G., Thrush, D. and Fay, H. (2006), *Addressing environmental inequalities: Flood risk*, Environment Agency, Bristol.

Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Belesova, K., Boykoff, M. et al (2019), 'The 2019 report of The *Lancet* Countdown on health and climate change: Ensuring that the health of a child born today is not defined by a changing climate', *The Lancet*, Vol. 394, No. 10211, pp. 1836–1878.

West, S. and Williams, R. (2004), 'Estimates from a consumer demand system: Implications for the incidence of environmental taxes', *Journal of Environmental Economics and Management*, Vol. 47, No. 3, pp. 535–558.

Whitcomb, I. (2021), *Therapists are reckoning with eco-anxiety*, web page, available at https://gizmodo.com/therapists-are-reckoning-with-eco-anxiety-1846686112, accessed 1 December 2022.

White House (2021), *Executive order on tackling the climate crisis at home and abroad*, web page, available at https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/, accessed 29 June 2021.

Whitmarsh, L. (2008), 'Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response', *Journal of Risk Research*, Vol. 11, No. 3, pp. 351–374.

WHO (World Health Organization) (2019), *Environmental health inequalities in Europe: Second assessment report*, Regional Office for Europe, Copenhagen.

WHO (2021), *WHO health and climate change global survey report*, World Health Organization, Geneva.

Wiedmann, T., Lenzen, M., Keyßer, L. T. and Steinberger, J. K. (2020), 'Scientists' warning on affluence', *Nature Communications*, Vol. 11, No. 1, pp. 1–10.

Wilson, J. L. (2011), 'Deliberation, democracy, and the rule of reason in Aristotle's *Politics*', *American Political Science Review*, Vol. 105, pp. 259–274.

Wolf, J., Adger, W. N., Lorenzoni, I., Abrahamson, V., Raine, R. (2010), 'Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities', *Global Environmental Change*, Vol. 20, No. 1, pp. 44–52.

Yamazaki, A. (2017), 'Jobs and climate policy: Evidence from British Columbia's revenue-neutral carbon tax', *Journal of Environmental Economics and Management*, Vol. 83, pp. 197–216.

Yohe, G. W. and Schlesinger, M.E. (2002), 'The economic geography of the impacts of climate change', *Journal of Economic Geography*, Vol. 2, No. 3, pp. 311–341.

Zhang W., Spero, T. L., Nolte, C. G., Garcia, V. C., Lin, Z., Romitti, P. A. et al (2019), 'Projected changes in maternal heat exposure during early pregnancy and the associated congenital heart defect burden in the United States', *Journal of the American Heart Association*, Vol. 8, No. 3, e010995.

Zsamboky, M., Fernández-Bilbao, A., Smith, D., Knight, J. and Allan, J. (2011), *Impacts of climate change on disadvantaged UK coastal communities*, Joseph Rowntree Foundation, York.

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EF/22/036

This paper presents an analytical summary of current academic and policy literature on the impact of climate change and policies to manage the transition to a carbon-neutral economy on four key domains: employment, working conditions, social dialogue and living conditions. It maps the main empirical findings around the impact of climate change and the green transition on jobs, sectors, regions and countries in Europe, identifying the opportunities and risks that climate change policies bring to European labour markets. It also develops a conceptual framework to outline the relevant drivers, relationships and outcomes of climate change and policies to ensure the transition to carbon neutrality, focusing on Eurofound's four strategic areas.

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