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Labour and social policies for the green transition

A conceptual framework

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Abstract

This paper proposes a conceptual framework for analysing the impact of climate change and mitigation efforts on the labour market, migration flows and people's health. Based on the current economic literature, it describes the likely consequences of climate change and mitigation policies on job creation and destruction, skill needs, income distribution, housing, health and migration. It then discusses the most important policy levers that can speed up labour reallocation and maximise the positive impact of climate change mitigation on health, jobs and incomes while cushioning the potentially negative impacts, thus facilitating the net-zero transition.

Résumé

Ce document propose un cadre conceptuel pour analyser l'impact du changement climatique et des efforts d'atténuation des effets du changement climatique sur le marché du travail, les flux migratoires et la santé des populations. S'appuyant sur la littérature économique actuelle, il décrit les conséquences probables du changement climatique et des politiques d'atténuation sur la création et la destruction d'emplois, les besoins en compétences, la répartition des revenus, le logement, la santé et les migrations. Il examine ensuite les principaux leviers politiques susceptibles de faciliter la réallocation, maximiser les bénéfices et atténuer les effets potentiellement négatifs des politiques de lutte contre le réchauffement climatique sur la santé, l'emploi et les revenus, facilitant ainsi la transition vers une situation « nette zéro ».

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Executive Summary

Rising global temperatures and the proliferation of extreme weather events are increasingly pushing climate change to the forefront of the policy debate. Consequently, many countries are taking steps to ensure that the recovery from the COVID-19 pandemic is not only job-rich, but also green. The urgency of the green transition – understood as the transition to net-zero emissions of greenhouse gases (GHG) – implies that the pace of the transformation, and in particular of cuts in emissions, needs to accelerate significantly. Depending on how such cuts are made, they could have large economic and redistributive consequences, and interact with other changes in the structure of the economy, such as digitalisation, population ageing and globalisation.

This paper sets out a conceptual framework to analyse the impact of climate change and GHG mitigation efforts on the labour market, migration flows and people's health, as well as the most important policy levers that can cushion potential negative impacts and maximise opportunities arising from the green transition. This paper is part of a larger ongoing effort by the OECD to understand the economic and policy implications of the green transition on jobs, income and health.

Impact on job creation and destruction. Damages from climate change can trigger the reallocation of workforce away from geographical areas that are most affected, and from sectors, firms and job profiles that are hampered and made less productive by difficult climate conditions.

Moreover, the transition to a less polluting, less carbon-intensive way of producing affects the demand for goods and services and the input mix of production. Consequently, employment shifts out of activities that are high-carbon or polluting, but also from other activities that are impacted by the reduction in GHG emissions, and from those activities that are hampered and made less productive by difficult climate conditions. At the same time, efforts to reduce GHG emissions, for example via climate change mitigation policies, can promote innovation and lead to job creation, for example, in the renewable energy sectors or in retrofitting buildings for greater energy efficiency.

Existing exercises that model the introduction of climate change mitigation policies predict large impacts on specific sectors and in some regions, but modest net overall employment effects in the long run, as labour eventually shifts from emission-intensive to less emission-intensive activities. However, the effects of mitigation policies are non-linear: current GHG reduction efforts, which are larger than in the past, could translate into potentially much larger labour market impacts. The quantification of these impacts is further complicated by the uncertainty on the pace of adoption of "green" technologies across sectors and firms, and on the way these relate to current skill and task requirements. Lastly, most existing analyses benchmark these jobs, income and health effects on the status-quo labour markets situation, while at present the most appropriate counterfactual scenario may be one where the damages of climate change are already widespread.

Many of these changes are localised and dependent on the current economic structure of a region or country. For example, populations that live in areas most affected by climate disasters may need to find new employment or relocate in search for better living conditions. Moreover, all individuals, no matter their labour status, face health risks from air pollution and severe climate events which, in turn, may affect their productivity and employability.

Working conditions can also be affected by climate change and climate change policies, insofar as some jobs are more exposed to extreme weather events or pollution. Moreover, as working conditions differ across sectors and occupations, any reallocation of employment due to climate change and climate change policies can also affect the distribution of working conditions in the economy, e.g., in terms of job security and tenure, working time and flexibility, or career prospects. More evidence is currently needed to understand these changes.

Impact on skill needs. No matter the aggregate employment effects, climate change and the green transition will entail potentially large sectoral, occupational, or geographical job transitions. Skills gaps and shortages are already recognised as a major bottleneck in several "green" sectors constraining innovation and technology adoption. Nevertheless, the limited existing evidence concludes that the net-zero transition is not necessarily skill-biased, and that it requires both technical skills that are specific to "green" industries, and transversal skills, such as management and communication skills.

Distributional impact. Distributional consequences of climate change and mitigation policies emerge from the employment and wage dynamics of displaced and transitioning workers, from households' capabilities to absorb increases in the price of carbon-intensive or polluting goods, and from the disproportionate consequences of climate change and climate change policies on some groups' non-pecuniary outcomes such as health, mortality, or the value of housing. The magnitude of these distributional effects depends on many parameters, and primarily a household's consumption bundle and elasticity of demand, the initial socio-economic conditions, and the design of climate policy instruments. As a consequence, inequalities may be reinforced between low- and high-income households, the low vs high skilled, older and younger individuals, men and women, different ethnic-racial groups, and rural and urban communities, among others.

Taking a wide, cross-government view on policy action. Governments can help firms and workers exploit new opportunities, while cushioning risks and shocks. Several fundamental principles apply across policy types and interventions, such as timeliness, targeting and a whole-of-government approach. Existing policy instruments to accompany the net-zero transformation, such as employment assistance for displaced workers, may require re-examination, as target populations differ and extra resources may be needed to expand the scope or generosity of the policy tools. This paper discusses the different dimensions of labour, social and health policy that have been mobilised so far or could be mobilised *a priori.* Further work will be needed to analyse the role these policies can play from now onwards and whether changes are due, and to formulate appropriate policy recommendations.

Active labour market policies. An effective activation strategy can help workers and firms to adapt quickly to changes brought about by greening the economy. Such a strategy combines measures that strengthen people's motivation to search actively and accept suitable jobs, with actions to expand opportunities and interventions to increase employability, particularly for more vulnerable workers.

Getting skills right. Upskilling and reskilling can be strengthened to ensure a smoother transition of workers out of declining sectors and into expanding ones as the economy becomes greener. To assess this and track emerging skill needs, countries will need high-quality labour market information systems. In the longer term, the new skill needs brought about by the green transition will also affect the design of curricula in initial education and vocational education, and the role of work-based learning.

The role of collective bargaining. Well-functioning collective bargaining institutions, particularly when associated with high coverage, can help advance the net-zero transition, by anticipating the expected adjustments from climate change policy and help design appropriate policy responses, and by fostering innovation, skills development and skills use. OECD work points at the significant role that collective bargaining, especially at the sectoral level, can play in helping displaced workers back to work.

The role of employment protection. A balanced approach to employment protection is required that does not prevent job reallocation (away from emission-intensive activities) by excessively increasing termination

costs for the firm, but still stabilises the employment relationships, provides sufficient advance notification, and protects workers against unfair hiring or firing practices. Relatively generous unemployment benefits can co-exist with less stringent dismissal regulation, and at the same time mitigate voter resistance to climate change mitigation policies among displaced workers.

Promoting labour mobility. Labour market institutions can support mobility of workers between jobs and away from climate-hit areas by reducing labour market concentration and monopsony power and via housing policies such as rental regulation, land-use and planning reforms, or investments in social housing.

Adapting social protection. Social protection (SP) helps to cushion any damaging disruptions of people's livelihoods the transition and climate change may produce, and it can contribute to easing voter resistance to net-zero mitigation efforts. Targeting ensures that the support provided is fair and effective, while maintaining price signals to encourage emission savings. Overdue reforms of SP systems may become more urgent to address e.g., strengthening financial sustainability, increasing portability of SP rights and benefits, or extending protection to non-standard workers, while maintaining adequate levels of protection. Attention should also be paid to: the integration of climate and disaster risk considerations into the planning and design of SP programmes; the extent and the way revenues from market-based climate change mitigation policies (e.g., carbon pricing) are recycled to prevent any regressive impact on incomes; and the sequencing of the policy, so that SP measures do not intervene too late.

The importance of housing policy. Heating and warming housing accounts for a quarter of GHG emissions on average in OECD countries, but the entire lifecycle of housing has a large bearing on GHG emissions. Interventions to increase the energy and emission efficiency of buildings and the construction sector more broadly can reduce emissions, but these investments are not affordable for all, and the COVID-19 pandemic and the current cost-of-living crisis have exacerbated the long-term residential affordability crisis.

Maintaining affordability of housing sector while strengthening carbon efficiency may entail a broad reflection on the location where the dwellings are built or how they are connected to energy and transport systems. Housing allowances and social housing are examples of financial support schemes that benefit low-income and other vulnerable tenants in particular, while subsidies to homeowners to retrofit buildings can be designed to enhance household income progressivity.

Tackling health impacts. Climate change can harm human health and mortality, via extreme weather events, extreme temperatures or anti-microbial resistance. Air pollution is further linked to increased severity and incidence of cardiovascular and respiratory diseases, and higher risk of cognitive decline. Air pollution can be decreased by raising standards of emissions for pollutants, improving urban and transportation design, promoting regular physical activity, providing adequate access to information about climate change that can influence personal behaviour, and minimising the contribution of the health sector as a pollution and GHG emitter. The increased difficulty of working under extreme climate conditions, and the possible new risks implied by less emission intensive jobs suggest the need to reassess and possibly strengthen occupational health and safety regulation and standards, including through social dialogue.

Implications for migration policy. Models estimate that, until 2050, between 78 and 175 million people will move due to climate change, but only a minority of these will move across borders. Conversely, a considerable share of the migrant workforce in OECD countries is concentrated in sectors that are important for the green transition, such as the construction and ICT sector, so that migrants can play a significant role in fostering the net-zero transition. Skills Mobility Partnerships (SMPs) integrate training in countries of origin with job or traineeship placement in countries of destination, and can support the green transition in both sending and receiving countries. Similarly, facilitating international student mobility and research exchanges could promote innovation and strengthen knowledge exchanges.

Introduction

Rising global temperatures and a proliferation of extreme weather events are increasingly pushing climate change to the forefront of the policy debate. Climate change is a major source of income shocks, and the occurrence of extreme events is likely to increase with the rise in average temperatures.

While the COVID-19 pandemic presented an enormous challenge for countries, it has also provided a unique occasion to build back better towards a stronger, sustainable and resilient economy and society. Many OECD countries have taken steps to ensure that the recovery is not only job-rich, but also green. Many governments have included GHG emission and pollution reduction measures in their recovery packages and a greater number of countries have now put in place commitments to net-zero emissions.

These targets imply that the pace of the transition, and in particular of GHG mitigation, needs to accelerate significantly, which will have important but varying economic impacts for households, regions and industries, in an effort to save energy and reduce emissions. Households will have to change their behaviour and orient their consumption patterns towards less energy-intensive goods and services, such as energy-efficient vehicles, appliances and home refurbishments, while firms will have to adapt their production to substitute away from polluting or carbon-intensive products and processes. Regions may see key industries, such as coal mining or steelmaking, scale back, while other regions may see an expansion of new industries, e.g., in renewable energy production.

Such a transition, in its scale and pace, inevitably entails the reallocation of jobs and capital. The extent of this reallocation is still uncertain, depending on the pace of adoption of "green" technologies across sectors and firms. This structural change is not affecting all workers and firms equally, depending on their exposure to either polluting or "green" processes, products and technologies and on how these relate to skill requirements on the job. To adjust to these changes, workers may need to move between jobs and sectors that require similar skills, or they may need to reskill to adapt to new requirements on their job. Either way, this underlines the importance of well-designed labour market institutions. Some workers may lose their job or income. Others, conversely, may benefit from new job opportunities and wage gains in "green jobs" that may not even exist today. Many of these changes are localised and dependent on the current economic structure of a region or country, and they may also entail cross-border flows of people. At the same time, these outcomes may result from the simultaneous occurrence of multiple changes in the structure of the economy, such as digitalisation, population ageing or globalisation, that may interact with climate change and mitigation policies to shape jobs, income and health.

Climate change is also affecting the lives of people beyond their labour market status. Populations that live in areas that are severely hit by climate disasters may be forced to relocate in search for better living conditions. Moreover, all individuals, no matter their labour status, suffer the burden of air pollution and severe climate events on their health which, in turn, may affect their productivity and employability. Considering the increasing likelihood of economic, social and health damages from already ongoing climate change, the status quo of labour markets may not be an appropriate benchmark to understand the consequences of GHG reduction policies on jobs, income and health.

Governments can help firms and workers exploit new opportunities, while cushioning risks and shocks. By facilitating labour market transitions and mitigating the effects of climate change and the net-zero transition on people's health and well-being, governments can not only promote fairness and inclusion, but can also shore up public support to reach a carbon-neutral economy.

This paper sets out a conceptual framework for analysing the impact of climate change and mitigation efforts on the labour market, migration flows and people's health, as well as the most important policy levers that – given the existing stock of knowledge – can maximise opportunities and cushion negative impacts on jobs and incomes from the green transition, thus facilitating it.[1] The paper is intended to inform policymakers in these areas as well as to identify where further evidence is required. It is part of a larger ongoing programme of work at the OECD to analyse these same phenomena and their policy implications.

Following an overview of the conceptual framework, a more detailed description is given in Section 2, and in particular the drivers of the transition. The consequences of climate change and mitigation policies for jobs, income and health are discussed in Section 3. Finally, the policies that can be leveraged to minimise the potential economic and social costs of these consequences, while ensuring that the net-zero objective is reached, are discussed in Section 4.

Overview of the conceptual framework

Figure 1 summarises the conceptual framework. At the top, the *drivers* of the green transition include climate change and all policies that are put in place to mitigate the impact of climate change, but also preferences of households and firms over the production and consumption ahead of price effects that are determined by climate change or mitigation policies. These phenomena drive changes in the patterns of production and consumption, as mediated by factors such as the inter-sectoral linkages or market frictions.

The middle section of Figure 1 traces out the *outcomes* of these changes in supply and demand for goods and services on jobs, incomes and health. Both climate change and mitigation policies engender flows of workers across sectors, occupations or regions, spur the creation of new jobs, and change the nature of a number of jobs. Some groups of individuals are affected more than others, with potentially sizeable impacts on household budgets and inequality. As labour reallocates so does capital, and resources are flowing to firms that are best positioned to embrace the transition, whether incumbents or new entrants.

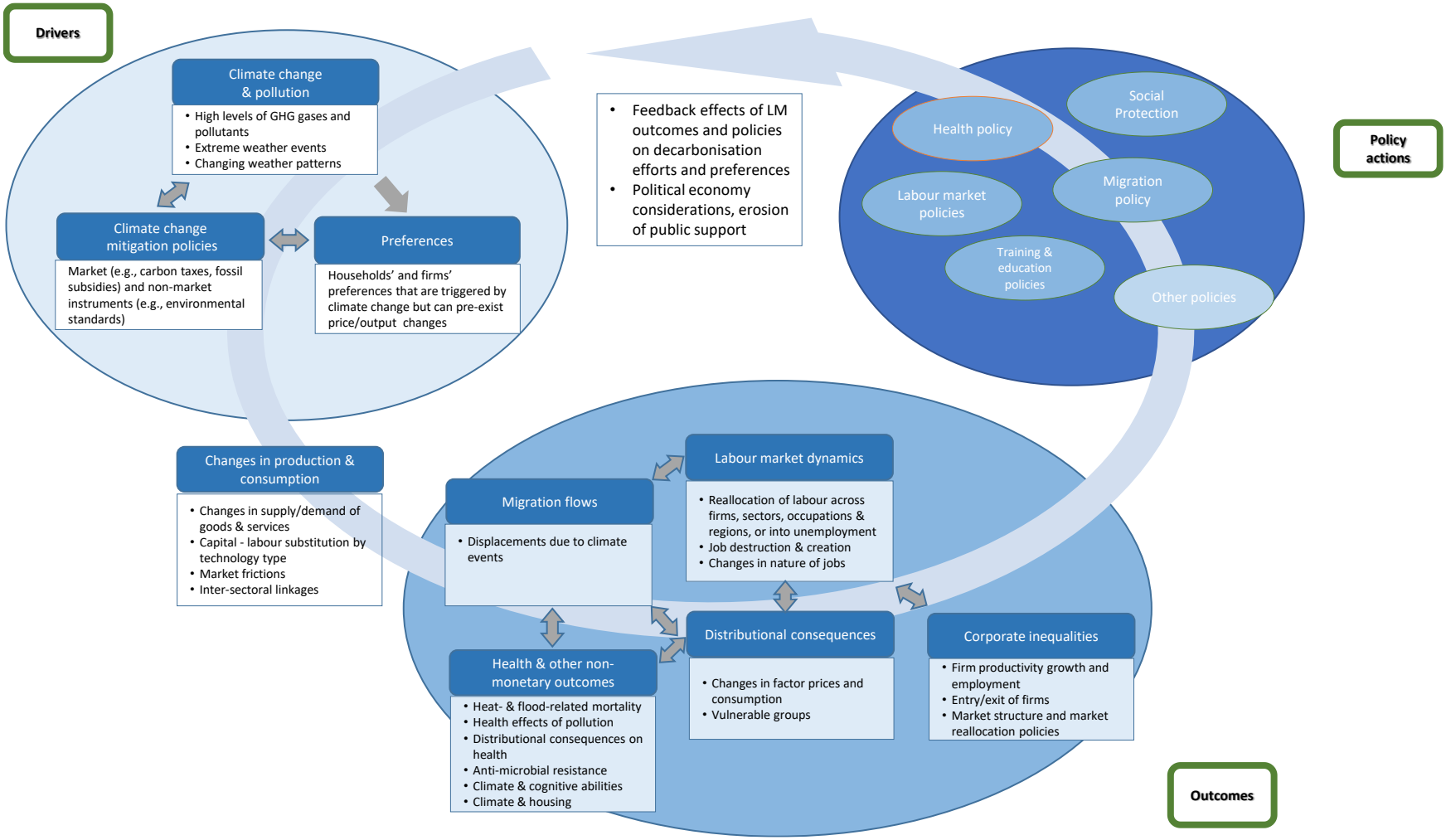
Climate change also affects people's health, directly or via their labour market participation and economic condition, as well as migration flows, and the fact that some individuals may need to leave their homes because of climate change shocks or the long-term impact of climate change on local labour markets.

The lower section of Figure 1 flags the areas of employment, social and health *policy action* that can underpin and accelerate the transition to a more carbon- and pollution-free economy. These policies aim to support the move towards a decarbonised economy while ensuring that the transition is fair and inclusive. Policies that reinforce existing inequalities, or create new ones, can hamper the transition by eroding public support for mitigation measures and to shift to a more environment-friendly lifestyle.

The framework is by nature and design limited in its scope. First, it focuses on the impact of climate change on health, migration, income, and labour dynamics, and only marginally touches on indirect channels such as for instance firms' investment that are related to climate change, or on related policies (trade, innovation or industrial policies). It does however stress where synergies can be found between climate change and the net-zero transition with other megatrends that affect the future of work. Second, the focus is currently restricted to the consequences of climate change and mitigation policies, and does not cover other aspects of environmental degradation such as land and resource depletion, loss of biodiversity, or the transition towards a sustainable and circular economy. Moreover, it does not delve deep into the consequences of adaptation policies. While some economic mechanisms in that area are intuitive and coherent with this framework, hard evidence on the labour market consequences of adaptation policies is scant. Lastly, the analysis leaves out some selected aspects of the labour market such as the impact of climate change on informal employment and on rural-urban migration.

[1] "Green transition" is here used to identify the transition to net-zero emissions.

Figure 1. Overview of the conceptual framework



Source: OECD.

Drivers

Greenhouse gas (GHG) emissions and pollution produced by human activities have been rising steeply in the last decades, caused by economic growth patterns based on overexploitation of natural resources and fossil-fuel energy generation. There is by now clear evidence that emissions are associated with rising atmosphere and ocean temperatures, changes in ecosystems, and the frequency and scale of extreme weather events such as hurricanes, floods and severe droughts, and catastrophic forest fires. These changes to the climate are affecting the structure of production and employment, population movements, and the occurrence of adverse health conditions such as cardiovascular diseases or breathing impairment.

Ambitious environmental policies are therefore needed to prevent or limit environmental degradation, avoid further deterioration of health conditions, and shift to a more sustainable and resilient economy. The main challenge is to mitigate GHG emissions and stabilise GHG concentrations in the atmosphere at a level that would limit dangerous interference with the climate system. As a consequence, reaching net-zero GHG emissions has become a pillar of efforts to support the long-term temperature goal of the Paris Agreement (Article 4.1). These efforts have also taken on a new urgency in the wake of the COVID-19 pandemic. Various OECD countries have launched recovery packages, which included environmental objectives and measures to "build back better", albeit with so far limited transformational impact (OECD, 2021[1]).

To achieve this objective, policymakers can mobilise various policy instruments to encourage emission reductions, such as carbon pricing, subsidies for green technologies, environmental standards, and others. Many of these instruments increase the price of fossil fuels and fossil-fuel generated electricity. They provide incentives to reduce the consumption of fossil fuels by firms and households, but also incentives to invest in alternative energy sources and energy saving technologies. Other policies imply the scrapping of existing forms of support that do not account for the full social cost of producing polluting or emission-intensive goods, and that distort incentives to consumption, such as fossil fuel subsidies, or lower trade tariffs for dirty goods. Climate policy instruments can differ significantly in their effectiveness in abating emissions, distributional impacts, administrative costs, and ability to encourage innovation, but no single instrument dominates the others across all considered criteria (D'Arcangelo et al., 2022[2]).

A number of additional policies exist that do not directly target a reduction in emissions but provide the enabling economic and social conditions to do so by lowering the economic and social costs of decarbonisation efforts. Structural reforms often involve significant reallocation of resources across firms and sectors that may entail costly adjustments, especially in the labour market. Other policies conversely can improve households' economic conditions as a response. Via their impact on jobs, income and health, all these policies can further affect climate change, mitigation policies and the views of households or firms on the importance of the net-zero transition, as represented by the feedback arrow in Figure 1.

Preferences and persistence in habits can perpetuate environmentally damaging patterns of consumption, too. While climate change and climate change policies can affect preferences, some of these exist independently of climate change and mitigation policies, and of the impact of these on jobs, income and health. However, their persistence is often rooted in the socio-economic status of individuals. On the one hand low-income households usually place a greater value on current than future consumption relative to higher-income households, and are therefore bound to consume fewer "green" options if these are not immediately available in the market (as in the case of innovative "green" appliances), or if their benefit materialises only in the future (e.g., in terms of energy savings). High-income households, on the other

hand, can have damaging patterns of consumption via more frequent air travel and large homes or cars. Furthermore, preferences may be shaped by limited information, including because of peer- and neighbourhood- effects. Households tend to self-select into neighbourhoods of similar income, which can exacerbate the gap in perception and consumption between the rich and poor, as information is less (resp. more) likely to receive positive feedback from peers in disadvantaged (resp. affluent) communities.

Lastly, some movements in energy and commodity prices are unrelated to climate change or mitigation policies, but can still affect progress towards net-zero emissions. For example, the supply chain disruptions linked to COVID-19 lockdowns and the interruptions in the provision of some raw materials as a consequence of Russia's invasion of Ukraine, have increased the price volatility of certain products, and induced a reflection on the reliance on energy- or carbon-intensive goods in OECD economies. At the same time, however, price increases have reduced countries' propensity to introduce price-based carbon mitigation measures in the short-term, as governments aim to avoid a deeper cost-of-living crisis.

Changes in production and consumption

The levers described above – including climate change mitigation policies and regulation – have been transforming the structure of production and consumption towards less-polluting and more resource-efficient economies. The changes are expected to be far greater if the net-zero target is reached.

A less polluting, less carbon-intensive way of producing affects the demand for intermediate goods and services within and across sectors, but also the input mix of production. For the latter, the shape of the production function of green products and changes in work organisation determine the degree to which labour is used as a substitute or complement to other inputs, which in turn changes the demand for labour. An important outstanding question is whether green technologies are also labour saving. For instance, most studies find that capital is a better substitute for polluting goods than labour, and that an increase in energy prices – a likely but not necessary scenario in the net-zero transition – leads to an increase in the demand for capital and a decrease in that of labour, especially when taking a long-run perspective. This elasticity of labour to energy prices, however, varies significantly across studies (Vona, 2021[3]).

Consumer spending patterns may also be affected by decarbonisation efforts, as "green" goods and services become cheaper relative to energy-inefficient or polluting goods, and consumers' and investors' preferences shift accordingly. For instance, changing regulations, market-based climate instruments such as carbon taxes, and the elimination of fuel subsidies impacting energy and food prices, may require important investments by households in "cleaner" housing and transportation. These, in turn are affected by constraints in households' ability to borrow and capital market imperfections. Moreover, consumption patterns depend on the substitutability of certain goods and services in people's consumption basket, i.e., on how some products provide a greater (lesser) utility if consumed together, as in the case of cars and fossil fuels. The degree of complementarity of products, together with existing input-output linkages across sectors, imply that changes in prices and demand transmit across sectors, and employment changes in emission-intensive or polluting industries represent only the tip of the iceberg of labour market adjustment.

The extent to which workers are able to switch between sectors and occupations as a result of these new production and consumption patterns influences the overall effect of the transition on employment. An increase in unemployment, for example, would give rise to income effects that produce further changes in the demand for labour. These adjustments, and in particular the reallocation of workers across emission- or pollution-intensive and less intensive activities, can be hindered by temporary costs of adjusting labour and wages to new market conditions, and shortages in the supply of certain occupational or skill profiles. Extensive empirical evidence suggests that labour market adjustments take place slowly in OECD economies, and this could lead to some temporary rise in unemployment if job losses lag behind job creation in response to mitigation policies. The remainder of this report focuses on these adjustments as a consequence of climate change and mitigation policies, and on the role of labour market, health and migration policies in them.

Outcomes

Labour Market Outcomes

The transition to a low-carbon and resource-efficient economy entails:

- A reduction in jobs in activities with a heavy GHG footprint, everything else held constant.
- An increase of jobs directly linked to emission- or pollution-saving ("green") technologies (e.g., renewables), including job profiles that did not previously exist (e.g., solar panel maintenance), and jobs that are linked to the invention and production of "green" technologies. These jobs may or may not be substituting for pre-existing jobs in emission- or pollution-intensive ("brown") firms or sectors. While this is the case for renewable energy production, for instance, some "green" products and services may be entirely new (e.g., carbon capture). There are also indirect employment effects: each new "green" job can also foster the creation of other non-green jobs locally (Vona, Marin and Consoli, 2019[4]), as much as the destruction of a polluting job can foster the destruction of other local jobs (Gathmann, Helm and Schönberg, 2018[5]).
- A transformation in the nature of jobs, when the tasks workers are required to perform on the job and the skills they use also change as a consequence of the green transition (e.g., from fuel-based to electric car manufacturing). This change in nature can potentially impact all jobs, and not just those that are connected to polluting or emission-intensive productions (e.g., the transition from paper-based book-keeping to digital accounting systems such as Enterprise Resource Planning software).

In assessing the importance of these effects, the current status of labour markets may be the most natural benchmark. Labour markets, however, are also affected by the cost of inaction, and the damages brought about by changes to the climate (extreme weather events, a rise in global temperature and sea levels). Factoring that in, labour markets should be compared under climate action and no climate action instead. Expected labour market dynamics under no climate action are:

- A reallocation of workforce away from geographical areas that are most affected by intense pollution, extreme climate events, or changing climatic conditions (e.g., coastal regions), in favour of other regions.
- A reallocation of workforce away from sectors, firms and job profiles that are hampered and made less productive by difficult climate conditions (e.g., farming and forestry under rising temperatures) and their related sectors, towards other activities or activities that are in stronger demand for the same reasons, if any (e.g., sustainable housing construction and refurbishment).
- A reallocation of workforce across sectors and job profiles that are differently impacted by changes in prices of inputs due to the two previous conditions.

It follows that a climate-damaged labour market, rather than the current status quo, may be the most appropriate benchmark to assess the labour market consequences of climate change mitigation policies. Most existing evidence, however, does not take this approach, possibly because of the uncertainty around

the economic and labour market consequences of damages from climate change. Similarly, until today evidence of labour markets under adaptation policies is scarce.[2]

Lastly, other megatrends can produce similar changes in the quantity and price of labour, such as the digital transformation of production, population ageing, and globalisation. The way these changes in the structure of the economy and society interact with each other can impact the pace of convergence to net-zero, and the effect of the transition on jobs, income and health as a consequence. For instance, firms that implement carbon-saving ways of producing may simultaneously decide to adopt automating technologies, so as to produce long-terms savings on labour costs. This could increase the job losses attributable to the transition to net-zero. A discussion of such interaction effects is offered at the end of this section. In the remainder of the section, conversely, the labour market outcomes of climate change and the net-zero transition are discussed in isolation, abstracting from the existence of these potential interaction effects, and in line with the bulk of existing studies on the topic.

Net employment effects of reaching net-zero

Reducing GHG emissions concerns first and foremost certain sectors, such as energy, construction, environmental services and manufacturing, where the effort to reduce emissions has been greatest, and where stringent mitigation policies may entail large adjustment costs, downsizing or even bankruptcy for the most emissions intensive and the least productive firms. OECD modelling predicts that fossil-fuel industries will experience the steepest employment declines and renewable energy industries the sharpest increases. Workers in these sectors, which are likely to bear the largest costs of mitigation efforts, are thus the most exposed to displacement and lower wages, especially when the sectors also rely relatively more on labour than on capital (OECD, 2012[6]; Chateau, Bibas and Lanzi, 2018[7]; OECD, 2020[8]). Some of these displaced workers could transition into unemployment or leave the labour force altogether, while others are transitioning into different jobs in less polluting, less carbon-intensive industries.

At the same time, efforts to reduce GHG emissions, e.g., via mitigation policies, can promote innovation and lead to job creation.[3] Some firms can effectively pull ahead of others and add to employment, e.g., less emission-intensive firms or firms that are more productive to begin with. Other firms can invest and innovate and become more productive after the change in regulation to avoid cost burdens (Porter, 1991[9]) – see Box 1 for a broader discussion. While these activities are likely less polluting and carbon intensive, they do not necessarily require entirely new tasks and skills (i.e., they do not create “new jobs”), and they do not necessarily employ workers that were previously employed in high-emission or high-polluting activities. Net job creation, however, could still be positive overall, depending on the growth-enhancing effect of climate change mitigation policies.

The quantification of the overall impact on employment of these transformations is especially important, albeit difficult, due to the uncertainty in the cost and pace of green-technology adoption (Way et al., 2022[10]). Exercises that model the introduction of climate mitigation policies predict – under a number of simplifying assumptions – that the net labour market impact will likely be modest in the long run: while certain green sectors, such as renewable energy production, will grow at a rapid pace, in the long run

[2] Adaptation can impact the labour market by reducing the harm caused by climate change, at least in the long run. Furthermore, adaptation can engender changes in labour demand, business models and training requirements via new investments (e.g., infrastructure protecting from flooding). To a more limited extent, costs of compliance with future adaptation requirements (e.g., mandatory air conditioning to keep office temperatures below a certain temperature) could harm some firms and sectors and affect employment in a similar way to mitigation costs. However, evidence on these mechanisms is currently limited, possibly because of the lack of structured data on adaptation policies and technologies (IPCC, 2014[178]).

[3] Enabling conditions should be in place to translate innovation into employment, such as the adoption of certain key technologies, the availability of skilled labour or sufficient investments in workers’ training.

labour should simply shift from emission-intensive to less emission-intensive sectors, thus producing large impacts on specific sectors, but a small aggregate impact on unemployment (Chateau, Bibas and Lanzi, 2018[7]). Moreover, both emission-intensive and less-intensive sectors currently account for only a small share of total employment on average across OECD countries, which should also limit the magnitude of jobs lost to unemployment. This consideration, however, neglects knock-on job destruction effects in sectors that are connected to the carbon-intensive industries that are being restructured, or on firms that may see their operating costs increase due to higher energy or carbon prices. Other recent estimates suggest that meeting the net-zero emissions objectives by 2050 that countries set for themselves can create 30 million jobs globally by 2030, compared to 8 million jobs lost (International Energy Agency, 2021[11]).[4]

Partial equilibrium analyses have also found relatively modest impacts of the efforts towards net-zero on the labour market of OECD countries, but conclusions can change depending on the driver of climate change that is considered and the level of aggregation at which the analysis is performed (OECD, 2021[12]). Hafstead and Williams (2016[13]), for instance, analyse the effect of stringent environmental regulations and conclude that the impact on net employment is likely small, while it is statistically insignificant for Morgenstern, Pizer and Shih (2002[14]). However, at the microeconomic level and in the short-run, the available evidence shows that the effects of environmental regulations on employment in energy- and pollution-intensive sectors are small but statistically significant. Dechezleprêtre and Sato (2017[15]) find a small but significant impact on employment in energy- and pollution-intensive industries. This impact, however, may not last long (Ferris, Shadbegian and Wolverton, 2014[16]). Dechezleprêtre, Nachtigall and Stadler (2020[17]) examine the effect of changes in energy prices instead, while Yamazaki (2017[18]) looks at the effect of introducing a revenue-neutral carbon tax, but with qualitatively similar conclusions and overall small-magnitude effects.

All in all, these studies find that past climate change mitigation policies have not had large impacts on overall employment in manufacturing industries, although there are heterogeneous effects across sectors and contexts. Modelling analyses so far also suggest that well-designed and well-implemented mitigation policies should not harm overall employment.

This does not imply, however, that the effect is bound to remain small in the future, and these analyses are not cause for complacency. Past policy changes and reduction efforts have been gradual and their impact on employment may not be a good guide to the impact of much larger or more rapid changes. The same modelling exercises above, furthermore, show that the effect of decarbonisation policies on employment can be non-linear: large and sudden changes in climate policy can produce disproportionately large employment losses (Chateau, Bibas and Lanzi, 2018[7]). The extent and pace of employment adjustment is affected by a number of labour market policies, the choice in climate change mitigation policies that are introduced, and by the extent to which policies can alleviate the regressive impacts of climate change on households' income, as described in more detail in the sections below.

Transitions for the employed

Furthermore, a manageable net aggregate employment impact of climate change and climate policy can still imply substantial levels of job creation and destruction within some sectors and regions, and that a sizeable number of workers may need to change job as a consequence.[5] Such reallocation of workers can take different forms:

[4] All these estimates account for differences between "green' and "brown" industries in capital-labour intensities and in intensity in labour of different occupational profiles.

[5] Transitions into and outside of unemployment are not treated in this Section, which only considers mobility of employed individuals.

- **Sectoral transitions**. Workers in high-polluting, high-emission industries or industries that are especially exposed to climate change may need to move to other industries, possibly characterised by lower emissions, where resources and capital are flowing, and new jobs are being created. There exist multiple ways to identify the sectors of origin (or destination) of such flows, in particular when the impact of climate policy is concerned: greenhouse gas emission intensity of production or consumption, pollution intensity and energy intensity are the main indicators considered in this review to identify target sectors. Some of the effects on these sectors can also trickle down to other sectors that are not necessarily polluting or emission intensive, via input-output linkages.
- **Occupational transitions**. Some occupational profiles are progressively losing employment, if they are typical of high-emission, polluting or climate-affected productions. One such example are coal miners, who are decreasing in number with the progressive phasing out of coal for energy production. While many displaced coal miners have stayed in mining (possibly of different ores), others have found employment in alternative, in-demand occupations. Conversely, job demand in some occupations may be driven by changes in consumption towards more sustainable goods and services (e.g., restored or refurbished consumer durable goods).
- **Regional transitions**. The geographic impact of this transformation may be highly uneven, considering the geographical concentration of certain activities that are carbon intensive (such as mining) or more exposed to climate change events (Black, McKinnish and Sanders, 2005[19]; Marchand, 2012[20]; OECD, 2023[21]). For other emission-intensive productions that are characterised by large set-up costs (e.g., basic metal transformation) and are therefore profitable only at scale downsizing can have a large impact on local employment. Other regions, conversely, can benefit disproportionately from the creation of "green" jobs: regions with a large proportion of highly educated workers, for instance, are likely to attract business, as they can trigger or support the innovative efforts required by the green transition. Indeed absorptive capacity of new technologies significantly differs across regions (Abreu et al., 2008[22]).
- **Employer churning**. Lastly, workers may have to seek employment in a company that relies on a "greener" technology, while staying in the same geographical region and sector of production, and keeping the same occupational title. Technology adoption is indeed uneven across firms, even within narrowly-defined sectors of production (Berlingieri et al., 2020[23]). Box 1 expands on the role of differences across firms for labour market dynamics in the framework of the green transition.

Lastly, the likelihood of these transitions (as well as those from and into unemployment or inactivity) are affected by the alignment of skills and knowledge between workers and the requirements in jobs that emerge from the green transition. As mentioned, climate change and mitigation policies are likely to entail a change in nature of many jobs, even while keeping the same occupational or sectoral structure. The role of skills in fostering transitions is explored further below.

Box 1. The role of firm differences in productivity growth

Empirically, a large literature has estimated the impact on firms' productivity of climate change mitigation policies, be they environmental regulation (Albrizio, Kozluk and Zipperer, 2017[24]), energy prices (Brucal and Dechezleprêtre, 2021[25]), the EU emission trading scheme (Dechezleprêtre, Nachtigall and Venmans, 2018[26]; D'Arcangelo, Pavan and Calligaris, 2022[27]) or carbon taxes (Dussaux, 2020[28]). The evidence, however, is still inconclusive, as productivity effects change depending on the sector, pollutant, country or time span considered (OECD, 2021[12]).

Some evidence, however, also points at the importance of initial differences in firm performance. Albrizio, Kozluk and Zipperer (2017[24]), for instance, find that more stringent climate policy is related to

higher industry and firm productivity, but only for firms close to the productivity frontier. Similarly, SMEs may be at a disadvantage, as they are relatively unaware of the technological and operational adaptations required by the low-carbon development, and suffer of more limited access to knowledge networks, skills, innovation access and finance (OECD, 2021[29]). Conversely, start-ups and young firms may outperform incumbent firms if they can invest in "green" technologies and organisational forms from the start, and can avoid potentially large switching costs.

When estimating the productivity effects at the aggregate (sectoral or country) level, these studies account both for the growth in productivity of the individual firm, and for the effect of reallocating labour and capital across firms. The ambiguity in sign holds for the reallocation term as well: workers may move to a firm that is as or even less productive than their initial employer, especially if the displacement is involuntary or if the market is strongly segmented between frontier and laggard firms. As a result, higher job mobility may not necessarily translate into a more efficient allocation of employment in the aggregate, giving cause for policy actions.

Green vs non-green jobs

Transitioning out of high-polluting, high-emitting jobs and anticipating the employment impact of the green transition implies the identification of the jobs that are more likely to be destroyed as a consequence of climate change and mitigation policies. At the same time, fostering the transition to a greener labour market would benefit from a definition of the activities and job families towards which workers should gravitate to achieve a successful green transition – all while acknowledging that not all jobs created and filled-in as a consequence of climate change and mitigation policies will necessarily be fully "green".[6]

Better defining "brown" and "green" jobs in a consistent way would help to collect and analyse information on the number of jobs that are created or destroyed, their remuneration, and their industrial, occupational, and geographic distribution. These definitions could be introduced in the analyses of the impact of mitigation policies on employment and improve their accuracy, or taken in consideration by policy makers when designing targeted labour market policies, thus maximising the efficient use of public resources. Whether a definition of a "green" job or a "brown" job is needed and the way these jobs are measured will ultimately be a function of the analytical or policy objective that are envisaged by the policy maker.

There are many definitions of what constitutes "green" activities and "green" jobs, both nationally and in the economic literature (CEDEFOP, 2019[30]; Causa, Soldani and Nguyen, forthcoming[31]). This hampers international comparisons but also meaningful policy discussions, if very different types of activities and jobs are classified as green according to different definitions. In this context, G7 Labour and Employment Ministers in 2022 called upon the ILO and OECD to develop a definition and methodology for monitoring "the creation of decent work and good quality jobs that are contributing to a green, nature-positive economy and a just transition". Subsequently, the ILO and OECD have proposed that green jobs should be defined in line with the guidelines of the International Conference of Labour Statisticians (ICLS) as employment in the environmental sector while also measuring the quality of these jobs. The environmental sector spans all environmental protection and resource management activities, defined as:

a) Environmental protection activities are those activities whose primary purpose is the prevention, reduction and elimination of pollution and other forms of degradation of the environment.
b) Resource management activities are those activities whose primary purpose is the preservation and maintenance of the stock of natural resources and hence safeguarding against depletion.

[6] An alternative definition of "brown" and "green" jobs would also consider whether these are more or less exposed to climate change itself. This, however, would not be consistent with the bulk of the current literature in this field, hence this paragraph restricts the focus of the definition to the emission or pollution content of these jobs.

The potentially very heterogeneous nature of green jobs, including in terms of job requirements and working conditions, suggests that not all "green" jobs will be good quality jobs in terms of wages, employment security and working conditions (OECD/Cedefop, 2014[32]; ILO, 2012[33]). Little data exist that allow for the international comparison of the quality of green and non-green jobs by, for example, average wage, unionisation rate, type of contract or the degree of job strain.[7]

Job quality

As working conditions differ across sectors and occupations, any reallocation of employment due to climate change and climate change policies is bound to affect the distribution of job quality in the economy, in terms of wages and benefits (treated separately in the next section), but also tenure, job security, working time and flexibility, career prospects, among others. For instance, workers in the agriculture sector tend to experience long working hours, limited flexibility and unsocial working time arrangements, hence employment shifts away from agriculture (or towards less intensive, more sustainable farming) could lead to improvements in working conditions for those workers. Another example is remote work, which reduces commuting and its related emissions, and increases working time flexibility. As mentioned here above, at the time of writing cross-country evidence on these dimensions of the quality of jobs destroyed or created by the green transition is not yet available.

More evidence exists, conversely, for the impact of climate change and decarbonization policies on physical working conditions. Communities that are more susceptible to natural disasters may experience increased stress and anxiety related to the impacts of climate change.

Workers exposed to adverse environmental conditions display higher rates of absenteeism, presenteeism or reduced engagement at work, either because they are sick or because they need to stay at home to take care of vulnerable family members (Aragón, Miranda and Oliva, 2017[34]). As temperatures rise, outdoor workers may experience reduced productivity and more heat-related illnesses or injuries, including stress, and death (Lucas, Epstein and Kjellstrom, 2014[35]; Narocki, 2021[36]). Workforce participation, productivity, and employment rates could also be negatively affected by air pollution, in line with previous similar findings on the effect of chronic diseases (OECD, 2019[37]). This is especially true for some occupations, where working conditions are very likely to worsen with the increase in incidence of extreme climate events, such as firefighters or health workers. Furthermore, jobs in high-emission sectors (mining, petrochemicals) are often characterised by challenging physical working conditions (physically demanding, subject to exposure to hazardous substances) (Bueno, de Paula Xavier and Broday, 2021[38]).

Decarbonisation policies can lead to shifts away of employment from these sectors or introduce new business models and practices, potentially offering workers better working conditions. At the same time, it should not be assumed that that all "green" jobs guarantee improved physical working conditions. New activities could expose workers to other hazardous substances or environments in a way that is not yet well understood. For instance, workers producing photovoltaic panels are exposed to toxic substances (Poschen and Renner, 2015[39]) and solar panel installers could suffer of great heat stress (EU-OSHA, 2014[40]) (eu osha 2014). New and fast-moving, innovative businesses and business practices (including remote work) could translate into insufficient awareness and culture of occupational safety and health (EU-OSHA, 2013[41]; EU-OSHA, 2014[40]).

[7] The United Nations nevertheless limit the scope of the definition by stating that "green" jobs need to simultaneously imply limited emission impact and meet the criteria for decent work: adequate wages, safe conditions, workers' rights, social dialogue and social protection (UNEP et al., 2008[173]).

The role of skills: transitions and beyond

Minimising the adverse impact of climate change and mitigation policies on the labour market requires that workers displaced as a result move quickly into new jobs. As the skills required in jobs that are adversely impacted are usually not completely transferrable to those new jobs (OECD/Cedefop, 2014[32]), workers in transition may have to adapt their skill set to the requirements of the destination job.[8] Skills gaps and shortages are already recognised as a major bottleneck in a number of sectors, such as renewable energy, energy and resource efficiency, renovation of buildings, construction, environmental services and manufacturing (OECD, 2020[8]). Indeed workers' relocation costs crucially depend on the skill similarity between occupations and sectors (Poletaev et al., 2008[42]; Gathmann and Schönberg, 2010[43]). The distributional consequences of climate change across groups of workers with different skills are discussed more in-depth further below.

Changes in skill requirements on the job can also concern existing jobs that need to evolve and workers that do not change employer, occupation or sector. As mentioned, the transformation does not necessarily entail a transition across jobs, and it has the potential to affect not just jobs that operate in emission- or pollution-intensive industries and related ones, but any job. This can significantly broaden the scope of climate change and mitigation policies' impact on the labour market.

As businesses adapt to mitigation policies and the increased demand for "green" products and services, a considerable proportion of employers may need to adjust and invest in the human capital of their workforce. Skills shortages can constrain the ability of firms to innovate and adopt new technologies, and skill mismatches reduce productivity (Haskel and Martin, 1993[44]; Bennett and McGuinness, 2009[45]). Investing in the skills of the workforce therefore enables the green transition via different channels: not only easing the reallocation of workers across jobs and out of unemployment, but also enhancing firms' ability to innovate and invest in cleaner technologies, and to create new jobs as a consequence (Popp et al., 2022[46]).

A first reskilling effort concerns adults, and in particular workers whose job is evolving, and the unemployed who are seeking job opportunities in a changing labour market. This requires the ability to identify the required skill needs and the mechanisms that can be activated to support their acquisition and effective use in the labour market. Further reskilling efforts could touch individuals irrespective of their labour market status. For the objectives of the net-zero transition to be met, consumption patterns and other societal behaviours of both children and adults may need to change, which requires a conscious effort in the measurement and updating of people's knowledge and attitudes towards climate change and the green transition.

Skills for the green transition

While the transition towards low-carbon and resource-efficient economy is certainly affecting job-skill demands, understanding which skills are or will be in stronger demand is much harder. The urgency of the transition imposes new challenges, and past evidence may not be informative for the future, considering the size of the forthcoming transition. The vast literature on the labour market impacts of automation, for instance, highlights that certain skills (e.g., abstract and cognitive) are complementary to new technologies and the organisational changes that come with them, while others (routine and manual skills) are substituted by them (Autor, Levy and Murnane, 2003[47]; Autor, 2013[48]). Whether this is also true in the case of the green transition when "green" technologies and production processes are adopted still remains to be assessed. Similarly, evidence that the net-zero transition is skill biased (i.e., demand is skewed

[8] Evidence that climate change is skill-biased is still limited, as mentioned (Marin and Vona, 2019[49]), so skill requirements may be different across "green" and "brown" productions, but not necessarily superior. Similarly, not all transitions necessarily require upskilling or reskilling: an accountant may be displaced from an emission-intensive technology company and find employment in the same position in a "green" technology company.

towards high-skill jobs and against low-skill ones) is still limited (Marin and Vona, 2019[49]). In other words, while the invention and production of some "green" technologies may very well require a disproportionately skilled workforce, the broader production transformations brought about by these technologies may not necessarily favour skilled over low-skilled labour.

A first approach to assessing these complementarities is the analysis of changes in skill requirements after a change in one of the drivers of the green transition, holding everything else constant. This approach can yield conclusions that are difficult to generalise over all aspects of the net-zero transition. A second approach instead defines what a "green" job is, then compares skill requirements across "green" and "non-green" jobs. As previously seen, however, agreeing on a definition of "green" job is not trivial. Moreover, many "green" jobs may be relatively new because low-carbon energy technologies (and other technologies needed for net-zero) are rapidly evolving, so that the required skills are also not clear.

In any case, the existing evidence is scant. OECD (2014[50]) concludes that the transition requires both technical skills that are specific to "green" industries, but also transversal skills, such as management skills, skills on innovation and change management and communication skills. Indeed, a successful transition needs to persuade businesses, workers and consumers to change their production and consumption behaviour. Similarly, Vona et al. (2018[51]) find that two main sets of skills are in demand, i.e., engineering skills and managerial skills, where the latter are needed to update managerial practices that support the implementation and monitoring of the green transition. Consoli et al. (2016[52]) find that some "green" jobs use higher levels of cognitive and interpersonal skills. These results resonate with a recent definition of what skills for the green transition are according to several international organisations, which encompass both technical and transversal skills (Inter-Agency Working Group on Work-based Learning, 2022[53]).

This limited existing evidence as well as the approaches described above suggest that many if not most of the skills in demand during the transition are not specific to "green" jobs only. There may be some skills that are more frequently relied upon as a consequence of climate change and mitigation policies, but they may also be present in other jobs. This conclusion further emphasises the importance of analysing the green transition at the same time as other macrotrends, where these may impact labour markets contextually and in similar ways.

A separate question investigates whether the "green" transition is biased towards high-skilled professions. Evidence that the net-zero transition is skill-biased exists but is still limited (Marin and Vona, 2019[49]). Elliott and Lindley (2017[54]) find that plants producing "green" goods and services employ a lower share of production workers. Consoli et al. (2016[52]) find modest skill differences between "green" and other jobs, but also a bias towards higher skills for "green" job. As already mentioned, Vona et al. (2018[51]) provide evidence that "green" jobs require more engineering and technical skills, while Marin and Vona (2019[49]) show that mitigation policies are skill biased against manual workers and favour technicians. The evidence points to a moderate skill-biased effect of climate change and climate change policy, but one where technical skills (more than cognitive abstract skills) are especially important. This is consistent with ILO (2019[55]), too, which finds that most job creation and reallocation is concentrated among mid-skill occupations in two of its key future scenarios.

"Green" awareness and attitudes

Looking beyond the role of individuals in the workforce, a net-zero transition can only be achieved if consumption patterns change based on greater awareness and knowledge about climate change and mitigation policies. While awareness of climate change is high across OECD countries (Whitmarsh and Capstick, 2018[56]), including among the young (OECD, 2020[57]), people do not necessarily agree on the policy action that is needed as a consequence. They do not have sufficient understanding of how mitigation policies work in terms of their effectiveness, economic impacts, distributional consequences, and effects on their household, and they do not know which policy is best activated (Dechezleprêtre et al., 2022[58]). A number of studies offer comprehensive reviews of work on attitudes towards carbon taxes (Carattini,

Carvalho and Fankhauser, 2018[59]; Maestre-Andrés, Drews and van den Bergh, 2020[60]) as well as other mitigation policies (Dechezleprêtre et al., 2022[58]).

In the long run, raising awareness of climate change and acquiring the skills required to navigate an evolving labour market will have to be integrated in school curricula. Most students learn about the environment at school (OECD, 2007[61]), and 88% of school principals in PISA 2018 reported that global warming and climate change are covered in school curricula (OECD, 2020[57]). Many students, however, lack a solid understanding of scientific principles to make sense of complex environmental problems and, in the future, pursue careers that promote "greener" production and consumption processes (Borgonovi et al., 2022[62]). When accounting for the multi-faceted nature of awareness of environmental problems, less than one student out of three throughout EU and OECD countries achieves at least the minimum benchmarks across all environmental sustainability competence areas (Borgonovi et al., 2022[62]; Borgonovi et al., 2022[63]). Nevertheless, there is a positive correlation between educational attainment and adults' self-reported understanding of climate change: across OECD countries, the percentage of adults reporting to perceive climate change as a major threat reaches 71% of individuals with a tertiary qualification, 65% of individuals with a secondary qualification, and 62% of individuals without secondary qualifications (Asai, Borgonovi and Wildi, 2022[64]). It can be important, therefore, to continue investing in curricula that strengthen attitudes of students and adults towards environmental problems, as argued in further detail in the training policy section below.

Distributional consequences

The labour market impact of the green transition is likely to be unequal. This is especially true for climate change itself, which impacts some sections of the labour market more than others (areas and sectors most exposed to sudden climate events). But it is the case for some climate change mitigation policy actions as well, which can have a regressive impact on income distribution, depending on how they are designed. This section describes the channels through which these unequal distributional effects can manifest themselves, and the groups of the population that are most exposed to them.

A first channel of transmission for inequality is people's labour market status.[9] Many workers benefit from new job opportunities and potential earnings growth in expanding industries; others, who work in shrinking emission- or pollution-intensive industries or industries that are especially affected by climate change, are losing their job and may need to reskill, with potential losses in income earned while unemployed or in new jobs at lower wages.

Job displacements often entail some form of adjustment costs, including long-term earnings losses (OECD, 2018[65]) (Von Wachter, Song and Manchester, 2011[66]) or the need to migrate (Kuminoff, Schoellman and Timminsy, 2015[67]). In the specific case of the "green" transition, Walker (2013[68]) finds that workers in sectors affected by the 1990 Clean Air Act lose 20% of their pre-regulatory lifetime earnings, with most of the burden falling upon displaced workers. Earnings losses are found to be especially large for workers who changed sector, thus corroborating the idea that specific skills are important in emission-intensive industries. McKibbin et al. (2009[69]) provide evidence of a negative effect on wages even for workers who find a new job relatively quickly, as earnings decline during the retraining period, or because the worker-firm match is imperfect. Naturally, other non-displaced workers may not experience an equally

[9] These are source-side income effects. Vona (2021[3]) and D'Arcangelo et al. (2022[2]) differentiate between source-side and use-side income effects of climate action. Source-side distributional effects emerge when climate actions affect the remuneration of capital and labour, while use-side income effects emerge when climate actions increase the prices of certain goods more than others, and households consume some of those products. For brevity reasons, this Section deals with both types of income effects and with health and non-pecuniary effects altogether.

unfavourable wage dynamics, and some workers on the contrary are likely to experience salary bumps if they find employment in growing ("green") activities.

While these distributional consequences are related to people's labour market status, climate change and mitigation policies can also impact individuals' real income and consumption directly.[10] As climate actions change relative prices of polluting and clean goods, households consuming "dirtier" goods are at disadvantage. If higher prices on GHG emissions are needed to curb energy consumption to the degree necessary to reach the goals of the Paris climate accord, they will pose significant burdens on households (Markkanen and Anger-Kraavi, 2019[70]). Current rises in energy prices, caused by a recovering world economy in 2021 and fuelled by Russia's invasion of Ukraine, are already placing significant hardships on many households. Some groups are clearly more affected by the price increase for certain essential goods, as e.g., food and energy prices for low-income households, and are less able to adjust to the changing climate, e.g., by insulating their homes or moving locations.

Lastly, some groups face disproportionate consequences of climate change and climate change policies on non-pecuniary outcomes such as health and mortality, value of housing, or human capital accumulation (Deschênes and Greenstone, 2011[71]; Currie, 2011[72]). While these are mentioned here for completeness, a more detailed account is given in a dedicated section below.

In all cases, evaluating these distributional consequences should consider that the status quo is an unlikely counterfactual scenario in case of no climate action. While the status quo is a natural starting point, any losses from climate action should also be compared to the possible labour, social and health gains from mitigating GHG emissions, or to the cost of climate inaction (i.e., more frequent extreme climate events) on the labour markets (Tovar Reaños and Lynch, 2022[73]).

Unequal effects across groups

By income

The first cleavage imposed by the transition is between high- and low-income households. Uncompensated increases in emission-intensive goods prices are likely to be regressive (i.e., producing a higher burden as a fraction of income for low-income households compared to high-income ones) (Vona, 2021[3]). On average, low-income households earn relatively less income from capital and land than from labour. As the transition requires investments in abatement technologies, wages decrease relative to rents from capital, as the demand for capital relative to that of labour increases (Fullerton, 2011[74]).[11]

Households in lower-income deciles also spend proportionally more on carbon-intensive goods such as heat and electricity[12], have lower elasticity of demand to gasoline prices (but not necessarily on cars) and fewer means to invest in mitigation measures (such as building insulation), as their budget constraint is tighter and their ability to borrow more limited (Zachmann, Fredriksson and Claeys, 2018[75]). Furthermore, discount rates are typically higher for poorer households, hence long-term health and economic benefits are weighted much less than upfront economic costs by those households (Vona, 2021[3]).

[10] Use-side income effects.

[11] The relative returns to labour, capital and land are key to evaluate whether uncompensated climate change and climate change policies are regressive. This is the case if decarbonisation increases the returns to capital more than the returns to labour, e.g., because capital is a better substitute than labour to polluting technologies, or because production can (threaten to) relocate in a pollution haven abroad in the long run. However, if capital is generally carbon-emitting and polluting, uncompensated decarbonisation can be progressive. A similar reasoning applies for low- vs high-skilled labour.

[12] As heat and electricity are necessary goods, their Engel curve is concave, meaning that their consumption grows less than proportionally as income increases.

The transition will not only impact jobs, but also consumption patterns. Many climate change mitigation policies increase the price of carbon-intensive goods and services, and discourage consumption of dirty ones. When these effects are not compensated (see the next section), mitigation policies tend to be regressive (Table 0).

Table 0 Distributional effects of uncompensated climate change mitigation policies, selected examples

Policy type	Distributional impact	Explanation / reservations	Confidence
Carbon pricing: Transport / road fuel	Mixed evidence	The number of low-income households with cars is lower under the policy, but those who own a car spend more on gasoline than other households. But results are heterogeneous between countries, with progressive outcomes especially in developing countries, or in countries where low-income households have access to good public transport.	Medium
Carbon pricing: Electricity	Regressive	Under the policy, low-income households spend higher shares of their income on electricity, and their demand for it is inelastic (e.g., due to financial limits to buy energy-efficient appliances).	Medium
Carbon pricing: Heating	Regressive	Similar to electricity.	Medium
Carbon pricing: Air transport	Progressive	High-income households use air travel at an above-proportionate rate compared to the general population.	High
Carbon pricing: Maritime transport	Regressive	In comparison to wealthier households, low-income households spend a higher income share on imported goods. However, fewer maritime trades might be beneficial for manufacturing jobs associated with low-skilled/low-wage households.	Low
Subsidies on low-carbon technology	Regressive	Domestic technology investments (e.g., building insulation, less-emitting vehicles, and solar panels) are usually done by higher-income households, given that credit market imperfections, uncertainty and financial constraints inhibit lower-income households from the required upfront investments in new equipment. For example, 90% of tax credits on electric vehicles in the US were received by the top income quintile.	High
Public investment in low-carbon technology or complementary infrastructure	Mixed evidence	Progressivity depends on the effect of the investment on demand for capital or low-skilled workers, but also on which households enjoy the investment most or are its main users (e.g., city buses are mainly used by low-income households, while high-speed trains are used by high-income ones).	Low
Higher tariffs on high-carbon imports	Mixed evidence	Low-income households rely more on high-carbon imports, but local high-carbon industries, associated with low-skill/low-wage workers, may benefit from the induced protectionism.	Low
Energy and vehicle efficiency standards (e.g., the US CAFE)	Regressive	More regressive compared to fuel taxes, and likely less efficient. E.g., for energy efficiency standards of houses: high-income households already buy relatively more efficient versions of appliances and homes and are thus less affected.	Medium
Agriculture related policies (e.g., taxes or standards)	Regressive	Low-income households spend a higher income share on food. However, both low and high-income households spend similar shares on high-emission food and may hence face a relatively proportionate rise in prices.	Low

Note: The 'Confidence' column is based on the availability of relevant literature, the existence of consensus and the original findings included in the source publication.
Source : OECD based on D'Arcangelo et al. (2022[2]).

For instance, electricity taxation in OECD countries generally harms households in the bottom income deciles because residential energy is necessary (Pizer and Sexton, 2019[76]). Subsidies to clean energy

investments (e.g., to electric cars or house refurbishing) disproportionately benefit richer households (Borenstein and Davis, 2016[77]). Importantly, carbon taxes and fuel prices affect not only the cost of transportation, heating and electricity but also the prices of other goods, depending on how intensive their production is on carbon-intensive inputs. Some of these effects, however, may be non-linear in income, as in the case of fuel, where poorer households use public transports rather than cars, so the effect is progressive at the bottom, while richer households drive new, energy efficient cars, so the effect is regressive at the top (Sterner, 2012[78]). The magnitude of these distributional effects depends on a number of parameters, and primarily the consumption bundle and households' elasticity of demand, the policy design, the price sensitiveness of different groups, and the initial socio-economic conditions in the country or sector (Zachmann, Fredriksson and Claeys, 2018[75]; Vona, 2021[3]; OECD, forthcoming[79]).

Lastly, low-income households are more likely to live in polluted places, and have once again fewer resources to mitigate its effect (e.g., air filtration or housing quality) (Banzhaf, Ma and Timmins, 2019[80]). The health and non-market benefits of climate change mitigation policies accrue disproportionately to those who are mostly affected by extreme weather events or by local pollution, making non-pecuniary benefits of climate actions generally progressive (Drupp et al., 2018[81]).

By skill level

Income is correlated with other individual or household characteristics of the individuals. For instance, low-skilled households tend to have lower incomes. The low-skilled face above-average risk adjustment cost to displacement, as lower levels of education and competencies are crucial barriers for reskilling and job mobility. Secondly, the low-skilled tend to participate less in training than the high-skilled in general, and to display lower motivation to train (OECD, 2019[82]), often due to more binding obstacles to participation. This may be especially constraining if the green transition imposed a disproportionate burden of training on the low-skilled, as for instance in the case of a skill-biased transition (with emission-intensive industries characterised by relatively low educated workforce). The phasing out of fossil fuel, for instance, is likely to increase the demand for software or electrical engineers to the detriment of mining or elementary factory workers more than for other types of engineers. Other expanding industries, conversely, may still need low-skilled workers, as e.g., the construction sector. Lastly, low-skilled migrants are likely to face above-average adjustment costs when faced with job displacement, especially since migrants are less likely to access training, and that the training gap persist also in times when training needs of migrants are particularly high (OECD, 2022[83]).

The net-zero transition may also affect the low-skilled via other channels besides reallocation. Several studies, for instance, find that air pollution has a disproportionate negative impact on low-skilled workers (OECD, 2021[84]).

By age

Research has consistently shown that higher tenure workers tend to experience greater adjustment costs following job displacement than do lower tenure workers, including because of the higher cost of reskilling. As older workers have on average longer tenure on the job than younger workers, higher adjustment costs of reallocation are therefore expected for those older workers who are currently employed in carbon-intensive industries. Furthermore, existing evidence shows that when older workers are displaced, they are likely to be out of work longer, and, if they find a new job, replace less of their former wages than their younger counterparts (OECD, 2018[65]). Efforts to reduce emissions could further imply reductions in energy consumption, at least during the transition towards a "cleaner" energy production mix. In this case, older people, as well as some suffering ill-health, would be especially negatively affected in their labour market participation, health, and wellbeing.

Furthermore, older people are more exposed to the consequences of climate change itself. Excess heat-related mortality and health risks related to pollution increases with age. Older people's decreased mobility

and changes in physiology, and often more limited access to resources, limit their adaptive capacity in case of climate change.

Children suffer from climate-change related illness, too, especially if from socially disadvantaged backgrounds (OECD, 2021[84]). Heatwaves and air pollution have also been shown to negatively affect children's educational outcomes (Currie, 2011[72]; OECD, forthcoming[85]).

By gender

Some of the most carbon-intensive industries (e.g., mining) employ disproportionately more men than women. At least in the case of the phasing out of coal mines in the UK, the displacement of men out of the sector crowded women out of employment in manufacturing jobs as well (Aragón, Rud and Toews, 2018[86]). Conversely, female employment in occupations related to Science, Technology, Engineering and Mathematics (STEM) is low, and so is female entrepreneurship. Women are in general better represented in the renewable energy sector than in the traditional energy sector, but they mostly hold non-STEM positions (OECD, 2020[87]), and are still overall underrepresented in "green" jobs overall (Causa, Soldani and Nguyen, forthcoming[31]; OECD, 2023[21]).

Moving away from fossil fuels and toward renewable energy will require investment in reskilling that should not only focus on the current, predominantly male workforce. A gender-sensitive transition strives to understand how business and policy makers can bring women into less emission-intensive jobs (OECD, 2021[88]). Evidence suggests that significant gender differences exist in consumption patterns, aspirations, approach to environmental issues, and the use, access and control of environmental resources (ILO, 2015[89]). Lastly, women – and especially single mothers and elderly single women – are disproportionately affected by energy poverty (Clancy et al., 2017[90]).

By ethno-racial status

Climate change is having a disproportionate impact on marginalized communities, including people of colour and indigenous peoples when in the minority of the population. These groups are often more vulnerable to the effects of climate change due to factors such as living in areas more susceptible to extreme weather events and exposure to environmental hazards. For example, people of colour in the United States are more likely to live in areas with poor air quality, which can lead to respiratory problems (Avtar et al., 2021[91]). Racial disparities related to climatic changes have been found in the U.S. with respect to mortality, respiratory and cardiovascular disease, mental health, and heat-related illness, also because of worse health and living conditions that pre-existed the adverse climate event (Basu et al., 2017[92]; Berberian, Gonzalez and Cushing, 2022[93]).

Moreover, these groups usually lack access to resources to adapt to the changing conditions. For instance, an increase in demand for credit usually follows disasters, but insurance and credit market imperfections restrict supply of credit more in high-risk areas (Garmaise and Moskowitz, 2009[94]). Lastly, the solutions to address climate change often require significant investments in infrastructure and technology, such as house refurbishing or electric vehicles. These investments may not be accessible to communities of colour that tend to have lower income, thus exacerbating existing inequalities.

In rural vs urban communities

Job and income effects are concentrated in some regions more than others. As mentioned already, employment in emission- or pollution-intensive industries is often geographically concentrated, so much so that within-country regional variation in emissions is larger than between countries (OECD, 2021[95]). The same holds true for the impact of climate change itself, either in the form of extreme weather events, or because of the regional specialisation in activities that are sensitive to climate changes (e.g., tourism, agriculture, energy production) (OECD, 2020[96]). These local or regional employment effects are often

difficult to mitigate, have large knock-on effects on the local economy (including on crime and mental health), and can give rise to strong narratives about the job-killing potential of the green transition (OECD, 2023[21]).

Moreover, insofar as climate change affects disproportionally the productivity of sectors that are prevalent in rural areas (e.g. agriculture, fisheries) while high-tech and knowledge-intensive employment concentrates in urban areas, the urban-rural divide may be exacerbated (Hsiang et al., 2017[97]). Rural households are also more affected by rising fuel costs because more car-dependent (Joyce et al., 2022[98]) and with lower average income, but less so by air pollution and rising temperatures (OECD, 2021[84]).

Health and other non-monetary outcomes

Health

Most nonpecuniary benefits are health benefits associated with a reduced exposure to pollution or extreme temperatures. Climate change can harm human health. Extreme weather events such as severe droughts and floods brought about by climate change can result in a heavy count of injured and dead people. Extreme cold and hot temperatures increase mortality, and the economic cost of this increases with the amount of carbon emitted in the atmosphere (Kovats and Hajat, 2008[99]; Carleton et al., 2022[100]). The age-adjusted mortality rate in the U.S. could increase by 3 percentage points by the end of the 21st century due to extreme (hot and cold) temperatures, under the "business as usual" climate scenario (Deschênes and Greenstone, 2011[71]). An analysis covering 43 countries worldwide for the years 2000-2019 also find that non-optimal temperatures were associated to substantial excess mortality, but that excessively cold temperatures were especially biting (Zhao et al., 2021[101]). In this light, moderate increases in temperature may reduce cold-related excess deaths in the short run. One specific channel through which rising temperatures can impact health is anti-microbial resistance. Higher temperatures are likely to enhance the diffusion of infectious diseases that require antibiotic treatment in both human and animal populations, and to produce thermal adaptation in microbes, leading to higher antibiotic resistance (Burnham, 2021[102]). A positive association between minimum ambient temperature and antibiotic resistance has already been established for 28 European countries and across pathogens and antibiotic subclasses, with the relationship increasing in strength over time (McGough et al., 2020[103]). Moreover, an empirical association seems to exist between higher summer temperatures, rainfalls and droughts and the spreading of the West-Nile virus in Europe (Watts et al., 2021[104]), which raises the issue of the link between climate change and the likelihood of epidemics more broadly.

Air pollution creates other serious health risks: it increases the incidence and the severity of cardiovascular and respiratory diseases, including asthma, bronchitis, lung cancer and heart disease (Kampa and Castanas, 2008[105]). Across EU countries, exposure to air pollution from fine particles ($PM_{2.5}$) was related to an estimated 168 000 to 346 000 premature deaths in 2018 (OECD/European Union, 2020[106]). Overall, better air quality, improved water quality, effective waste management, and enhanced biodiversity protection should not only reduce the vulnerability of communities to pandemics, but also improve overall societal well-being and resilience.

Older people are especially affected by air pollution and extreme temperatures, as the effects of these on health accumulate over the lifetime. Other vulnerable categories include children, those with chronic diseases and those experiencing material deprivation, but differences across populations exist depending on climate, culture, housing conditions and other factors (Kovats and Hajat, 2008[99]). Lower-income households are more vulnerable to the health effects of air pollution, either because they are *more exposed* to pollutants, or because they are *more susceptible* to serious health consequences when they are exposed (OECD/European Union, 2020[106]). Higher *exposure* among the poor may be due to their lower ability to pay for environmental quality goods, or the lower willingness to pay for them, because

environmental quality is not considered an essential need, or because of limited information about the consequences of poor air quality on health.[13] Higher *susceptibility* may be related to poor initial health conditions, constrained access to healthcare, or limited means to invest adaptation strategies (e.g., housing quality). Overall, vulnerable groups may have a considerable stake in the success of climate polices since they bear a disproportionate share of the health costs of air pollution and temperature changes.

The aggregate economic effect of these relationships can be important. For example, OECD (2020[106]) estimates that exposure to air pollution from fine particles in 2018 was related to a welfare loss of 4.9% of GDP across the EU. This was due mainly to the impact these air pollutants have on mortality, but also on health expenditure, quality of life and labour productivity for people living with related diseases.

Cognitive development

Exposure to high levels of air pollutants has been linked to the likelihood of an array of diseases, including accelerated aging of the arteries and brain, higher risk of dementia and cognitive decline (Clifford et al., 2016[107]). High temperatures can further affect decision making, and cognitive functioning and attainment (Heyes and Saberian, 2019[108]; Zivin, Hsiang and Neidell, 2018[109]). Horvath and Borgonovi (2022[110]) offer a comprehensive review of the cognitive effects of air pollution and ambient temperatures, and show that some of these effects manifest themselves already at birth or in-utero, impairing natural developmental processes that occur in the central nervous system as well as physical growth. The effects can then persist and amplify over time due to post-natal environmental conditions, including because of absenteeism from school and lower students' performance in high-stake exams. Differential human capital accumulation over the lifetime creates increasing opportunity gaps across socio-economic groups that have different exposure to pollution, and tend to perpetuate inequality across the generations (Currie, 2011[72]).

Housing

Heating and warming housing accounts for a quarter of GHG emissions in OECD countries, but the impact of housing on GHG emissions worsens when the entire lifecycle is accounted for, from construction and demolition to the choice in location and commuting for individuals. Tackling emissions from housing is therefore an essential component of OECD countries' plans to reach net-zero. These efforts should consider both new and existing buildings, because housing that exists today will still make up the bulk of all housing in countries for the next several decades.

Interventions to increase the energy and emission efficiency of buildings and the construction sector more broadly can reduce emissions, all while mitigating the impact of extreme weather conditions (heat waves, hard winters) on households' wellbeing. Investments in "green" housing include investment in renewable energy appliances connected to housing and retrofitting existing homes to improve insulation and to make heating, cooling, lighting, and appliances and electronics more energy efficient. Stronger demand for these services is likely to sustain employment in the construction sector.

These investments are not affordable for all. Housing prices have increased over the past decades, and households are dedicating a larger share of their budget to housing costs than they used to. This applies to the low-income and, increasingly, to the middle class (OECD, 2021[111]). The COVID-19 pandemic, coupled with the current cost-of-living crisis, has exacerbated the long-term residential affordability crisis by reducing income and job opportunities for some, accelerating supply-demand mismatches in housing, and increasing the price of some commodities that are needed in construction. These extra costs have added to the challenges of lower income households living in energy-inefficient homes in particular, making

[13] Past and present policies may also disproportionally expose the poor to pollutants, for instance by placing toxic and polluting facilities or high-traffic roads closer to poorer neighbourhoods.

their housing even more unaffordable. Badly insulated homes with energy inefficient appliances increase energy consumption and worsen the impact of the current cost-of-living crisis price spikes on household finances (OECD, 2023[112]).

OECD countries can introduce subsidies to building regeneration, among other climate policy measures targeting housing (see next Chapter). Targeted subsidies have the potential to benefit low-income households the most, who are less willing or able to pay for environmental quality. In the case of housing, however, progressivity is counterbalanced by the fact that environmental improvements – including those instigated by climate change mitigation policies – accrue to housing prices, and in many OECD countries home ownership is concentrated among the rich and renting among the poor (Bento, Freedman and Lang, 2015[113]). In these cases, housing regeneration subsidies, can be regressive, and targeting becomes all the more important. Policy measures further need to account for the split incentives of owners and renters to invest in housing regeneration: while costs are typically covered by owners, the immediate benefits (in terms of warmer and healthier housing, and savings on bills) are accrued by renters. At the same time, the time to break-even from a retrofitting investment (via lower bills) is generally too long to for renters to find the upfront investment convenient (OECD, 2023[112]).

Public policies on housing can also affect the reallocation of individuals across regions. Individuals in regions that are especially exposed to extreme weather events, or in regions that are intensive in emission-intensive jobs, may need to seek employment opportunities elsewhere. To the extent that residential mobility is linked to labour mobility, housing policies that limit residential mobility can delay the transition to net-zero, by increasing the incidence of long-term unemployment in a given region (OECD, 2020[114]; Causa, Abendschein and Cavalleri, 2021[115]).

Migration

The direct and indirect consequences of climate change for migration have generated alarming headlines, with fears that climate change will cause future mass migration. Evidence to date suggests that migration in response to climatic shocks mainly takes place internally or to neighbouring countries (Selby and Daoust, 2021[116]), and that OECD member countries are less directly affected due to highly urbanised populations that are less dependent on local environmental conditions (de Sherbinin, 2020[117]). Model calculations show that, until 2050, between 78 and 175 million people will be mobile due to climate change, but only a minority of these will move across borders (Czaika and Münz, 2022[118]).

Moreover, the impact of climate change on migration flows is complex and difficult to isolate, as climate change is only one of several factors that influence migration decision-making. Climate change affects human mobility often indirectly, via economic factors such as declining or more volatile agricultural incomes, shrinking livelihood opportunities, and rising food insecurity.

Besides migration due to slow- and fast onset climate events, future migration may also be indirectly influenced by policy responses to climate change. The impacts of job creation and destruction resulting from policy measures to decarbonise the economy are expected to be higher for non-OECD countries, and particularly for countries and regions which heavily depends on fossil fuels (Chateau, Bibas and Lanzi, 2018[7]), which also hosts large number of migrants. The members of the Gulf Cooperation Council together host around 30 million migrants, often employed in constructions projects that revolve around oil (Huckstep and Dempster, 2022[119]). A global shift towards more renewable energy sources, and a sequential fall in oil prices, is likely to result in some changes in the patterns of future migration flows in the region.

While the impact of climate change on migration flows has received significant focus, much less attention has been paid to the role of migrants as a positive force in the net-zero transition process. Migrants constitute a key source of labour in OECD countries, representing between 16% (OECD Europe) and 25% and above (Australia, Canada, and New Zealand) of the employed (OECD, 2020[120]). A considerable share

of the migrant workforce in OECD countries is concentrated in sectors that are important for the green transition, such as the construction and ICT sector (OECD, 2020[120]). As discussed above, ill-designed labour market institutions hamper the reallocation of workers between sectors and occupations, and certain key sectors are already experiencing skills gaps and shortages. Labour migration offers one way to address labour and skills demand-supply mismatches and speed up the transition process.

Other megatrends and the net-zero transition

The transition to net zero needs to be managed alongside other global megatrends, such as the digital transformation of production, population ageing, and globalisation. These changes in the structure of the economy and society interact with each other, in ways that can both speed up and hinder the transition towards a carbon-free economy. Such interactions are numerous and complex, but some are especially relevant to design climate, labour, health and social policies that can support the transition to net-zero.

The digital transformation

An important enabler of the net-zero transition is investment in emission-saving, pollution-free technologies, and in the organisational changes that are required to make these work on the job place and in everyday life. This relevant technological component – and the labour market changes it causes – draws a parallel between the "green" and the digital transformations (OECD, 2012[121]). In both cases technology adoption and innovation foster the reallocation of labour away from some occupations and sectors, stimulate the creation of new jobs and professional profiles, and change the task composition and skill requirements of (some) jobs.[14] At the same time, one of the key features of the digital revolution is the large and rapid decline in prices of digital technologies, which facilitates their diffusion across all sectors of the economy. Similar declines and rapid uptake is now being experience in a number of sectors relevant to the net-zero transition, including renewable energy, batteries and electric vehicles (International Energy Agency, 2022[122]), but the potential for these technologies to diffuse to all sectors is yet to be assessed.

Some of these technology-driven labour market changes may be caused by both transitions simultaneously. First, advanced digital technologies and AI can accelerate the transition to net-zero by helping manage energy systems and achieve faster progress in emission reductions (OECD, 2022[123]).[15] Secondly, savings generated by firms that automate parts of production or adopt artificial intelligence technologies can be reinvested in "green" technologies and in expanding employment in "green" jobs.[16] Thirdly, firms that have successfully adopted digital technologies may be at advantage when switching to a "greener" way of producing, which can amplify pre-existing differences between frontier and laggard firms, but also accelerate the exit of less-viable firms and the reallocation of labour and capital towards "greener" productions.

At the same time, however, firms that decide to invest in "green" technologies may decide to invest in automation technologies as well, so as to generate long-term savings on labour costs. Indeed, some jobs may be "green" and involve a high share of non-routine, manual tasks, such as jobs linked to sustainable consumption (e.g. handicraft occupations, repair technicians) (Georgieff and Hyee, 2021[124]). Others, conversely, may be "green" but automatable, making them poor candidates for sustainable employment in

[14] Skill requirements from the two transitions may be quite different in nature and complexity, as pointed out here above in previous sections.

[15] On the downside, producing, transporting and powering artificial intelligence technologies likely generates substantial GHG emissions and contributes to resource depletion. The climate impact of artificial intelligence applications, conversely, is so far ambiguous (OECD, 2022[123]).

[16] Naturally, the sizeable public and private investments that are needed to reach net-zero can also trigger further automation and adoption of digital technologies.

a net-zero economy. In this case, and when the double transition magnifies the gap in skill requirements between "old" and "new" jobs, the coexistence of both structural changes can raise unemployment and exacerbate voters' resistance to climate change mitigation policies.

Demographic change

Climate change can impact the size of the working-age population to some extent. As mentioned, some aspects of climate change increase mortality, the frequency of sickness and absenteeism, and workers' cognitive and learning abilities. They also have a disproportionately negative impact on older people.

Some aspects of demographic change can delay the transition to net-zero. First, demographic change shrinks the size of the working-age population and of the labour force via ageing and lower fertility. Older workers, moreover, are less likely to engage in reskilling activities, including those that enable their reallocation towards "greener" jobs. These aspects of demographic change reduce the number of qualified workers that can enable the transition. Furthermore, a shrinking working population can erode the tax base, while a higher dependency ratio increases the need for spending on social protection and health, possibly reducing the resources available to invest in the green transition (European Environment Agency, 2019[125]). Lastly, several studies show that older adults are less inclined to sacrifice part of their income on behalf of a clean environment than younger adults (Stokes, Wike and Carle, 2015[126]), and that younger adults are more concerned about climate change than are older individuals (Gifford and Sussman, 2012[127]; Carlsson et al., 2013[128]).

Globalisation

A long literature has discussed the environmental consequences of international trade (Copeland and Taylor, 2004[129]). Between a quarter and a third of global pollution emissions are used to produce traded goods (Copeland et al., 2021[130]). The most emission-intensive industries (e.g., manufacturing) tend to be subject to the lowest tariffs and to be most exposed to trade. These estimates also factor in emissions from the entire value chain of traded goods, including electricity and other intermediate goods.[17] However, stopping to trade certain goods would not guarantee a reduction in emissions: goods may then be produced and sold domestically, so emissions from intra-national trade would simply replace at least some of the emissions from international trade, while limited economies of scale and diffusion of clean technologies could actually increase the carbon content of domestic production. In the meanwhile, prices, quantities, and even technologies embedded in goods traded would change, making it difficult to predict the outcome of emissions. Similarly, autarky would drop direct emissions from international transportation, but not necessarily overall emissions from transportation, because goods would need to be produced and transported within each country to satisfy demand (Shapiro, 2016[131]).[18]

Greater openness, however, can cause more emissions if polluting activities can be offshored away from countries with more stringent climate legislation (carbon leakage) (Peters et al., 2011[132]). Most of the evidence from recent empirical work is consistent with the view that more stringent pollution policies tend

[17] The increased fragmentation of production across global value chains since the 1990s implies that part of the CO2 emitted during the manufacture of a country's exports in fact stems from a third-party country located upstream in the value change (Yamano and Guilhoto, 2020[179]; Shapiro, 2021[175]).

[18] As an example, imagine a country sourcing a fixed quantity of goods from a single foreign producer 1 000 kilometres away, then switching to purely domestic production from multiple producers (and locations) in the country while using the same means of transportation. It is possible that the sum of the distance using location and multiple sourcing ones exceeds 1 000 kilometres.

to contribute to a comparative disadvantage in pollution-intensive production. That is, there is evidence for a pollution haven effect, but this seems to be small and vary with circumstances (Copeland et al., 2021[130]).

Lastly, globalisation increases technology diffusion across borders, and the exchange of relevant research and development can further stimulate "green" innovation. Exposure to the international market further increases firm productivity, and accelerates the exit of non-viable firms from the market.

The implications of all these mechanisms for income and jobs, however, are still unclear, as more evidence is needed. For example, existing studies find that trade globalisation has a small positive effect on income inequality (Heimberger, 2020[133]). This may translate into somewhat higher willingness to pay for environmental goods among the rich, but whether this is enough to outweigh the emissions associated with increased economic activity still remains to be assessed. An enhanced fragmentation of the global trade system that would require to produce "green" technologies domestically (or regionally) would also affect skills demand and could exacerbate skills shortages in some regions.

Policy responses

Potentially large short-term reallocation costs between jobs and into unemployment, disproportionate distributional impacts on some disadvantaged groups, and other pervasive externalities of climate change mitigation policies, all require governments to ensure the smooth functioning of the labour market and a fair sharing of the adjustment costs of the transition, while preserving the incentives to decarbonise. At the same time as policy makers seek to rebuild their economies after the COVID-19 pandemic and enhance resilience against the current cost-of-living crisis and future shocks, they will also need to push ahead with addressing the challenges and opportunities of the net-zero transition.

This section describes the most important dimensions of labour market, social and health policies that can enhance the adaptive capacity of the labour markets in the face of climate change and the greening of the economy while protecting those most adversely impacted and preserving or strengthening the economic incentives to achieve net-zero by 2050.[19] Some of these policies can also contribute to accelerating the transition towards net-zero, as in the case of labour mobility policies that foster entrepreneurship and innovation in the "green" sector, for example.

In line with the OECD Jobs Strategy (OECD, 2018[134]), the structural adjustment pressures resulting from green transition policies and climate change should reconcile employment flexibility and security by focusing on securing workers' employability and income, rather than their jobs, and fostering resilient and adaptable labour markets.

Several fundamental principles can be identified which apply across different types of policy interventions:

- **Anticipating the impact of climate change and mitigation policies on the labour market**. To a large extent, the green transition is policy-driven, in response to the clear evidence of the need for urgent action raised by climate science, including increasing extreme weather events and the failure of pure market forces to foster the transition in time to avoid irreversible climate damage. Moreover, some economic aspects of the net-zero transition are inevitable – such as the phasing out of coal and oil as principal sources of energy. There will be both winners and losers from climate change mitigation policies and, hence, planning should be undertaken as to how to support the losers from the green transition. This should include better consultation with the key stakeholders on the necessity for the green transition and the measures that may be needed to support the affected communities.
- **Public policy interventions should be timely**. A key lesson from the OECD's reviews of government assistance to workers who have lost jobs because of structural changes in the economy is to act quickly, as the cost of for the losers accrue with time (OECD, 2018[65]), and so does political opposition, if effective policy interventions are not forthcoming. For instance, interventions to reallocate workers should not wait until workers have lost their jobs or once they have exhausted their severance pay, as this delays the transition process to new jobs or increases

[19] The ILO Guidelines for a Just Transition offer a portfolio of policy options for addressing the issues associated with the "greening" of the economy and the workplace. They postulate that policies should anticipate the impact of the transition on employment, provide adequate and sustainable social protection, and feature skills development and social dialogue (ILO, 2015[158]).

the cost of job search for the unemployed. Similarly, early interventions to limit the harm of certain climate conditions on health can reduce mortality or the cost of treatment. In some cases, timely interventions should also be time-bound: while policy actions accompanying a structural transformation may need to be generous and lasting to achieve their objective, they should also make efficient use of public resources, and limit distortions to prices and incentives, to preserve the smooth functioning of labour, social and health institutions. Other interventions, conversely, may need to be long-lasting to produce the expected behavioural change (e.g., a carbon tax), thus suggesting that the duration of the policy intervention, everything else held constant, should be the object of a case-by-case assessment.

- **Taking a tailored approach**. There is no one-size-fits-all approach. Initial conditions and exposure to climate events and climate change mitigation policy actions vary across workers' groups and regions. Mitigation policies that are blind to these differences risk to be perceived as unfair and may bolster discontent among communities that suffer the most from the climate policy action. Labour market and health policy interventions, therefore, should be targeted – to the extent that this is possible. While targeting is usually more demanding than general measures in time and administrative resources, it can eventually decrease the overall cost of the policy intervention, and allow for more generous support for those that really need it. For those situations where swift action seems appropriate instead – as in the case of the spike in energy prices caused by the war in Ukraine, or in presence of an extreme weather event – the policy maker should evaluate whether the fiscal burden of a fast and horizontal, possibly even universal intervention is acceptable.
- **Policy interventions should take a whole-of-government approach**, to provide comprehensive support for workers and communities affected by the transition. This goes beyond immediate employment and training support and includes local economic development and better framework policies for promoting mobility. For instance, policies that aim at revitalising or communities hit by a climate shock or those where emission-intensive activities must be scaled down should contribute to create alternative employment opportunities, rehabilitating polluted areas, and reducing barriers to job and geographical mobility. Another important implication is that governments can design climate policy as part of a larger policy mix that includes labour, social and health policies.
- **Existing policy instruments may require re-examination**. Many of the labour market policy interventions warranted by the net-zero transition may already be in place, as they were developed to address the labour market, social or health consequences of other structural changes, such as the digital transformation or the shift to a globalised economic system. For the net-zero transition, the target populations may differ, and extra resources may be needed to finance an expansion in the scope or generosity of these labour market, social and health policy instruments. Existing tools may need to be used more effectively. The extent to which innovations in their design are required in the context of the net-zero transition, however, is not yet clear – at least for those policies that proved effective in the first place in the context of other industrial transitions. The design of ad-hoc programmes, furthermore, may not be necessarily desirable (OECD, 2006[135]). They increase the administrative cost of the overall intervention and raise questions of fairness towards non-recipients who are affected by other structural or cyclical phenomena.

Activation policies

Addressing effectively structural change brought about by the net-zero transition underscores the importance of an efficient and effective activation strategy. This combines measures that strengthen people's motivation to search actively and accept suitable jobs (e.g., via the incentives of the tax and benefit system and job-search requirements linked to benefit sanctions), with actions to expand

opportunities (e.g. job-search assistance, subsidised employment), and interventions to increase employability (e.g. training programmes) (OECD, 2015[136]). Active labour market policies (ALMPs) can help workers and firms to adapt quickly to changes brought about by greening the economy, in a similar way to what has been happening for other megatrends, by providing information, guidance, matching services and training. Building resilience for the upcoming net-zero transition would certainly benefit from adaptive ALMP systems that can respond to labour market challenges in agile and effective ways, with some systems in OECD countries being more suitable than others (Lauringson and Lüske, 2021[137]).

Efficient employment services and ALMPs are crucial for the success of an activation strategy. An ambitious green transition calls for a focus by employment services on skills profiling, identifying transferable skills and providing guidance. Effective profiling tools must be developed and used sufficiently early in the jobless spell or even during the notice period, to provide more targeted support and in doing so alleviate the cost of job displacement (OECD, 2018[138]). Digitalisation of employment services can help deliver better services to clients and free up resources which can be redirected towards recipients who need them most (OECD, 2022[139]). Indeed, for more vulnerable workers, the provision of these services may require more intensive support, the effectiveness of which is typically enhanced by a low client-to-staff caseload ratio. Local employment offices should also receive sufficient resources to recruit qualified personnel who can acquire local labour market expertise to effectively place people into jobs, which is especially important in the framework of the net-zero transition, whose impact on the labour market will vary across regions. ALMPs should be evaluated, with the goal of discontinuing or modifying ineffective ones and investing resources where they really make a difference for the transition.

Current ALMPs do not generally have a specific focus on “green” jobs or skills. Defining “green” occupations however could be important for placement activities, and guidance and career services. In several EU Member States, public employment services (PES) have been involved in identifying “green” and “greening” occupations and to establish corresponding occupational profiles according to PES or national classification of occupations. A few PES have already started to improve labour market information system accordingly, but these efforts could be expanded. Close cooperation with other partners – including social partners – is important: it can lead to an easier identification of prospective job opportunities and of the skills that are most portable under current market conditions (European Commission, 2021[140]).

A different question is whether workers in emission- or pollution-intensive activities who have lost their jobs or risk job loss should also receive special assistance, as they shoulder a larger share of the labour market cost of the net-zero transition. In this case, solving the hurdle of defining who falls in this category becomes necessary. While some industries and occupations are more clearly “brown”, others may be more difficult to place, and different employers in the same sector may use technologies of different carbon-generating potential. Moreover, the downsizing of an emission-intensive company may have important employment spillovers in its region, and policy makers should decide to what extent workers in these satellite, potentially less emission-intensive activities should also receive special assistance. Lastly, not all individuals employed in emission-intensive activities need the same level of assistance, if their skill set is transferrable or already in demand on the labour market.[20]

Many studies have concluded that hiring subsidies paid to the employer have a relatively strong positive impact on future employment outcomes for their participants (OECD, 2015[141]). For an effective use of public resources, subsidies should create long-term, sustainable employment that grants higher salaries than the counterfactual scenario. They should target individuals that the market cannot allocate efficiently, i.e., those that would not find a job without support (in the subsidised firm or in a competitor). This may be

[20] In any case, such special assistance should be time-bound and conditional to being employed in an emission- or pollution-intensive job at the time of the intervention, to avoid creating incentives for firms to move into emission-intensive technologies or sectors, so as to benefit of the extra resources of the programme.

related to the specific moment of the business cycle in which subsidies are activated, with more generous contributions being offered during contractions.[21]

Link to tax-and-benefit programmes

Effective activation should be accompanied by unemployment and social-assistance benefit systems that lower displacement costs by providing income support during the unemployment spell and effective re-employment services. The benefit system often provides the principal instrument for linking jobless people to employment services and active labour market programmes, as benefit recipients are referred to employment services, which then provide job-search assistance and other services. Moreover, the threat of benefit withdrawal provides an important incentive for engaged participation in active programmes (OECD, 2018[134]). The structural transformation of the labour market imposed by climate change strengthens the need for the coordination of ALMPs with well-designed tax-and-benefit systems (ref. section on social protection here below).

Adult learning policies

Labour market policies for a successful net-zero transition should ensure that workers are equipped with the right skills to thrive in the labour market. Individuals with the right skills are more likely to be employed and to land in a better-paid job, especially if they are well matched in terms of skills and qualification. A skilled workforce also makes it easier to innovate and adopt new ("green") technologies and work organisation practices, which can raise firms' productivity and stimulate further job creation.

The transition towards low-carbon economies will affect skills demand due to both rapid employment growth in emerging "green" sectors and the diffusion of climate-friendly production technologies and practices more broadly across the economy. Upskilling and reskilling can be strengthened to ensure a smooth transition of workers across jobs, or to adapt their current job to the needs of the green transition. In the short run, public training programmes, public support to training of individuals and firms can help to reduce skill shortages.

Targeted training programs are known to be more effective than broad training programs. However, strategies, policies and initiatives that focus explicitly on "green" skills and employment are still rare (CEDEFOP, 2019[30]).[22] The causes of this are numerous. Some workers may not require large retraining efforts to adapt to the new reality, as in the case of occupations that are not intrinsically "green" or "brown", but where workers may be employed in emission- or pollution-intensive industries (e.g., a data scientist working in a fossil fuel power production company). In a similar way, occupations requiring specifically new, "green" skills also typically require many skills that overlap with those required by similar "non-green" occupations, as e.g., in the case of a boiler maintenance worker that needs to work with heat pumps. Special training for "green" jobs could then simply "top-up" workers' knowledge. This could be specific to the "green" job, or transversal, thus fostering workers' adaptability and reallocation potential.

Lastly, reliable information on the specific skills required in specific sectors may be lacking. Countries need high-quality labour market information systems that track emerging skill needs and share that information

[21] Direct job creation measures and public works with ecological objectives can also be activated to support the integration of vulnerable groups. Public sector employment programmes, however, have on average negligible, or even negative impacts (Card, Kluve and Weber, 2018[174]), The variation in successful outcomes depends on a host of factors, including differences in the target groups, the design of the programme, or the economic environment in which the intervention takes place.

[22] There are of course examples of training programmes that target "green" skills. The French public employment service (Pôle Emploi), for example, monitors "green" developments and directs clients into "green" job opportunities.

with labour market actors, policy makers, and training and education providers. Effective strategies to leverage qualitative and quantitative information on skills needed in a low-carbon economy into relevant policy actions are described in OECD (forthcoming[142]). Through a comparative assessment of practices for skills assessment and anticipation (SAA) in five OECD countries (Australia, Austria, France, Norway, and Sweden), the report finds that designing a SAA for the green transition requires a range of decisions, including defining skills and "green" policy targets, focusing on current vs future skills needs, covering the whole-of-economy or just some industries, stakeholders' involvement, and the use of quantitative or qualitative methods. What they choose, and more importantly, what they exclude, will set the basis for which policies can be supported by the SAA findings.

Further actions to improve the effectiveness of training policies in the net-zero transition include the ability to reach out to potential learners and guide them in their choice of training course and potential new jobs, the recognition of individuals' existing skills, and the development of a high-quality market for training providers that delivers on the requirements of the green transition. Most of these actions will require bringing different levels of government together with relevant stakeholders, including employer associations and trade unions.

A job-rich transition crucially hinges on the adoption of "greener" business models, too. These encompass both the appropriate internal processes that enable firms to evaluate and change their emission impact ("green" managerial work practices), and a set of skills, knowledge and abilities that managers should have to successfully deliver the net-zero transition ("green" management skills). For instance, teleworking practices and worktime flexibility could help reduce the carbon footprint of commuting to work, although it can increase emissions from more intensive use of computer resources and extra heating and cooling of homes (albeit only seasonally). Evidence suggests, however, that few firms overall adopt advanced managerial practices (Eurofound and Cedefop, 2020[143]), including of the "green" type (De Haas et al., 2021[144]), thus making room for appropriate policy actions.

In the longer run, the skill needs brought about by the green transition will affect the design of education curricula, which can reduce the incidence of skill imbalances and improve school-to-work transitions.

Vocational education and training (VET) are particularly well-placed to support the net-zero transition, because of their close link to the world of work both in the development and delivery of curricula that match market needs, and in promoting work-based learning. Furthermore, the green transition does not necessarily need the diffusion of radically different products and process, but rather incremental improvements to existing ones. This requires activities such as tooling up, developing prototypes and testing, which heavily rely on skills acquired through vocational training. The outstanding challenge is the capability of VET systems (including Initial VET) to anticipate the new skill needs and adapt curricula quickly enough to avoid the emergence of significant skill mismatches.

In parallel, education institutions have the potential to increase students' awareness of the environment and the upcoming green transition. This can draw more young people into professions in "green" sectors and produce important changes in society's behaviours and consumption patterns.

Education institutions should provide the foundational knowledge and skills to identify and resolve environmental challenges, and shape attitudes and behaviours that lead to both individual and collective actions.[23] Environmental sustainability competences can be developed in school via two main channels: socialisation among students, and curricular content and didactics (Borgonovi et al., 2022[62]). For the first channel, the literature recognises the existence of peer social effects on the attitudes towards climate change of students belonging to the same school, and schools represent the most important social environment outside the family (Coertjens et al., 2010[145]). For the second channel, evidence exists that

[23] Education systems can also act responsibly as a consumer, by choosing goods and services that have a reduced emission impact.

collaborative teaching methods strengthen students' critical spirit towards climate change, for instance. Moreover, PISA 2018 reveals that most countries already deploy curricula that teach of climate change and global warming, but this does not translate into uniform acquisition of environmental sustainability competences, including within countries. Family, society and education institutions complement curricula in developing these competencies. Schools in particular can influence students' educational and professional aspirations, particularly in Science, Technology, Engineering and Mathematics (STEM) disciplines (Borgonovi et al., 2022[62]).

Regulatory framework and labour market institutions

A well-functioning labour market is a prerequisite for a successful net-zero transition. Workers – and those in emission- or pollution-intensive jobs in particular – should be able to shift across jobs (within or across sectors) without long periods of unemployment, but also to change location if that becomes necessary. Similarly, opportunities for the unemployed can only be created if employers have the right incentives to hire, create new ventures or liquidate their business and possibly relocate it elsewhere.

The efficiency of this process of reallocation is largely determined by the functioning and regulation of financial, housing and product markets, including through policies that affect entry and exit of firms. Labour market policies and institutions play an important role by determining the flexibility with which firms can adjust their workforces and the ease with which workers can move across firms.

Labour market regulation can enable the development and diffusion of new "green" technologies if they do not unduly prevent firms that lead in the development of "green" technologies from growing and gaining market shares, including by recruiting workers previously employed in laggard firms. Labour regulation should also be supportive for the creation of new firms, considering that business start-ups account for a large share of new technologies, and in particular break-through innovations.

A key role in determining the rate of reallocation away from emission-intensive firms or sectors is played by *employment protection provisions.* A balanced approach to employment protection yields regulation that does not prevent job reallocation by excessively increasing termination costs for the firm, but still protects workers against unfair hiring or firing practices, and the destruction of viable worker-firm matches (OECD, 2018[134]). Some worker turnover can indeed contribute to innovation and technology adoption, but an excessive one, or a large gap in protection between workers on open-ended and fixed-term contracts, can limit investment in firm-specific human capital and therefore inhibit innovation. This holds true for both "green" and "brown" activities that are investing into the green transition, as in the case, for instance, of oil and gas firms that are transitioning towards cleaner energy sources. At the same time, workers' protection should not hamper the reallocation of workforce away from emission- or pollution-intensive activities when these are downsizing because of climate change mitigation policies, and can be outright detrimental to innovation and risk-taking in ("green") start-ups (Bottasso, Conti and Sulis, 2017[146]). Creating different standards of regulation across sectors, however, may not be an appropriate policy response. Governments can activate other complementary policy levers that can be modulated by sector, and in the degree of employment protection (when this is already balanced), or introduce them jointly with a reform of the Employment Protection Legislation.[24] Lastly, a balanced approach to employment protection legislation should also be reflected in the system of benefits and transfers that protects workers in case of job losses. Relatively generous unemployment benefits can co-exist with less stringent dismissal regulation and, at the same time, lower voter resistance to climate change mitigation policies among displaced workers.

[24] A reform of employment protection legislation itself should be considered with caution, as it can induce additional short-time employment costs and therefore exacerbate the cost of the transition – see (OECD, 2016[176]) and (Bassanini and Cingano, 2018[177]).

Job retention schemes can complement the system of incentives created by EPL, when protection is very limited but there is scope to maintain the worker-firm match during temporary downturns (e.g., in "green" start-ups), or in case of a sudden fall in demand, as in the case of the energy crises caused by the war in Ukraine. Some job retention schemes require supported workers to engage in training while on furlough, which can enhance their ability to move across jobs (see the dedicated section below on adult learning). Existing studies, however, point to the importance of finding the optimal duration for the scheme (Hijzen and Martin, 2013[147]) to reduce the risk of keeping workers in jobs that are not viable in the long term. This is especially important in the context of a structural transition to a net-zero economy, where switching from a "brown" to a "green" job is a welcome policy outcome, and the policy marker may want to reduce the incidence of "brown" employment.

Other labour market institutions can support mobility of workers between firms by removing barriers to and strengthening incentives for job mobility. *Occupational licenses*, for instance, by imposing minimum standards of competence to practice for pay, limit entry into the occupation only to those practitioners whose skills have been recognised to be at or above the minimum requirements. Licensed workers that lose their job in a region where the frequency of "brown" jobs is highest have limited possibilities to find employment that matches their skills in other regions, if their license is not recognised there. Reviewing the regulation on occupational licenses could extend mutual recognition of entry requirements across jurisdictions, for example, or allow for a public subsidy to the cost of occupational licensing for workers that wish to work in "green" industries.

Other provisions can further enhance labour mobility by reducing the pervasiveness of labour market concentration and monopsony power. Monopsonistic competition is a frequent occurrence in OECD labour markets (Araki et al., 2022[148]), and it limits the number of outside options for workers who seek to change jobs. This can reduce the pace of reallocation out of emission-intensive jobs or regions, and job creation in high-productivity firms in all sectors. Policies which directly limit concentration or counteract uneven employer power in the employment relationship include the expansion in the scope of action of antitrust authorities, to investigate mergers and no-poaching agreements, and a renewed effort to legislate these phenomena (Araki et al., 2022[148]). Non-compete agreements (NCAs) may also be reconsidered, as there is little evidence that they can effectively promote innovation (Belenzon and Schankerman, 2013[149]), while they can constrain the reallocation of workers from "brown" to "green" employers in the same sector and region (insofar as workers seek to find employment in the same occupation).[25] Removing obstacles to geographical mobility can also expand the worker's set of outside options. First-order tools in this sense are *housing policies* such as rental regulation, land-use and planning reforms, taxation on housing purchases, or investments in social (or public) housing (OECD, 2021[150]), but also public investment programmes, and improvements in higher quality healthcare and transport policies in a region (Causa, Abendschein and Cavalleri, 2021[115]).

Well-functioning *collective bargaining institutions*, particularly when associated with high coverage, can also add to the effort of bringing forward the net-zero transition. Social partners are generally involved in policy design, with the scale and nature of involvement being shaped by the overall approach to social partner engagement in individual countries. Evidence from Europe, however, suggests that *collective bargaining and social dialogue* practices on the effects of climate change mitigation policies on industries and workers are currently not widespread (Eurofound, 2021[151]).

Depending on its design, collective bargaining can allow for more differentiation in terms of wages and working conditions than statutory rules, but it can also improve product or service quality, increase productivity and promote a broad sharing of productivity gains (OECD, 2018[134]; OECD, 2019[152]; Bednorz

[25] Many NCAs, however, cannot lawfully prevent workers to seek ("green") employment in a different region. The policy maker can consider whether there exist other ways to protect trade secrets or preserve professional quality standards that are less noxious to within-region job mobility.

et al., 2022[153]).[26] In support of industrial transitions – including the "green" one –, collective bargaining can foster innovation in the workplace and skills development and skills use, including via the continuous update of workforce skills requirements and the creation of new education curricula to meet them as they emerge. Almost half of OECD countries have Skills Councils for instance, which conduct skills assessment and anticipation exercises, produce national occupational standards, and design and approve apprenticeship frameworks (OECD, 2019[152]). While these institutions are usually sectorial in focus, in some cases social partners set priorities for adult learning at company level as well.

OECD work on displaced workers highlighted the significant role that collective bargaining, in particular at the sectoral level, can play in helping displaced workers back into good jobs (OECD, 2018[65]). The Swedish Job Security Councils, for instance, provides support and guidance to displaced workers even before the displacement occurs, but also access to training opportunities in the case of plant closures and mass layoffs. In Austria Outplacement Labour Foundations provide assistance, guidance, reskilling solutions, and practical training to displaced workers, together with extended unemployment insurance.

As sectors differ greatly in their needs and preparedness to tackle the green transition, sector-specific approaches to collective bargaining are reasonable and relevant. However, the uneven cost of climate change mitigation policies across sectors can also generate sector-specific resistance to change and demands for specific support, that could delay the achievement of net-zero, if spillover effects to other industries and in the aggregate are not properly accounted for. A cross-sectoral approach to social dialogue at the national level can therefore also play its part. At national level, social dialogue can help design equitable measures of public support for the transition of the most affected workers, but also negotiate new regulations, discuss the role of industrial policies in developing the value chain of certain key technologies, or plan new investments.

Social protection

Social protection is a crucial building block of governments' strategies to promote the adjustments necessary for the net-zero transition, and to prevent or cushion any damaging disruptions to people's livelihoods that transition and climate change could produce. Social protection can help mitigate risks ahead of the displacement or the shock, and help people cope with their consequences. In the long term, social protection systems can promote better livelihood conditions, which can further reduce exposure to climate-related risks and be a vehicle of change. It cushions or prevents income losses, eases short-term credit constraints and helps the most affected protect or event increase their asset base, thus enhancing their ability to invest in adaptation strategies and adaptive capacity.

Furthermore, social protection can contribute to easing voter resistance to net-zero mitigation efforts, by making the green transition more inclusive and by pitching it as an opportunity to move up the economic ladder. Those most affected by climate change policies should not feel they are left alone to shoulder the high adjustment costs of the transition to net-zero, while the broad majority of the population benefits from the improved environment quality resulting from it. These political economy and equity arguments can motivate the implementation of special programmes targeted at assisting the individuals most affected by the green transition.[27]

[26] The accent on the design of the collective bargaining system is of importance: some collective bargaining systems can reduce voluntary mobility but also increase involuntary mobility; others can prevent competition and start-ups from growing, if rigid or reflecting negotiations in large firms.

[27] Equity arguments, however, may fall through if the needs of assistance for workers displaced by environmental policies are similar to those of persons displaced for other reasons. In that case, favouring one type of displaced worker

Some parts of social protection systems may already be well suited to serve these goals. Current extensive rises in energy prices have already required the mobilisation of some social protection instruments to help the poor respond to the price shock, including energy assistance, heating allowances, and food support (OECD, 2022[154]).

Targeting the support seems to be especially important in the context of climate change and emission-reduction efforts: targeting ensures that the support provided is fair and effective, while limiting its effects on government budgets and maintaining price signals to encourage carbon savings (Pototschnig et al., 2022[155]). Targeting can work in contexts where impacts are localised or community-specific, as in the case of those physically affected by extreme weather events, or those that heavily rely on large emission- or pollution-intensive industries or companies that require reconverting or downsizing. Targeting strengthens the case for investing in the technical capabilities of the administration to recognise and measure actual needs, and to effectively deliver the support while integrating multiple different policy instruments. Early warning mechanisms could then enhance the timeliness of the policy response.

Past lessons on the generosity and transitory nature of unemployment benefits are also likely to apply: high benefit replacement rates for the unemployed translate into relatively strong downward wage rigidities, especially for the low-wage workers (OECD, 2012[6]), which could discourage employment. In such cases, tax and benefit systems could be complemented with active labour market policies supporting job search and up-and reskilling, which would not require tinkering with the generosity of the benefit system.

Nevertheless, significant reforms or reinforcements in some countries and social policy areas may still be needed. These include the portability of social protection instruments across jobs (and jurisdictions, where applicable), mechanisms to ensure the financial sustainability of public funds, and the protection of non-standard workers, to name a few (Queisser, 2021[156]). An outstanding fundamental question that is to guarantee the resilience and continuity of national social protection systems in presence of multiple co-occurring shocks, including those induced by climate change (Lambeau and Urban, 2022[157]).

Moreover, coordination between the areas of social protection and climate change mitigation policies will need to be reinforced. Negative inequality impacts of mitigation policies can be mitigated and possibly even prevented, but this requires careful planning and rethinking in all stages of climate change policy making (Markkanen and Anger-Kraavi, 2019[70]). Climate and disaster risk considerations could be integrated into the planning and design of social protection programmes, for instance (ILO, 2015[158]). Furthermore, the previous chapter has already pointed out that certain mitigation policies are less regressive than others (e.g., taxes compared to standards), and that certain elements of design in both climate and social policy instruments can enhance progressivity. Attention should be paid, for instance, to the way revenues from market-based mitigation policies are recycled to compensate the losers from the policy, and to the sequencing of the policy, so that social protection measures do not intervene too late relative to mitigation policies (Dechezleprêtre et al., 2022[58]).

Offsetting the distributional effects of climate change mitigation policies

If some climate change mitigation policies have regressive redistributive outcomes, several examples exist across countries of policymaking that delivers both on climate and social objectives. It requires paying attention to the policy design and to appropriate mechanisms that can ensure that costs and benefits are shared across different income groups. These would help to combat poverty and address gender, race, health and economic inequalities, and to improve the political acceptability of mitigation policies.

Market-based climate change mitigation policies (i.e., policies that use markets and prices to incentivise behavioural changes that reduce emissions, such as pollution taxes and emission trading schemes) allow

over the others could be unfair and politically charged. An analysis of how the adjustment costs of workers displaced by climate change policies compare with those of other job losers is currently not available.

raising revenues that can be used to compensate the losers of the policy, as opposed to command-and-control policies (regulations and standards, such as mandates to use certain technologies). Market-based policies are therefore especially suited to adjust climate policy design and use a portion of the carbon revenues to offset detrimental distributional effects.

A large literature has investigated the design of carbon pricing policies in this perspective. For instance, Chateau et al. (2018[7]) show that introducing a carbon tax in OECD countries increases the probability of layoff the most for blue collar workers (central scenario), but these are also benefiting the most from reductions in income taxation paid for by the revenues from the carbon tax. The benefits, however, decrease with the level of ambition of the carbon tax, and very high carbon tax rates lead to lower net wages overall. Feindt et al. (2021[159]) analyse the incidence of carbon tax in 23 European countries, and find that where the policy is regressive, national redistribution can yield progressivity. Recent evidence from OECD analysis confirms that a lump-sum transfer to compensate for the introduction of a carbon tax in Lithuania leaves households in the bottom decile better off, and at least half of households up to the seventh decile. Compensation via lower taxes on labour income, conversely, can strengthen work incentives, but leaves more than 85% of the poorest third of Lithuania's population worse off (OECD, forthcoming[79]).

Whether the regressive effects of a market-based climate policy can be offset by transfers is therefore a function of a number of conditions and parameters, and in particular (holding the design of the climate policy instrument constant):

- The design of the revenue-recycling scheme. Several options are available: lump sums (including both targeted and universal cash transfers), cuts in payroll taxes or social security contributions, "green" investment plans, progressive subsidies for "green" goods, or place-based policies for distressed communities. Each of them has different advantages and disadvantages in terms of fiscal and administrative cost, coverage, redistributive properties and efficiency in GHG reduction, as pointed out in Shang (2021[160]) and Vona (2021[3]). A well-known result in the literature is that lump-sum rebate makes a carbon tax progressive (Rausch, Metcalf and Reilly, 2011[161]) because the rich pay a higher tax bill in absolute terms than the poor.
- The initial conditions, i.e., the economic and social context that contribute to growth and distribution (from the economic cycle, to distortions, to the quality of government services).
- The possibility to combine other policy instrument with the climate policy action, each tackling a different equity and efficiency aspect of the climate policy.

Housing policies as social policies

One particular area of social policy action for the green transition is supporting efforts to increase energy efficiency whilst maintaining affordability in the housing sector. In this field, minimising the adverse impact of climate change and mitigation policies on people's wellbeing may entail a broad reflection on the location where the dwellings are built, how they are connected to energy and transport systems, or to jobs and services that can reduce pollution and energy consumption.

An aspect of concrete policy action is the retrofitting and upgrading of the housing stock, while maintaining their affordability. There can be a trade-off between these two policy objectives, insofar as improvements to dwellings may translate into higher prices that can only be afforded by mid- or high-income households. Conversely, housing policy in the context of the net-zero transition may want to focus on policies that simultaneously address climate change and affordability concerns.

Housing allowances and social housing (public housing) are examples of financial support schemes that benefit low-income and other vulnerable tenants in particular. Other financial measures in support to prospective or existing homeowners (e.g., tax relief for home ownership) are more likely to benefit median-income households (OECD, 2021[111]). To facilitate the green transition of the existing housing stock,

however, subsidies to homeowners to retrofit buildings can be designed to enhance progressivity in the household's income (by capping and means-testing), or be paid depending on the actual energy efficiency gains achieved by the household (Hoeller et al., 2023[162]). On-bill tariff programs allow for energy efficiency upgrades in low-income households to be made in collaboration with utilities, with households being charged over time by modest amounts through the monthly billing system.

Financial support measures can be coupled with new regulations and standards relating to energy efficiency, construction materials or land use, and with information campaigns that promote best practices in the use of resources for housing. Renewed public and private investment in the affordable and social housing stock can be a lever of economic recovery and progress towards net-zero, with the potential to generate benefits for lower-income households in particular, provided that such upgrades do not lead to higher prices that are unaffordable to low-income households (OECD, 2020[163])**.** Building new social housing and retrofitting existing social and affordable housing according to high environmental standards contributes to move forward towards the net-zero transition, while at the same time reducing the risk of energy poverty for tenants and encouraging and creating a market for "green" capabilities in the construction sector (OECD, 2020[114]; OECD, 2021[111]). Land-use restrictions can also be eased to increase and diversify the supply of private housing with high environmental standards, while preventing urban sprawling (OECD, 2020[114]).

Enhancing the responsiveness of housing supply to changes in demand could make housing more affordable in the longer term and contribute to the effort of reallocating workers away from emission-intensive activities. To this end, areas with increasing employment opportunities could enforce rental market and land use restrictions that do not limit geographical mobility, and that strike a reasonable balance between renters and owners in terms of security of tenure and rent levels (Causa, Abendschein and Cavalleri, 2021[115]). Planning land-use governance at the metropolitan rather than local level could also facilitate the matching of supply and demand for housing and increase affordability.

Health policies

A first set of health-related policies for the green transition aims to limit the adverse effect of pollution on human health. For example, standards of emissions for pollutants already exist in many OECD countries, and in particular for producers in certain sectors such as energy production, transport or manufacturing (OECD/European Union, 2020[106]). Urban design can also help to improve air quality, by leaving space for trees and limiting that for fossil-fuel vehicles (e.g. low-emission zones, car-sharing schemes), and by creating partnerships among local stakeholders that incorporate health and climate change considerations into urban planning (OECD, 2017[164]). Redesigning transportation with an eye to foster the net-zero transition can benefit of a systemic approach, or a policy package that includes carbon pricing and incentives for electrification, but also street redesign, spatial planning, and the development of transportation networks (OECD, 2021[165]).

Limiting over-reliance on car use can go hand in hand with the promotion of regular physical activity, for instance via mass-media campaigns. Designing and implementing nutritional guidelines encouraging healthier food consumption can contribute to an overall healthier lifestyle, but also to a more efficient use of environmental resources in food production (soil erosion, deforestation, GHG emissions from agriculture production) (OECD, 2017[164]). Evidence exists that information campaigns and food labelling have contributed to mitigate the adverse effects of obesity on labour supply, for example (OECD, 2019[37]).

Moreover, the health sector is itself a source of air pollution and GHG emissions, albeit not a primary one. Minimising its contribution to overall air quality requires interventions to improve energy efficiency and the use of high-emission products, as well as incentives for healthcare workers to use "cleaner" transportation means. Hospitals and nursing homes can also lead by example in providing healthier food and reducing waste (OECD/European Union, 2020[106]).

Lastly, improving health conditions in schools, homes or workplaces can mitigate the impact of climate change (and in particular air pollution and extreme temperatures) on cognitive development. Adaptations and protective measures include ensuring adequate access to information about climate change that can influence personal behaviour, and installing air filtration, air purifying systems or air conditioning units. In the latter case, the long-term benefits on cognitive development should be weighed against potential increases in energy use and emissions from energy production (Horvath and Borgonovi, 2022[110]).

In line with the Guidelines for a Just Transition (ILO, 2015[158]), governments can mobilise several instruments to limit the damages of climate change and climate policy to workers' health and safety on the job. A first set of measures touches on information and awareness: there is a need to assess the level of occupational safety and health (OSH) risks linked to climate change and "green" jobs, and to understand what protection measures can be put in place. Access to such knowledge would be especially beneficial for small and medium enterprises and firms in sectors that are critical to the green transition. New or improved OSH regulation and OSH standards, for instance with respect to hazardous materials or new "green" technologies, could be coupled with greater efforts to embed OSH considerations in policy design, including in procurement standards (EU-OSHA, 2021[166]). The adoption of adequate standards and compliance with OSH regulation can be incentivised by designing or updating certification programmes, providing ad-hoc funding to firms, or strengthening monitoring and enforcement mechanisms, for instance endowing labour inspectorates with sufficient resources. Lastly, support to social dialogue can go a long way in improving OSH governance and standards in firms, and introduce or expand training on OSH, and a culture of learning more broadly.

Migration policies

Enabling migrant workers to bridge labour and skills gaps can support the low-carbon transition and become an integral part of adaptation strategies in both potential destination and origin countries. This requires policies to facilitate the mobility of migrant workers of different skill level, such as the recognition of migrants' skills, which ensures that migrant workers can contribute their maximum capacity to destination economies, and that they get matched with suitable jobs displaying lower emission- or pollution intensity. Procedures to recognise foreign qualifications and convert them into their host-country equivalents can also improve labour market outcomes for migrants (OECD, 2014[167]). Lastly, migrants should be granted access to education and training opportunities for upskilling and reskilling, and especially low-skilled migrants, who are particularly vulnerable to adverse labour market impacts. This may also enable the acquisition of occupational licenses for those "green" jobs that may require them, and that are therefore closed to migrants.

The increase in the demand for "green" skills can be met from both countries of migrant origin and destination. A way to support a more global transition process, and avoid that labour and skills required for the green transition are simply shifted from non-OECD to OECD countries, would be the use of Skills Mobility Partnerships (SMPs). SMPs integrate training in countries of origin with job or traineeship placement in countries of destination (OECD, 2022[168]). SMPs with a "green" skills focus could help develop relevant skills adapted to support the green transition in both countries of migrant origin and destination. Similarly, facilitating international student mobility and research exchange between OECD and non-OECD countries could promote innovation and strengthen knowledge and technology transfers in sectors of particular important to the green transition. These policies could negatively impact the adoption of carbon-reducing targets in origin countries in case a sizeable share of the skilled workforce migrates away.

Feedback effects and political economy considerations

As mentioned above and in a vast literature, the pace and success of the transition to net-zero by 2050 is linked to people's acceptance of the public policy sequence that will make that possible. Identifying prevalent views among the public about policies can help to implement more acceptable climate change mitigation policies, design compensatory employment and health policies, and boost public support to climate action as a consequence.

Individual (health, labour market or migration) conditions of course matter, but so do perceptions and beliefs about the existing policy framework. Recent evidence from 14 OECD and 6 non-OECD countries suggests that people's support for climate policy stems from three main beliefs: (i) the effectiveness of climate policy, i.e. its ability to reduce emissions; (ii) inequality concerns, or the perception of climate policy's distributional impact; and (iii) the perceived impact of the policy on the respondents themselves (self-interest) (Dechezleprêtre et al., 2022[58]). For instance, communities that rely on fossil-fuel production and are therefore exposed to potential employment losses of climate policy prefer to compensate the economically vulnerable, but communities that are also directly hit by a climate shock support broad-based climate instruments such as investment in "green" technologies or adaptation efforts (Gaikwad, Genovese and Tingley, 2022[169]). However, if information distortions and biases are large enough, effectiveness may become a secondary factor, and economically efficient climate policies, such as carbon pricing, may face harsher political obstacles (Millner and Ollivier, 2016[170]). High levels of inequality in a country can constrain public support for climate policies, especially when these are poorly designed or communicated (Banzhaf, Ma and Timmins, 2019[80]), as in the case of the yellow-vest movement in France, where the perceived unfairness of the climate provision towards the low-skilled strengthened the opposition to the regulatory change (Douenne and Fabre, 2020[171]).

Compensatory distributional mechanisms are therefore key to raise public acceptability of climate policies (Coady et al., 2018[172]). The same is true for providing people with sufficient information on the policies and their effects. Outreach and information campaigns can fill knowledge gaps in the population (including about the benefits of climate policies and the way they can be made neutral or progressive), directly address and modify perceptions, or promote a transparent political debate (D'Arcangelo et al., 2022[2]). Moreover, attention should be paid to the sequencing of reforms, and to pre-announcing them, as communication may be as important as proactively, creating incentives for behavioural change in economic actors (Dechezleprêtre et al., 2022[58]).

Conclusions

Labour, social and health policies will play an important role in both facilitating the green transition and in maintaining strong public support for climate change mitigation efforts. Achieving net-zero by 2050 requires important changes in production and consumption, in the attitudes and beliefs of people as well as in the actions of governments.

This report has proposed a framework to describe the impact of climate change and mitigation policies on the labour market, migration flows and people's health in OECD countries, as well as the most important policy levers that can mitigate such impacts in the realm of labour, social and health policies. Changes in production and consumption engendered primarily by climate change and mitigation policies can have a significant impact on the employability of some workers, on labour reallocation across firms, sectors or regions with different GHG intensity, and on households' revenues and consumption patterns, including of education, health and housing. In several instances, vulnerable groups such as the low-income and the low-skilled are most at risk of income or job loss because of climate change and mitigation policies. In other cases, the green transition can be the trigger of innovation and job creation.

Labour, social, and health policies can compensate for potentially adverse outcomes of climate change mitigation efforts. These policies should be designed to ensure the smooth functioning of the labour market and a fair sharing of the unavoidable adjustment costs of the transition, while preserving the incentives to decarbonise. While further work is needed to analyse the effectiveness of policies in attaining this double dividend and to formulate appropriate policy recommendations, policies should aim to anticipate the impact of the transition, and intervene in a timely, targeted and coordinated way across policy areas. In fact, some policy instruments may already be in place as a response to other global drivers of structural change, and only need retooling. Importantly, identifying prevalent views among the public about policies can help to implement more acceptable climate policies, design compensatory employment and health policies, and boost public support for climate action. Future work could expand this framework to account for the impact of climate adaptation policies, as well as discussions of other forms of environmental degradation, such as land and resource depletion, or loss of biodiversity.

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