Job Creation and Local Economic Development 2023

BRIDGING THE GREAT GREEN DIVIDE

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BETTER POLICIES FOR BETTER LIVES

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Foreword

The year 2022 set a number of alarming records as a result of climate change and environmental degradation. It was one of the warmest years on record in many countries, widespread draught took its toll on nature and economic activities, and contamination of our environment and air continues. Encouragingly, OECD governments are taking action and momentum is growing for the green transition.

However, the green transition won't happen without "green talent", meaning the workers with the skills that a greener economy requires. While change is underway, the green transition will drive a massive shift in the demand for skills, jobs, or specific goods more rapidly than the market can adjust. Consumer preferences are shifting, and the market is responding, but many of those changes are, and will be, due to policies that will take effect with short time frames. Whether it is new regulations on construction or production processes, taxes on carbon emissions or reforms of land use planning, all will change the way people live, work, produce and consume. Governments will have to ramp up efforts to anticipate and prepare for the changes in the labour market hand-in-hand with their environmental policies.

When people think green, they often think of jobs in renewable energy, but those are only one part of the story. New skills will be needed throughout the economy, whether it is retraining construction workers on environmentally friendly materials and techniques, or reskilling automotive workers for electric vehicle production. The jobs and skills needed will differ geographically—some local labour markets will have people with skills that can be easily redeployed and others not.

This 2023 edition of *Job Creation and Local Economic Development* fills a critical gap by examining the implications of the green transition on local labour markets with new internationally comparable metrics. It provides novel insights into the geography of "green" and "polluting" jobs within OECD countries based on the tasks that those jobs imply. It examines which places are leading or lagging behind in their progress towards a greener labour market in terms of these "green-task" jobs. It also analyses whether the green transition might alleviate or exacerbate existing divides within local communities on gender, levels of education and skills, or wages of workers. To deliver a green transition that is just in terms of jobs for different people and places, targeted policy action is required.

This report offers guidance on local action in preparing communities, workers, and firms for the labour market changes driven by the green transition. It builds on lessons from other transitions past and present, such as digitalisation, globalisation, and the exit from coal on local economies. It provides actionable recommendations on how local skills systems need to adapt to enable a green transition, and at the same time, deliver it in a socially just way. It lays out strategies for building effective green skills coalitions through improving collaboration across government and beyond. It also points out the need for better regional labour market intelligence that informs retraining and upskilling programmes for the green transition.

This publication contributes to the work of the Co-operative Action Programme on Local Economic and Employment Development (LEED), created in 1982 to provide practical solutions about how to build vibrant communities with more and better jobs for all. It was approved by the Local Economic and Employment Development Directing Committee via written procedure on 9 February 2023 [CFE/LEED(2023)1].

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Table of contents

FIGURES

INFOGRAPHICS

TABLES

BOXES

Executive summary

Tackling climate change and environmental degradation is one of the most formidable tasks the world faces. Yet, a lack of workers with relevant skills could hold back the green transition. The environmental and climate challenges of our time call for new sustainable solutions and significant reductions in emissions, which will affect industrial production, consumption and energy provision globally. This shift to a sustainable and net-zero economy will result in a significant transformation of local labour markets, as workers move into different occupations and sectors. The green transition compounds megatrends such as digitalisation and demographic change that have also been reshaping the geography of jobs and the world of work.

The greening of the labour market will have several effects on people, places, and firms. First, new types of jobs will emerge, creating opportunities in occupations that may not yet exist. Second, it will likely result in the loss of some existing jobs, especially in highly polluting activities such as coal and gas extraction. Third, the green transition will lead to a shift in the skills required for many other jobs throughout the economy - from construction to fashion to scientific research. Addressing these challenges requires a rethinking and updating of education curricula and training courses to enable workers to attain the skills demanded by the changing labour market. But because the geography of these transitions will also differ, a place-based strategy will be vital, with local economic development and business support programmes complementing national green transition policies, particularly for small and medium-sized enterprises.

However, an absence of a universally agreed definition of "green" jobs may hamper policy design. This shortcoming means there is scant evidence on the green transition's impact on labour markets, especially on the geography of green jobs within countries and the socio-economic effects on different types of workers within communities. This report fills that void. It provides novel estimates of regional differences in the share of and the demand for green jobs across 30 OECD countries by looking at the tasks workers perform.

The effects of the green transition on local jobs and communities

Local economies differ in terms of the risk of job loss as well as the opportunities for "green" jobs

While the green transition is a global megatrend mainly spurred by policy, its labour market impact is inherently local. Both the risks and opportunities for workers are uneven across different places within the same country. Regions relying on high-emission sectors are more likely to see jobs disappear due to green policies. Likewise, economic opportunities and "green" job creation will not materialise equally everywhere. Therefore, aggregate effects or national data can conceal regional disparities in the labour market impact of the green transition.

Around 18% of workers in the OECD have jobs with a significant share of green tasks that directly help improve environmental sustainability or reducing greenhouse gas emission. However, the share of those "green-task" jobs differs across regions, ranging from 7% to more than 35%. Some

regions, including many capital regions, are at the forefront of the green transition – they already have a high and increasing share of green-task jobs and a low share of "polluting" jobs at risk of disappearing. In other regions, a high share of polluting and green-task jobs coincide, which creates space for job transitions. However, there are also regions with above-average risk of job displacement that have not yet managed to capture the benefits of the green transition. Overall, few regions with a low share of green-task jobs show signs of catching up.

Despite the increasing attention to climate change in the public discourse, local labour markets have not become much greener over the last decade. Yet, momentum has been building recently. The share of workers in green-task jobs grew overall from 16% in 2011 to 18% in 2021, ranging from 10 percentage point increases to 7 percentage point decreases across OECD regions. While most regions have not made much progress in greening their labour force, recent regional labour demand suggests momentum is growing. Since the start of the pandemic, growth in the demand for green-task jobs has outpaced overall labour market demand by 30 percentage points. Additionally, the share of green vacancies is higher while the share of polluting vacancies is lower compared to the current employment shares, which may be the first signs of a shift towards a more environmentally friendly labour market

The green transition may deepen divides within local labour markets

The green transition has a strong gender dimension in the labour market. Women tend to be under-represented in green-task jobs, accounting for only 28% of them, requiring policy efforts to raise female participation in the green transition. On the other hand, men will be the most affected by the disappearance of polluting jobs.

Without policy action, the green transition may have other significant distributional effects. Green-task jobs tend to offer up to 20% higher pay than other jobs. While future green jobs might shift towards medium- and low-skilled occupations, in activities such as waste management, retrofitting or construction, so far, high-skilled and educated workers have predominantly captured the employment opportunities brought about by the green transition. In contrast, people with lower educational attainment and in medium-skilled occupations are at higher risk of displacement due to the green transition.

- Some regions, including many capital regions, have already benefitted from the green transition and have a high and increasing share of green-task jobs and a low share of polluting jobs at risk of disappearing. In other regions, a high share of polluting and green-task jobs coincide, which creates space for job transitions. However, there are also regions with above-average risk of job displacement that have not yet managed to capture the benefits of the green transition. A closer look at demand suggests that few regions with a low share of green-task jobs show signs of catching up.
- **A region's ability to benefit from the green transition has, so far, depended on its industrial composition and the skills in the local labour market.** Higher shares of scientific, technical and information activities in the region correlate with a higher share of green-task jobs. The top regions in terms of the share of green-task jobs also tend to have a higher share of population with tertiary education.

Local actions will be essential in creating green jobs and supporting the development of green skills

Alongside national governments, local actors will play an important role in managing the green, and just, transition. With both the challenges and opportunities of the green transition being place-specific, local actions or national initiatives tailored to local realities are needed. Additionally, local and

regional governments cover the spaces where local development needs to be joined up with employment and skills policies.

While the actions for a green transition are being largely driven by policy, there are helpful lessons from past and other ongoing transitions that were typically more market driven. Digitalisation, globalisation, and the exit from coal, all entailed significant readjustment processes in the labour market. These shifts have created both new risks and opportunities, and had an uneven impact across local labour markets and different population groups. They show striking similarities to the green transition in several dimensions. Lessons from those transitions highlight the importance of setting a clear long-term vision for the local economy, leveraging regional assets, and acting proactively in areas such as investments or reskilling.

Many of the challenges brought about by the green transition can be tackled by adapting and ramping up the existing local labour market and skills systems, others will require tailored policies. Local skills systems are already struggling to keep pace with the rapid change of jobs and skills needs, and, often, to reach those individuals that would benefit the most from training. Therefore, governments need to double down on adult learning, and active labour market policies informed by skills assessment and anticipation systems. This requires active engagement from workers, employers, and public actors and targeted measures that address the uneven risk of job losses across regions, industries, and individuals.

Learning from other transitions. . .

Share a clear and long-term vision and strategy

- Develop a long-term vision and strategy for local economic transition, involving both public and private actors and civil society
- Provide support to groups most affected by the labour market transition to minimise push-back against green policies that create adjustment costs for some workers and sectors
- Align local re-skilling and re-education programmes to match demand and local development efforts

Use regional assets to restructure the local economy

- Use available skillsets to smooth the transitions of workers into jobs that require limited reskilling and exploit local assets or existing comparative advantages to lower adjustment costs
- Facilitate, instead of just postpone, economic transitions that are inevitable, especially by providing easily accessible career guidance and retraining programmes for workers at risk of displacement.
- Direct investments to innovation and raising local attractiveness (public services, cultural amenities) to retain (and attract) workers and generate quality jobs

. . .and rethinking local skills systems

Align environmental policy with employment and skills efforts

- Assess how environmental policies will drive the demand for green skills, to match skills and labour market policies, which are responsible for the supply of green skills
- Tailor skills and labour market policies to local needs by engaging local governments and collaborating with local stakeholders such as training institutions, PES, and social partners
- Support and incentivise firms to help workers develop green skills on-the-job, generate local green initiatives, and involve employers in the design and delivery of training offered by TVET

Develop a forward-looking strategy for adult learning based on sound labour market intelligence

- Review skills assessment and anticipation exercises to ensure that they (i) reflect the impact of environmental regulation on skills demand, (ii) are sufficiently disaggregated at the sectoral and regional level, and (iii) align with policy needs
- Systematically update educational and training curricula to reflect the shift in skills and knowledge for green jobs – ranging from awareness raising to comprehensive transition-oriented re-skilling
- Tailor training offers for up- and re-skilling with a special focus on occupations, sectors and regions heavily affected by the green transition
- Raise awareness of the impact of the green transition among employers, with a special focus on supporting SMEs, to overcome barriers in the adoption of green technology

Offer targeted support for vulnerable groups within local labour markets to promote a just green transition

- Develop better intelligence on the local characteristics of individuals at risk of displacement to prioritise re-training and up-skilling efforts
- Leverage the social economy and private-public partnerships to broaden local employment and training opportunities to vulnerable groups

1 The green transition and jobs: what do we know?

This chapter provides an overview of the concept of green jobs used in this report. It describes the evidence of the effects of green policies on the economy, including the labour market. It reviews and explains the main approaches commonly used to define green jobs and describes their advantages, caveats, and limitations. Finally, it describes how the share of green jobs can be estimated at the regional level to shed light on the green transition's impact on local labour markets and to inform policy.

In Brief

Information on the geography and characteristics of green jobs is important for effective policy design

- **Despite the fundamental changes the green transition entails for labour markets, there is a lack of systematic evidence on the green transition's impact on local labour markets**. So far, analysis on the location and geographic distribution of green jobs has been limited to just a few countries. Similarly, information on the characteristics of workers in green jobs has also been scarce. This lack of evidence creates a barrier for effective policy.
- **Different approaches to classifying green jobs exist and complement each other**. Top-down approaches classify jobs as green if they are in specific sectors or industries. Bottom-up approaches define green jobs based on the skills or tasks different occupations require and the extent to which those tasks or skills are green.
- **This report uses information on occupations' tasks to measure green jobs at the regional level in 30 OECD countries**. In using this approach, the analysis sheds light on geographic differences in the share of workers in jobs with green tasks that directly relate to reducing greenhouse gas emissions or improving environmental sustainability. Furthermore, it offers a close link to labour market policies because it provides information on the skills, education, or gender of workers in those jobs and can help inform re-training and up-skilling programmes.

Introduction

Climate change and environmental degradation are among the most formidable challenges the world faces that will change how we live, work, produce and consume. Leading scientists have pointed out the risk of exceeding environmental tipping points, i.e. critical thresholds at which a tiny disturbance can alter the Earth's climate system (Lenton et al., 2008[1]). Surpassing such tipping points could expose the world to long-term irreversible changes, with potentially dramatic consequences for lives and livelihoods globally. Consequently, "the growing threat of abrupt and irreversible climate changes must compel political and economic action on emissions" (Lenton et al., 2019[2]) (OECD, 2022[3]). Environmental policies and regulation that support the transition to a net-zero economy will lead to changes in industrial production, consumption patterns and energy provision. They will also require a transformation across every industry in the economy, ranging from production processes and innovation to the adoption of new technologies and investments.

Climate action and policy will need to contribute to a "greening" of the labour market, which has four major labour market implications. First, it will lead to the creation of new types of jobs. Second, it will entail the loss of some existing, "old" jobs. Third, it will cause a shift in the skills required in many jobs in the economy. Fourth, the green transition has a strong local angle. Risks and challenges in terms of jobs are uneven and are often concentrated in specific regions. Economic opportunities and job creation, likewise, will not materialise everywhere, with some places likely to benefit more than others from the shift towards carbon-neutral and environmentally friendly jobs and sectors.

Despite the fundamental changes that the green transition will bring about for labour markets, there is a lack of systematic evidence on the green transition's impact on local labour markets. Existing

work is often either very descriptive or qualitative. Most analysis has focused on the risks of the green transition (e.g., job losses) while its opportunities remain an under researched topic and is often limited to only a handful of sectors (e.g., agriculture, renewable energy or carbon-intensive industries) or a few specific jobs. The discussion has yet to cover the full picture, because green jobs and green skills extend beyond those subsets of sectors or jobs. Finally, most existing work on green jobs focuses on national level analysis and therefore does not identify any of the (potentially significant) geographic discrepancies within countries.

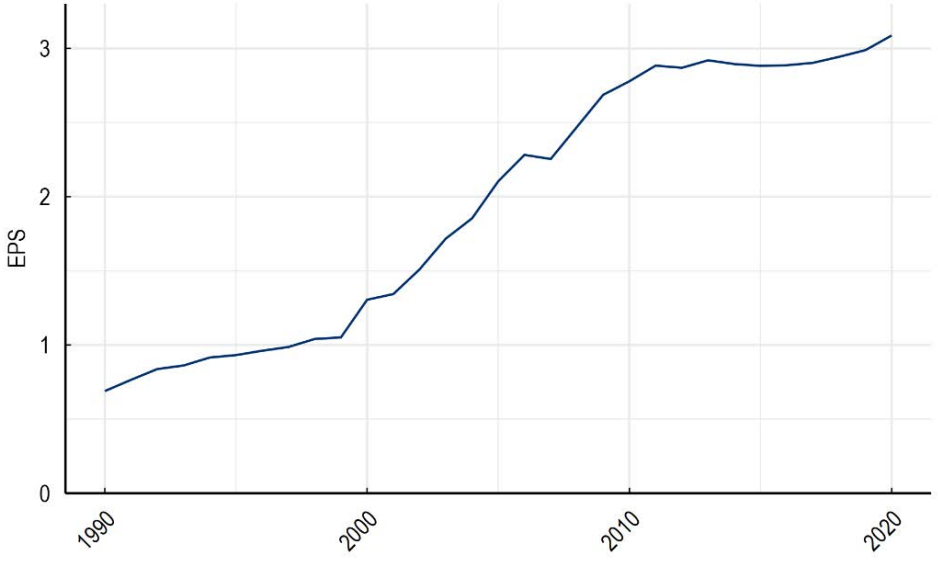
This chapter fills that gap and provides an overview of analytical work on the green transition's labour market effects and local implications. It explains different approaches of assessing the opportunities and challenges that the green transition poses for workers, firms, sectors, and local economies. It summarises the main existing evidence on the impact of green policies on jobs in different communities. Finally, it sheds light on what we know and what we do not (yet) know with respect to the uneven effects of the green transition.

The push for green growth

What are OECD governments doing to support green growth in general?

In most OECD countries, policies on environmental change have been on the political agenda for decades but policy actions to address the labour market implications of environmental policies are more recent. Over the last 30 years, the stringency of environmental policies related to air pollution, energy and carbon emissions in OECD countries increased significantly (Figure 1.1) — particularly between 2000 and 2010. However, until recently, many of those programmes included only limited direct labour market support despite a general expectation that green policies and stricter environmental regulation will affect the labour market. A number of new initiatives put a stronger focus on labour market aspects.

Figure 1.1. Environmental Policy Stringency across the OECD, 1990-2020



Note: The figure shows the OECD Environmental Policy Stringency (EPS) indicator for the OECD average. The OECD EPS average is an unweighted average across 28 OECD countries for which data are available.
Source: Authors' elaboration based on (Kruse et al., 2022[4]).

Advanced economies around the world have recently passed major policy packages for supporting the green transition and generating green economic growth. The European Commission's European Green Deal (EGD) calls for all EU countries to reduce greenhouse gas emissions by 2030 by 55% compared to their levels in 1990 and aims to support EU member countries by mobilising more than EUR 1 trillion to finance the transition (Box 1.1). In the United States (US), the Inflation Reduction Act provides USD 369 billion for climate and clean energy, making it the single largest climate investment in US history (Box 1.2).

Box 1.1. The European Green Deal and Just Transition Mechanism

The European Green Deal

The European Green Deal (EGD) consists of three pillars: (i) net zero emissions by 2050, (ii) economic growth decoupled from resource usage, and (iii) leaving no person or region behind (EU green deal). Furthermore, it calls for all EU countries to reduce, before 2030, greenhouse gas emissions by 55% compared to their levels of 1990. To achieve these goals, the EU relies upon two transitions: decarbonising and digitalising Europe's economy. The deal itself is not legislation, it is a roadmap including approaches and legislation that the EU needs to pass to become more sustainable.

The EGD aims to mobilise EUR 1 trillion to finance the transition. Half of this money is from the EU budget, the other half consists of mobilising private and national capital, which will be incentivised through the creation of new business opportunities. Nextgen EU, the European Covid recovery package was negotiated to also follow the Green Deal as a guideline. As a result, the total funding available now amounts to EUR 1.75 trillion. With the inclusion of this new fund, the talk of the Green Deal has shifted to a framework of a Green Recovery.

The European Green Deal is, first and foremost, an industrial blueprint. However, it also includes a biodiversity strategy and the promotion of green agricultural practices as a guideline on agricultural spending, under the Farm to Fork initiative. Furthermore, it will provide extra funding for regions where job losses are likely, through the Just Transition Mechanism.

The Just Transition Mechanism

The Just Transition Mechanism is a key tool in the European Green Deal that aims at making the transition towards a green economy inclusive and equitable under the slogan "leaving no one behind" (EU official website). The Mechanism aims to raise EUR 55 billion divided over three pillars:

- **The Just Transition Fund** is the largest pillar of the mechanism and currently mobilises EUR 19.2 billion which is expected to rise to EUR 25.4 billion between 2021-2027. The fund sets out to alleviate the socio-economic costs associated with the climate transition, supporting economic diversification and increased resilience of territories most at risk of negative economic impact. This includes investments in SMEs, the creation of new firms, R&D, clean energy, environmental rehabilitation, up- and reskilling of workers, job-search assistance, and active labour market policies. The Fund aims to foster cooperation at the regional level by giving regions and local communities a voice in spending the money.
- **The InvestEU** Just Transition Scheme will provide a budgetary guarantee across four policy windows: (i) sustainable infrastructure; (ii) research, innovation and digitisation; (iii) small and medium-sized businesses; (iv) and social investment and skills. Furthermore, the **InvestEU Advisory Hub** will act as a central entry point for advisory support requests. It expects to mobilise EUR 10-15 billion in mostly private sector investments.

- The **Public Sector Loan Facility** will combine EUR 1.5 billion in grants financed from the EU budget with EUR 10 billion in loans from the European Investment Bank, to mobilise a total of EUR 18.5 billion in public investments.

Source: EU green deal: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en#timeline; Euractiv: https://www.euractiv.com/section/energy-environment/news/brussels-postponed-green-finance-rules-after-10-eu-states-wielded-veto/ EU official website: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en

Box 1.2. The US Inflation Reduction Act

The Inflation Reduction Act of 2022 aims to raise tax revenue and use the resources for inflation reduction and green investment. It is a fiscal policy that will increase tax revenue and spend it to both lower inflation and boost green investment. To raise the tax base, the US Biden administration is planning to target corporations and higher income households, by increasing taxes and closing tax evasion loopholes. By increasing the corporate minimum tax to 15%, USD 313 billion will be raised. Another USD 288 billion will be raised by prescription drug price reform. Furthermore, USD 124 billion will come from IRS Tax enforcements, and USD 14 billion from changing carried interest loopholes. In total, USD 739 billion will be raised. Of the new revenue, USD 64 billion will be allocated to continue the Affordable Care Act and USD 369 billion for Energy Security and Climate Change. The remaining amount is used to reduce the budget deficit and combat inflation.

The USD 369 billion set aside for energy and climate change is used to finance the US government goal of a 40% emission reduction in 2030 compared to 2005 and enhance energy security. In the spending on energy security and climate neutral technology, emphasis is put on the national labour effects of funding. The goal is to make the US a world leader in clean energy technology, manufacturing, and innovation, powered by American workers. Special attention is given to *historically underserved communities* and the act prioritises creating shared prosperity to make the US more resilient. It offers options to distribute extra funds for initiatives located in economically distressed regions or traditional energy communities. Such projects are required to pay prevailing wages, hire apprentices, and to include persons who have been out of the labour market. The Act will also be led in conjunction with the Justice40 initiative, which requires 40% of investment to benefit the climate, clean energy, and marginalised communities that are overburdened by pollution. Furthermore, the US government will use the funds to facilitate local contracting opportunities for underserved small businesses. Finally, investment in both energy and traditional infrastructure should lead to an increase in high-quality union jobs for middle class workers.

Source: Building a clean energy economy, a guidebook to the inflation reduction act's investment in clean energy and climate action. Summary, the inflation reduction act of 2022.

Given the urgency of addressing the climate emergency, these green policy packages are unprecedented in size and ambition. They entail multiple objectives. They aim to facilitate the reduction of greenhouse gas emissions and ease the reliance on fossil fuels. At the same time, they aim to boost sustainable economic growth that benefits all, ensuring a just and inclusive transition. For example, the European Commission emphasises the importance of focusing on "the regions, industries, workers, households and consumers who will face the greatest challenges in terms of employment, social and distributional impacts when decarbonising their economy" (European Commission, 2021[5]).

COVID recovery packages provide new impetus for the green transition but also need to consider local labour market implications

In response to the COVID-19 pandemic, most OECD governments passed large-scale economic measures, often including green recovery measures. Green policy measures account for a significant proportion of the recovery packages so far passed in 44 countries, consisting of OECD countries, EU countries and selected large economies (see Box 1.3). Spending on green recovery measures in those countries and the European Union totalled USD 1 090 billion by April 2022. Thus, spending on green recovery measures rose by more than USD 400 billion compared to September 2021.[1] At the same time, however, some governments also introduced COVID-19 recovery measures that will have a negative or mixed impact on the environment.

Box 1.3. Green recovery measures

The OECD Green Recovery Database tracks recovery measures adopted by OECD member countries, the European Union and selected large economies and their environmental impact. Between the onset of the pandemic and April 2022, total recovery spending in those countries exceeded USD 3 300 billion (OECD, 2022[6]).In assessing the environmental implications of recovery-related policies and measures, it classifies each measure as having positive, mixed, negative or indeterminate environmental implications (OECD, 2021[7]).

Table 1.1. Environmental Categories in the Green Recovery Database

	Description	Examples
Positive	The measure has clearly discernible positive environmental impact for one or more environmental dimensions, without any clearly discernible significant negative impacts on other environmental dimensions.	Investment commitments for renewable energy; support for innovation targeted to clean technologies; measures for improved forest management, regulatory changes that strengthen the investment case for cleaner technologies
Negative	The measure has clearly discernible negative impacts on one or more environmental dimensions, without any clear positive environmental impacts.	Rollbacks of environmental regulations; investment commitments for emissions-intensive fossil-fuel projects
Mixed	Both positive and negative environmental impacts are clearly discernible. This can happen either i) where the measure has clear positive environmental benefit on one dimension, but has clearly significantly negative impacts on at least one other dimension; or ii) where the measure is very broad and contains some elements that will have strong positive implications but other elements that are likely to have clear negative implications (whether for the same environmental dimension or another)	Examples of (i) include biofuel investments without safeguards, which may have impacts on biodiversity and lead to indirect GHG emissions from land-use change; a broad infrastructure investment plan that includes both renewable energy and carbon-intensive infrastructure
Indeterminate	The measure does not have clearly identifiable environmental implications at the level of assessment carried out for this exercise. This does not mean that the measure is environmentally benign, just that the impacts are difficult to determine. Many countries' stimulus measures could be considered indeterminate but not all are captured in the Database (full tracking of all stimulus measures was not the purpose of this Database nor within the mandate of the OECD Environment Directorate). Measures tagged indeterminate have been excluded from the analysis, to avoid introducing unnecessary bias	Support for small businesses with no particular green focus; increased welfare support for vulnerable families;

Source: (OECD, 2022[6]).

Despite their importance, only a very limited number of measures are directed at areas that will support the development of "green" skills. The green COVID recovery programmes mainly reflect broader grants, tax reductions/other subsidies, and regulatory changes. In contrast, a relatively small share of measures are directed at two areas that are essential for the creation of green jobs and the provision of workers with the right ("green") skills for the green transition: 8% promote research and development (R&D) and 2% relate to skills development.

Skills development and retraining are vital to ensuring that workers have the right skills to prosper in a changing world of work and are a prerequisite for making the green transition a "just transition". Many workers in polluting jobs or sectors will require targeted support so that they can move into new jobs, greener sectors or retrain if the requirement of their jobs change as polluting sectors green. Indeed, even without the changes the green transition will entail for jobs and skills, many OECD countries already experience skills gaps and mismatches as obstacles to economic growth and productivity gains (OECD, 2021[8]).

The limited number of green measures on skills development is even more striking in terms of committed funding and subnational focus. Around USD 15.6 billion of the total funding of USD 1 090 billion are allocated to skills training.[2] While skills gaps and mismatches affect most OECD economies, they differ substantially within OECD countries. Thus, training needs and the challenges of developing skills for the green transition must take into account local challenges and conditions (OECD, 2018[9]). For example, designing skills training with a subnational lens can yield a more effective matching with the demand for skills and jobs by employers in a local economy (OECD, 2022[10]). However, as a percentage of all recovery funding, skills training at the subnational level is considerably less than 1% (0.0024%).

What we know (and don't know) about the impact of green policies on employment and local implications

Green policies and environmental regulation can affect the economy in many ways. Empirical analysis has so far focussed on their impact on economic growth, labour productivity, investments, technology adoption, firm performance, international trade, and the demand for skills (Box 1.4).

An outstanding, and politically sensitive, issue is the impact of environmental policies on employment, particularly the differential impact across communities. So far, the evidence on whether green policies lead to job losses or gains is mixed and suffers from considerable evidence gaps and depends on the impacts on the economy more generally (Box 1.4). A number of studies find negative employment effects of environmental regulation, particularly for energy-intensive industries (Walker, 2011[11]), (Greenstone, 2002[12])), while other works suggest there is a relatively small effect on overall employment ((Gray et al., 2014[13]), (Brucal and Dechezleprêtre, 2021[14])). Evidence on fiscal stimulus packages shows that targeted green investment stimulates significant employment creation, especially of green jobs (Popp et al., 202[15]).

Even if the employment effects of green policies have a small impact at the national level, they may have a strong localised impact. As a result of the reallocation of workers from energy-intensive (or polluting) to non-energy-intensive (non-polluting) sectors, regions that specialise in the former are likely to bear, at least in the shorter term, a greater share of the labour market costs of environmental policies. For example, while a 10% increase in energy prices leads to a reduction of manufacturing employment by 0.7%, this reduction reaches 1.9% for energy-intensive sectors such as iron and steel production (Dechezleprêtre, Nachtigall and Stadler, 2020[16])**.**[3]

Box 1.4. Impacts of green policies on the economy

Recent OECD analysis provides an overview of how green policies affect economic performance (OECD, 2021[17]). Drawing from empirical OECD research over the past decade across countries, it finds little effect of more stringent environmental policies on economic performance overall, although they result in clear environmental benefits. However, little is known about the local effects of green policies. Evidence on green policies' impact on the economy is extremely relevant, as the public discourse on environmental policies often entails emphasis on possibly negative effects on the economy. Furthermore, public support for environmental policies hinges on the perception of not only their environmental benefits (see (Dechezleprêtre, Nachtigall and Venmans, 2018[18]) and (Dussaux, 2020[19])) but also their economic benefits and costs.

Overall, environmental policies have a diverse effect on firm or industry performance. For example, the effects on firm and industry productivity vary according to the technological advancement of sectors and firms (Albrizio, Koźluk and Zipperer, 2017[20]). Industries that are close to the technological frontier record productivity growth increases in response to more stringent environmental policy. Among firms, more stringent environmental policy leads to higher productivity growth of technologically advanced firms but to a decrease in productivity growth for firms further away from the technology frontier. Environmental policies also influence firms' investment decisions. For example, analysis of the balance sheets of listed companies in the manufacturing sector across 75 countries shows that higher energy prices are associated with lower domestic investment but with a rise in foreign direct investments (FDI) of firms in energy-intensive sectors (Dlugosch and Kozluk, 2017[21]). Changes in relative energy prices appear to pivot firms to shift investments abroad (Garsous, Koźluk and Dlugosch, 2020[22]).

A major concern for policy makers is that strict environmental regulation can harm firms' international competitiveness. In the aggregate, environmental policies do not appear to affect international competitiveness. OECD analysis of 23 countries and 10 manufacturing industries finds no large effect on international trade or the domestic value added embedded in exports (Koźluk and Timiliotis, 2016[23]). However, as with productivity, there appear to be winners and losers. In response to more stringent environmental policies, exports of lower-pollution sectors increase whereas exports of pollution-intensive sectors decrease.

Source: (OECD, 2021[17]), (Dechezleprêtre, Nachtigall and Venmans, 2018[18]), (Dussaux, 2020[19]), (Albrizio, Koźluk and Zipperer, 2017[20]), (Dlugosch and Kozluk, 2017[21]), (Garsous, Koźluk and Dlugosch, 2020[22]), (Koźluk and Timiliotis, 2016[23]).

The main body of work on green policies and employment has two major caveats. First, it lacks analysis of the geographic impact, i.e., the uneven effects. Second, it does not offer insights into how green policies change the composition of jobs in a labour market, which matters for a range of policies such as education, adult learning, vocational training, or active labour market policies. Even though the consensus is that job losses and job creation due to green policies and the green transition overall will not necessarily be evenly spread across different places, most existing work does not investigate the different impact across places within countries (OECD, 2017[24]). This matters even more because labour is relatively immobile in the short run, so that those risks of green policies can result in a rise in local unemployment and relevant adjustment costs in areas affected the most (Valero et al., 2021[25]). A just transition requires not only better understanding the spatial impact of green policies, but also their distributional consequences for different workers, which can then inform policy responses that help support workers negatively affected or in risk of displacement.

The quest for better data on jobs created by and at risk from the green transition

As highlighted for G7 environment ministers, more quantitative evidence on the employment effects of green policies is needed (OECD, 2017[24]). Better and consistent data play a vital role in filling evidence gaps across multiple dimensions, including numbers and characteristics of jobs that might be created or destroyed as well as estimates of the number of workers who will need to transition into different sectors or occupations. Additionally, effective policy design requires knowing whether those workers possess the skills and competencies required in newly created jobs or how they can re- or upskill to meet those requirements.

Subnational data are critical. Most of the existing evidence on the link between green policies and employment focuses on aggregate, national information. However, when it comes to employment effects, green policies inevitably have a spatial impact. They will affect particular jobs and industries, especially those with greater pollution intensity, the most. As those jobs are not evenly spread out but often concentrated in specific areas, the challenges in terms of employment loss or changes in job requirements will also differ markedly within countries. Likewise, the opportunities that green policies present for job creation and green economic clusters also require a local perspective.

These data are also essential to deliver the green transition in the first place, as a lack of "green" talent can hold back the green transition. Across the OECD, companies face unprecedented labour shortages (OECD, 2022[26]). For example, in the European Union, almost 30% of firms in both manufacturing and services encountered production constraints in the second quarter of 2022 because of a lack of labour. In the United States, the number of vacancies is almost double that of unemployed persons. Those labour shortages are exacerbated by widespread skills mismatches, which make it hard to fill vacant positions with unemployed individuals. To mitigate labour shortages and skills mismatches for green industries and firms, policy makers need to know what skills and tasks green jobs entail before they can effectively design policy.

The lack of consensus on measuring green jobs is a major reason why the evidence on job creation by green policies varies widely. Different studies and institutions use different approaches, which makes it hard to assess the impact of green policies consistently across countries. Comprehensive and solid evidence with comparable data is needed for designing and evaluating green policies that support the creation of green jobs. Additionally, data and evidence on polluting jobs and how they are affected by green policies is important for policy.

Lack of clarity and consensus on what "green" jobs are

Despite the fundamental changes the green transition entails for labour markets, there is not yet a universally accepted definition of what a green job is. Thus, different studies have come to different conclusions about the proportion of green jobs in the economy or green job creation (Bowen and Kuralbayeva, 2015[27]).[4] Consequently, it is difficult to compare studies on the magnitude of green job creation or the relative importance of green jobs in the labour market. Additionally, most work until now has focussed on single or a narrow set of countries.

Across international organisations and national governments, definitions of green jobs vary. The United Nations defines green jobs as jobs in sectors that contribute substantially to preserving or restoring environmental quality and minimise waste creation and pollution (UNEP, ILO, IOE, ITUC, 2008[28]). The ILO defines green jobs as "decent jobs in any economic sector (e.g., agriculture, industry, services, administration) which contribute to preserving, restoring and enhancing environmental quality." Thus, the ILO's definition combines two criteria. First, green jobs help 'reduce the environmental impact of enterprises and economic sectors by improving the efficiency of energy, raw materials and water; de-carbonise the economy and bring down emissions of greenhouse gases; minimise or avoid all forms of

waste and pollution; protect or restore ecosystems and biodiversity; and support adaptation to the effects of climate change' (ILO, 2022[29]). Second, the ILO includes a social component, referring to 'decent' jobs that are productive, secure and deliver a fair income, among other things.

Other international organisations refer to skills as a means of defining green jobs. For example, the European Centre for the Development of Vocational Training (Cedefop) defines green skills as "the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society" (OECD/Cedefop, 2014[30]). Then, green jobs are those that require green skills. Another possible way of defining green jobs is to first determine what the green economy is and then include those jobs are part of it (see Box 1.5). These definitions are relatively broad and not operationalised, i.e., systematically applied to available data across the world.

Box 1.5. The green economy – definition by the ILO

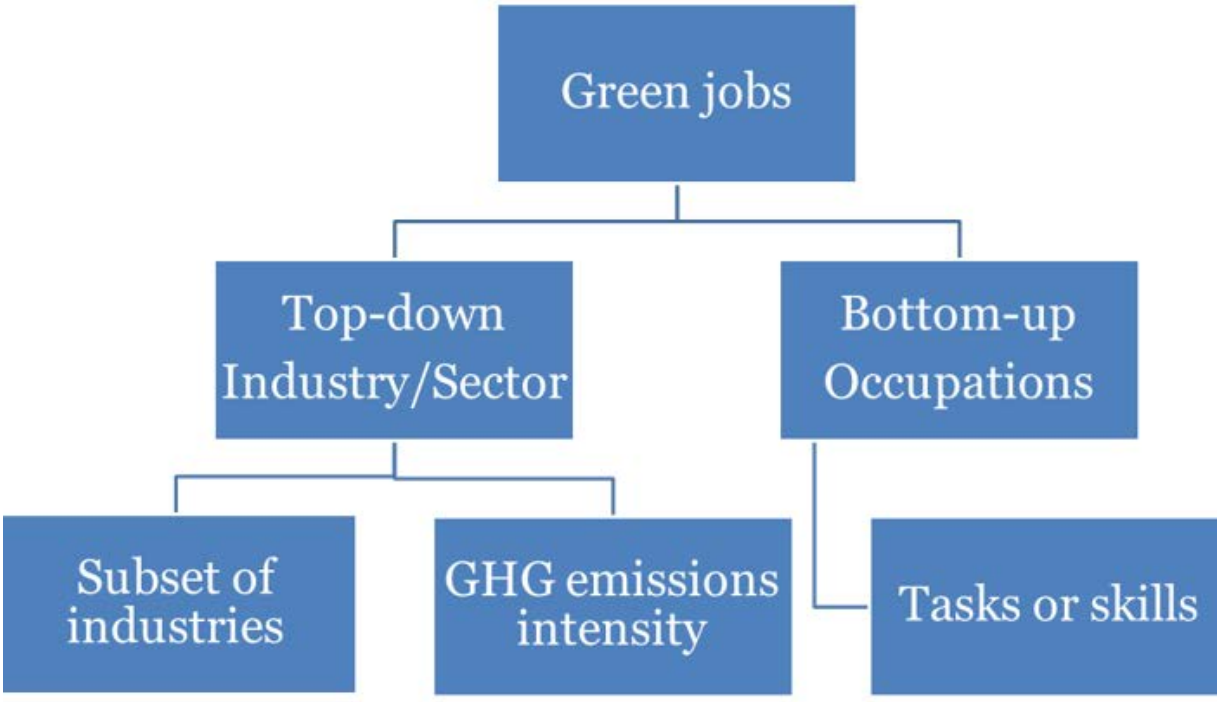
What is meant by the green economy?

There is no unique definition of the green economy. The main characteristic of the concept is the acknowledgment of the economic value of natural capital and ecological services and the need to protect those resources. Most definitions include not only environmental aspects but incorporate the more holistic approach of sustainable development. Environmental sustainability, social justice and locally rooted production and exchange of goods and services are therefore elements that can be found in most green economy definitions. The United Nations Environment Programme defines a "green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive."

Source: ILO, Frequently Asked Questions on green jobs (ilo.org).

The vast majority of the empirical literature draws on two dominant approaches to quantify green jobs (Figure 1.2). The first type consists of top-down approaches that identify sectors or industries that are green and consider that all employment in those sectors or industries is green. The second type, i.e. bottom-up approaches, exploits information on occupations. They define green jobs based on the skills or tasks different occupations entail and the extent to which those tasks or skills are green (for a more detailed discussion of the different approaches see (Valero et al., 2021[25])). A third strand of macro-modelling approaches does not explicitly measure the number or location of green jobs but can provide an important overall assessment of the impacts of environmental policies on the labour market.

Figure 1.2. Defining green jobs: top-down and bottom-up approaches



Source: Authors' elaboration.

The fact that there is no universally agreed definition creates a number of challenges. First, it causes some research to avoid the term completely (Bowen and Kuralbayev, 2015[31]). Second, it makes it extremely difficult to compare different studies, which differ with respect to the countries, parts of the economy and time frame they cover. Thus, studies that include estimates of the share of green jobs in the labour market come to widely different conclusions (Table 1.2). Those estimates range from 2% (Eurostat, 2022[32]) to 40% (Bowen and Hancké, 2019[33]).

However, data and statistics on the relative importance of green jobs and their characteristics are crucial for policy and supporting the green transition. They provide an understanding of the magnitude of the labour market implications of the green transition and environmental policies, and can give a sense of pending structural changes to local and national economies. Furthermore, such statistics are required for an effective design and evaluation of labour market and skills policies. This is particularly important in the current context, with widespread skills and labour shortages, which raise an important question for policy makers: Do we have enough green talent? Amid prevalent skills shortages, notably for skills required the most in green jobs, the job creation potential of green sectors and industries might not be fulfilled (ILO / CEDEFOP, 2011[34]).

Table 1.2. Estimates of green jobs differ widely across studies

Study	Green job estimates	Country (coverage)	Time period	Approach
(Eurostat, 2021[35])	2%; 4.4 million full-time equivalent jobs	EU-27 (cross country)	2019	Environmental Goods and Service Sector
(IRENA and ILO, 2022[36])	1.24 million full-time equivalent jobs	EU	2021	Renewable Energy Employment
(ONS, 2020[37])	1% (of non-financial employment)	United Kingdom	2020	'Top-down': Industry based (low carbon sectors)
(Valero et al., 2021[25])	17-39%	United Kingdom (economy wide)	2011-2019	Task-based, O*NET; Occupation based
	20%	Former EU15 countries		
(Bowen and Hancké, 2019[33])	40%	EU-28 (cross country)	2006-2016	Task-based, O*NET; Occupation based
(ECO Canada, 2021[38])	3.8% Canada (economy wide)	Canada (economy wide)	2020	'Mixed': Occupation and industry based (EGSS)
(Elliott et al., 2021[39])	around 30%	Netherlands	2006-2008	Task-based, O*NET; Occupation based
(Vona, Marin and Consoli, 2019[40])	3% green intensity of employment (employment-weighted share of green tasks in the economy)	US metropolitan and non-metropolitan areas	2006 and 2014	Task-based, O*NET; Occupation based
(Bowen, Kuralbayeva and Tipoe, 2018[41])	Around 19.4% (direct and indirect green jobs)	US	2014	Task-based, O*NET; Occupation based

To better understand why the existing work on green jobs produces wildly different estimates, the subsequent sections review top-down and bottom-up approaches of defining green jobs as well as more general macro-modelling forecasts. Those sections explain some of their advantages, limitations, and the assumptions they entail for understanding why policymakers sometimes choose particular approaches in line with specific policy objectives and how, in the end, those approaches are complementary (Martinez-Fernandez, Hinojosa and Miranda, 2010[42]).

Top-down approaches

Top-down approaches have in common that they classify green employment based on the production process and/or outputs. For example, a sector could be classified as green based on its output, and thus all employment (regardless of the occupation) in that sector would be considered green. Prominent cases of such sector-based definitions include, for example, estimates for the renewable energy sector. In practice, empirical studies adopting this approach tend to make use of existing sector and/or industry classifications. This, coupled with limited data availability, nudges studies towards measuring employment in certain sectors (as defined by a standard classification) of the economy first, and then refining their estimates, depending on the resources available. However, top-down approaches could also generally consider areas of the economy that produce environmental goods or services, and therefore include industries from different sectors.

Top-down approaches can vary significantly in their estimates and in the breadth of their analysis. For example, a recent report on renewable energy estimated that the sector provides around 1.24 million full-time equivalent jobs in the EU (IRENA and ILO, 2022[36]). Broader definitions often consider a larger set of activities, also referred to as the environmental goods and services sector (EGSS), which comprises industries centred on environmental activities, i.e. activities that either directly serve an environmental

purpose or produce goods that are specifically designed to serve an environmental purpose.[5] In the EU, estimates find that EGSS accounts for 4.4 million full-time equivalent jobs, or 2% of total employment (Eurostat, 2021[35]). The EGSS is a leading example of the top-down approach, and it is therefore relevant to describe it in more detail.

Box 1.6. Employment estimates in renewable energy

The International Renewable Energy Agency (IRENA) provides estimates for the number of jobs in different renewable energy technologies across the world. Data for Europe relies on statistics by EurObserv'ER. The latter is a project that aims to provide technical support to the European Commission when monitoring the renewable energy sector and sources.

EurObserv'ER employs a so-called 'follow-the-money' approach to estimate employment across different technologies of the renewable energy sector (RES). To address the lack of official employment data for renewable energy (a subsector of energy), they use a common methodology in calculating the effect of RES deployment on employment and revenues, enabling a comparison between Member States and different renewable energy technologies. They use data on newly installed capacity, operation and maintenance cost and biomass feedstock cost for 11 sub-sectors related to renewable energy, which are translated into employment numbers using detailed information on average labour costs. However, this approach is limited to national level data.

Source: EurObserv'ER (2019), The State of Renewable Energies in Europe. 19th EurObserv'ER Report. https://www.eurobserv-er.org/19th-annual-overview-barometer

Environmental Goods and Services Sector

This top-down approach aims to quantify employment (and other measures such as GDP, GVA and exports) on the environmental goods and services sector (EGSS). It builds on the UN System of Environmental-Economic Accounting Central Framework (see Box 1.7). EGGS revolves around the concept of environmental activities, including examples such as the manufacturing of bio-fuels, installation of photovoltaic panels, or environmental consulting services. The EGGS includes the set of producers who engage in environmental activities, such as environmental protection activities, aimed at reducing and preventing greenhouse emissions or other harmful environmental impacts, and resource management activities related to energy.

A core challenge of this approach is that producers may engage in secondary activities, which may or may not be environmental. Ideally, those secondary activities should be separated and classified accordingly. However, in practice this is not always possible given the data limitations. In the end, it is up to countries to decide how and if to separate secondary activities, which might weaken comparability across countries.

Results for this approach show that the size of the green labour market is small, around 2.2% of the jobs in the EU in 2019 were in the EGSS. Within the EU, there is some dispersion across countries, but the share of green jobs remains low, ranging from 0.9% in Belgium to 5.1% in Finland. Although the EGSS labour market has grown faster than the total labour market since 2000 (43.3% for the former and 11.7% for the latter), the growth in the proportion of jobs in the economy has been limited to 0.5 pp (from 1.7% to 2.2%). In addition, 97% of growth in the proportion of EGSS jobs was between 2000 and 2011, with little growth over the last decade.

This framework also requires that each country develop its own environmental statistics. Ideally, each country would follow the same methods and definitions, but inevitably, discrepancies in the process

exist. The work done by the UK's Office for National Statistics (ONS) is a useful example of the EGGS in practice. ONS follows the definitions provided by the EGSS and applies them using a variety of sources such as the Low Carbon and Renewable Energy Economy (LCREE) Survey, among others.

Box 1.7. UN System of Environmental-Economic Accounting Central Framework

The System of Environmental-Economic Accounting Central Framework (SEEA Central Framework) conceived and maintained by the United Nations is a multipurpose conceptual framework that provides definitions and classifications compatible with existing data frameworks that aim to place "… statistics on the environment and its relationship to the economy at the core of official statistics".

This method is not directly constructed to measure employment, but rather other stocks and flows. Such information can then be related to employment estimates using, for example, supply-use, input-output tables, or asset ratios. For example, employment in renewable energy can be hard to estimate as the renewable energy sector is usually not classified as a distinct sector in national sector classification systems such as the UK's SIC or the European NACE. The closest classifier in this case is "production of electricity" (SIC 35110 and NACE 35.1.1). Employment in the renewable sector can then be estimated as a proportion of employment in this sector, using for example information on total and renewable energy generated as well as employment productivity estimates. However, this assumes that productivity is the same across different electricity generation methods.

Individual countries are responsible for compiling and publishing their environmental accounts. In practice, this means that national statistical offices or similar administrative units are in charge of interpreting the framework in order to tailor it to their local situation, which may differ from other countries in terms of data available, employment or sector classifications and statistical units, among others. One practical example of an economic area applying the SEEA Framework is the Environmental Goods and Services Sector Accounts put forward by the European Commission (Eurostat, 2016[43]).

Source: UN. (2014). System of Environmental-Economic Accounting 2012. https://seea.un.org/content/seea-central-framework

Since 2014, the UK's ONS has compiled data on the LCREE. The data are derived from survey-based estimates of turnover, exports, employment and acquisitions and disposals of capital assets in 17 low-carbon sectors[6]. This is part of a broader program by the ONS that compiles information on Environmental Accounts such as natural capital, atmospheric emissions, and energy use. Businesses are considered to be part of the LCREE if they report activity in one of 17 defined sectors.[7] Results show that for 2020, employment in the LCREE was around 207 800 full-time equivalents (ONS, 2020[37]).[8]

In short, LCREE and EGSS have the same objective, but the former serves as an input for the latter as the EGSS has a broader focus. LCREE does not include some "green" activities, such as recycling and the protection of biodiversity.[9] Furthermore, EGSS, uses a combination of other surveys, supply-use/input-output tables, and other complementary data to provide estimates in line with international guidelines.

Advantages and limitations of the top-down approach

Advantages:

- **Ease of interpretation**: It is easier to interpret if the primary objective is industrial analysis, and, depending on the information systems available in the country, may provide details on specific activities that are not typically identifiable in Labour Force Survey data (the primary source for the bottom-up approach), as they are less detailed than the most detailed industry classifications.

- **Limited data collection needs:** Given that quantifying employment using the top-down approach is a spin-off of quantifying GVA, import and exports (national accounts), a lot of the data is already collected. New data collection requirements are limited.
- **Ancillary green jobs:** Because the approach captures all jobs engaged in a certain activity it also captures jobs in the 'green' firm, that may not in and of themselves be considered green but, rather, support green activities. However, at the same time, as shown below this can also generate challenges with comparability depending on the degree of outsourcing a firm may engage in.

Limitations:

- **Statistical unit:** A key difficulty with the top-down approach is the choice of statistical unit. The preferred choice would be the *Local Kind of Activity Unit* used in the European Statistical System or the *Establishmen*t used in the international system but in practice many countries use other measures of statistical units, such as the enterprise, and commonly legal units, which can impair international comparability. In addition, the choice of enterprise for example can also create challenges for estimating sub-national breakdowns as it may assume similar production activities across all regions where the parent has operations.
- **Limited subnational data availability:** A key caveat of most top-down approaches is that data are not reliable enough to construct sub-national estimates. National data might, however, obscure potential regional differences that may be relevant.
- **Jobs unrelated to green activities may still be considered green**: As all jobs in the sector are included, estimates inevitably include jobs that are only indirectly related to the underlying green activity. A clear example of this is ancillary activities, accountants or security guards for example, who will be classified as green as long as their statistical unit is deemed to have an environmental purpose. Indeed, the argument that all jobs engaged in the 'green' firm should also be included creates an argument that all upstream jobs (including in non-green activities) should also be included.
- **The approach is affected by market structure:** The degree of jobs that are considered as being in green activities are also dependent on the market structure of the economy given the varying degrees of outsourcing firms may engage in. For example, if a company in the recycling industry that has an accounting department decides to outsource that department, then those employees (previously considered to be in green jobs) would no longer be part of the estimates of green jobs if they were integrated by a third-party company fully dedicated to accounting. Such issues could lead to unstable results that may be impacted by arbitrary changes in the production structure.

Box 1.8. Using sectoral data to identify vulnerable regions in the industrial transition to climate neutrality

Manufacturing activities are some of the most difficult to make climate neutral. Using sectoral information on employment and emissions data for firms, a new OECD report identifies regions that are particularly vulnerable in the industrial transition to climate neutrality (OECD, 2023[44]). Manufacturing sectors are regionally concentrated, hence sectoral transformations will have place-based implications. The transition will require more investments in new forms of production and new energy carriers.

The report identifies six manufacturing sectors as facing particularly large transformation challenges:

- Coke and oil refining,
- Chemicals,
- Basic metals, in particular steel and aluminium,
- Non-metallic minerals, in particular cement,
- Paper and pulp,
- Motor vehicles.

The six sectors above generate some of the highest emissions in manufacturing and are the most energy intensive, requiring them to profoundly transform their production process.

Regional transformation challenges are likely to be largest where both employment shares in pollution-intensive sectors and emissions per capita are high. Employment shares in those six manufacturing sectors are calculated using 2-digit NACE sectors for large regions (NUTS 2) provided by Eurostat Structural Business Statistics (SBS). To calculate emissions per capita, facility emissions data from the European Emissions Trading Scheme (ETS) is matched to firm level data from ORBIS. This makes it possible to identify the 2-, 3-, and 4-digit NACE sectors for large regions (NUTS 2) and small regions (NUTS 3) where the companies own facilities.

Regions with a high employment share in those polluting manufacturing sectors will have to decarbonise production assets, while at the same time capitalising on opportunities and addressing challenges for workers to achieve a just transition. Regional transition requires new infrastructure and technologies. However, regions' ability to access this infrastructure differs. Most of the infrastructure needed, such as hydrogen transported via pipelines, is subject to economies of scale. Hence, regions with clustered production sites, such as the chemical industry in Belgian and German regions, will face lower costs than dispersed ones.

The socio-economic characteristics of regions, workers, and firms also impact the risks faced by regions. Most of the exposed regions already have low GDP per capita and wages, and the workers could face skills gaps and/or job and income loss. The regions also do not seem to be attractive to workers or firms, which makes it more difficult to diversify the economy. Additionally, the regions with less productive firms may also face greater risks, as those firms may find it hard to incorporate technological transformations.

Source: (OECD, 2023[44]).

Bottom-up approaches

Bottom-up approaches of defining green jobs are based on information from individual occupations. They classify occupations based on their characteristics and the work they entail (Table 1.3). Quite common among these approaches is identifying green jobs based on the tasks they require and the extent to which those tasks are green (i.e., they support environmental objectives). Alternatively, green jobs can also be determined by defining specialised green skills and examining the jobs that require them. Finally, as pointed out above, some organisations also include a 'decent job' requirement as a condition for a job to be green.

Table 1.3. Main bottom-up approaches to define green jobs based on job characteristics

	Description
Tasks	Occupations are analyzed, irrespective of the sectors in which they are located. The greenness of occupations is drawn from the greenness of the related task content of a job.
Skills and abilities	Certain jobs require workers to possess certain specialised green skills.
Job decency	The UNEP and the ILO have both stressed the fact that "green" jobs need to be decent jobs, i.e., good jobs which offer adequate wages, safe working conditions, job security, reasonable career prospects, and worker rights.

Source: (Martinez-Fernandez, Hinojosa and Miranda, 2010[42]).

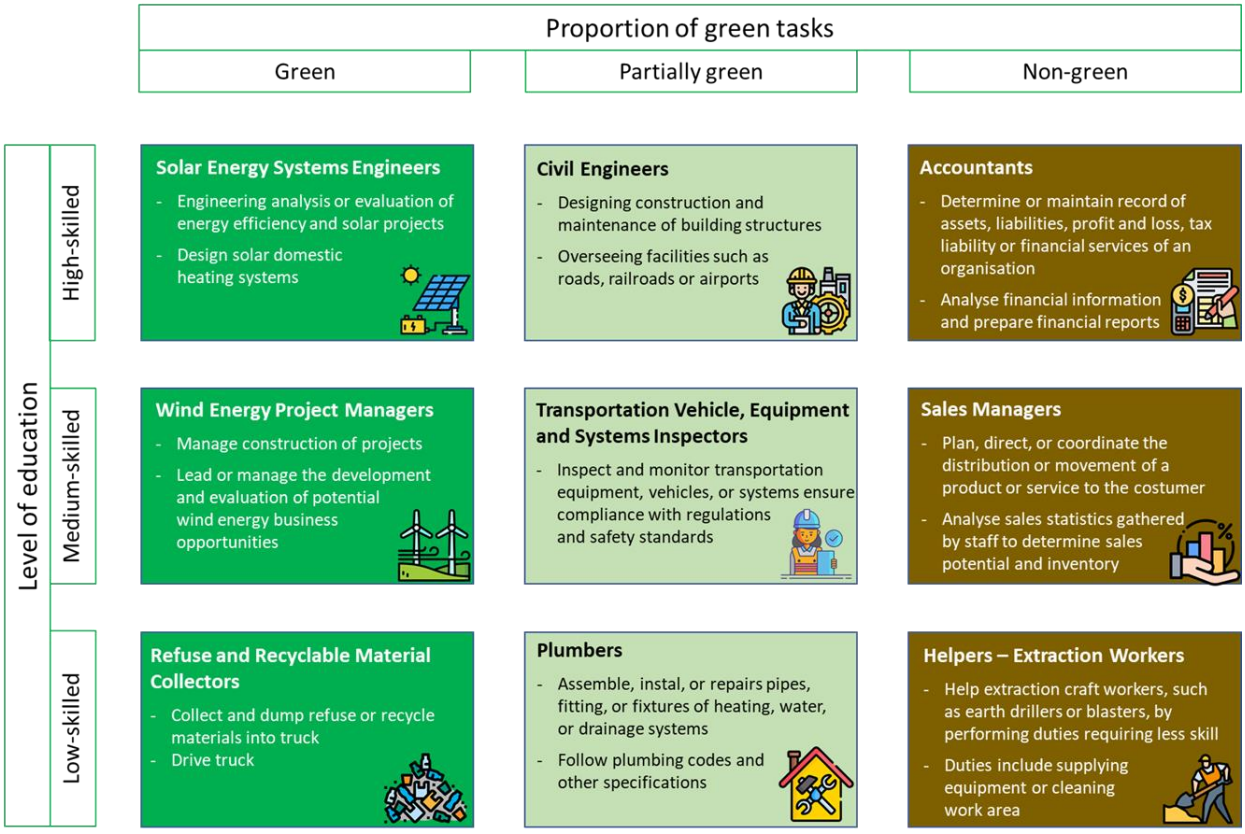
Task-based approach in theory

Most studies to date that take a bottom-up approach follow the methodology proposed by (Vona et al., 2018[45]). Their work rests on the fact that each occupation can be divided into different functions, called tasks, which may be carried out daily, monthly or even on a yearly basis. Therefore, each occupation can be divided into a unique set of tasks. Occupations can then be analysed and categorised based on the content of these tasks.

The task-based approach is the dominant approach in labour economics for studying the labour market impact of structural transformation. Pioneering contributions include work by David Autor and co-authors ((Autor, Levy and Murnane, 2003[46]), (Autor, 2013[47])), who assessed the impact of computers and digital technologies on the labour market, as well as (Acemoglu and Autor, 2011[48]) and (Acemoglu and Restrepo, 2018[49]), who provided further theoretical consolidation/confirmation of the approach by examining the effects of automation and digitalisation.[10]

While different sources can be used to retrieve information on occupations, the most widely used source is the Occupational Information Network (O*NET) of the U.S. Department of Labor. Through a mixture of direct surveys, occupational expert consultation and case-by-case analysis, O*NET (see Annex for further details) provides information on a large number of occupations and the tasks they entail, the relative importance of those tasks and the skills generally required to fulfil those tasks (Dierdorff and Norton, 2011[50])[11]. While bottom-up approaches need not be task-based but could instead be, for example, skills-based, most research focuses on tasks. O*NET's Green Economy Programme (Dierdorff et al., 2009[51]) provides a list of individual tasks for each occupation and classifies these tasks as green or non-green.[12] Based on this information, an occupation can be classified according to the overall greenness of its tasks. The infographic below provides some examples of this.

Infographic 1.1. Green-task jobs can be found across the economy and skills spectrum



Note: The greenness of occupations is based on their task content and whether those tasks are green or not. The greenness score of an occupation ranges from 1 (all tasks are green) to 0 (all tasks are non-green). The classification of high-, medium-, and low-skilled occupations follows ISCO.
Source: OECD elaboration based on O*NET's Green Tasks Data.

Task-based approach in practice

A number of academic articles and reports have used the task-based approach to examine the share of green jobs in the labour market and to shed light on the effects of the green transition. They combine information from O*NET with granular employment data in different economies. Vona et al. (2019[40]) examine drivers of green job growth in US metropolitan and non-metropolitan areas between 2006 and 2014 and is thus one of the first studies to examine spatial differences in terms of green jobs. They provide estimates of the green intensity of employment, which is the employment-weighted average of the greenness of tasks in a given local labour market (see previous section).[13] The green intensity of employment can be broadly interpreted as the share of tasks or time spent on green activities. They find that the green intensity of employment is around 3%, although this ranges from 2.4 to 3.9 within the US. Although they find a convergence of green employment over time across the US, it remains geographically concentrated, especially in high-tech areas.

Recent analysis extended the scope to 34 countries, mainly consisting of more advanced economies in the EU, South Africa, Mexico and the US (International Monetary Fund, 2022[52]). It finds comparable green intensity of employment across the economies covered, ranging from about 2 to 3%. Additionally, the study examines the average employment-weighted pollution intensity of economies (see Measuring green jobs at the regional level for further detail), which ranges from 2% to 6%. The study finds that high-skilled urban workers are in occupations with a higher green intensity, which also comes with a

wage premium. A second study adopted the same approach with a global perspective (IMF 2022). This study focuses on the green intensity of workers (i.e., the share of their tasks that are considered green). The work estimates that high-skilled urban workers tend to have a higher green intensity, and that this measure ranges from 2% to 3% in the economies they study.

A related body of work applies the task-based approach but looks at a different outcome, namely green jobs. Instead of examining the green intensity of employment, those studies use the same occupation and task classification provided by O*NET to identify green jobs as either those that entail any green task or include a significant proportion of green tasks. Valero et al. (2021[25]) consider not only workers who directly contribute to preserving the environment and reducing emissions, but also indirect green jobs, which are jobs that may not directly contribute but are expected to be positively impacted by the green transition through increasing demand. Overall, they find that around 17% of the jobs in the UK are either directly or indirectly green, and that the share of green jobs differs widely across sectors. Furthermore, they document that a disproportionately large proportion of green jobs are held by men and highly educated individuals.[14] For the US, (Bowen, Kuralbayeva and Tipoe, 2018[41]) estimate that around 19.4% of workers are directly or indirectly employed in green jobs. In accordance with the other studies which consider the sub-national dimension, this study finds relevant differences across regions as the share of green jobs ranges from 13% to 25%. Finally, (Elliott et al., 2021[53]) study eco innovation and job creation within Dutch firms. Defining green jobs as those occupations with a greenness index (the weighted share of green tasks among all tasks of an occupation) greater than the average greenness index, they find that around 30% of jobs are green.

Advantages and limitations of the bottom-up approach

Bottom-up approaches, especially those based on tasks of occupations, offer a number of appealing features that might be particularly helpful for policy. At the same time, however, they also have a few limitations. Below is a short description of the most important aspects.

Advantages:

- **Subnational information:** When detailed LFS data is available, computing sub-national estimates is straightforward as it does not require collecting extra data or further estimation compared to national estimates. This is particularly relevant for policy because, like other megatrends, the green transition will have different effects across different places.
- **Socio-economic information:** Unlike most top-down approaches, task-based definitions enable detailed analyses of workers in green jobs and how their characteristics such as education, skills levels, gender, age or wages differ from non-green jobs. Thus, it can provide useful information on how the green transition might affect socio-economic disparities.
- **Link to labour market policy:** A key implication of the green transition is that it will lead to a reallocation of jobs and a change of skills that are in demand. Occupational task-based approaches lend themselves to examining how workers can transition into new jobs or sectors through retraining or upskilling and can inform, with greater precision, skills and active labour market policies.
- **Coverage of green 'activities across sectors':** Workers outside of sectors traditionally considered green can also contribute to net-zero and other environmental objectives. Task-based approaches are "sector-blind" and include all workers that support such objectives directly, for example researchers employed in high-emitting firms that are engaged in activities aimed at reducing, mitigating, or eliminating emissions.

Limitations:

- **Crosswalks and US-based tasks:** O*NET task data were built in and for the US. Applying the concept of green tasks to occupations in other countries assumes that the same set of tasks are green in other countries and indeed at the sub-national level. Additionally, information on occupations' tasks needs to be translated from the US occupational system (SOC) into the occupational classification systems of other countries. In practice, official crosswalks, i.e., mappings, are available. However, such crosswalks are not perfect for all occupations. For example, SOC-2010 occupations *"Technical Writers"* and *"Writers and Authors"* (SOC-2010 27-3042 and 27-3042 respectively) are both mapped to ISCO-08 occupation *"Authors and related writers" (ISCO-08 2641)* meaning not all matches are one-to-one.
- **Green tasks over time**: O*NET's Green Task Development Project offers a static picture of what green tasks are at a given time. It does not include information on how the set of green tasks has changed over time, nor does it claim that future green tasks will be the same.
- **Occupational employment data:** Although data on occupational tasks is available at a detailed level[15], occupational employment data is not always collected or published at the same level of detail across countries. This might undermine international comparability of estimates when sufficient detail is not available in certain countries (see section "Measuring green jobs at the regional level" for ways to resolve this issue).
- **Exclusion of ancillary or indirect activities:** the approach mainly includes direct green jobs and therefore excludes workers that are employed in ancillary activities or jobs. Examples of this include security guards or accountants in the renewable energy sector.

Macro modelling approaches

Macro modelling approaches do not directly estimate the share of green jobs but instead examine the possible impact of green policies on the labour market. They may also measure the impact of other environmentally inspired changes in the economy, such as changes in consumer demand, preferences, or productivity. Therefore, this approach is flexible with regard to the definition of green policy. Macro-modelling approaches usually consist of dynamic computable general equilibrium (CGE) models that provide projections on how the economy and the labour market may respond to a given policy change. Thus, they can for instance be employed to provide ex-ante projections of the effects of concrete policy objectives such as the Paris Climate Agreement or the European Green Deal. One such approach is the OECD ENV-Linkages model (Box 1.9).

Box 1.9. OECD ENV-Linkages model

The ENV-Linkages model is a dynamic equilibrium model built primarily on a database merging national accounts that describes how economic activities are linked to each other among sectors and across world-regions through international trade. The model stylises the global economy as it splits the global economy into several global regions and sectors (usually 25 regions and around 50 sectors, but the regional and sectoral aggregation of the model is tailored by project). Jobs can be divided into 5 homogenous categories.[16] Furthermore, firms can substitute employees with either capital or workers from another category but it is assumed that workers do not change category given the rigidity of most labour markets.

Source: (Chateau, Bibas and Lanzi, 2018[54]).

Macro-economic models can be used to study different questions or policies. For example, the OECD ENV-Linkages model has been used to study the jobs potential of a transition towards a resource efficient and circular economy (Chateau and Mavroeidi, 2020[55]). Other work has explored the consequences on the labour markets of structural changes induced by decarbonisation policies (Chateau, Bibas and Lanzi, 2018[54]). The latter finds a relatively small impact on the labour market, as less than 2% of jobs across the world would be destroyed compared to the baseline scenario. The study argues that this impact is not expected to be the same across industries or worker-types, with workers in both the energy industry and energy-intensive industries to be the most affected (i.e., 80% of total job destruction). In producing these estimates, the model assumes that revenues from the carbon-tax issues to foster decarbonisation will be recycled, meaning that tax revenues will be redistributed.

Advantages and limitations of the macro modelling approach

Macro models face a number of limitations but also offer benefits that complement top-down or bottom-up approaches used to define green jobs.

Benefits:

- **Policy guidance**: They contribute to policy options by providing projections of likely consequences.
- **Future outlook**: Those approaches can help identify possible challenges ahead, which can then inform policy choices. They also provide a forward-looking perspective, which complements top-down and bottom-up approaches that mainly look at the current situation or recent changes.

Limitations:

- **No short run:** As the main objective of these models tends to focus on the medium to long term, they do not provide insights into the short-term impact of green policies or the dynamic relationship between the short and medium term. However, the short-term effects of green policies can be very relevant for a number of reasons. First, the short-run effects might differ from the long-run impact. For example, some sectors of the economy, which see no or positive influence in the long run, might suffer strong negative shocks in the short-run due to, for example, adjustment costs. Second, short-run adjustment costs, especially if high or concentrated on specific groups of workers, companies or places, can leave long-lasting detrimental effects that make it hard to return to a positive growth path or lead to widespread labour market detachment.

- **No sub-national analysis:** One limitation imposed by the prioritised global perspective is the fact that sub-national impacts are unclear. Even international analysis is limited as most models focus primarily on comparisons between world regions.
- **Limited job categories:** Most macro-models offer limited information on job categories. For instance, the OECD ENV-linkages model includes five job categories, preventing the analysis of specific job gaps that serve as labour supply bottlenecks limiting the green transition.

Measuring green jobs at the regional level

Analysis of the green transition's labour market implications at the regional level is scarce. In fact, no study has, to date examined the green economy or the share of green jobs at the regional level consistently across different OECD countries. Subnational data and analysis have been limited to individual countries such as the US (Vona, Marin and Consoli, 2019[40]), the UK (Valero et al., 2021[25]) (Broome et al., 2022[56]), or the Netherlands (Elliott et al., 2021[39]).

This report fills that void with novel estimates on jobs that consist, to a significant degree, of green tasks. Those estimates are at the regional level, covering annual data for a decade (2011-2020/21) in 30 OECD countries. Thus, this report defines *green-task* jobs as those jobs with tasks that contribute to the green transition (see sub-section below for details). This stands in contrast to jobs in green sectors and is in line with the bottom-up approach discussed above.

There are a number of reasons why the analysis in this report applies a task-based approach to defining green jobs. First and foremost, it enables regional analysis across a host of OECD countries because of the availability of regional information on employment by occupation (either via labour force surveys or direct data provision by national statistical offices). This contrasts with sector-specific approaches, for which detailed data on employment across regions is often unavailable or not available at a meaningful level of sectoral disaggregation.[17] Furthermore, in supporting policy makers in designing effective policy for managing the green transition, especially with respect to active labour market or skills policies, understanding how green jobs differ from non-green or polluting ones is crucial. In order to help workers navigate the pending labour market changes, one needs to know what skills they would require and what tasks they would have to pursue if they were to transition into green jobs and help deliver the green transition. Therefore, a task-based approach might be better positioned to help design training programmes and re- or upskilling offers. Another possible advantage is that sectoral approaches might only capture a small subset of green jobs due to their narrower focus on selected sectors, which will exclude jobs in other "non-green" sectors that may also, however, contribute to the green transition. Additionally, the approach also accounts for the fact that many jobs can be partly green, i.e. consist of both green and non-green elements (tasks).

Estimating the share of green-tasks jobs

Following the work done by (Vona et al., 2018[45])**, this report adopts a task-based approach to measuring and quantifying green jobs.** O*NET's Green Task Development Project (O*NET, 2010[57]) identifies occupations affected by the green economy activities and emergence of new green technology. It provides a list of individual tasks for each of these 8-digit SOC occupations and classifies these tasks as green or non-green.

O*NET identified two types of occupations with green tasks:

i. ***Green New and Emerging Occupations*** – These are new occupations, which correspond to jobs that were created in the economy in response to green economy activities and the emergence of new green technologies. Examples include solar photovoltaic installers and wind energy engineers.

These occupations did not previously exist in the O*NET taxonomy. All tasks performed in these occupations are considered green.

ii. ***Green Enhanced Skills Occupations*** – These are occupations that underwent a significant transformation in terms of tasks performed in response to green economy activities and the emergence of new green technologies. Examples include construction and building inspectors and car mechanics. These occupations previously existed in the O*NET taxonomy. For these occupations a list of green tasks, associated with the impact of green activities and technologies, was created and added to the existing list of tasks in the occupation (non-green tasks).

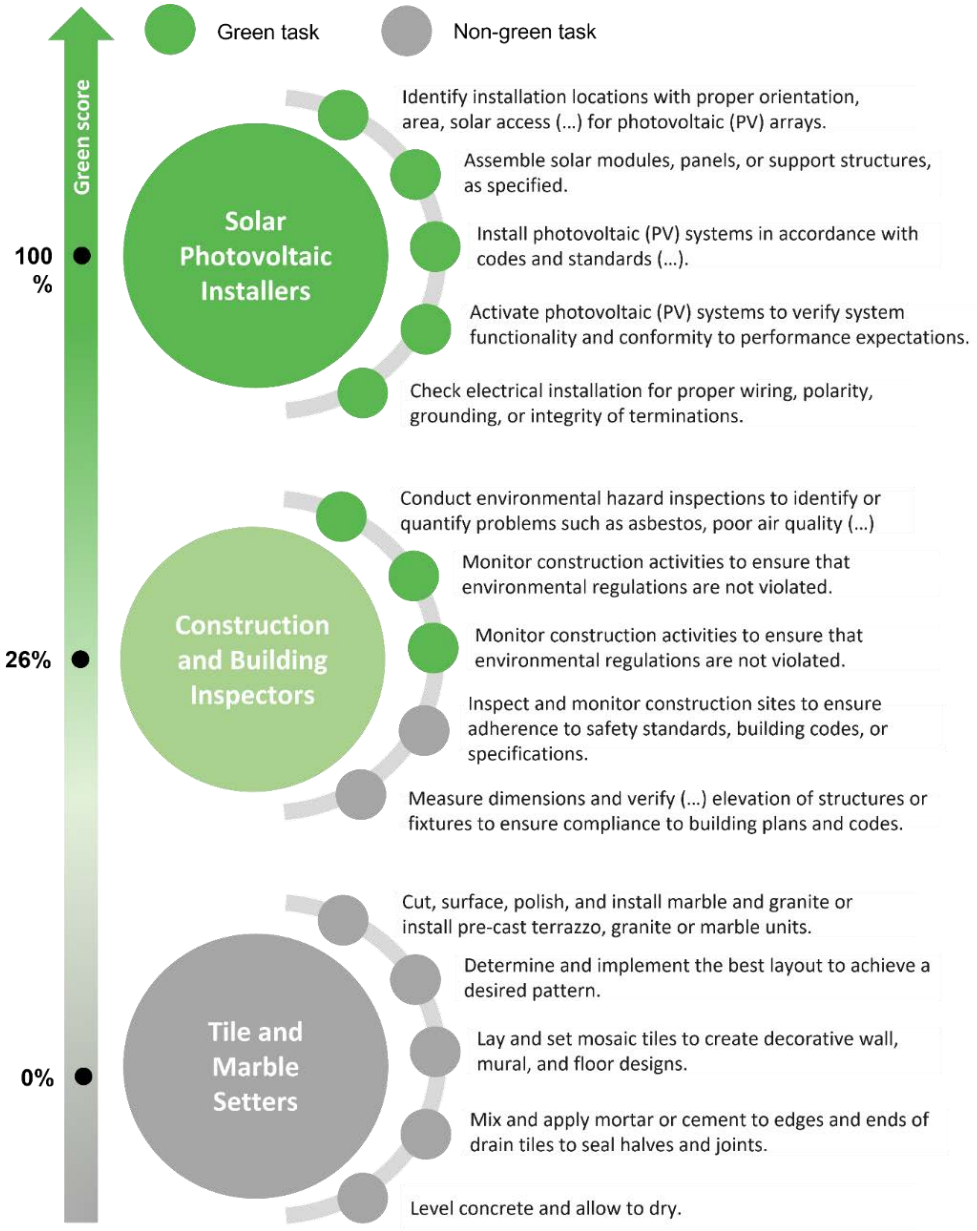
As a result of the process, 1 386 green tasks were identified. All other tasks that were previously included in O*NET taxonomy are considered non-green.[18]

Using that information, Chapter 2 of this report computes the green intensity of an occupation, which can be broadly defined as the proportion of tasks within an occupation that are green. Therefore, this task-based approach provides a continuous measure of the greenness of occupations according to the share of tasks a worker completes on activities that contribute to the green transition. Infographic 1.2 shows examples of green and non-green tasks performed in selected occupation (non-exhaustive list of tasks), together with the green score (i.e., the share of green tasks) of the occupation. It is important to note that this measure focuses on jobs with green tasks rather than jobs in green sectors such as renewable energy. Although the two often coincide, this is not always the case.[19]

Based on the share of tasks in an occupation with some green tasks, a binary measure, which classifies an occupation as a green-task or non-green job, is constructed. This binary measure considers that a green-task occupation is one that consists of a considerable share of green tasks. In practice, an occupation is considered green if its green intensity is larger than 10% (0.1). This means that at least 10% of the tasks it entails are green.[20] This 10% threshold also helps make estimates comparable across countries with different occupational employment information and occupation classification systems.

Indicators constructed at the occupation level are aggregated to regional (and then national) indicators. For this, occupational employment data at the regional level is used. The share of green-task jobs in a given region is simply the proportion of jobs within that region that are green. The green intensity of a region, on the other hand, is the simple weighted (by employment) average of the green intensity measures at the occupational level.

Infographic 1.2. Examples of green and non-green tasks performed in selected occupations



Source: Authors' own elaboration based on O*NET.

Estimating the share of polluting jobs

To identify polluting jobs, the approach by (Vona et al., 2018[45]) **is used.** This approach combines elements of the top-down and bottom-up approaches. It uses industry information regarding both employment and emissions. Furthermore, polluting jobs are a subset of non-green jobs, i.e. they entail no green tasks. Polluting jobs are determined by first identifying the occupations that are very prevalent in highly polluting industries.

Highly polluting industries are defined as those four-digit NAICS[21] industries in the top 95th percentile of emissions of at least 3 (out of 8) contaminants. These eight contaminants are those controlled by the US-based Environmental Protection Agency plus CO_2[22]. This analysis yields 62 brown

industries. Within these sectors, those occupations that are at least seven times more likely to be found in brown industries than in any other industry are identified as polluting occupations. For more detail and discussion on these occupations and their identification, see (Vona et al., 2018[45]).[23]

This analysis yields a binary indicator for polluting occupations. As with green jobs, this indicator is aggregated at the occupation level to obtain regional (and then national) indicators. The share of brown jobs in a given region is simply the proportion of jobs within that region that are brown. It complements the share of green jobs by examining the opposing side, which refers to the part of the labour market that is expected to be negatively affected by the green transition. Nevertheless, both these indicators originate from different definitions as green jobs are defined purely bottom-up while brown jobs are defined in a way that integrates elements from both the bottom-up and top-down approach.

Conclusion

Supporting OECD countries in their ambitions to move to a net-zero and green economy requires good data and evidence. The effective design and evaluation of policies aimed at supporting environmental objectives, green economic growth and the creation of green jobs benefit significantly from comprehensive evidence. Furthermore, setting up training and learning offers as well as targeted career guidance in supporting a just green transition requires information on green jobs and the skills they require. Finally, it requires a sound understanding of the green transition's different impacts among workers, regions, and sectors of the economy.

A major caveat of existing evidence on the green transition is the lack of analysis of its uneven impact within countries, especially on jobs. Most analysis of jobs at risk or the contribution of the green economy focus on national data, individual countries or examine entire supranational entities such as the EU. Even less is known about the spatial dimension of green policies in the labour market. Within countries, regions differ significantly in their economic and industrial structure as well as the composition of their labour force. Therefore, they have both different exposure to risks of job loss and the potential to benefit from green job creation. Thus, the green transition might have implications for the spatial divide within countries and socio-economic disparities in and across local labour markets.

To help fill this gap, Chapter 2 of this report offers novel evidence from regions in around 30 OECD countries. It presents new estimates on the employment opportunities and risks at the subnational level while pointing out geographic differences across regions. More specifically, it shows that the shares of green jobs and polluting jobs, which face a greater risk of displacement due to the green transition, vary widely within countries. Furthermore, it documents the links between the greenness of local labour markets and a number of regional factors. Finally, it zooms in on the socio-economic impact of the green transition within local labour markets.

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Notes

[1] Measures aimed at supporting the green transition in recovery programmes include: grants, loans and tax relief directed towards green transport, circular economy and clean energy research, development and deployment; financial support to households and businesses for energy efficiency improvements and renewable energy installations; new funding and programmes to create jobs and stimulate economic activity through ecosystem restoration; Control of invasive alien species and forest conservation (OECD, 2020[59]).

[2] None of the skills and training programmes included in the recovery plans appear to have a negative environmental impact.

[3] The authors contrast the effect of increases in energy prices with those of automation and globalisation, stating that they are 30% and 80% smaller, respectively.

[4] A recurrent theme in work on the green transition is the lack of evidence and clear definitions of green jobs.

[5] Examples include environmental protection activities, aimed at reducing and preventing greenhouse emissions or other harmful environmental impacts, and resource management activities related to energy.

[6] These sectors were developed in consultation with LCREE experts from various government departments, who are also data users.

[7] Note that for lower-level disaggregation of the survey data, for example, country or region, the accuracy of estimates can be low, limiting the level of detail of the results. In addition, the survey only collects data on direct LCREE activity. Furthermore, this activity does not have to be the main activity of a business for a business to be counted as active in the LCREE economy.

[8] Notably, the survey has registered no significant change since 2015 in employment. Energy efficient products (excluding energy efficient lighting) and the low emissions vehicles sectors remained the largest sectors in the LCREE economy in 2020. The energy efficient products sector is particularly important in terms of employment as it accounts for 42% of employment.

[9] The challenges of defining a "green job" - Office for National Statistics (ons.gov.uk).

[10] Task-based analysis has been applied to many other labour economics issues such as remote working potential.

[11]For more information on the data available and their structure, visit the O*NET data dictionary https://www.onetcenter.org/dictionary/24.1/excel/

[12] O*NET includes such information for each 8-digit SOC (the United States' Standard Occupational Classification) occupation.

[13] Other studies instead examine the share of jobs with any green task or the share of jobs with a significant proportion of green tasks.

[14] The authors also show that workers in green jobs enjoy a wage premium and have more secure work contracts.

[15] Note that it is available at a detailed level for the USA, but by using crosswalks this detailed information can be translated and used in other countries.

[16] Blue collar and farm workers, clerical workers, service and sales, managers and officials, professionals.

[17] Task-based approaches might also avoid an “arbitrary” designation of green sectors since they are based on the content of individual jobs.

[18] Note that O*NET also provides and importance score for each task. The weighted proportion of green tasks yields qualitatively the same results as the unweighted shares and has the drawback of shrinking the dataset as the importance variable is not available for all tasks.

[19] The measure of green jobs used in this chapter treats occupations with the same tasks equally, regardless of their sector. For example, accountants working in different sectors such as renewable energy or manufacturing would be consistently defined as non-green given the lack of greenness of their tasks.

[20] The annex of Chapter 2 provides more information on this and alternative thresholds and further discusses this choice.

[21] The North American *Industry* Classification System.

[22] Specifically, these are: CO, VOC, NOx, SO2, Pm10, PM2.5, lead and CO_2.

[23] Web Appendix C, especially for data and other methodological details.

Annexe 1.A. Data sources and methodology

Data on occupational employment

Estimating the share of green jobs depends on detailed employment data at the regional level. National statistical offices provide information on the total employment by occupation either directly or via micro data from labour force surveys. While many countries use International Standard Classification of Occupations (ISCO) developed by the ILO, several countries such as the US, Canada or Australia have their own classification systems. The level of detail of occupational classifications systems varies across countries as these are built according to the needs and objectives of each country. Nevertheless, one thing is constant with regard to their structure: occupation codes are constructed in such a way that each digit represents a category or subcategory. The first digits usually represent a major or broad category, the second digit represents a subcategory of the first, and so on. For most classification systems, one digit represents one category or sub-category, except for the US where, for example, the major category uses two digits as they have more than 10 major categories.

In addition, the structure of the datasets available on employment by occupation differs across OECD countries. For the empirical analysis in this report, microdata from the respective Labour Force Surveys (LFS) was used for European countries and Canada, while the analysis for the US and Australia was based on their aggregated datasets on occupational employment. The latter reports the estimated employment per occupation and TL-2 region.[1] Information on occupational employment for European countries is less detailed than in the US, Canada and Australia. The European LFS (EU-LFS) provides information up to three ISCO digits.[2] This means that estimates for the greenness of occupations need to be aggregated from more detailed 4-digit to less detailed 3-digit ISCO occupations, which can lead to an overestimation of the share of green jobs (see (JRC, 2021[58])).

To ensure comparability across countries, occupational data is aggregated for countries with more detailed information to a level that is comparable across countries, without sacrificing detail. Therefore, for the US and Canada, information is aggregated to a lower number of digits to make it more comparable with European data, which is only available at the three-digit level for ISCO-08. The digits of aggregation were chosen in such a way that the number of unique occupations is similar across countries without losing too much detail. Based on the examples of the US and Canada, choosing a lower digit of occupational detail does not lead to significant changes in the estimates (see Annex Chapter 2).

Occupation mapping and crosswalks between occupational classifications

O*NET provides data for SOC-2010, therefore the green and brown indicators were computed for this occupation classification and then assigned to the rest of the occupation classifications using one or more crosswalks provided by national statistical offices. Crosswalks are matchings that provide a way to translate occupational classifications and therefore merge labour data from different countries. These matchings are not always one-to-one and can be either full or partial; this creates an issue with aggregation (see (JRC, 2021[58])), as the green score of two or more origin-occupations needs to be combined in order to assign a unique indicator to the destination-occupation. An approach that mitigates the impact of this is discussed in Chapter 2.

O*NET

The green indicators are based on task information provided by the Occupational Information Network (O*NET). O*NET provides several relational datasets that describe occupations, tasks and task ratings, among other things. The latest available dataset (version 24.1 from Nov. 2019) with information on green tasks is used. This dataset provides information for 974 occupations (out of 1 110) using SOC-2010 occupation classification at the 8-digit level.

Industry emissions

Information on emissions is extracted from the National Emission Inventory database and the Greenhouse Gas Emission for Large Facilities (2011), both of which are maintained by the Environmental Protection Agency (2011). This data is aggregated to the main 4 digit NAICS code.

Notes

[1] Information on employment is not reported for the Northern Territories in Canada, as access to this micro-data is limited.

[2] In addition, note that Poland and Slovenia were excluded from the analysis given that for these countries the occupational codes are disseminated at 2-digit level only. This does not allow for sufficiently precise identification of green jobs.

2 The green transition in local labour markets

This chapter sheds new light on the effect of the green transition on local labour markets. It provides novel estimates for green and polluting employment across OECD regions. It analyses if and why regional labour markets differ in the extent to which their jobs comprise green tasks. It also examines whether green-task jobs differ from non-green task jobs and how that might impact socio-economic divides within local labour markets. Finally, it uses information on recent labour demand to assess in which regions a greater share of new vacancies is green.

In Brief

The green transition creates new challenges and opportunities for local communities

- **Around 18% of workers in the OECD work in jobs with a significant proportion of tasks that contribute to environmental objectives (green tasks), ranging from 7% to over 35% depending on the region**. Some regions, including many capital regions, have already benefitted from the green transition and have a high and increasing share of green-task jobs and a low share of polluting jobs at risk of disappearing. In other regions, a high share of polluting and green-task jobs coincide, which creates space for job transitions. However, there are also regions with above-average risk of job displacement where the benefits of the green transition have yet to be captured. The demand analysis suggests that few regions with a low share of green-task jobs show signs of catching up.
- **A region's ability to benefit from the green transition has, so far, depended on its industrial composition and the skills in the local labour market**. Higher shares of scientific, technical and information technology activities in the region correlate with a higher share of green-task jobs. The top regions in terms of the share of green-task jobs also tend to have a higher share of population with tertiary education.
- **Despite the increasing prevalence of climate change in the public discourse, labour markets have not, on average, become much greener over the last decade**. The share of workers in green-task jobs grew from 16% in 2011 to almost 18% in 2021. However, this masks significant differences across regions, with changes ranging from an increase of 10 percentage points to a decrease of 7 percentage points. Regions that invest more in R&D recorded larger growth of green-task jobs. However, recent data on regional labour demand paint a more positive picture. The share of green-task vacancies is higher while the share of polluting vacancies is lower compared to the current employment shares, which may be the first signs of a shift towards a more environmentally friendly labour market.
- **Green-task jobs exist across sectors and regions, including industries that are not traditionally considered green**. While sectors such as "water supply, sewage, waste management and remediation activities" or "electricity, gas, steam and air conditioning supply", which include many green activities, have a high share of green-task jobs, other sectors such as manufacturing and construction consist of both green-task and polluting jobs.
- **The green transition may deepen divides within the local labour markets**.
  - **The green transition has a strong gender dimension in the labour market.** Women are currently under-represented in green-task jobs, accounting for only 28% of them, suggesting that efforts need to be made to increase female participation in the green transition. On the other hand, men will be the most affected by the disappearance of polluting jobs.
  - **High-skilled and highly-educated workers are better positioned to benefit from the green transition.** Green-task jobs tend to offer higher pay but require more education. While it is possible that in the future green jobs will shift towards medium- and low-skilled occupations (in activities such as waste management, retrofitting or construction, for example), the majority of workers in green-task jobs are currently high-skilled and have completed tertiary education. In contrast, polluting jobs, at risk of disappearing, are held by individuals with lower educational attainment and in medium-skilled occupations.

Net-zero transition: a global challenge with local implications

Tackling climate change and environmental degradation is one of the most formidable tasks the world faces. The United Nations Framework Convention on Climate Change (the "Paris Agreement") set out the objective of keeping the global temperature increase below 2°C and pursue efforts to keep it to 1.5°C compared to pre-industrial levels. Limiting global warming requires a considerable reduction in the emission of greenhouse gases (GHG), with net GHG emissions falling to zero by 2050. Such emission reductions will demand drastic actions that will affect industrial production, consumption patterns and energy provision across the world. Furthermore, it will likely entail a transformation across every industry, most notably in pollution-intensive sectors such as manufacturing (OECD, 2023[1]).

The shift to a net-zero economy will result in a significant transformation of the labour market as workers move into different occupations or sectors. The greening of the labour market will have three main effects. First, new types of jobs will emerge, creating economic opportunities in occupations that may not yet exist. Second, it will likely result in the loss of some existing jobs, especially among jobs that are highly polluting. Beyond the creation of new jobs or the displacement of old jobs, the green transition will lead to a shift in the skills that are required for many jobs. Therefore, while the public discourse on the green transition has so far focused on its potential risks for workers and firms, the transition can also create new opportunities for local job creation. Reducing the risks and capturing the benefits of the green transition requires a rethinking and updating of education curricula and training courses, which need to enable workers to gain the right set of qualifications and skills demanded by the changing labour market (CEDEFOP, 2019[2]). Hence, risks and opportunities in the labour market in terms of new green jobs and disappearing jobs has direct consequences for policy making in areas such as education, as well as upskilling and retraining opportunities.[1]

While the green transition is a global megatrend, its labour market impact is inherently local. Both the risks and opportunities for workers are uneven across different places within the same country. Employment risks are often concentrated in specific regions. For instance, regions with a strong reliance on jobs in high-emission sectors are more likely to see jobs losses, due to green policies or market forces. Likewise, economic opportunities and green job creation will not materialise everywhere to the same degree. Therefore, aggregate effects or national data may mask regional disparities in the labour market impact of the green transition (OECD, 2017[3]).

Empirical work on green jobs has so far mainly neglected subnational differences. Most of the existing analysis provides global averages or, at best, examined national data. Studies that offered subnational breakdowns focused on a single country such as the US (Vona, Marin and Consoli, 2019[4]) or the Netherlands (Elliott et al., 2021[5]).

This chapter tries to fill the void of local data and analysis on the labour market and the green transition. This report presents novel analysis of green-task jobs at a regional level that goes beyond studying individual countries. It presents new estimates for the greening of local labour markets in 30 OECD countries. It investigates the geographic differences within countries in terms of green-task jobs as well as employment in polluting jobs that might be at risk of displacement. It also examines in which sectors green-task jobs are concentrated and assesses reasons for their regional variation in labour markets. Finally, it provides a first glimpse of differences between workers in green-task and non-green-task jobs and explores how recent labour demand has developed for green-task jobs since the COVID-19 pandemic.

Green-task jobs: an opportunity for local economic growth?

The public discourse on the green transition has so far focused on its potential risks for workers and firms but the transition can also create new opportunities for local job creation. Like other global megatrends such as digitalisation or automation, the green transition will affect the world of work. It will reshape some sectors and jobs, changing job requirements and qualifications for specific occupations. It might also lead to job losses in the sectors most affected by environmental regulation, such as energy-intensive industries (Vona et al., 2018[6]), (Walker, 2011[7]). However, the transition to net-zero may also give rise to new jobs and support local economic growth.

Measuring green-task jobs across local labour markets

The analysis in this report takes a bottom-up approach to defining "green jobs" referred to as *green-task jobs*. It is based on the tasks different occupations entail and the extent to which those support environmental goals. Two measures are used in this chapter. The main measure is the ***share of green-task jobs*** in a regional labour market (Box 2.1). The additional measure is the weighted ***green intensity of employment*** in a region (Box 2.2). The former defines green-task jobs as those that have a significant green component (at least 10% green tasks) and enables comparisons of differences across workers in different jobs within regional labour markets. The latter broadly describes the extent to which tasks in a regional labour market contribute to the green transition.

Other definitions of "green jobs" exist and the preferred approach depends on the objectives of the study. For the purpose of this analysis, the bottom-up, task-based approach is preferable as it makes it possible to (i) study the distribution of green-task jobs at the local level, (ii) investigate the characteristics such as education, skills levels, gender, age, etc. of workers in green-task jobs, (iii) examine how workers can transition into new jobs or sectors through retraining or upskilling, and (iv) include in the analysis workers who contribute to net-zero and other environmental objectives but are outside of sectors traditionally considered green. The advantages and disadvantages of the approaches used in the literature to measure "green jobs" are discussed in detail in Chapter 1.

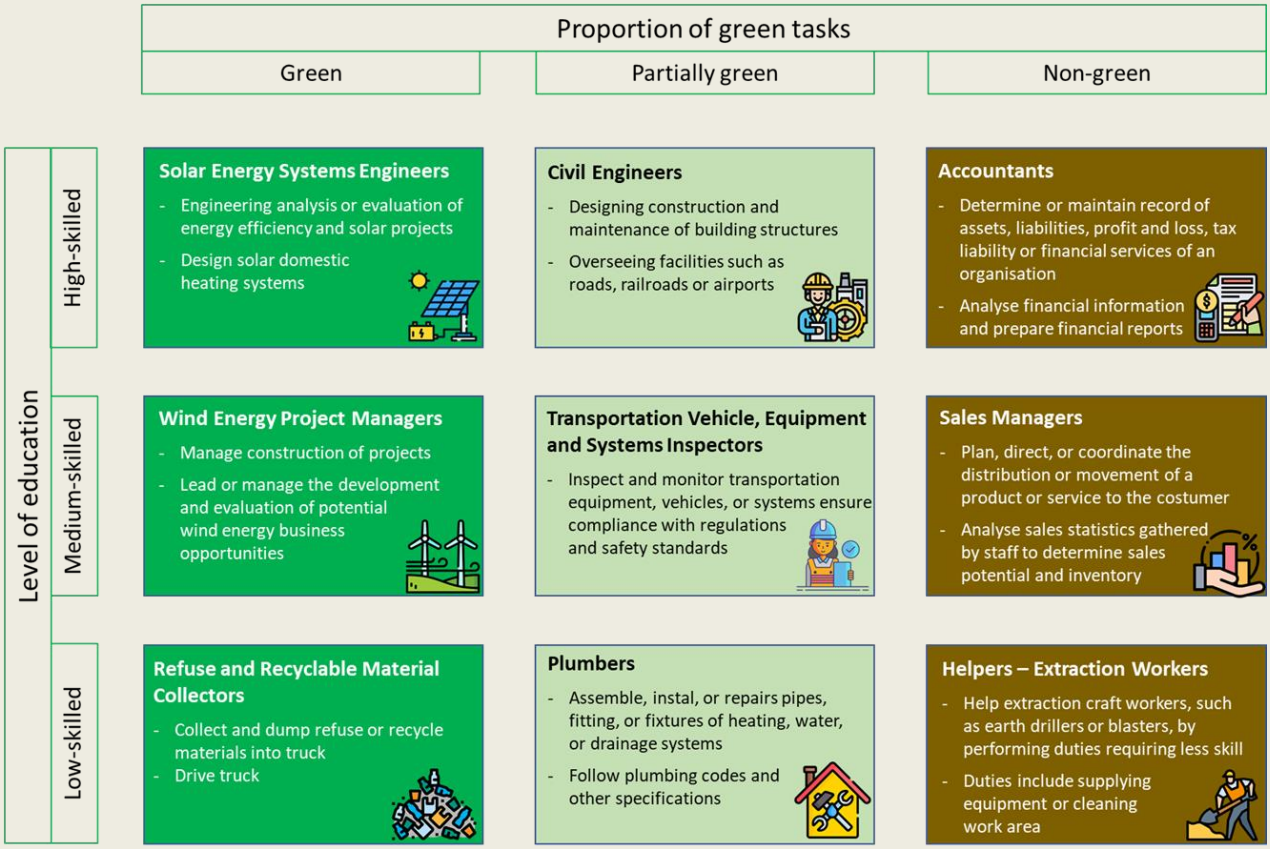
Box 2.1. Measuring the share of green-task and polluting jobs

O*NET classification of green jobs and tasks

Green-task jobs are defined and analysed at the occupation level based on the greenness of their related task content, following the work of (Vona, Marin and Consoli, 2019[4]). It relies on classifications developed by O*NET, which provides a taxonomy of the greenness of all tasks for more than 900 occupations (Dierdorff et al., 2009[8]). Broadly speaking, tasks identified as green contribute to environmental objectives such as preserving the environment and reducing emissions. More details on the methodology of classifying tasks as green and non-green are provided in Chapter 1.

Using the information on the tasks of an occupation, one can compute a greenness score for each occupation. The score of each occupation can range continuously from 0 to 1, with higher values indicating a higher share of green tasks in the occupation. A score of 0 denotes an occupation with no green task. Infographic 2.1 offers a number of illustrative examples of different occupations, including those with a very high greenness score, those with some green tasks, and those with no green tasks. Based on O*NET's classification, the majority of jobs have no green task. Occupations with no green tasks in O*NET's classification are not necessarily 'dirty', as illustrated by examples below.

Infographic 2.1. Green-task jobs can be found across the economy and skills spectrum



Note: The greenness of occupations is based on their task content and whether those tasks are green or not. The greenness score of occupations ranges from 1 (all tasks are green) to 0 (all tasks are non-green). The classification of high-, medium-, and low-skilled occupations follows ISCO.
Source: OECD elaboration based on O*NET's Green Tasks Data.

Green-task jobs

To examine the geography of jobs with a significant share of green tasks and to examine differences across workers within regional labour markets, a binary measure is constructed which classifies an occupation as being green-task or non-green-task. For this report, green-task jobs consist of those occupations with at least 10% of their tasks considered green.

Polluting jobs

In addition to the share of green-task jobs, a classification of polluting jobs is constructed, building on the classification of (Vona et al., 2018[6]) and the IMF (International Monetary Fund, 2022[9]). Polluting jobs are a subset of non-green-task jobs that are particularly concentrated in high-polluting sectors.

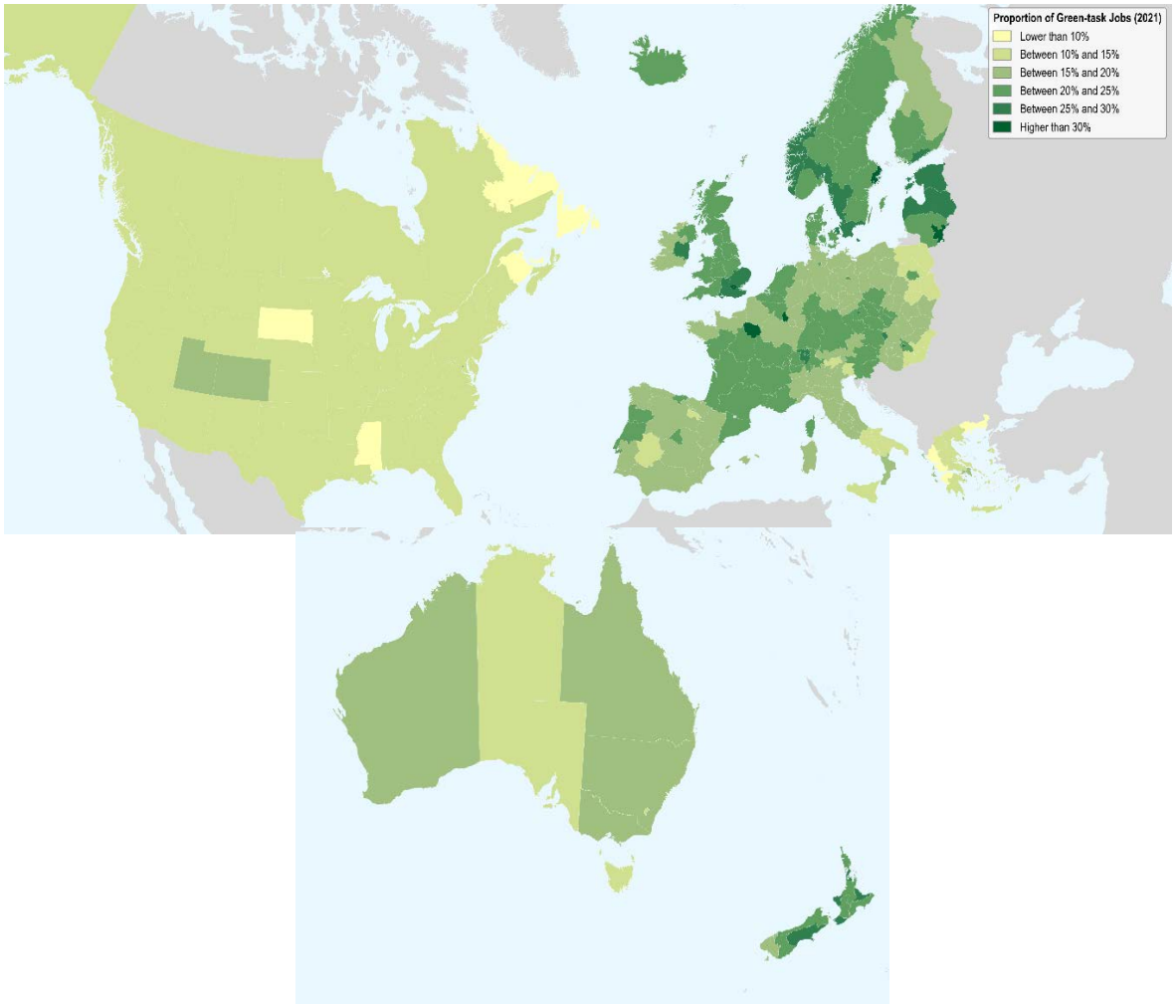
Given that O*NET's classification of green tasks is not frequently updated, the analysis presented in this report captures the evolution of the share of green-task jobs in the economy over time but does not capture the evolution of the share of green tasks within occupations. Similarly, differences between regions are driven by the differences in occupational composition, given that the task composition of occupations follows O*NET classification and is constant across regions. Moreover, the estimates on green-task jobs are likely to correspond to upper-bound estimates given the aggregation of employment data by occupation. The assumptions and limitations of the analysis are discussed in detail in Chapter 1 and in Annex 2.A Sensitivity Analysis and Robustness Checks.

How green are local labour markets?

The majority of the labour force in OECD regions is employed in non-green-task jobs. Less than a fifth of the workforce in the OECD holds green-task jobs that were either created as a result of the green transition or because their task composition changed. As of 2021, 18% of jobs in the OECD comprised a significant share of green tasks. This headline figure, however, masks large variations (Figure 2.1). Regions in southern Europe - in Greece, Italy, Portugal, and Spain – as well as in North America tend to have a lower share of green-task jobs, while regions in the Baltic and Nordic countries score high on this measure. Many regions in France, United Kingdom, Luxemburg, and Switzerland have a high share of green-task jobs too. The share of green-task jobs ranges from 7% (Western Greece) to 35% (Vilnius Region), which highlights the large differences across regions in the OECD.

Figure 2.1 Share of green-task jobs across regions

The proportion of green-task jobs in regional labour markets, OECD regions, 2021 or last available year

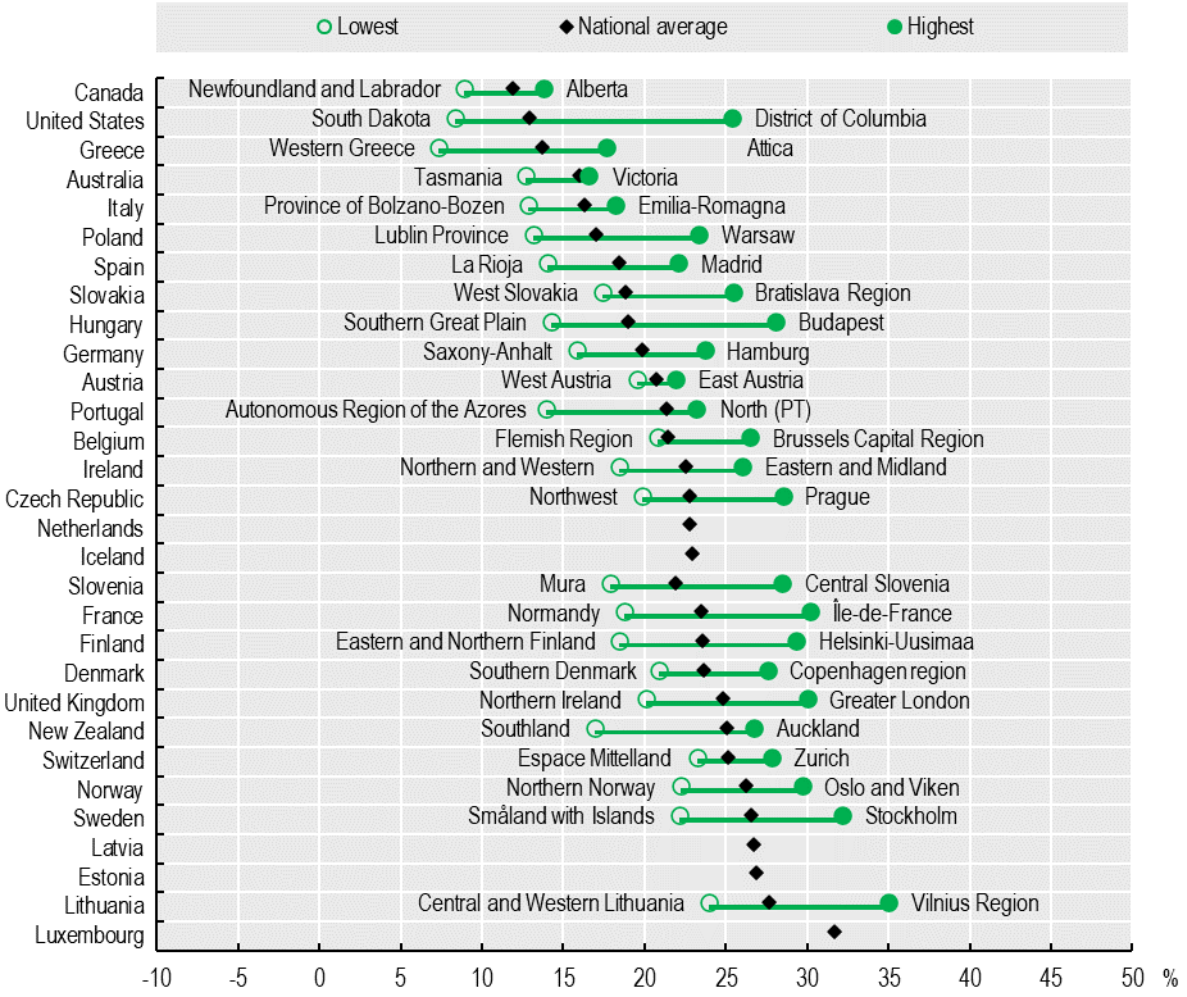


Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, Norway, New Zealand, Switzerland, and the US. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

The share of green-task jobs differs significantly within countries. On average, the difference between the top and bottom regions is 7 percentage points (Figure 2.2). In Europe, large subnational differences exist in Hungary (14 percentage points), Lithuania, Finland, and France (all 11 percentage points). In the US, this gap reaches 17 percentage points, but this is driven by a significantly greener labour market in the District of Columbia compared to the rest of the country. In 19 out of 25 countries with data for multiple regions, the capital region has the highest share of green-task jobs in the country. Canada, Germany, Italy, Portugal, New Zealand, and Australia are notable exceptions. In the case of Australia, Canada, and the United States (when the District of Columbia is excluded), the smaller regional variance might be partly due to the large size of the regions, which hides sub-regional variation.

Figure 2.2. There is significant dispersion in terms of green-task jobs within countries

Share of green-task jobs across and within countries, OECD regions, 2021 or last available year

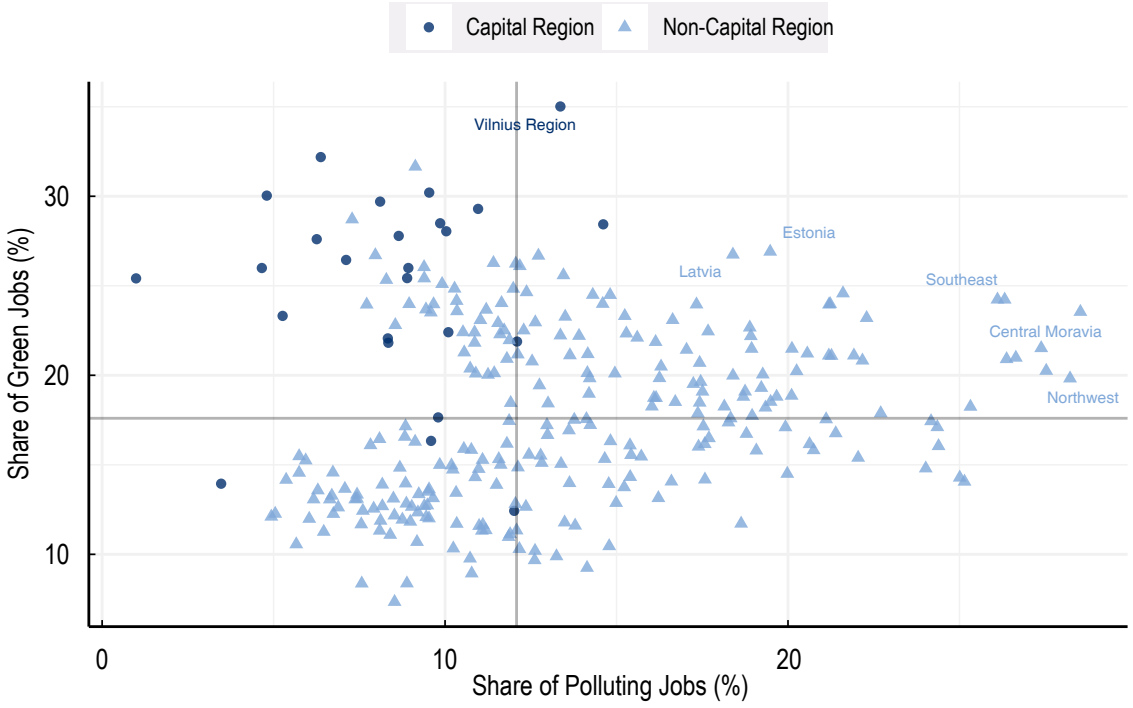


Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, Norway, New Zealand, Switzerland, and the US. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

A lower share of green-task jobs and a high share of polluting jobs do not always go hand in hand. For example, Greek regions tend to have a low share of green-task jobs as well as a low share of polluting jobs. Regions can also have a high share of green-task and polluting jobs at the same time, as is the case in the Baltic States (Figure 2.3). Regions with a below-average share of polluting jobs range from 7% (Western Greece) to 32% (Stockholm) in terms of the share of green-task jobs, while regions with an above-average share of polluting jobs oscillate around the average score for the share of green-task jobs. Many regions are neither green nor polluting, for example Western Greece, Epirus, and Eastern Macedonia-Trace (Greece), or Newfoundland and Labrador (Canada).

Figure 2.3. Regions can have a high share of polluting jobs and green-task jobs at the same time

Share of green-task and polluting jobs in OECD regions, 2021 or last available year.



Note: The vertical and horizontal lines indicate the average share of polluting and green-task jobs across regions, respectively. Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, Norway, New Zealand, Switzerland, and the US. See Box 2.1 for the definition of green-task jobs and polluting jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

On average, capital regions tend not only to have greener but also less polluting labour markets. For example, in France the share of green-task jobs in the capital region is 30% compared to 22% in the rest of the country (Figure 2.5). The opposite pattern holds for polluting jobs, which account for 10% of employment in Ile-de-France and 16% in the rest of France. Overall, green-task jobs are over-represented in OECD capital regions.[2] The opposite is true for polluting jobs, which tend to be under-represented in the capital regions.

The green transition may widen regional economic gaps. Within countries, regions with a higher share of polluting jobs tend to have significantly lower GDP per capita.[3] Since polluting jobs face a higher risk of displacement, those regions might experience greater job losses than more affluent regions and a reduction in economic activity, which could lead to further economic divergence across regions in OECD countries.

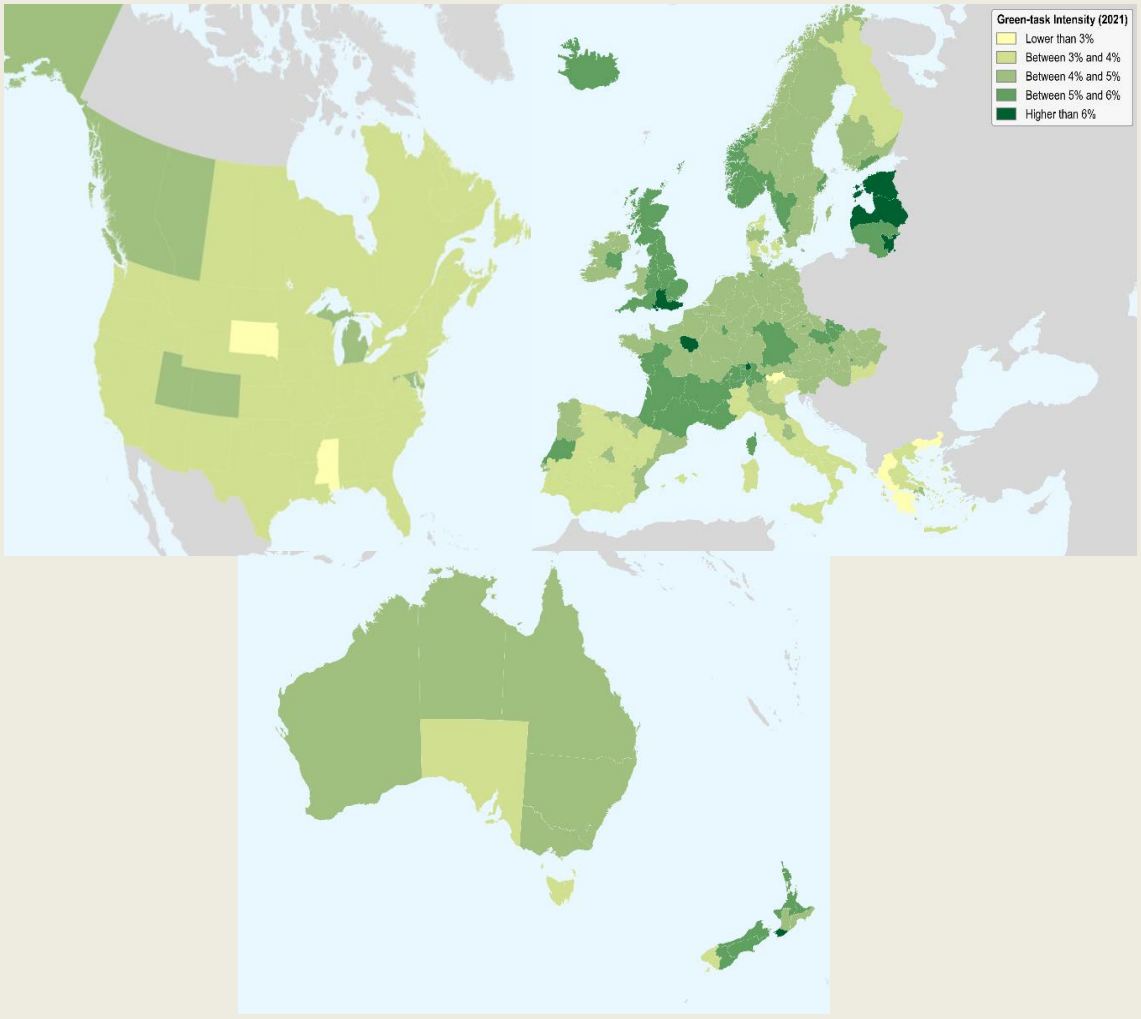
Box 2.2. How "green" are the green-task jobs in OECD regions?

In addition to studying the share of jobs that involve a significant proportion of green tasks, it is also possible to look at the green intensity of local labour markets. The greenness score for each occupation is calculated as the share of green tasks out of total tasks. It is a continuous measure that ranges from 0 to 1, with higher values indicating a higher share of green tasks in the occupation. The main statistic used in this report is a transformation of this continuous measure into a binary measure, which classifies occupations as "green-task" or "non-green-tasks" jobs (Box 2.1). However, it is also possible to use the greenness score directly to calculate the average share of green tasks out of total tasks carried out by all workers in a local labour market, referred to as ***green-task intensity of employment***. It combines the greenness score for individual occupations with data on the employment share by occupation.

Green-task intensity of employment is necessarily lower than the share of green-task jobs, but it exhibits the same spatial patterns. On average, the green-task intensity of employment is only around 4% in OECD regions. Broadly speaking, this means that, on average, 4% of tasks carried out by workers in OECD regions are green. Regions with a higher share of green-task jobs tend to have a higher green-task intensity of employment.[4] Similar to the share of green-task jobs, the green-task intensity of employment differs significantly across regions – from 2% in Western Greece to 7% in Vilnius (Lithuania) – and within countries. Spatial patterns are also similar. In Europe, the regions with the lowest green-task intensity of employment are located in Greece, Italy, and Spain, while many of those regions with greener employment are located in the Baltic States, France, Switzerland, and the United Kingdom. Compared to most of Europe, regions in the US and Canada record a low green-task intensity of employment.

Figure 2.4. Green-task intensity of employment across regions

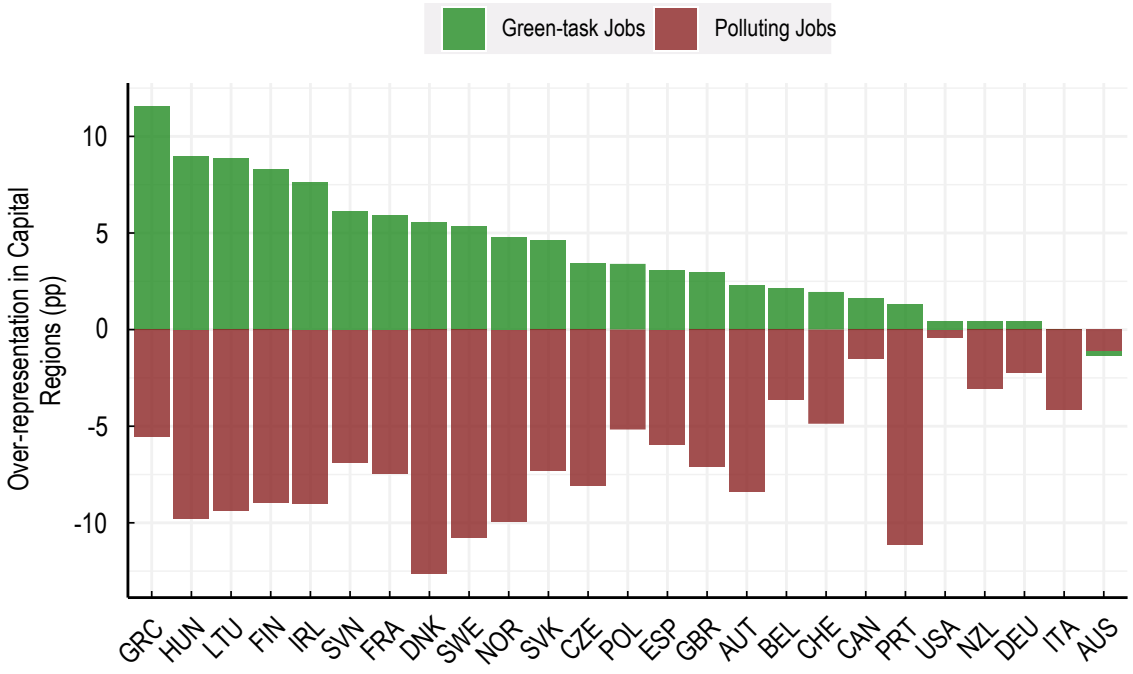
The proportion of green tasks in regional labour markets, OECD regions, 2021 or last available year



Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, Norway, New Zealand, Switzerland, and the US. See Box 2.1 for the definition of green-task intensity.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

Figure 2.5. Capital regions stand out with more green-task and fewer polluting jobs

Difference between the share of green-task (polluting) jobs in the country that are located in the capital region and the share of all jobs in the country that are located in the capital region, 2021 or last available year.

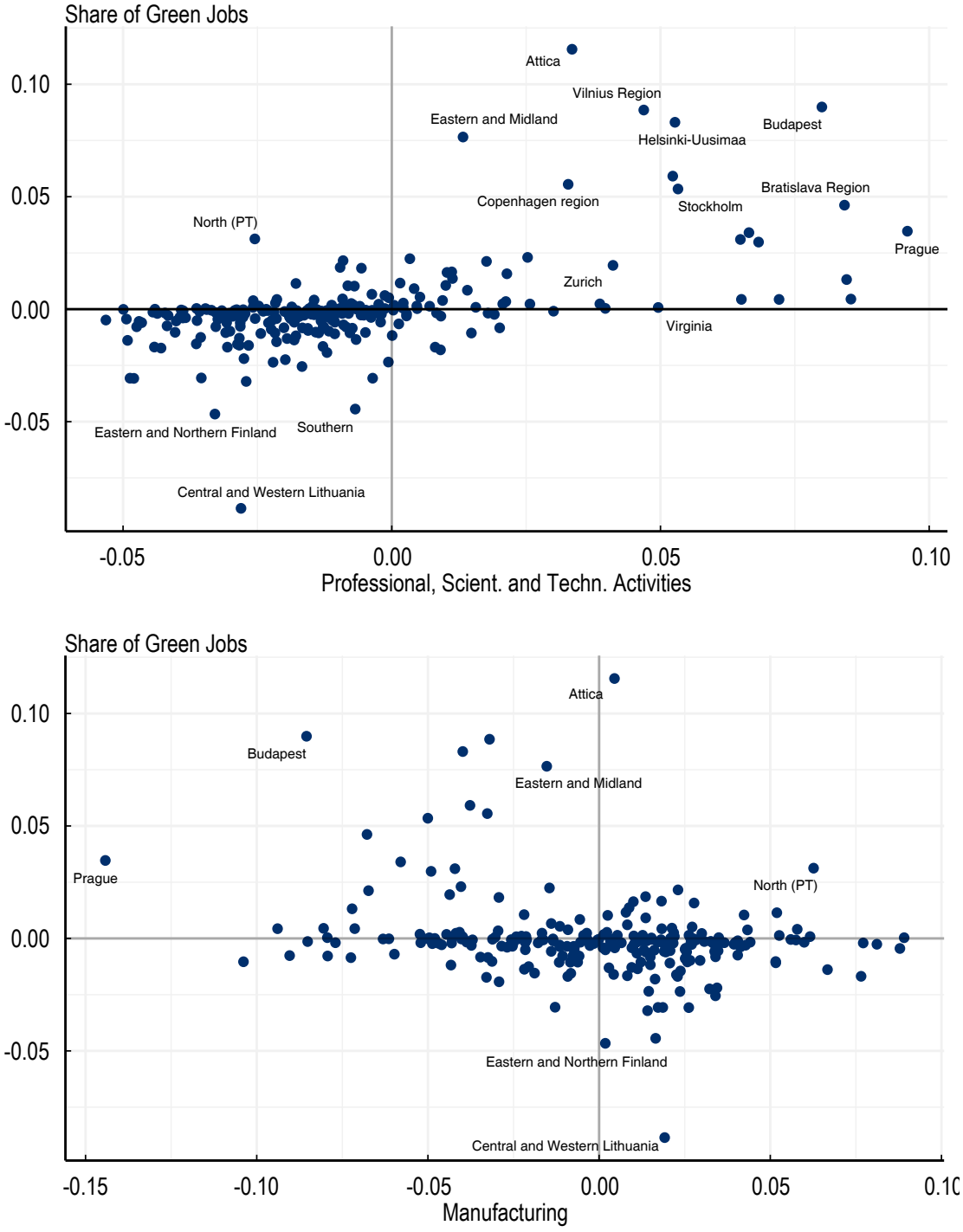


Note: Countries for which sub-division at TL2 level does not exist or is not available are excluded. Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, Norway, New Zealand, Switzerland, and the US. See Box 2.1 for the definition of green-task jobs and polluting jobs.
Source: OECD calculations based on EU LFS, Canadian LFS, OEWS (U.S Bureau of Labor statistics), Table EQ08 (Australian Bureau of Statistics).

Innovation, industrial composition, and the education of the workforce are factors associated with the greenness of regional labour markets. Regions that concentrate certain industries such as professional and scientific activities within their country tend to record above average shares of green-task jobs (Figure 2.6). The opposite is true for other specific industries such as agriculture or manufacturing. Regions with relatively low employment in those sectors record higher shares of green-task jobs than the national average.[5]

Figure 2.6 Share of green-task jobs and industry over/under representation

Regional over/under representation, compared to country average, of share of green-task jobs and share of industry employment, 2021 or last year available.



Note: Positive value indicates a region is over-represented (i.e., has a higher share than the country average) on the respective variable. A positive value of (for example) 0.05 means that a region's share of green-task jobs is 5% percentage points larger (or share of employment in that industry) than the national average.

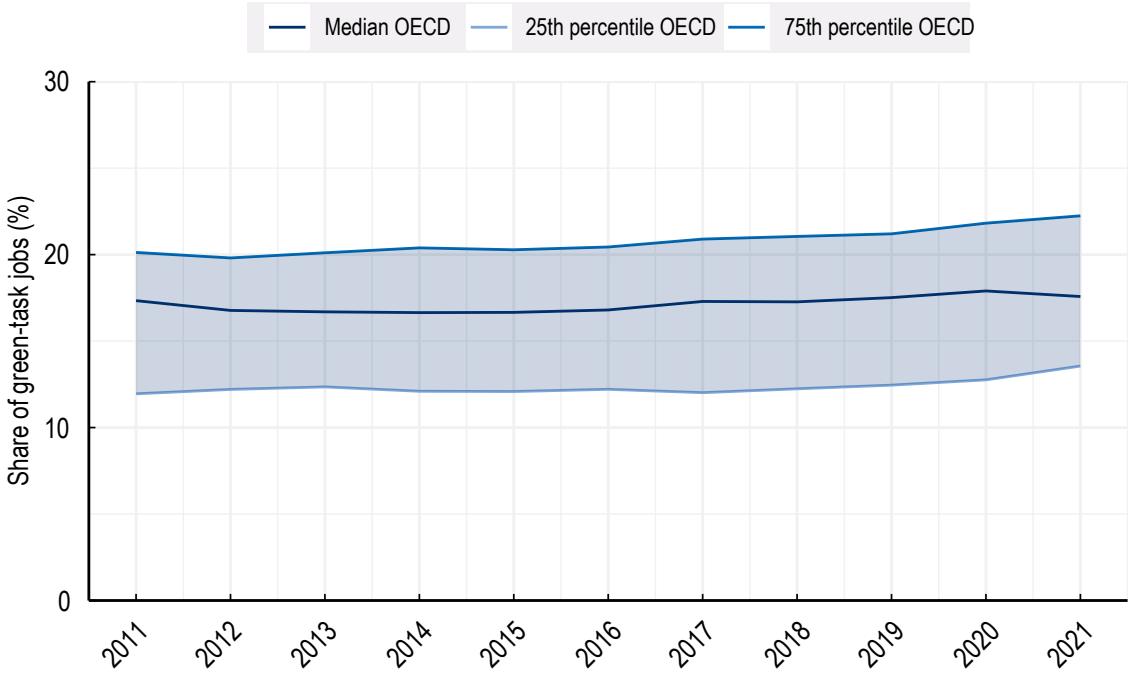
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland). 2021 for Australia, Canada, USA, and EU countries, Norway, and Switzerland. 2019 for UK.

Where has the share of green-task employment grown the most?

Despite the attention that green policies receive, on average labour markets have not become much greener over the last decade. The share of workers in green-task jobs grew from 16% in 2011 to 18% in 2021 (Figure 2.7). However, that masks significant differences across regions.

Figure 2.7. The share of green-task jobs in the OECD did not change over the last decade

Share of green-task jobs across OECD regions, 2011-21.



Note: The statistics should be interpreted in the following way: 25 percent of regions in the OECD have a share of green-task jobs lower than the 25th percentile presented in the graph. From 2011 to 2021. Data for Australia, Canada, EU countries (excluding Poland and Slovenia), Norway, New Zealand, Switzerland, and the United States. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

However, there have been more significant changes in the share of green-task jobs at the sub-national level. For example, in Taranaki (New Zealand), the share of green-task jobs grew the most, by 10 percentage points between 2011 and 2021 (Figure 2.8). In contrast, the share of green-task jobs fell by 7 percentage points in the Australian Capital Territory over the same period. Many regions with an already high level of green intensity, recorded a further improvement – notably regions in Nordic countries. Regions in New Zealand stand out as those with the highest percentage point increase in the share of green-task jobs. Across the OECD, most capital regions recorded further increases to already relatively higher shares of green-task jobs.

Figure 2.8. Capital regions have tended to see an increase in green-task jobs

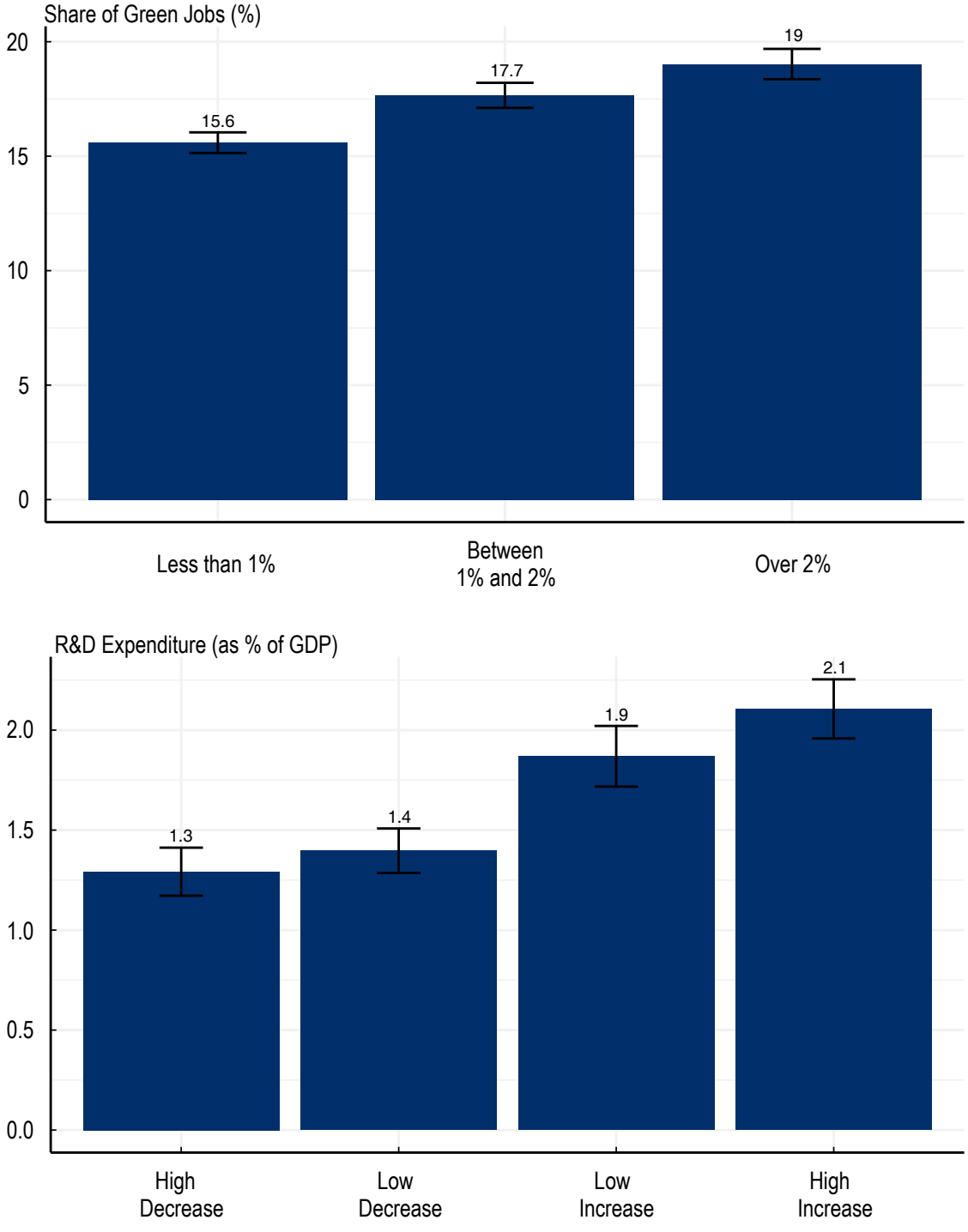
Change in the share of green-task jobs between 2011 and 2021 or last available year and the share of green-task jobs in 2011 for OECD regions.

Note: The vertical line indicates the average share of green-task jobs across OECD regions in 2011. From 2011 to 2021 or last available year. 2011-19 for the UK. 2011-20 for Iceland. 2011-21 for Australia, Canada, EU countries, Norway, New Zealand, Switzerland, and the United States. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

Regions with greater innovation spending have not only greener labour markets, but also recorded significantly larger progress in greening their labour markets (Figure 2.9). The more regions spent on R&D investment (as a % of GDP), the greater the increases they recorded in green-task jobs. Regions with above median growth (marked as "high increase") in the share of green-task jobs spent almost twice as much on R&D (relative to GDP) as regions that recorded above median reductions in the share of green-task jobs. While it is unclear how such R&D spending is allocated across different activities and fields, policy priorities for the green growth include "unleashing innovation" by supporting "the creation and diffusion of new products, processes and methods" (OECD, 2020[10]).[6]

Figure 2.9. Green-task jobs and regional innovation

Average R&D expenditure (as % of GDP) and the share of green-task jobs (top panel) as well as above-median increase/decrease in the share of green-task jobs (bottom panel)



Note: High and low increase (decrease) is defined as being above (below) the median increase (decrease) in the share of green-task jobs over the 2011-20 period, 2011-21 for the US, Canada, and Australia.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

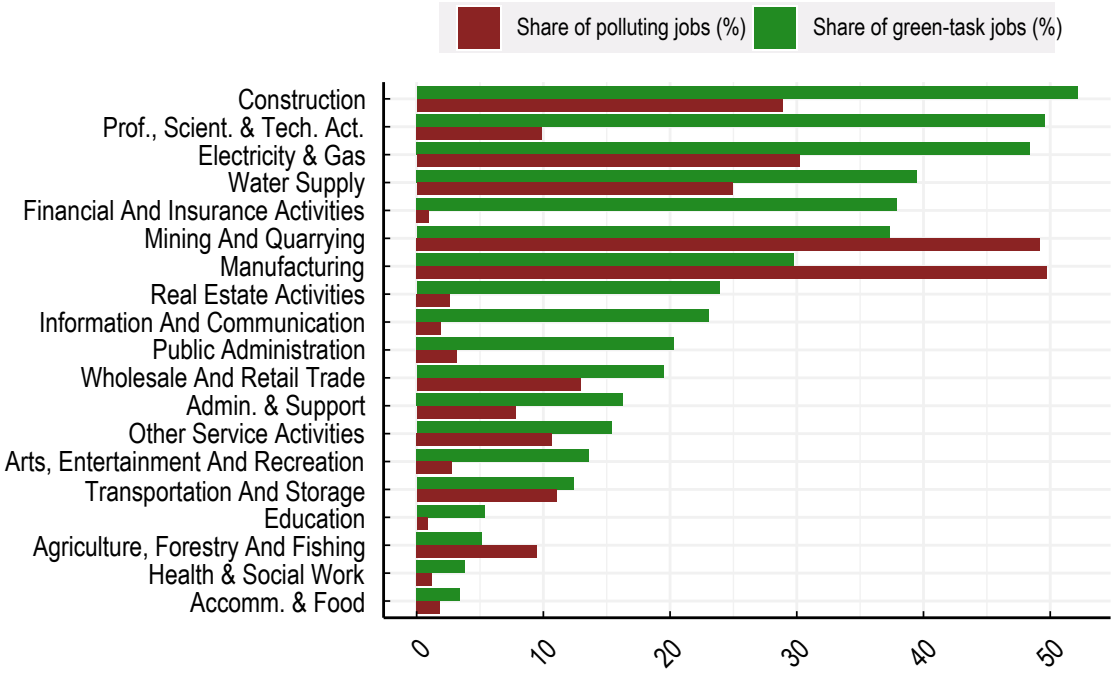
How does the 'greenness' of employment differ by industry?

Green-task jobs can be found across all industries, including in industries that were not traditionally considered green. These include water supply, sewage, waste management and remediation activities; electricity, gas, steam, and air conditioning supply, which include economic activities such as, for example waste collection, treatment and disposal activities; materials recovery and remediation activities[7], which are traditionally considered green have a high share of green-task jobs and high green-task intensity (Figure 2.10). Professional, scientific and technical activities, which includes scientific research and development and architectural and engineering activities, stand out as an industry with a high share of green-task jobs.

However, other sectors such as construction and mining and quarrying also score high in terms of the share of green-task jobs and green intensity. These industries, while polluting, also employ individuals responsible for the reduction of pollution and mitigation of environmental risks, such as environmental engineers, brownfield redevelopment specialists, solar photovoltaic installers, weatherisation installers and technicians or hazardous materials removal workers. As the green transition gathers momentum, the relative greenness of different sectors might change. For example, while construction employs many polluting jobs, future efforts in activities such as retrofitting or insulation could help create more green-task jobs. Likewise, sectors such as agriculture might experience a rise in green activities through a shift to more sustainable operation models such as organic farming.

Figure 2.10. Green-task jobs can be found across all industries

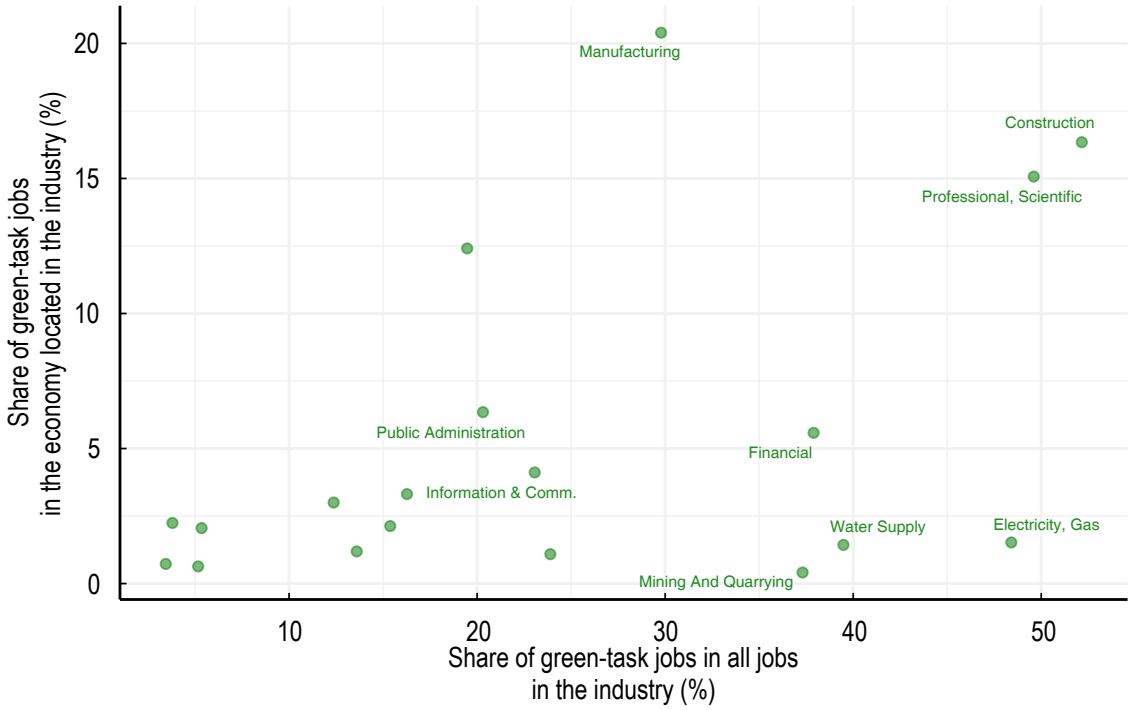
Share of green-task and polluting jobs as a percentage of all jobs in each industry, 2021 or last year available.



Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for EU countries, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs and polluting jobs.
Source: OECD calculations based on EU LFS.

Figure 2.11. Manufacturing stands out as the industry with a high share of green-task jobs and a high contribution to the number of green-task jobs in the economy

Share of green-task jobs by industry, 2021 or last year available.

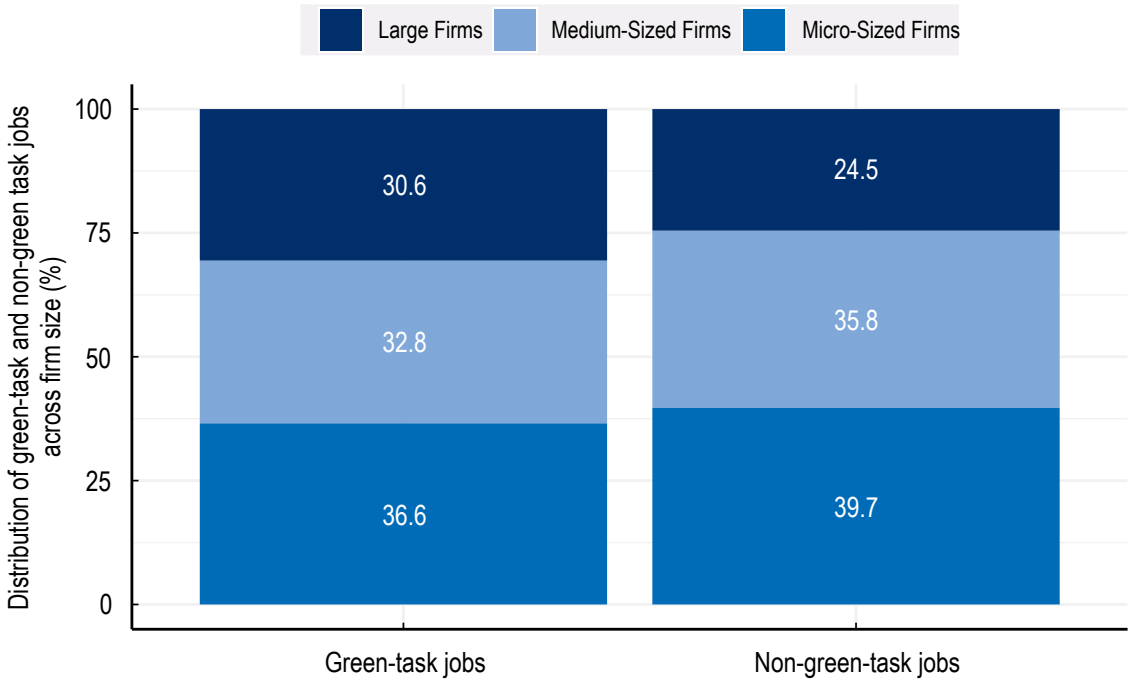


Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for EU countries, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS.

Within regional labour markets, the greenness of firms differs by their size. Green-task jobs are overrepresented in large firms with at least 250 employees. Large firms account for around 31% of green-task jobs, but only for around 25% of other employment. In contrast, smaller firms provide relatively few green-task jobs compared to their overall share of total employment. These differences across firm size might be related to limited resources in smaller firms, which makes it harder for them to invest in new and greener technology or production processes or provide training that enables workers to acquire green skills.[8]

Figure 2.12. Green-task jobs are more concentrated in large firms than other jobs

Share of green-task (and non-green-task) jobs located in each size category of firms, 2021 or last year available.



Note: Micro-sized firms have less than 20 people. Medium-sized firms have between 20 and 249 people. Firms with 250 people or more are considered large firms. Statistics calculated for EU countries, Norway, Switzerland, and the UK. Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for EU countries, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS.

The green transition may deepen divides within local labour markets

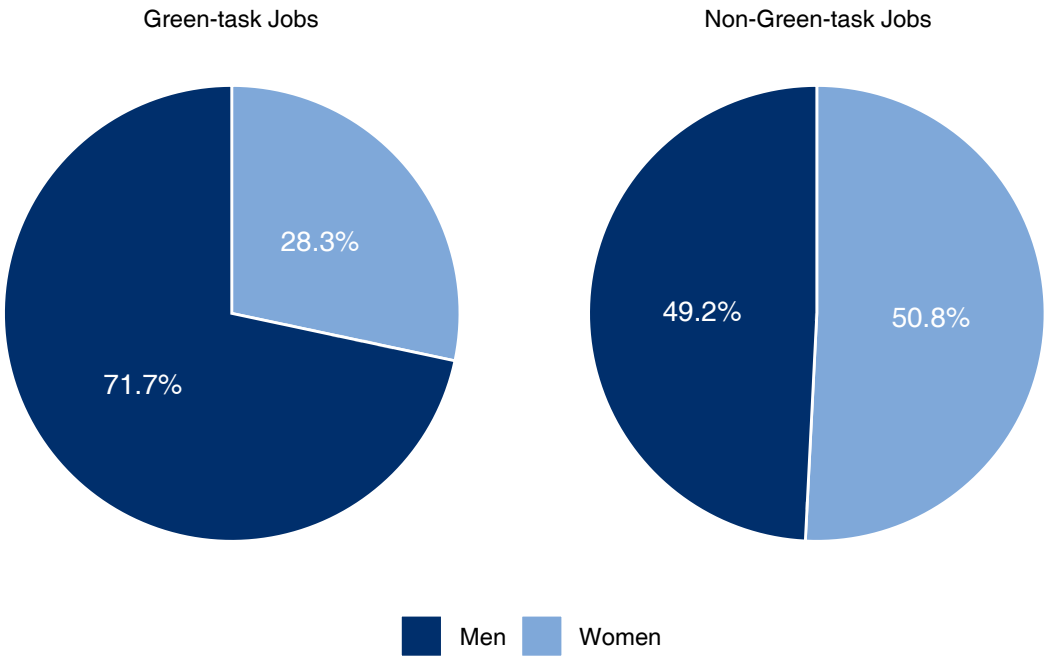
The impact of the green transition is different for men and women

Equitable access to new economic opportunities arising from the green transition for both men and women is an important aspect of ensuring a just transition for all. Past labour market transitions have had gender-specific impacts (Brussevich et al., 2018[11]). Therefore, policy makers need to pay particular attention to both the labour market opportunities and risks of the transition to net-zero and how they might differ for men and women.

Evidence from OECD regions shows that the green transition has a strong gender dimension in the labour market. Currently, women are underrepresented with men making up the majority of workers in green-task jobs. Across OECD regions, around 72% of all green-task jobs are held by men, while men and women make up roughly equal shares of non-green-task jobs (Figure 2.13). The disparity in the share of green-task jobs held by women and men differs across regions but, overall, women account for less than half of green-task jobs in all OECD regions (Figure 2.14). The capital regions such as Vilnius Region, Australian Capital Territory, Île-de-France, Stockholm, Warsaw, and Wellington get closest to equal representation of men and women in green-task jobs. Ten regions in Canada are on the other end of the spectrum, with less than 10% of green-task workers being women.

Figure 2.13. Women are significantly under-represented in green-task jobs

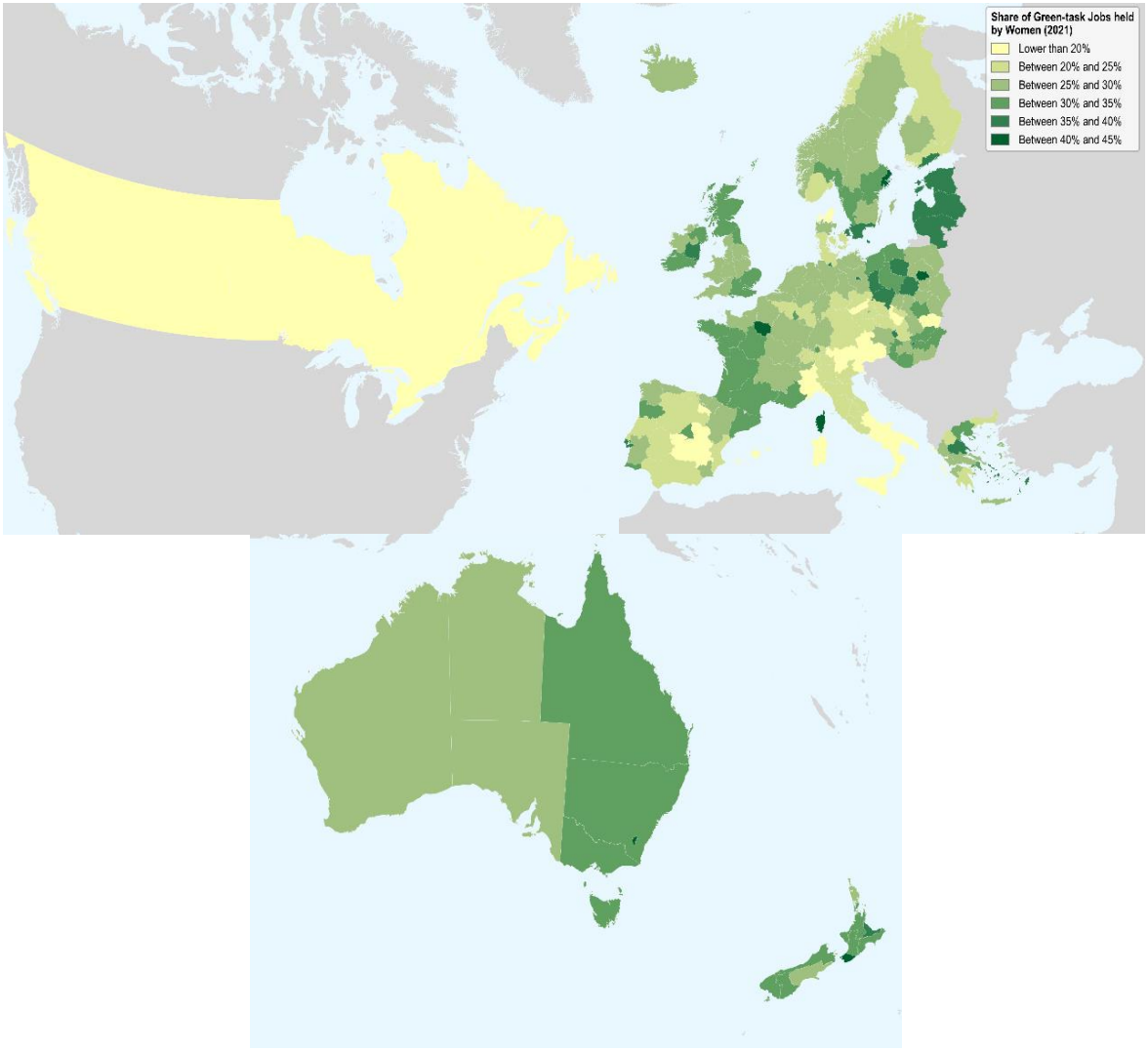
Share of green-task (non-green-task) jobs held by women and men, 2021 or last available year.



Note: Statistics calculated for Australia, Canada, EU countries, New Zealand, Norway, Switzerland, and the UK. Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, New Zealand, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

Figure 2.14. Share of green-task jobs held by women across regions

Share of green-task jobs held by women, 2021 or last available year.



Note: Statistics calculated for Australia, Canada, EU countries, New Zealand, Norway, Switzerland, and the UK. Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, New Zealand, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

While effort needs to be made to increase the share of women in green-task jobs, gender disparities also exist in polluting jobs. On average, men face a higher risk of displacement caused by the green transition, with 83% of polluting jobs held by men. The gender differences in green-task and polluting jobs are mainly driven by differences in the industries, and thus occupations, in which men and women tend to be employed. Women are underrepresented in manufacturing and construction, which are the industries with the highest share of green-task and polluting jobs. Nonetheless, these findings suggest that policies for a just transition need to focus on both broadening the access of women to emerging green-task jobs and to provide targeted support measures. These measures include greater engagement in STEM (science, technology, engineering, and mathematics) early in school, career guidance, and retraining and upskilling opportunities to workers in polluting jobs, which are mainly held by men.

Green job opportunities typically require high skilled and tertiary educated workers

Regional labour markets have experienced a gradual job polarisation over the past decade. Overall, the share of medium-skilled jobs has declined, and in many cases a significant number of medium-skilled jobs disappeared (OECD, 2019[12]). While the share of high-skilled jobs has often compensated for a large part of those displaced jobs, the share low-skilled jobs has also risen in most local labour markets (OECD, 2020[13]). While this development partly reflects higher educational attainment of the labour force, it is also a consequence of megatrends that have been reshaping the world of work. Technological change due to digitalisation and automation has been skills-biased, i.e., has increased the demand for educated workers and complements the skills of more highly educated and skilled workers (Autor, Levy and Murnane, 2003[14]). Thus, it has posed a risk of exacerbating socio-economic inequalities across workers of different skill levels (Acemoglu and Autor, 2011[15]).

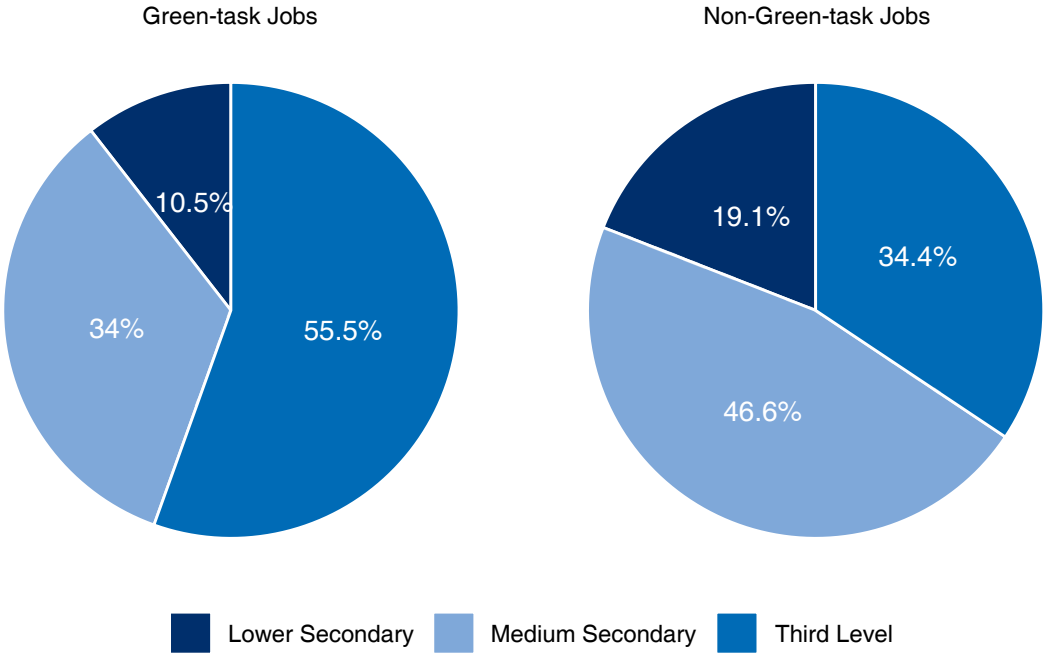
Whether the green transition will drive further job polarisation and increase inequalities within regions is still an open question. The social dimension of the green transition's implications for employment (Cedefop, 2010[16]) as well as productivity or other job characteristics (Fankhauser, Sehlleier and Stern, 2008[17]) is an area that still lacks comprehensive information. However, evidence from past green policies in selected OECD countries shows that they, in fact, were biased towards more skilled workers. In the US, changes to environmental regulations via the US Clean Air Act increased demand for engineering, scientific, and analytical skills (Vona et al., 2018[6]). This shift was also driven by technological and organisational changes in firms. Across European countries, climate policies over the period 1995-2011 were skills-biased, and favoured technical skills and high-skilled occupations at the expense of manual workers and jobs with routine tasks (Marin and Vona, 2019[18]).

So far, mainly workers with higher levels of education appear to have seized green labour market opportunities. Employees in green-task jobs tend to be better educated than those in non-green-task jobs (Figure 2.15). Over 50% of those employed in green-task jobs completed higher education, compared to 34% of those in non-green-task jobs. The opposite is true for those in polluting jobs – they tend to have lower educational attainment, with 22% having completed tertiary education. While polluting jobs represent 12% of employment at the OECD level, the share almost doubles for individuals with lower-secondary education (21%).

Similarly, workers in green-task jobs also have significantly higher skill levels than those in non-green-task jobs across OECD regions. High-skilled occupations such as senior officials and managers, professionals, technicians, and associate professionals currently account for larger proportions of green-task jobs. This pattern is in line with evidence from the US that finds that green occupations are, on average, higher-skill and less routine-intensive than non-green occupations. This, in turns, requires high-level analytical and technical skills linked to technology (Vona et al., 2018[6]). In contrast, individuals with lower educational attainment and in medium-skilled occupations are at higher risk of displacement due to the green transition. In particular, medium-skilled occupations make up the majority of polluting jobs.

Figure 2.15. Distribution of educational attainment in green-task jobs vs. other jobs

Share of green-task (non-green-task) jobs by educational attainment of workers, 2021 or last available year.



Note: Statistics calculated for EU countries, Norway, Switzerland, and the UK. Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for EU countries, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on EU LFS.

Future green jobs might shift towards medium- and low-skilled occupations. The fact that currently the majority of workers in green-task jobs are high skilled or have tertiary education does not mean that this will always be the case, as new jobs emerge due to the green transition. In fact, in Europe, forecasts about the impact the European Green Deal (EGD), a major policy package to address climate change and generate economic growth, suggest an attenuating effect on job polarisation (CEDEFOP, 2021[19]). The forecast indicates a diffusion of the employment benefits of the EGD, with employment growth expected to be higher in skilled manual and elementary occupations than high-skilled occupations. This is linked to larger projected employment increases due to the EGD in specific sectors. A push for recycling and increasing electricity supply is projected to generate new, mostly medium- or low-skilled, jobs in utilities. In construction, the need for energy-efficient buildings could heighten demand for occupations such as heat pump boiler installers, carpenters and joiners, bricklayers, and technicians.

Workers in polluting jobs have particularly low participation rates in training

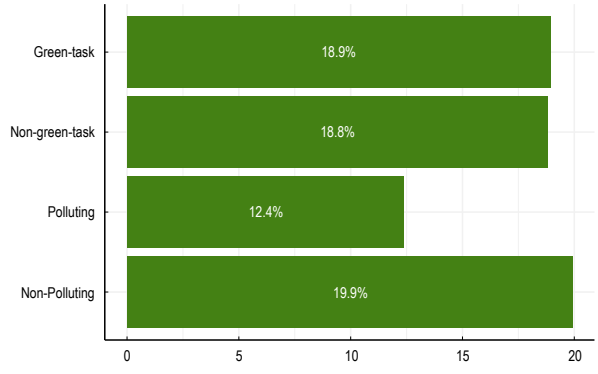
Continuous education and adult learning are vital tools for managing labour market transformations such as the green transition. The accelerated transformation of the world of work since the start of the COVID-19 pandemic poses new challenges for local labour markets. Therefore, future-proofed local continuous education and adult learning systems are more important than ever (OECD, 2021[20]). As skills needs and job requirements evolve rapidly, targeted retraining and upskilling opportunities that are aligned with local labour market demand are crucial for individual workers, firms, and local economies alike (OECD, 2022[21]). The green transition constitutes a further transformation of jobs

and sectors, which means it is more urgent than ever to ensure that workers have access to effective training offers.

Workers in greater need of reskilling are less likely to participate in training. In general, participation rates in training and lifelong learning remain low among workers across OECD regions. On average, 19% of workers took part in training in the four weeks prior to being surveyed. While there is little difference between workers in green-task and non-green-task jobs (19% for both), individuals who work in polluting jobs have significantly lower training rates than other workers (12%) (Figure 2.16). Thus, training rates for workers facing a higher risk of job loss or skills changes due to the green transition have significant room for improvement. Lower training participation rates among workers in polluting jobs is observable across all OECD countries, but the gap is especially alarming in countries with an overall low level of training rates (Figure 2.17).

Figure 2.16. Individuals in polluting jobs are less likely to participate in training despite higher risk of displacement

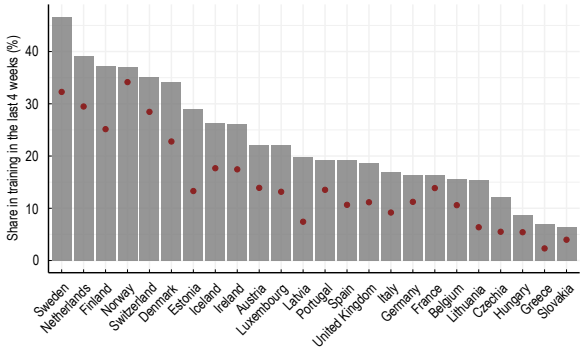
Share of individuals who participated in training in the last 4 weeks by category of employment, 2021 or last available year.



Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for EU countries, Norway, and Switzerland. See Box 2.1 for the definition of green-task jobs and polluting jobs.
Source: OECD calculations based on EU LFS.

Figure 2.17. Individuals in polluting jobs are less likely to participate in training

Share of individuals in polluting and non-polluting jobs who participated in training in the last 4 weeks, 2021 or last available year.

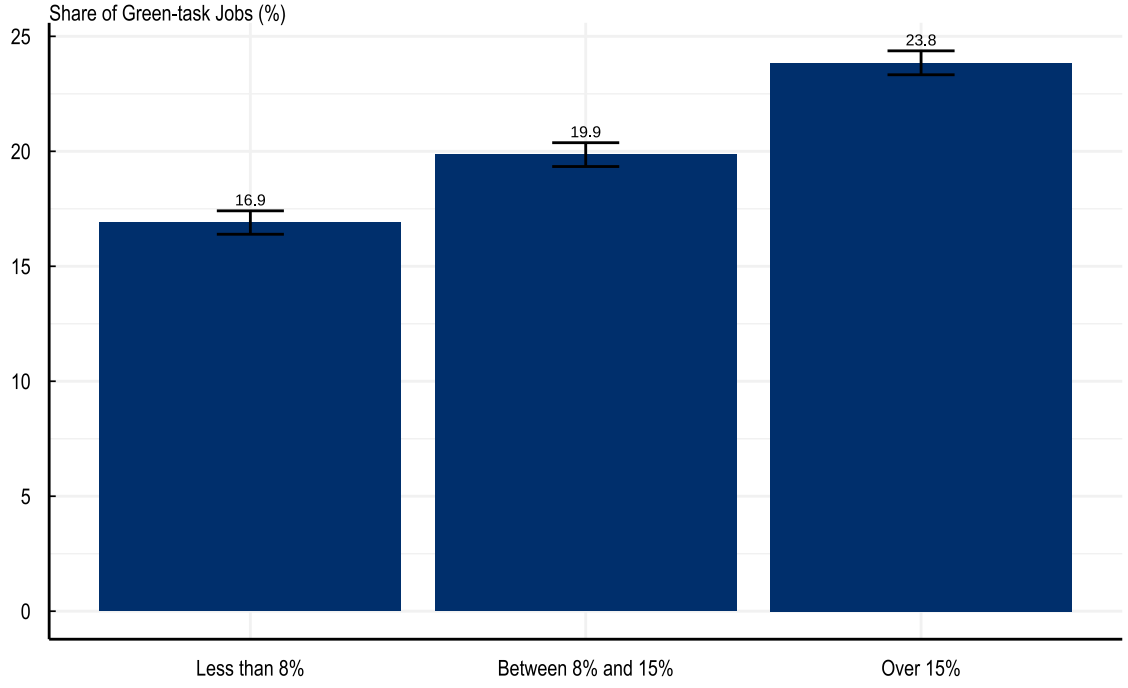


Note: Last available year: 2019 for the UK; 2020 for Iceland; and 2021 for EU countries, Norway, and Switzerland. See Box 2.1 for the definition of polluting jobs.
Source: OECD calculations based on EU LFS.

Across regional labour markets, there is a misalignment of training needs and training participation. Polluting jobs face greater changes or risks, as the green transition gathers momentum. Nonetheless, regions that have labour markets that are less green record lower training participation among their workforce (Figure 2.18). Top regions in terms of participation rate, i.e., those with over 15% of population participating in training, have up to 3.9 percentage points more green-task jobs on average than those regions whose participation rate ranges between 8% and 15%, and almost 7 percentage points more green-task jobs than regions with participation rates below 8%.

Figure 2.18 Participation rate and share of green-task jobs

% of population that participates in education or training by TL-2 regions and average share of green-task jobs



Note: Participation rate in education and training (last 4 weeks) 2021 or last year available.
Source: OECD calculations based on EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia), Polish LFS (Statistics Poland).and Eurostat data. Data from 2021 for Australia, Canada, and USA; 2020 for EU countries, Norway, and Switzerland; and 2019 for the UK.

Box 2.3 Green skills: What are the skills most associated with green-task jobs?

Green skills

In addition to providing the set of tasks that make up an occupation, O*NET also provides the skills usually required to carry out each occupation. Given that no skills are equally relevant for a given job, O*NET also provides an importance score for each skill.

Given this information, a regression approach is adopted to identify those skills that are more important in green occupations (an approach first proposed by Vona (2018)). A green skill can then be interpreted as a skill that is not only necessary but also actually important to green-task jobs. In practice, the importance scores of each skill are regressed on the green scores of the respective occupations controlling for the occupations' primary group. A green skill is then one where the coefficient associated with the green score is significant and positive.

Sixteen skills are identified below as green, categorised into five macro-groupings to simplify presentation, and highlight key features.

List of skills which significantly correlate with green-task jobs

Macro-Groupings	Skill Name	Description
Engineering and technical		
	Engineering and Technology	Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
	Design	Knowledge of design techniques, tools, and principles involved in production of precise technical plans, blueprints, drawings, and models.
	Building and Construction	Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
	Mechanical	Knowledge of machines and tools, including their design, uses, repair, and maintenance.
	Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment	Providing documentation, detailed instructions, drawings, or specifications to tell others about how devices, parts, equipment, or structures are to be fabricated, constructed, assembled, modified, maintained, or used.
	Estimating the Quantifiable Characteristics of Products, Events, or Information	Estimating sizes, distances, and quantities; or determining time, costs, resources, or materials needed to perform a work activity.
	Inspecting Equipment, Structures, or Materials	Inspecting equipment, structures, or materials to identify the cause of errors or other problems or defects.
Operation Management		
	Systems Analysis	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
	Systems Evaluation	Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.
Monitoring		
	Law and Government	Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.
Science		
	Physics	Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.
	Chemistry	Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
	Biology	Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.
	Geography	Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.
	Science	Using scientific rules and methods to solve problems.
General Management		.
	Economics and Accounting	Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

Note: Skills as defined by (Vona et al., 2018[6]) encompass what O*NET defines as skills, knowledge and work activities.
Source: OECD calculations based on O*NET data.

Where is the demand for green-task jobs increasing?

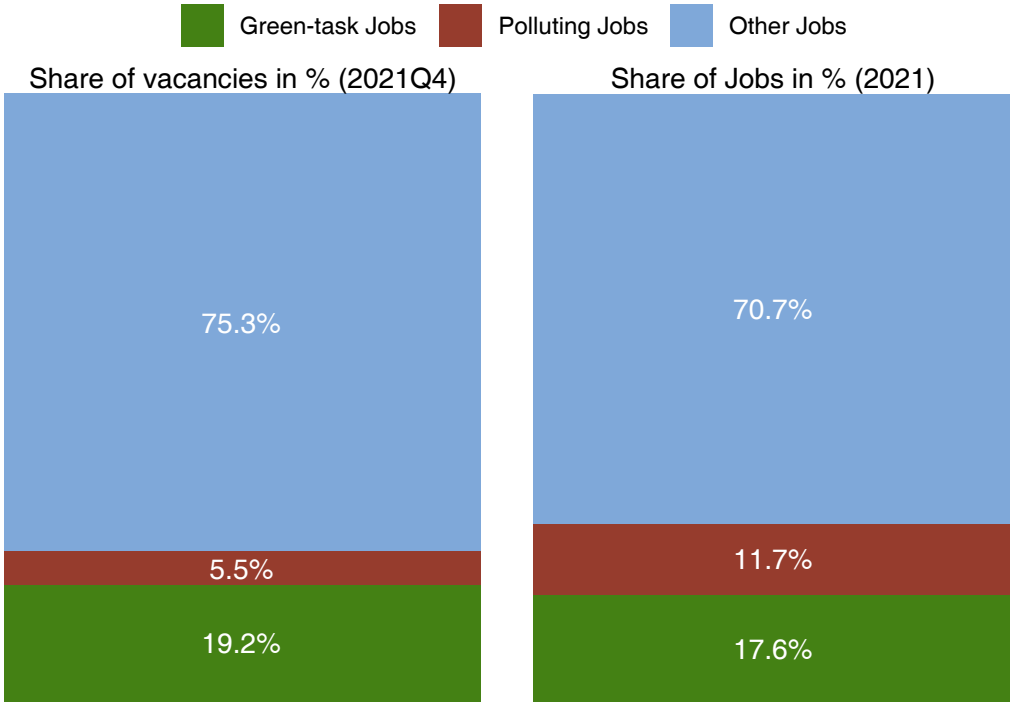
This section examines recent labour market demand for green-task jobs. Using Big Data on online vacancies provides a more recent picture of labour market changes and complements the analysis from the preceding sections that looked at the existing shares of workers in green-task jobs.

What is the demand for green-task jobs vs. non-green or polluting jobs?

While most regions have not made much progress in greening their labour force, recent data on regional labour demand paint a more positive picture. Currently, green-task jobs represent 19% of labour demand; while polluting jobs account for 5% of vacancies (see Figure 2.19). Thus, the share of green-task vacancies is almost 2 percentage points higher than the current share of green-task jobs across OECD regions. In contrast, the demand for polluting jobs is over 6 percentage points below their share in terms of employment. A higher share of green vacancies and lower share of polluting vacancies in labour demand compared to the current employment shares may be the first signs of a shift towards a more environmentally friendly labour market.[9]

Figure 2.19. The majority of vacancies are in jobs that are neither green-task nor polluting, but the demand for non-polluting jobs is higher than current employment levels in non-polluting jobs

Share of vacancies and share of employment that is green, polluting or neither.

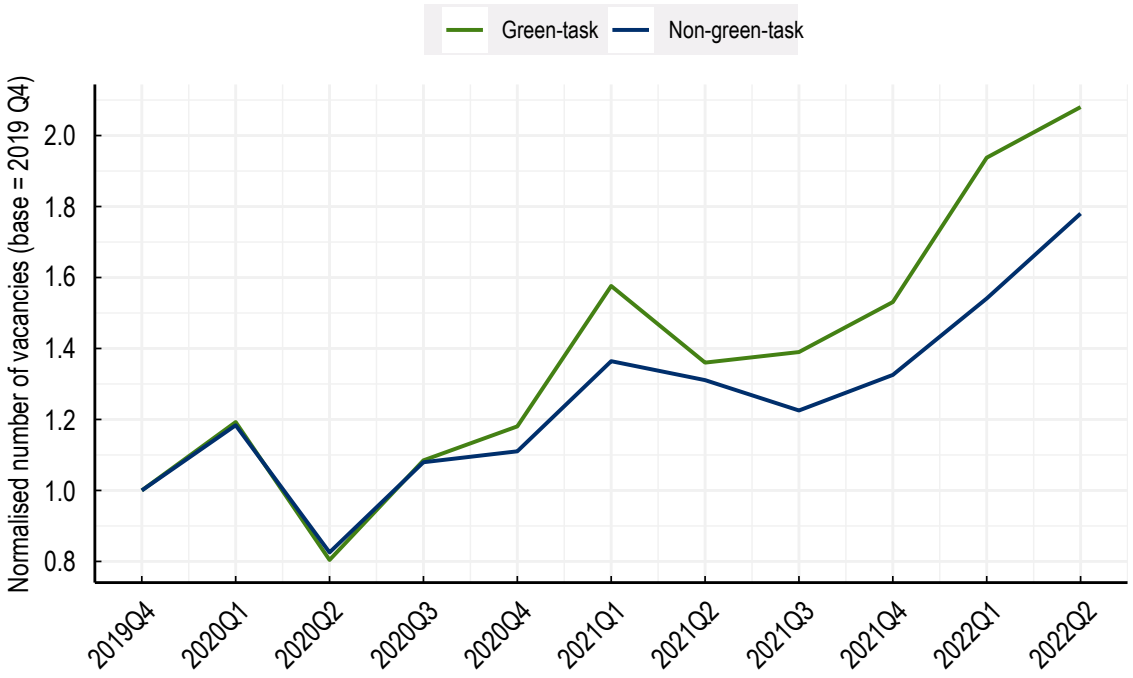


Note: 2022 Q2 for vacancy data. 2021 or last available year for the share of employment: 2019 for the UK; 2020 for Iceland; and 2021 for Australia, Canada, EU countries, New Zealand, Norway, Switzerland, and the US. See Box 2.1 for the definition of green-task and polluting jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries, EU LFS, Canadian LFS (StatCan), OEWS (U.S Bureau of Labour Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

Encouragingly, the demand for green-task jobs is rising faster than labour market demand overall. Since the start of the COVID-19 pandemic, the number of green-task vacancies has grown faster than the number of non-green vacancies (Figure 2.20). Green-task vacancies increased by almost 110% (a factor of 2.1) between the last quarters of 2019 and second quarter of 2022, while the number of non-green-task vacancies rose by around 80% (factor 1.8). This faster growth has led to an increase in the share of green-task vacancies from 17% to 19.4%. However, the share of polluting vacancies also increased in that period, from 4% to 5.5%.

Figure 2.20. Over the last two years, the demand for green-task jobs has grown faster than for other jobs

Normalised number of green-task and non-green task vacancies, Q4 2019– Q2 2022

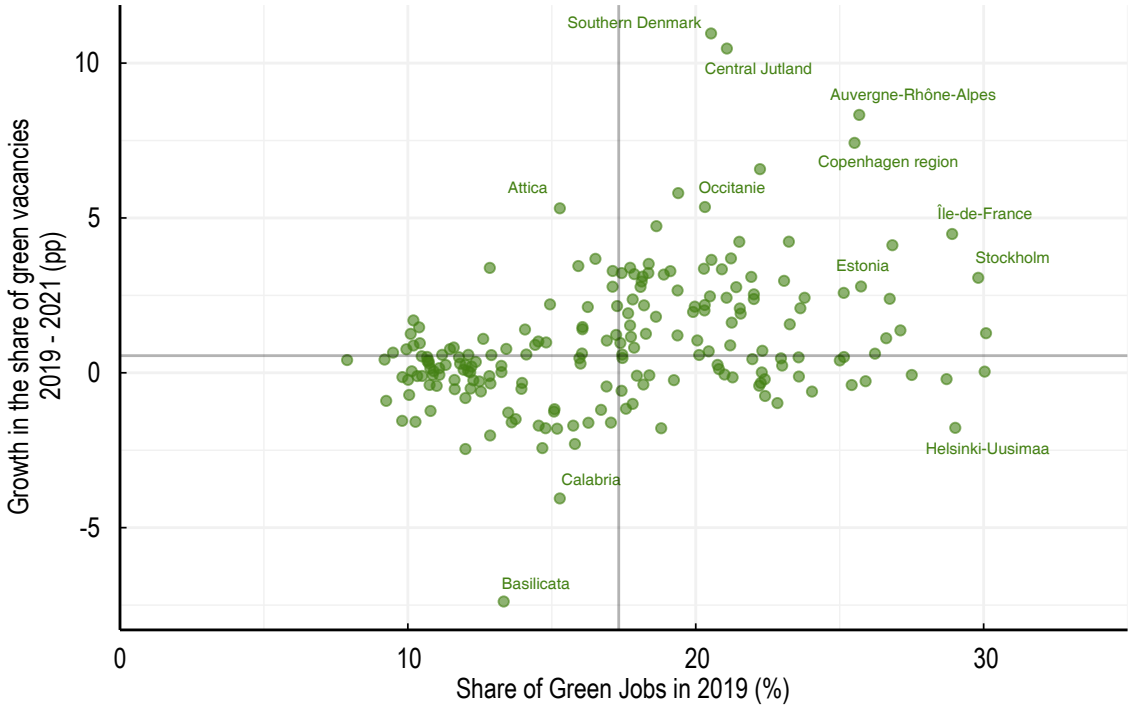


Note: The numbers have been normalised so that demand equals 1 in the last quarter of 2019 and is a ratio of the demand in the following quarters to the demand in the last quarter of 2019. Quarterly data Q4 2019 to Q2 2022. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries.

The demand for green-task jobs evolved differently across OECD regions over the last two years. It rose in roughly two-thirds of regions (68%), though the change ranged from a 7-percentage point decrease in Basilicata, Italy to a 11-percentage point increase in Southern Denmark (Figure 2.21). The French region of Auvergne-Rhone-Alpes and the region Copenhagen in Denmark stand out as those with an already high share of green-task jobs in employment and a fast increase in demand for green-task jobs. Southern Denmark and Central Jutland have experienced the fastest "greening" of labour demand and may be on track to join the group of regions with the highest share of green-task jobs in the OECD. However, other regions with a low share of green-task employment, such as Asturias, Sardinia and Basilicata, are at risk of falling further behind with the demand for green-task jobs faltering over the last two years in these regions.

Figure 2.21. Few regions with a low share of green-task jobs show signs of catching up

Share of green-task jobs in 2019 and the change in demand for green-task jobs as a share of total demand over the last 2 years for OECD regions.



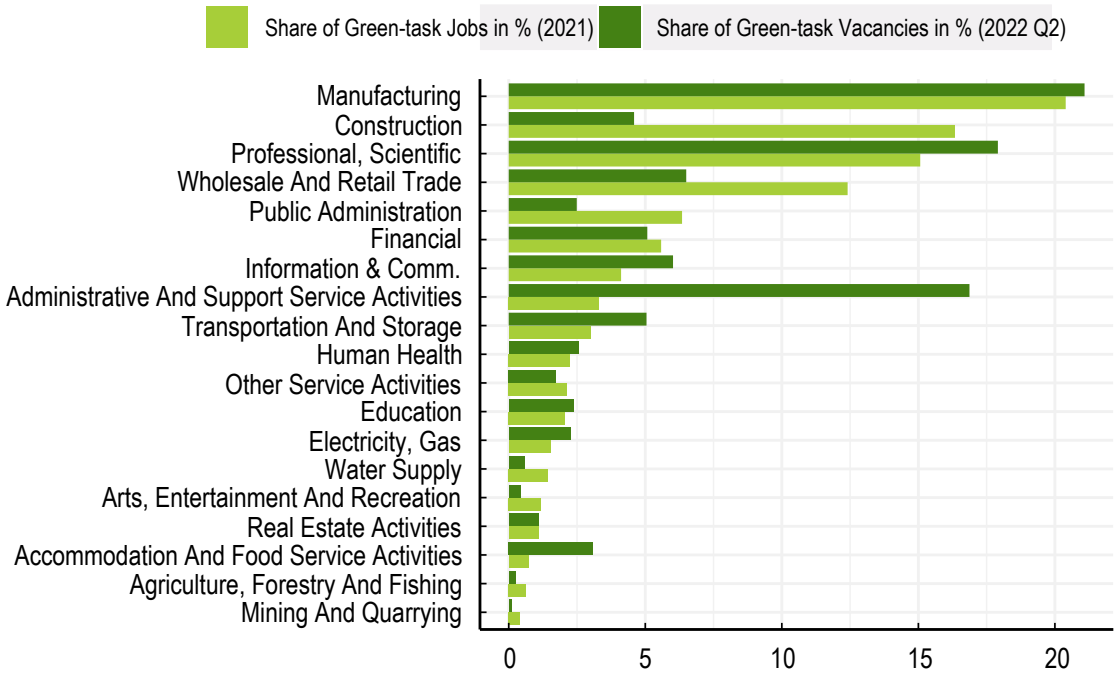
Note: 2019 Q4 and 2022 Q2 for vacancy data. Last available year for employment data: 2019 for the UK; 2021 for Australia, Canada, the EU, New Zealand, Norway, Switzerland and the US. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries, EU LFS, Canadian LFS (StatCan), OEWS (U.S. Bureau of Labor Statistics), Table EQ08 (Australian Bureau of Statistics), HLFS (Stats NZ), Slovenian LFS (Statistical Office of the Republic of Slovenia) and Polish LFS (Statistics Poland).

What are the industries with the highest demand for green-task jobs?

Manufacturing, construction, professional, scientific and technical activities, and wholesale and retail trade are the four industries where green-task jobs are concentrated, as described in the previous section. Three of these industries are also the leading industries in terms of the demand for green-task jobs. In Europe, green vacancies are concentrated in manufacturing (21%), professional, scientific and technical activities (18%), and in administrative and support service activities (17%) (Figure 2.22). These three industries together account for 56% of all green vacancies in Europe and for 54% of green vacancies added in the last two years. Therefore, manufacturing and scientific and technical activities are expected to remain the main contributors of green-task jobs in the economy.

Figure 2.22. Distribution of green-task jobs and vacancies across industries

The distribution of green-task jobs and green-task vacancies across industries.

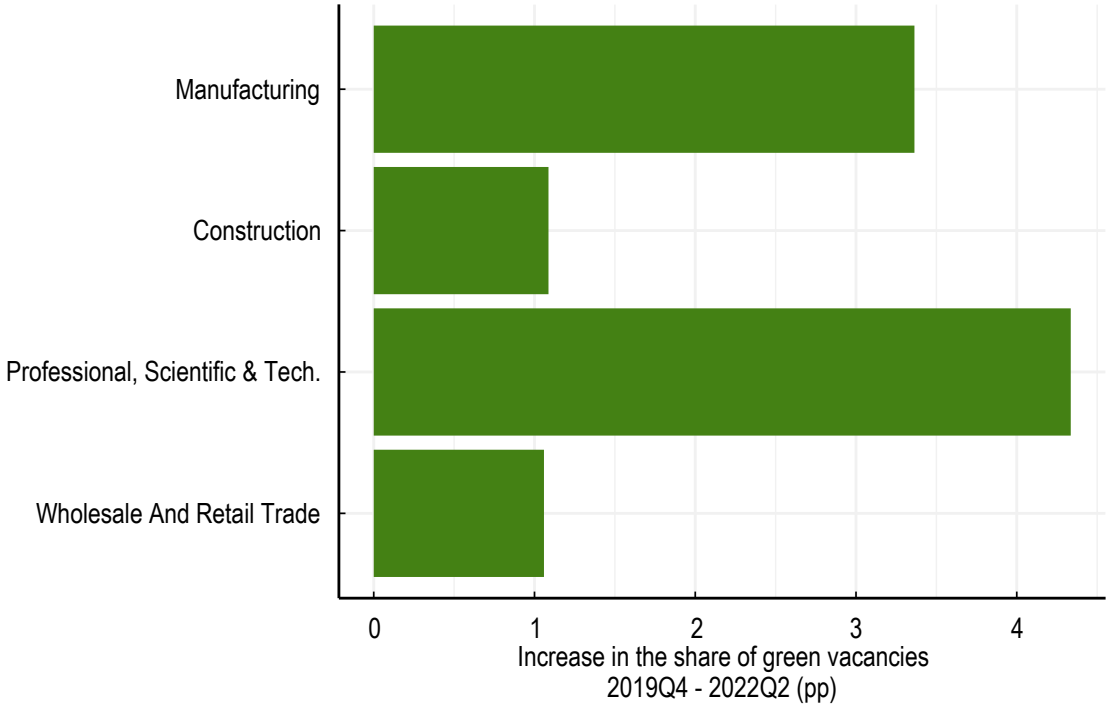


Note: Statistics calculated for EU countries, Norway, Switzerland and the UK. 2022 Q2 for vacancy data. 2021 or the last available year for employment data; 2019 for the UK; 2020 for Norway and Switzerland; 2021 for the EU. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries, EU LFS

The overall trends in terms of demand for green-task jobs across industries are mixed. Fifteen out of 19 industries registered an increase in the share of green-task vacancies. Notably, in the four industries with the highest share of green-task jobs, the demand became "greener" over the last two years (see Figure 2.23). The change in demand for polluting jobs as a share of total demand was mixed. The largest increase was registered in manufacturing and professional, scientific and technical activities. Therefore, the positive contribution in terms of green vacancies of the first two industries is, at least partly, offset by the increase in demand for polluting jobs in these industries.

Figure 2.23. The demand in three out of four industries that contribute the highest share of green-task jobs to the economy has become "greener"

This graph shows the percentage point change in the share of green-task vacancies in the total number of vacancies for the four industries that contribute most to the number of green-task jobs to the economy.



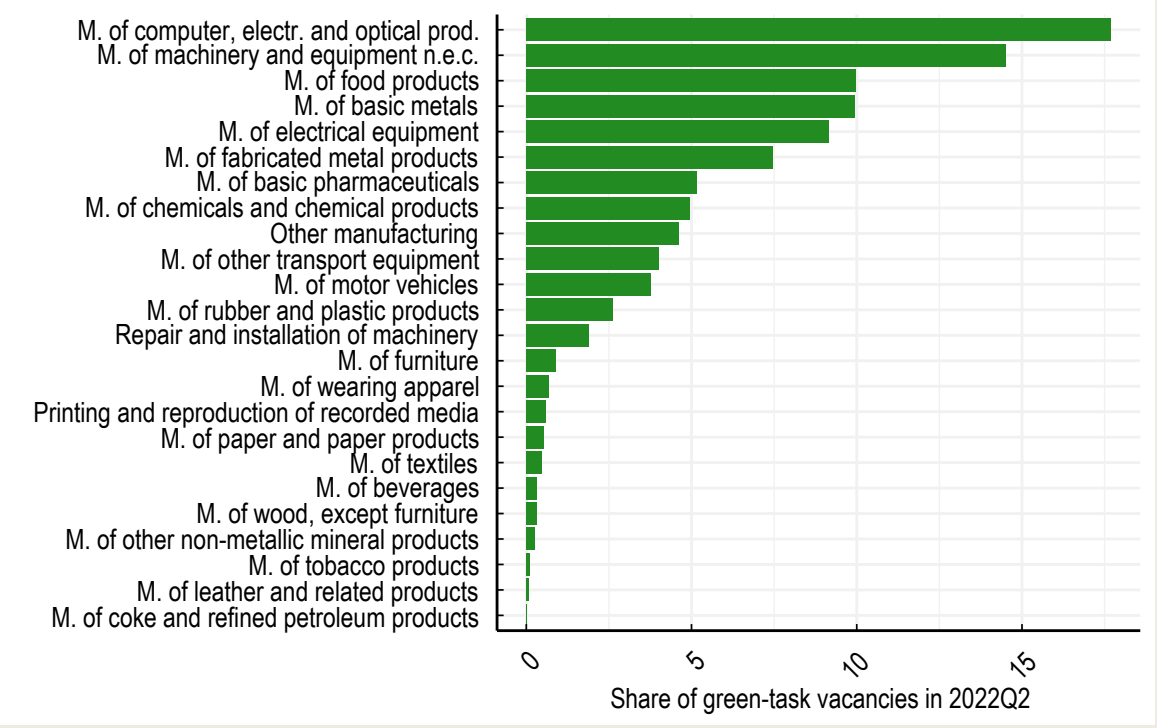
Note: Q4 2019 and Q2 2022. Data for the EU, Norway, Switzerland, and the UK. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries.

Box 2.4. Manufacturing will play a critical role in the green transition

Manufacturing is likely to play a critical role in the green transition. Manufacturing stands out as the industry with the highest contribution of green-task jobs in the economy, a high share of green-task jobs, and a high demand for green-task jobs as a percentage of total labour demand in the industry. Moreover, manufacturing accounts for a high share of polluting jobs in the economy and a high share of polluting vacancies. Therefore, manufacturing is the industry where new jobs that contribute to the reduction of greenhouse gas emissions are likely to be created. At the same time, manufacturing is also the industry that will be significantly affected by the displacement of workers who are currently employed in polluting jobs. A successful shift in employment from polluting to neutral and greener jobs in manufacturing will be critical for the success of the green transition. However, even within manufacturing there are significant differences in the contribution of the industrial groups to the greening of the economy (see Figure 2.24). Policies targeted at the manufacturing sector should therefore take into account the diversity within the manufacturing sector.

Figure 2.24. There are significant differences in demand for green-task jobs within the manufacturing industry

Share of green-task vacancies by industrial groups within manufacturing in Europe, last quarter of 2021.



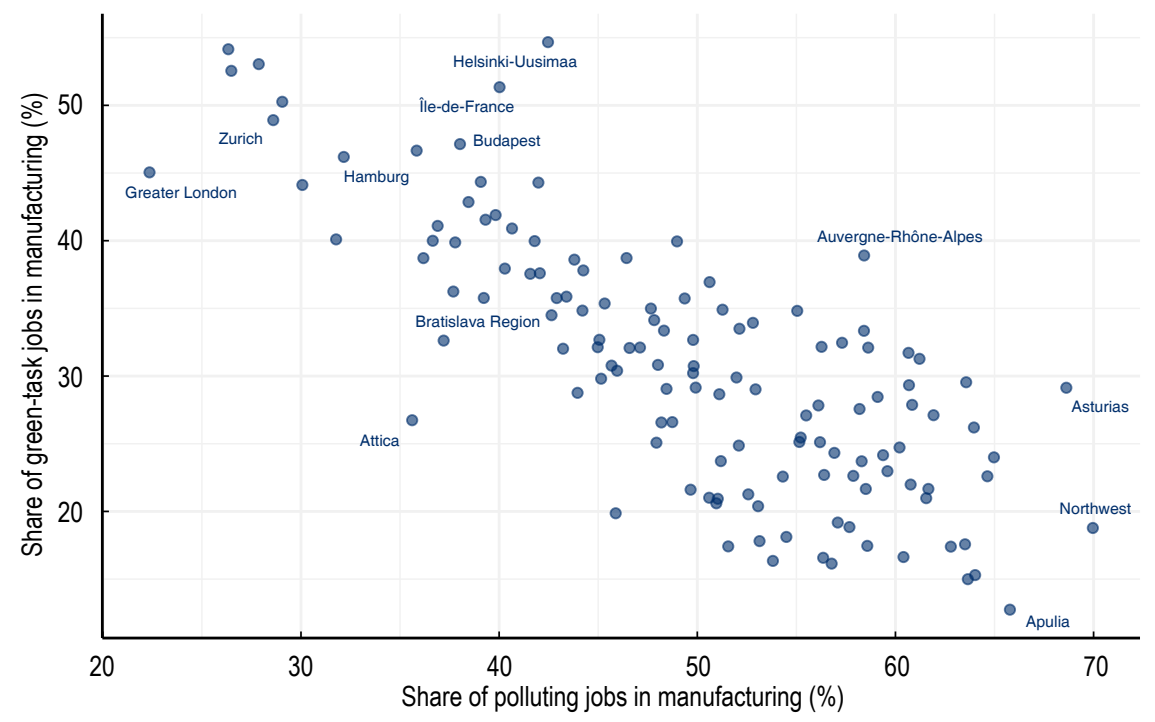
Note: 2022 Q2. Data for the EU, Norway, Switzerland, and the UK. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries.

The aggregate green-task and pollution scores for manufacturing mask significant differences across regions. For example, in Stockholm, South East England, Helsinki-Uusimaa, Ile-de-France and Oslo and Akershus more than half of jobs in manufacturing are green-task jobs, while less than 10% of jobs are in Epirus, Western Macedonia and Corsica. Regions with a higher share of green-task jobs in

manufacturing tend to have a lower share of polluting jobs in this industry (Figure 2.25). While this is partly mechanical, this result demonstrates that the aggregate share of green-task and polluting jobs in manufacturing (30% and 50%, respectively) is to a large extent driven by green-task and polluting jobs being present within manufacturing but in different regions. This observation implies that there might be scope for regions to support a transition within manufacturing from a polluting to a green employment structure. However, further analysis is needed at the more detailed sub-sector level.

Figure 2.25. There is significant dispersion across regions in the 'greenness' of the manufacturing sector

Share of green-task and polluting jobs in employment in manufacturing across regions in the OECD, 2021 or last year available



Note: Data for the EU, Norway, Switzerland, and the UK. 2021 or last available year. 2019 for the UK. 2020 for Iceland. 2021 for EU countries, Norway and Switzerland. See Box 2.1 for the definition of green-task and polluting jobs.
Source: OECD calculations based on EU LFS.

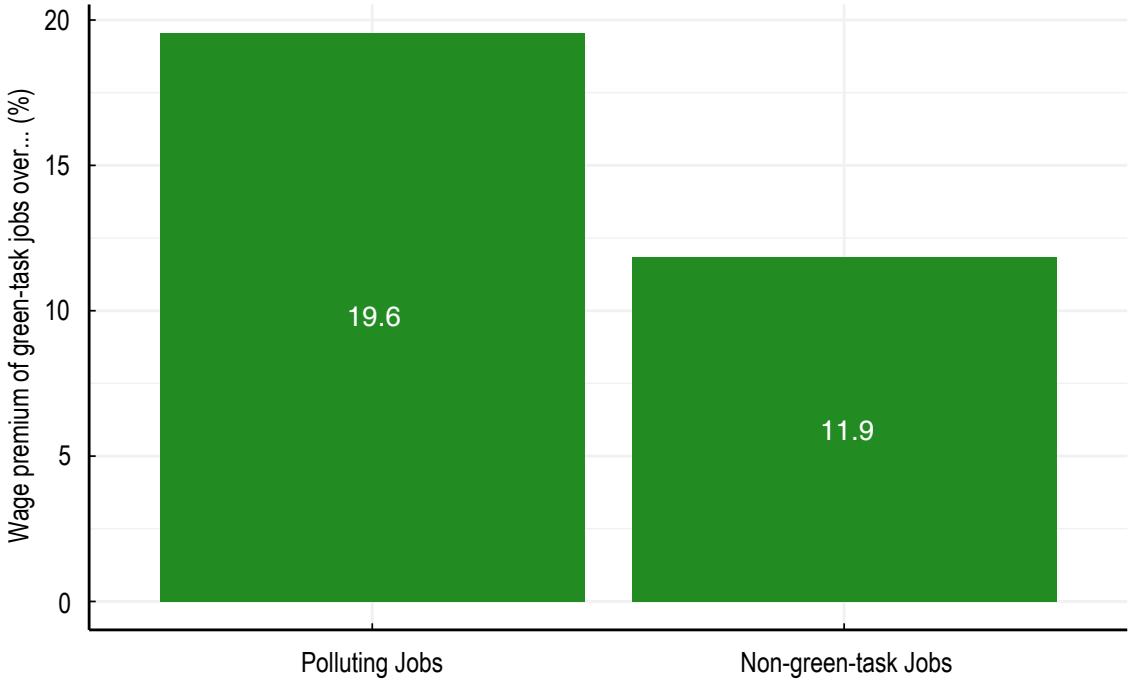
Do green-task jobs (skills) come with a wage premium?

Financially, green-task jobs appear to be more attractive than other jobs. Based on data for online vacancies, green-task jobs come on average with higher wages than both polluting and non-green-task jobs.[10] Across the OECD, the wage premium of green-task jobs over non-green-task jobs is 20% and 12% compared to polluting jobs (Figure 2.26). These results are qualitatively the same as the wage analysis conducted using employment data from labour force surveys. The wage premium is present in almost all OECD countries. The higher wages in green-task jobs are partly a result of the fact that they, on average, require higher levels of education and experience (see analysis below). It might also reflect a lack of supply of workers with the right set of skills, qualifications and experience needed to fill green vacancies.

Green skills shortages are a major obstacle to local economic growth, firms' investments, and delivering the green transition. As documented in a recent report, "growth in the demand for workers with green skills has outpaced the growth in the supply of green talent" (Linkedin, 2022[22]). In Europe, more than four-fifths of companies face skills shortages, especially for green and digital skills, and almost 70% of local authorities report a skills shortage that prevents projects on climate change from being implemented (EIB, 2023[23]). Those skills shortages are particularly acute in engineering and the digital economy.

Figure 2.26. Green-task jobs pay higher wages than other jobs

Average wage difference between green-task jobs and polluting and non-green-task jobs in the OECD. The average is calculated as a weighted sum of wage premiums in OECD countries, where the weights are equal to the share of OECD's labour force of each country.

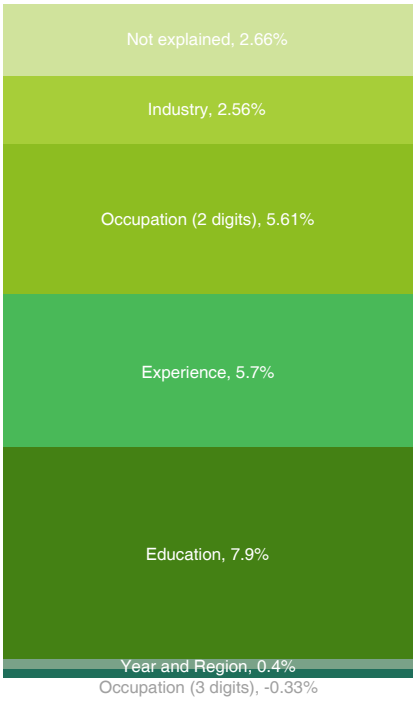


Note: 2022 Q2. See Box 2.1 for the definition of green-task and polluting jobs.
Source: OECD calculations based on Lightcast job posting data for selected OECD countries.

More detailed analysis of the green-task job wage premium across US regions offers further insights on observable factors that contribute to the wage premium. On average, the green wage premium (compared to non-green-task jobs) amounts to 25% in US regions. Higher levels of education and greater requirements in terms of work experience jointly explain more than half (13.6 percentage points) of this wage premium. The fact that green-task jobs are concentrated in specific, more high-skilled occupations explains around 6 percentage points of the wage premium. Thus, skills, education and experience explain around 20% higher wages for green-task jobs (see Figure 2.27). Once the general type of occupation (2-digit) is taken into account, further differences in occupations (3-digit) do not explain the wage difference. The wage premium decreases further when industry of employment is taken into account. However, the fact that green-task jobs pay more because they are concentrated in different industries than other jobs can be interpreted as an opportunity for workers to shift between industries and benefit from a higher salary.

Figure 2.27. Wage premium associated with green-task jobs is, to a large extent, explained by the differences in the level of education, experience and skills of workers

Part of the wage premium of green-task jobs over non-green-task jobs in the United States explained by the job and individual characteristics.



Note: The values should be interpreted in the following way: 7.9% difference in wages between workers in green-task and non-green-task jobs is associated with different levels of education. The parts of the bar chart add up to 25%, which is the wage premium of green-task jobs over non-green-task jobs in the US. Average for 2019 to 2022. Data for the US. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast job posting data for the US.

Conclusion

The impact of the green transition differs across regions. Large regional differences are observed both in the share of green-task jobs and in the share of polluting employment. The "greenness" of regional labour markets is associated with its industrial composition and the level of education of the workforce, but more research is needed to better understand what helps regions capture opportunities that are emerging with the advent of the green transition. Despite the prominence of climate change in the public discourse, on average, labour markets have not become much greener over the last decade, but that too differs across places. Regions with larger investments in innovation recorded faster increases in the share of green-task jobs in greening. Encouragingly, there are positive signs that momentum for the green transition is growing. The demand for green-task jobs has been growing in recent years and, since the start of the pandemic, has outpaced demand for non-green task jobs by around 20%.

The green transition could deepen social divides within regions. There is a strong gender dimension to the impact of the green transition on the labour market, with women under-represented in green-task jobs and men over-represented in polluting jobs that are at risk of disappearing. These differences are to a large extent driven by the composition of occupations held by men and women. Workers in green-task

jobs also differ from other workers in terms of their skills-level and educational attainment. So far, most green-task jobs, which come with a significant wage premium, are held by high-skilled and highly educated workers. In contrast, polluting jobs are dominated by medium-skilled workers with lower educational attainment. While future jobs created by the green transition may be in medium-skilled and low-skilled occupations in activities such as construction, retrofitting, insulation, or waste management, these effects are yet to fully materialise. Monitoring the characteristics of workers in green-task and polluting jobs can help design and target up- and re-skilling initiatives to avoid further social divergence.

The green transition will affect industries differently, and while some industries can transition from polluting to green employment, the reallocation of workers across industries will likely be needed. On aggregate, green-task and polluting jobs often coincide within an industry. However, more detailed analysis reveals that, for example, in manufacturing, this effect is driven by the industry being dominated by green-task jobs in some regions and by polluting jobs in others. More research at sub-industry level would help policy makers ascertain whether this phenomenon could constitute an opportunity for regions to transform their manufacturing and other sectors from polluting to green employment. In other sectors, such as mining, the green transition is likely to reduce employment, thus creating a need for transition-oriented re-skilling of workers. The analysis presented in this chapter focuses on jobs with tasks directly related to reducing greenhouse gas or improving environmental sustainability. Future research could shed light on the supply chain effects of the green transition.

More research is needed to understand the shortages and mismatches in terms of green-task jobs in local labour markets, the scope for transitions between occupations, and the way skills demand evolves in response to the green transition. New jobs will be created as a result of the green transition, many existing jobs will require new skills, and some jobs will disappear. The labour force will need to re- and up-skill to adapt. However, training rates remain low in many OECD regions and workers in polluting jobs, at risk of displacement, tend to train less. In addition to increasing participation in training, efforts could be made to improve the effectiveness of training and its alignment with labour market needs. Forecasts at the local level can help direct students and job seekers towards occupations that are in high demand. Studying the 'skills proximity' of occupations, in combination with labour market demand at the local level, could reveal the potential new employment opportunities of workers in polluting jobs and identify appropriate training. It could also shed light on the potential for workers in non-green-tasks and polluting jobs to re-train into green-task occupations. Finally, better tools to measure how skills required in each occupation evolve in response to the green transition and other megatrends could also help adapt the training content to labour market needs. The following chapters – Chapters 3 and 4 – provide recommendations for how national and local actors alike can learn from past major transitions and ensure that local economies can adapt, equip their workforce with the right set of skills, and deliver a just and inclusive transition.

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Notes

[1] While job transitions are a normal feature of modern labour markets, the feasibility of transitions to green jobs hinges on the proximity of available jobs and those that might be displaced by the greening of labour markets.

[2] Over-/under-representation of green-task jobs in the capital region is measured as the difference between the share of all green-task jobs in the economy that are located in the capital region and the share of all jobs in the economy that are located in the capital region.

[3] Based on regression results that take into account country fixed effects.

[4] The correlation between green-task intensity of a region and its share of green-task jobs is very high (0.93), which indicates that in regions with a high share of jobs with some green tasks, green-task jobs tend to have a high share of tasks that are green.

[5] Several sectors have substantial future greening potential. For example, greater adoption of activities such as organic farming, retrofitting, or insulation could result in a rising share of green-task jobs in agriculture and construction.

[6] There is limited evidence of the effects of R&D on green job creation. Focussing on clean innovation within Dutch firms, (Elliott et al., 2021[5]) use matched employer-employee data and find that over the 2006–2010 period, firms that pursued eco-innovation had 12 more green employees than non-innovating firms. However, the effects are driven by a replacement of non-green workers rather than net job creation.

[7] See https://ec.europa.eu/competition/mergers/cases/index/nace_all.html.

[8] The methodology for identifying green-task jobs assumes the same greenness of tasks in the same occupation regardless of whether a job is in a large or small firm.

[9] Vacancy data collected by Lightcast may not be representative of all vacancies in the economy. Therefore, care should be taken when comparing the vacancy and employment data.

[10] Wage data is available only for a subset of vacancies, which may introduce bias to the analysis.

Annex 2.A. Sensitivity Analysis and Robustness Checks

Comparing labour market estimates based on occupations across countries entails two challenges. First, different occupational classification systems vary in their level of detail. Second, employment data by occupation based on labour force surveys or from national statistical institutions also differ by level of detail.

Detail of occupational data

The level of detail of occupational classifications or available employment data differs across countries, which may undermine international comparability as less detailed data could lead to an overestimation of the green intensity of employment or the share of green jobs (see (JRC, 2021[24])).

To ensure comparability across countries, occupational data for countries is aggregated with more detailed information to a level that is comparable across countries. Therefore, for the United States and Canada, information is aggregated to a lower number of digits in order to make it more comparable to European data, which is only available at three digits for ISCO-08. The digits of aggregation are chosen in such a way that the number of unique occupations is similar across countries preserving the greatest level of detail possible. Based on the examples of the United States and Canada, choosing a lower digit of occupational detail does not lead to significant changes in the estimates (see below).

Aggregation of employment and occupational data

Aggregating green scores is necessary for two reasons. First, crosswalks are not always one-to-one matches. For example, an occupation at 3-digit ISCO level may correspond to two occupations at 6-digit US SOC level. Second, data is available at a less detailed level than the O*NET classification of green occupations.

When aggregation is necessary, the green intensity of an aggregated occupation is the simple average of the green intensities of the original occupations. Determining if an aggregated occupation is green or not green is not as straightforward. In the original O*NET classification, occupations are classified as green if they contain any green tasks. However, at an aggregate level, when an occupation corresponds to two or more occupations, with some but not all of them being green, there is no obvious way to classify.

The simplest approach is to consider an occupation at a higher level of aggregation as green if any of the corresponding occupations in the O*NET classification are green. This would be in line with the approach of considering an occupation green if at least one task it relates to is green. Unfortunately, this method generates an upwards bias in the estimation as a small number of green tasks are passed on to aggregated occupations. To mitigate the impact of this upward bias, a threshold approach is adopted where occupations must have a minimum level of green intensity for them to be green. The thresholds are chosen in such a way that they minimise the gap between the share of green jobs across multiple digits without being so large that detail is lost by removing jobs with some significant green intensity.

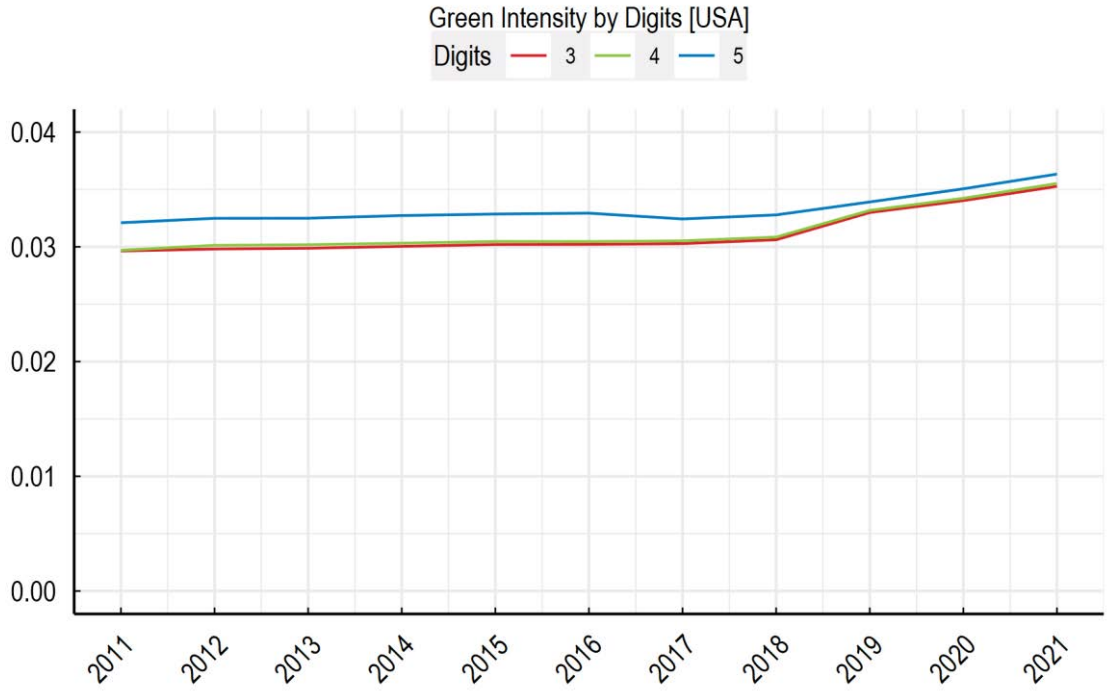
Using data from the US and Canada as examples, where the data is highly granular, sheds light on this estimation bias. The objective is to aggregate US detailed data into fewer digits and measure the

green scores at different levels of aggregation. By comparing the results of the greenness measures for different aggregation levels (digits), coarser employment data, i.e., aggregation, only results in a small upward bias of greenness measures.

For green intensity of employment, less detailed employment data does not have a strong effect. Additionally, the analysis reveals that using a 10% threshold yields a share of green jobs that is not significantly affected by the aggregation from 6-digit level (lowest aggregation level available in the data for the US) to 5 or 3 digits. Aggregating from 6 to 5 or 3 digits generates a difference of 1% and 1.6% in green intensity of employment respectively on average. Therefore, we define a job as green if its green intensity is at least 10%.

Annex Figure 2.A.1. Robustness check: green intensity in the US

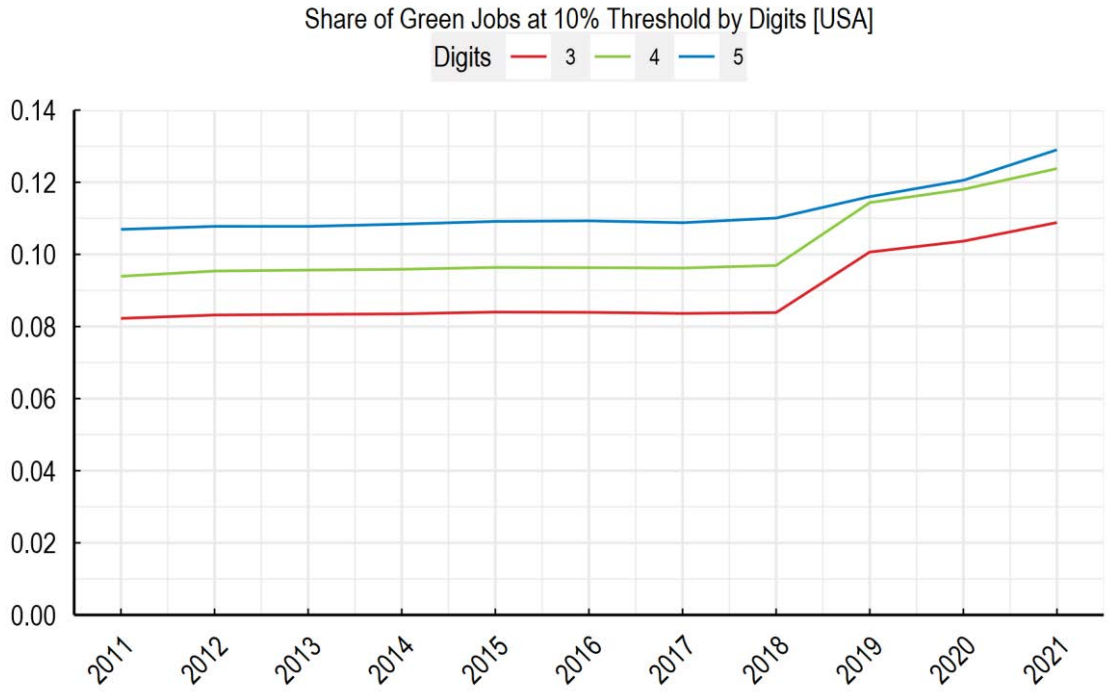
Green employment intensity for different levels of detail of occupational data, US



Note: A lower number of digits represents a higher level of aggregation and lower level of detail
Source: OECD calculations based on O*NET 24.1 and OEWS (U.S. Bureau of Labor Statistics)

Annex Figure 2.A.2. Robustness check: the share of green-task jobs, US

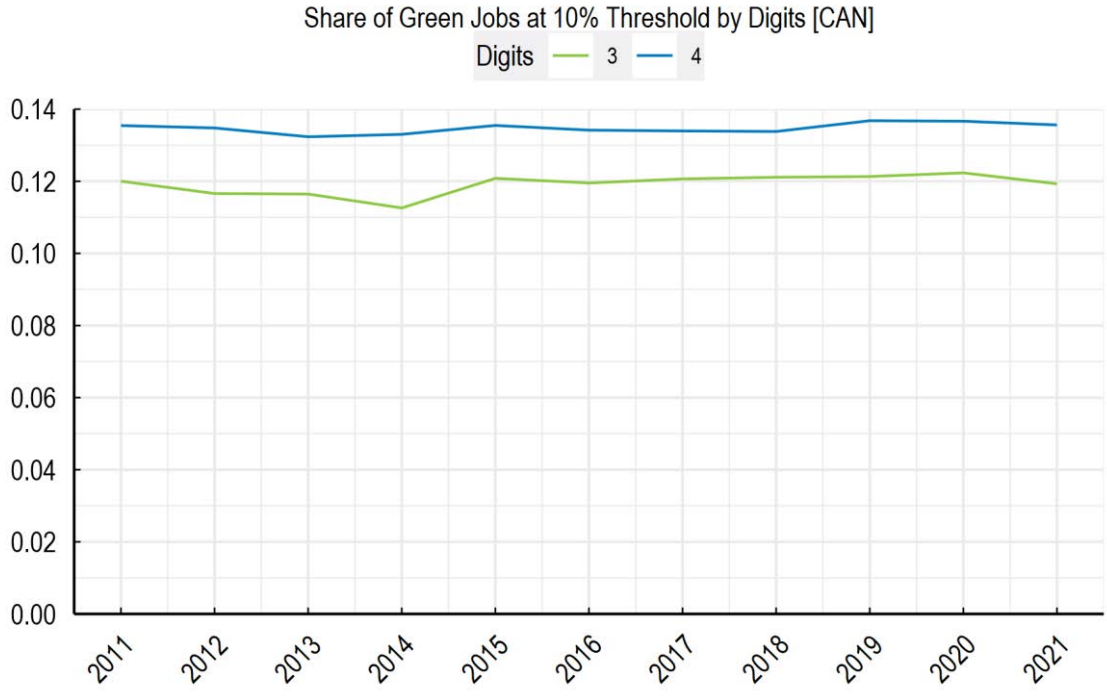
The share of green-task jobs for different levels of detail of occupational data, US



Note: A lower number of digits represents a higher level of aggregation and lower level of detail
Source: OECD calculations based on O*NET 24.1 and OEWS (U.S. Bureau of Labor Statistics)

Annex Figure 2.A.3. Robustness check: the share of green-task jobs, Canada

The share of green-task jobs for different levels of detail of occupational data, Canada



Note: A lower number of digits represents a higher level of aggregation and lower level of detail.
Source: OECD calculations based on Canadian LFS.

Annex 2.B. Additional tables and figures

Annex Table 2.B.1. Wage premium associated with green-task jobs is, to a large extent, explained by the differences in the level of education, experience and skills of workers

This table shows results from regressing the log of wage on a dummy indicating that a job is green and on other covariates using data from the US.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
green_th10	0.256***	0.257***	0.252***	0.170***	0.116***	0.0481***	0.0524***	0.0281***
	(0.000580)	(0.000580)	(0.000568)	(0.000485)	(0.000463)	(0.000528)	(0.000566)	(0.000569)
Constant	10.68***	10.71***	10.62***	10.35***	10.24***	10.39***	10.46***	10.52***
	(0.000230)	(0.000410)	(0.00228)	(0.00193)	(0.00183)	(0.00183)	(0.00224)	(0.00601)
Observations	5,510,884	5,510,884	5,510,884	5,510,884	5,510,884	5,510,884	5,510,884	5,510,884
R-squared	0.034	0.036	0.075	0.343	0.412	0.462	0.486	0.504
Year		YES	YES	YES	YES	YES	YES	YES
Region			YES	YES	YES	YES	YES	YES
Education				YES	YES	YES	YES	YES
Experience					YES	YES	YES	YES
Occupation 2d						YES	YES	YES
Occupation 3d							YES	YES
Industry 3d								YES

Note: From 2019 to 2021. Data for the US. See Box 2.1 for the definition of green-task jobs.
Source: OECD calculations based on Lightcast.

3 Learning from past and ongoing transitions

This chapter examines past labour market transitions that affected regional labour markets and communities. It analyses how digitalisation, globalisation and the transition out of coal compare to the green transition. Furthermore, it examines local success drivers of managing past labour market transitions and aims to draw policy lessons for the green transition. The chapter combines macro analysis of transformations, such as globalisation or the shift away from coal, with local case studies from around the OECD.

In Brief

Past transitions hold policy lessons for future challenges

- **The effects of past and ongoing labour market transitions bear similarities to the green transition. Digitalisation, globalisation and the exit from coal have been disruptive to local labour markets and communities and have had an uneven impact on regions**. Some regions benefitted from these changes, whilst others faced new challenges. The economic readjustment and diversification that occurred in negatively impacted regions had varying success. Good practises and success drivers in these regions can serve as lessons for the hardest-hit regions in the green transition.
- **Past transitions have been largely market-driven, whereas the green transition is largely policy driven**. This gives policy makers more opportunities to control both the supply and demand effects of labour markets but it also comes with great responsibility in terms of getting policy right.
- **Drivers of successful local policy in past transitions:**
  - **Share a clear and long-term vision and strategy for local economic transition.** This vision can be created top-down, but it is important that stakeholders operating at different levels of government generally agree with this vision. Coherence is important to create trust amongst workers, communities and businesses as well as a willingness to invest and anticipate long-term changes.
  - **Invest in local re-skilling and re-education programmes.** Re-skilling the workforce is important to increase resilience. The availability of future-proof skills is also a comparative advantage for a region. It is important to monitor the demand for skills and offer programmes that match demand.
  - **Build strong coalitions focussing on social inclusion.** These can include horizontal as well as vertical levels of government, worker representatives, employer representatives, educational institutions and other possible stakeholders.
  - **Invest in the attractiveness of the region and promote innovation.** Investment in infrastructure, education, healthcare and recreational facilities can help retain and attract the workforce during an economic downturn. Investment in innovation is needed to stimulate demand for jobs and skills.
  - **Assist laid-off personnel quickly immediately after—or ideally before—they are let go.** Providing easily accessible career guidance and well-designed income support to maintain household finances can consolidate trust and cooperation between different institutions and workers while reducing resentment.
  - **Use regional comparative advantages.** Regions can use worker skillsets available in the labour market, and exploit existing comparative advantages, thereby significantly lowering adjustment costs. However, locking in ailing business models would need to be avoided.

Introduction

Throughout the past decades, OECD countries have gone through a number of significant economic transitions. Megatrends such as globalisation, digitalisation, automation or demographic change have been transforming economies. For example, globalisation has driven a closer integration of national economies[1], which has increased overall prosperity but also heightened the risk of job displacement for some workers. Likewise, technological progress has generated new job opportunities but has also radically reshaped or displaced jobs (Frey and Osborne, 2017[1]; Nedelkoska and Quintini, 2018[2]; OECD, 2018[3]). More recently, the impact of COVID-19 and rising energy prices have forced both employers and employees to become even more flexible and resilient (OECD, 2020[4]; OECD, 2022[5]; OECD, 2019[6]).[2]

Implementing the Paris climate goals will require an economic transition to greener economies (see Chapter 1). In order to manage the detrimental effects of climate change, OECD economies have pledged to make efforts to maintain the global temperature increase, relative to pre-industrial levels, to below 2 degrees. Awareness is growing that such a change will require a paradigm shift. Societal and economic systems must undergo a fundamental change to facilitate growth with a lower carbon footprint or in a circular model. This will cause transitions in how firms operate, and how people live, which will have repercussions in the labour market, thus requiring many employers, employees, and governments to be increasingly adaptive. Most research so far agrees that the green economy will provide many opportunities. However, for heavy polluting industries and professions, the future might require a complete overhaul. (OECD, 2019[7])

Labour market transitions in OECD countries are not limited to global megatrends. During a transition, regions may experience the sudden downsizing or disappearance of an important employer or industry (Fouquet and Pearson, 2012[8]). Local communities' may also face a large-scale economic restructuring. The exit from coal and mining or the offshoring of economic clusters such as textiles or manufacturing to other parts of the world have had a strong impact on affected communities. In many cases, they forced them to rethink their economic development strategy and turn to new sources of job creation.

All of those transitions have a number of features in common with the green transition. First, they entail a readjustment process in the labour market, with the reallocation of employment across sectors and industries, and a transformation of job requirements. Second, they can generate considerable opportunities and gains, as well as new risks. Third, they have an uneven impact across regions and segments of the population, which can exacerbate geographic and socio-economic inequality.

This chapter examines what national and local governments can learn from past and ongoing transitions in managing the transformation to a greener economy. It combines insights from both case study examples, including places that managed a restructuring of their economy successfully, and wider economic trends that affect entire national economies. It will first discuss the importance of policy in economic transitions. Next, it draws on past experiences and economic transitions to identify successful policies. Furthermore, it will explore good practices that could inspire solutions to the challenges associated with the green transition.

The importance of policy for managing the green transition

Regions dependent on carbon-intensive industries face many challenges when it comes to managing the green transition and making it inclusive. Achieving the Paris climate goals will require a fundamental change in carbon-intensive industries (OECD, 2018[9]). Many carbon-intensive industries, such as iron and steel production, chemical production, and extractive industries, tend to be geographically concentrated (OECD, 2022[10]). For communities depending on polluting industries, the green transition

might entail large adjustment costs, especially in the short term. Managing the transition efficiently can mitigate both some of the short-term shocks and long-term negative effects (OECD, 2019[7]).

Policy can mitigate the negative effects of forced structural adjustments in regions. Without an adequate policy response, the green transition may exacerbate regional disparities and raise resentment amongst heavily impacted workers and resistance to climate policy (OECD, 2017[11]). Policies at the supranational, national, regional or local level can influence how communities can effectively benefit from the opportunities provided. Policies that helped regions successfully navigate past structural adjustment processes can provide lessons for communities facing such challenges in the near future.

A well-planned and successful economic transition requires time. Transitions take place gradually and often unfold in vastly different ways, making it complex to identify vital moments. Transitions usually involve a broad range of actors and extensive changes in different sectors and dimensions (Fouquet and Pearson, 2012[8]) (Jackson, Lederwasch and Giurco, 2014[12]). In a similar vein, managing a transition requires planning for the long run. It is not enough to act when industries are closing. It is paramount to plan interventions before factories, businesses or mines close down as well as invest in the area afterwards (Box 3.1).

Box 3.1. Phases of intervention before and during layoffs

- ***Phase 1: Explore the potential for diversification.*** First, regions need to identify stakeholders in the area, at all levels of government, including workers' representatives and important employers in the area. At this stage, regions can explore the local potential for diversification, and examine if the necessary infrastructure is in place to support the process. This includes roads, trains, digital infrastructure, etc. but also educational institutions and liveable communities.
- ***Phase 2: Understand the labour market impact.*** Secondly, it is important to inquire about the specificities of the workers likely to be affected. In particular, it is fundamental to identify the characteristics of the workers (age, skills, etc), to understand potential complications, such as workers' age when considering a reskilling policy. Furthermore, it is important to map the existing labour market policy.
- ***Phase 3: Announce closing, anticipate layoffs and provide services.*** It is advised to announce the closing only when there is a clear timeline of the process and when there is an assistance programme in place. Communication is vital in this phase, workers could seek help in the form of retraining offers, career counselling, or unemployment benefits. Monitoring the success rate of programmes will help the effectiveness of future policy.

Source: (World Bank, 2022[13]; OECD, 2022[5]; OECD, 2020[14]).

What are the similarities between other transitions and the green transition?

The negative effects of other megatrends have been highly concentrated geographically making it similar to the green transition's localised nature. For some areas, the green transition will provide employment opportunities in innovation, R&D and new forms of infrastructure planning. However, in other regions the green transition will be a bigger challenge, including regions where there is a large manufacturing, chemical or extraction industry.

Acting against the current wave of resentment towards globalisation and digitalisation requires decisive actions by governments and international organisations. Individuals in regions that are falling behind are increasingly dissatisfied with these megatrends. A lack of progress in addressing the

widening of regional gaps in economic opportunities has been cited as creating public resentment. Certain communities and regions are increasingly sceptical of global developments and policy elites (OECD, 2019[15]; Krugman, 2018[16]). The main priority is ensuring that globalisation works for everyone. This requires the implementation of policies that ensure that benefits of trade, investment automation and digitalisation are widely shared. Tools to achieve such policies are social protection, labour market activation policies, and strategic investments in education, skills, health, innovation, and infrastructure (OECD, 2017[11]). Similarly, the green transition is also likely to increase divergence in development between regions and within them. If the green transition does not coincide with redistributive policies, support for a green agenda can diminish. Failing to address the geography of discontent could extend the current backlash to the green transition, making it increasingly difficult to build essential political coalitions.

Empirical evidence on effective adjustment and transition policies is relatively rare. To design targeted policies to combat structural adjustment failures and to assess their efficiency, empirical evidence is needed. However, very little empirical evidence exists on measures that work well (WTO, 2019[17]). There are still considerable gaps in the research and many questions remain unanswered. Little evidence on the overall effectiveness of adjustment measures (WTO, 2019[17]) is available. The same problem is encountered regarding the green transition. Much attention is devoted to making this transition a just transition, but little empirical evidence on effective policy is available to inform the debate.

The costs of adjusting to a new economic structure can be high and are often borne by specific workers. In the United States, research suggests that adjustment costs can be up to five times the annual wage of a worker (Artuç and McLaren, 2015[18]). Other research suggests that sectoral mobility costs are higher than regional mobility costs. In other words, it is sometimes easier for workers to leave a region to find similar work elsewhere than to stay and re-skill (Cruz, Milet and Olarreaga, 2017[19]). Given the fact that many vulnerable workers are unwilling or unable to move to another region, this can lead to increased regional inequality and erode social cohesion (WTO, 2019[17]).

Many past or ongoing transitions have led to skills-biased changes, requiring higher skills and leading to polarisation as well as increased inequality in the labour market. For example, in the move to a more digital economy, both middle skilled and decently paid low-skilled jobs have been decreasing due to the introduction of digital tools. This can be either because the work can be (partly) automated, thus requiring fewer workers, or because, due to the introduction of digital tools, employees now require a higher level of skills to complete tasks (Muro et al., 2017[20]) (OECD, 2020[21]; Warhurst and Hunt, 2019[22]). These effects put negative pressure on wages for low skilled and middle skilled jobs. Meanwhile, high-skilled digital jobs pay better than average wages, leading to increasing wage divergence. Similarly, so far, mainly high skilled workers are employed in green-task jobs and are paid higher wages as a result. Thus, in absence of effective re- and up-skilling systems, the green transition is likely to increase labour market inequality, just as digitalisation or globalisation has.

The digital transition and green transition are twin transitions, complementing each other. Smart resource management and smart solutions in industry can help polluting industries lower their carbon footprint. For example, digital tools can help lower the demand for energy in the steel industry (Branca et al., 2020[23]). Likewise, many green solutions and innovations require digital skills to be developed and to be used. Thus, green-skills and digital-skills often overlap, and occur simultaneously.

The supply of digital and green skills lags demand, **which makes skills a major bottleneck**. Almost all workers in almost every business, and every job in OECD member states need to be able to use digital tools (OECD, 2020[24]) (OECD, 2016[25]). This means that digital skills are essential in today's labour market. Digitalisation is not only causing job creation and displacement but is also changing tasks most jobs require. A successful green transition will likewise require a shift in the way people work. Many workers will require a certain set of green skills to function in a green economy. However, a lack of digital and green skills remains a problem in most places. Many workers do not yet have the necessary skills to thrive in a digital environment. Reskilling the workforce is a bottleneck to realising the full potential of a digital

economy. To overcome this problem, the initiative called 'Training the trainers' was designed to increase the quality and quantity of digital skills courses in southern Europe. The same initiative is now teaching trainers in the area of green skills.

How does the green transition differ?

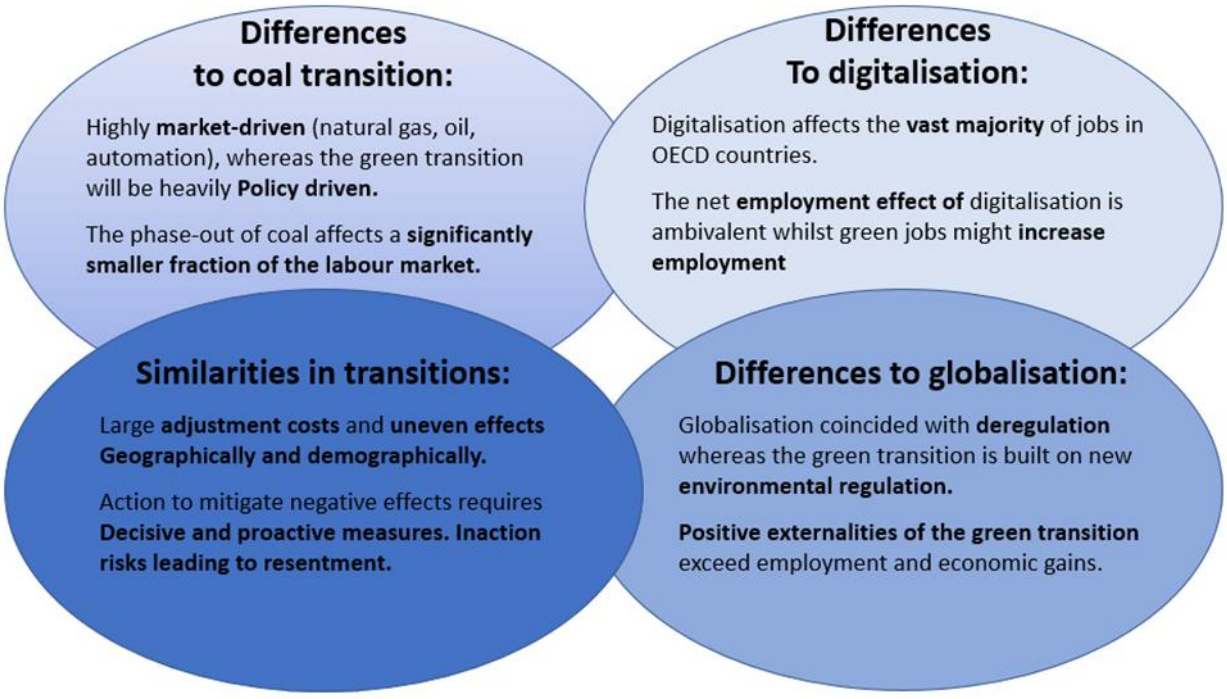
Earlier and ongoing transitions are all largely market-driven, whereas the green transition will be primarily policy driven. In previous transitions, technological innovation allowed a niche technique to become more cost-efficient. In the case of past energy transitions, the old energy source experienced increased extraction costs, which made the new energy source a competitive alternative. The same is true for automation and digitalisation. In the case of globalisation, improved communication and transportation techniques made it possible to produce many goods offshore with cheaper labour costs. It became more affordable to produce goods or sell services and thus allowed the new and more efficient forms of production to become dominant over old techniques. However, for the green transition, despite rising prices of oil and natural gas, circular economies and renewable energy are unlikely to become dominant in time to fight climate change by relying only on market forces. Thus, current and past transitions differ, as policy will be a driving force in the green rollout (Fouquet and Pearson, 2012[8]).[3]

Globalisation largely coincided with deregulation, but the green transition is policy driven and might coincide with reregulation. Institutions at the forefront of globalisation such as the WTO, World Bank, and IMF often pushed for the lowering of trade barriers, tariffs and complex product regulations. Furthermore, many governments cut back on public spending and deregulated non-market orientated social programs and subsidies. The green transition is taking a different approach. In order to foster the development of the green economy, which is not yet competitive on its own in all areas, massive public spending is being allocated to green initiative to subsidise green innovation and production. Moreover, to ensure that the green transition is a 'just' transition some governments have rolled out large-scale welfare programmes.

Current environmental policies are insufficient for dealing with the global externalities of climate change and environmental degradation that affect most people. Environmental deprivation left unattended will have a drastic impact on public health and the economy. The positive and negative externalities of environmental policy are not appropriately costed in market mechanisms. The green transition has externalities that are beneficial for all. Successful green policy delivers broad benefits such as clean air, soil, and water, and consequently less extreme weather, natural disasters, and increased longevity. Globalisation on the other hand is, besides its achievements, also associated with negative externalities, such as global warming. Increased trade and consumption have put pressure on environmental preservation.

Digitalisation has a wider impact than the green transition on local labour markets, affecting the majority of OECD employment, whilst the green transition is not affecting most jobs yet. The green transition, like digitalisation, has the potential to change the tasks associated with many jobs. Digitalisation and digital tools have done so already. The number of tasks an average worker preforms using digital tools has risen drastically.

Figure 3.1. Similarities and differences: the green transition, globalisation, digitalisation, and the exit from coal



Source: Author's elaboration.

The digitalisation transition

This section will look into the effects of digital tools and digital automation on the regional labour market. It will show that digitalisation poses a risk to certain occupations but offers many other opportunities. The case study of Estonia will show how economies can seize the opportunities provided by the digital transition.

What are the effects of digitalisation?

Digitalisation, defined as the process of introducing digital information technology and digital tools to transform business operations, is affecting most jobs in OECD countries (Muro et al., 2017[20]; Gartner IT Glossary, n.d.[26]). Though digitalisation is ongoing, over the last decade, developments have been so fast that many speak of the *digitalisation of everything* (Muro et al., 2017[20]). The penetration of digital technology into the world of work has been further accelerated by the Covid-19 pandemic, as many businesses resorted to e-commerce and remote working (OECD, 2020[24]). All of this has changed local economies, jobs, and the way we work and communicate.

OECD regions are increasingly connected to digital infrastructure. Between 2014 and 2020, the amount of high-speed fibre in OECD regions has more than doubled. Amongst businesses, the divide between small and large firms has narrowed as 93% of enterprises are now connected to a broadband connection (OECD, 2020[24]).[4] This enabled a quicker and deeper integration of digital tools in the workplace, forcing employees to adapt to new work environments. One of the most extensive efforts to integrate digital tools into industry is found in Germany (see Box 3.2).

Despite increased coverage of digital infrastructure, regional discrepancies in digitalisation are widening. While disparities between OECD countries have decreased over the past decades, regional

divergence within countries is generally worsening and remains large (OECD, 2018[27]; OECD, 2018[28]; OECD, 2019[15]). The digital frontrunners are increasing digital usage faster than the regions that are behind, pointing at a first mover advantage.[5] Unsurprisingly, this is also reflected in wages, where workers in digitally-advanced regions earn more than workers in regions that are falling behind. Thus, this digital regional divergence has the potential to increase and exacerbate inequality (Muro et al., 2017[20]; European Commission, 2017[29]).

Automation risks driven by digitalisation have an uneven impact on different areas within OECD countries. Overall, risks of automation of jobs are more pronounced in rural areas and regions with a strong manufacturing base, whilst new job opportunities are found in urban areas (OECD, 2019[15]). Moreover, the sectoral composition of business that open in urban areas are more likely to be in knowledge-intensive industries which are less at risk of digital automation. Therefore, the shift to digitalisation not only generates greater employment opportunities in urban areas but also puts fewer jobs in urban areas at risk of displacement (OECD, 2019[15]). Moreover, there is increasing evidence that, without supportive policy, heavy hit regions take a long time to offset job losses by local job creation (OECD, 2017[30]).

Box 3.2. Industry 4.0, Germany

Industry 4.0

The German export industry cooperated on a national level to develop a strategy to stay competitive in an age of far-reaching digitalisation, which is believed to have spurred the advent of what is being hailed as the fourth industrial revolution (Arbeitskreis Industrie 4.0, 2012[31]; Spath et al., 2013[32]). At the core of industry 4.0 is a network in which machines, products, materials, and people are connected through systems of sensors, communication, and artificial intelligence (Kuhlmann, Wiegrefe and Spellt, 2018[33]; Hirsch-Kreinsen, 2018[34]; Haipeter, 2020[35]). Despite being a well-coordinated and thorough plan, in practise the results of the industry 4.0 network have found limited success. Survey data found that although two-thirds of firms had introduced software systems, only one-third used the integrated network for digital logistics. Furthermore, only 44% of the plants were digitally linked, 47% used automated production planning, 12% used AI to take over administrative tasks, and 16% utilised robotic assistants (Haipeter, 2020[35]). This showcased that many potential benefits of digital tools are hard to integrate, as companies and their employees are not always comfortable with their usage.

Arbeit 2020

Given that technology will change the way people work as well as industrial relations, trade unions face a choice between resistance or adaptation. Arbeit 2020, a plan developed by national trade unions in Germany, informs worker councils in companies about the changes and impacts of digitalisation to encourage negotiations and social dialogue between employer and employees. This strategy of cooperation was meant to make sure that workers were included, and their voices heard in the discussion on how to incorporate new digital tools. It clarified how digital tools are used by workers, in what way they are affecting work, and how they can help to create decent jobs (Haipeter, 2020[35]). National Unions also collaborated with universities to do research and gather experts that can help as consultants for local work councils that face challenges in introducing new digital tools (Haipeter, 2020[35]).

Source: (Haipeter, 2020[35]; Hirsch-Kreinsen, 2018[34]; Kuhlmann, Wiegrefe and Spellt, 2018[33]).

Work increasingly relies on digital skills.

Employment increasingly requires deeper knowledge of digital tools. Overall, high skilled jobs that already required far reaching digital knowledge got more complex. Moreover, many jobs that used to require medium digital skills are now evolving to highly digital jobs requiring increased skillsets. But most notably, many jobs in sectors that were not considered digital have rapidly integrated digital tools. Thus, the increasing importance of digital knowledge has transformed the workplace, and especially drastic in low-skilled occupations. (Muro et al., 2017[20]). Yet, some workers struggle to adapt to new digital work practises. Preliminary evidence suggests that increased digitalisation is causing increased stress amongst workers (Haipeter, 2020[35]).[6]

Strong digital skills are increasingly rewarded in the labour market. Longitudinal research from 1970s to 2000s shows that workers who use digital technology in their work are generally better paid and evidence from the US confirms a digital wage premium between 2002 and 2016 (Muro et al., 2017[20]). A lot of the effect can be attributed to general skills and education level of workers. However, even after correcting for those factors, digital knowledge still significantly relates to pay.

Displacement effect

Automation is causing job displacement. While pessimistic scenarios calling for *the end of work* are grossly overestimated (OECD, 2020[24]), automation does endanger employment in certain industries. Especially employment in routine non-creative tasks in manufacturing industries faces increased risk of being automated. Furthermore, the introduction of smart AI and digital resources is also replacing routine tasks in management work and service industries. These jobs often require a low or middle skill level. Yet, digitalisation does also stimulate growth in other industries, creating jobs in the area of social media.

There is no clear evidence of net job losses caused by automation. However, since such job losses are concentrated, they pose significant challenges for some regions and sectors. How much risk a region faces varies widely within a country. Regions that depend more on manufacturing will face the greatest challenges (OECD, 2018[28]). These regions require extra investment and policy to encourage job creation in low-risk industries (Muro et al., 2017[20]; OECD, 2018[36]; Warhurst and Hunt, 2019[22]). Even within industries and sectors, big regional differences in automation risks can be observed. For example, in Poland 78% of jobs in the textile sector, and 84% of jobs in the automotive industry are at risk of automation. In France, only 50% of employment in textiles is at risk, and only 30% of jobs in the automotive industry (Warhurst and Hunt, 2019[22]; Cedefop, Eurofund, 2018[37]).

Automation and new digital technologies mainly displace middle skilled and low skilled jobs. It simultaneously creates more high skilled jobs.[7] This means that some individuals, especially those with tertiary education levels, will move to higher skilled professions. Others however will move from a middle skilled job into a low skilled job. This may put downward pressure on wages in low-skilled jobs. There has been a real wage loss observed for those workers who are not capable of working with digital sources. All of this is hollowing-out the middle pay segment and increasing polarisation in local labour markets (OECD, 2020[24]; OECD, 2018[36]; OECD, 2018[27]).

New forms of work

Digital forms of communication and interaction have given rise to new forms of work. A prominent example of work that emerged because of digitalisation is *gig work* or *platform work.*[8] Services can be provided locally, such as ride hailing, housekeeping, or delivery, or completely digitally such as translation, design or clerical and data entry work (Charles, Xia and Coutts, 2022[38]; Biagi et al., 2018[39]; OECD, 2019[40]; OECD, 2019[15]; De Stefano, 2016[41]). In OECD countries, the share of workers who depend on platforms as their main income is small[9], but expected to grow in the future.[10]

Despite platforms being a global phenomenon, there is a regional angle to it. Globally, the platform economy is largest in metropolitan and capital rich regions. (Warhurst and Hunt, 2019[22]; Graham, 2017[42]). However, within the OECD, some more scarcely populated regions including, amongst others, the Baltic states, the Czech Republic, have been able to attract platform work and workers by creating a good environment for *digital nomads*.

What are the local drivers of successful policy for the digital transition?

Provide workers with the right skillset for the digital transition, which is essential for local economies to thrive. The increased use of digital technologies in almost every sector and industry as well as the rising number of jobs qualifying as 'highly digital' show the need for digital skills in the workforce (Muro et al., 2017[20]). However, 50% of the workforce does not have more than very basic digital skills,[11] or no digital skills at all (OECD, 2019[43]; OECD, 2019[15]). Therefore, policy should prepare for a massive upskilling of the workforce in line with local labour market demand. Moreover, improving cooperation with relevant stakeholders can lead to increased quality of education and vocational educational training (VET) curricula. This policy should focus on regional needs. How trained the general workforce is with digital tools varies per region. It is important that lagging regions invest extra in catching up as a divide in digital knowledge can lead to further divergence in regional prosperity.

Prepare workers for the digital world of work, by boosting ICT and digital skills for some, but also a wide variety of non-digital skills for many others. Each region or industry requires its own digital skillset. Demand is increasing for high skilled ICT workers, and workers with high levels of digital skills but in different ways in different places. For some regions, it is important to invest in the availability of highly skilled digital workers to capitalise on economic potential. However, for most regions and most workers, increasing knowledge of how to function in an increasingly digital environment is equally desirable. This requires a wide range of skills, including transversal skills. Tasks such as browsing the web and finding credible information is increasingly difficult in an age of information overload. Completing basic digital tasks requires digital knowledge but also solid reading and calculation skills, cognitive intelligence, and socio-emotion abilities (OECD, 2019[43]). It is important that regions map the digital skill demand to be able to offer the right training. Regional actors should determine how much training should focus on complex ICT skills, and how much on general usage of digital tools.

Increase interest and participation in local adult learning to accelerate re- and upskilling. The task of re-skilling and re-training is large. Thus, early and voluntary attendance is required to ease the organisation and logistics. Interest in digital skill courses can be increased by using awareness campaigns that promote the benefits of training. Furthermore, these campaigns can work to increase how directly wages correspond to productivity gains as a result of training participation (OECD, 2019[43]). Lowering barriers to participate can also increase interest. Currently, barriers exist such as: (i) financial, which can be resolved by beneficiary tax schemes, (ii) time, which can be resolved by increasing the flexibility of training hours, (iii) or sustainability, which can be overcome by making training certificates better transferable between employers and industries (OECD, 2019[15]). Regional actors can utilise knowledge of regional digital skill demands to advertise skill courses that best fit the regional needs and thus are more directly applicable in local communities.

Expand the use of digital tools in early education. Digital learning holds many benefits over conventional teaching methods. Benefits include such things as: (i) better and more flexible access to study materials; (ii) better tools to facilitate collaboration amongst children and students, thereby increasing social skills; (iii) easier methods to personalise learning experiences and increase engagement; (iv) and increased transparency to track progress. Providing courses where teachers can learn how to reap the benefits of digital learning tools will lead to better education, and increased digital knowledge among children, students, and teachers (OECD, 2021[44]). Furthermore, digital education provides participants in remote areas with the opportunity to take courses offered only in bigger educational institutions. Digital

cooperation can allow regional schools to connect to a main facility, thereby providing education that would otherwise be impossible to facilitate in some areas. While digital attendance cannot fully replace in-person training, a hybrid model can increase the quality, quantity, and range of courses offered in less populated areas.

Learning from Estonia: seizing the benefits of digitalisation

Estonia is one of the most digitally advanced countries in the world. After breaking away from the Soviet Union, the Estonian economy rapidly modernised. Since 1991, digitalisation has been a vital part of the Estonian strategy for economic development. Today, Estonia ranks 7th in the EU Digital Economy and Society Index (DESI), above more advanced economies such as Germany and France, and 20th in the IMD world digital competitiveness rankings, one place below Germany (19), and above Japan (29). This is also much higher than most other eastern European countries, many of which lag behind their western and northern counterparts (IMD world competitiveness centre, 2022[45]; European Comission, 2022[46]). This high score in digitalisation has enabled Estonia to excel in the digital economy. To illustrate this point, in the OECD, on average, 9% of jobs are at risk due to digitalisation, in Estonia this is only 6% (OECD, 2017[47]).

The Tiger Leap initiative was designed to establish Estonia as a global digital frontrunner, with a special focus on technology in education. The Estonian government in 1996 wanted to consolidate Estonia with a strong tech industry. Their philosophy was that Estonia, after soviet rule lagged behind in many areas, but the internet was new, and thus in this industry they did not have to catch up. In the 1997 Tiger Leap Plan, digital tools were given a central role to play in Estonia's development into a competitive modern economy.

The Estonian Tiger Leap had a special focus on education. In Estonian education, both teachers and students work with digital technologies. Teachers attend classes on the optimal usage of digital teaching tools. This has led to deep integration of such tools in schools. Over 70% of kindergartens, and over 90% of schools make use of digital tools in their teaching methods. This strategy was recently modified, which should lead to over 90% of 16-24-year-olds having above average digital skills (European Comission, 2022[46]).

Tech industry and start-ups contribute considerably to the Estonian economy. Considering the country's size, it is noteworthy that companies like Skype, TransferWise, Playtech, and Taxify (Bolt) all originated in Estonia. Around 6,2% of the Estonian workforce is working in ICT-jobs, significantly higher than the EU average of 4.5%. Estonian ICT exports have also risen consistently, recording a growth of 108% between 2015 and 2022. The ICT industry is responsible for 7% of national GDP. Estonia's early adaptation to and embrace of digitalisation has allowed the country to seize its benefits and job creation opportunities.

Estonia ranks first in the DESI E-government index. Almost all Estonian citizens use electronic tools provided by the government to streamline both government services (such as taxes) and business operations by providing an open and transparent database and tools for reliable e-signatures. Taken together, the smoothing of these processes is believed to increase Estonian GDP by 2%.

Digital nomad visa and E-residencies have attracted many start-ups and entrepreneurs to Estonia. With the help of E-residency, entrepreneurs from over 176 countries have been able to establish a business, or an EU business branch in Estonia. Over 30% of Estonian start-ups have E-resident amongst their founders, and 20% of companies registered annually in Estonia are created by E-residents (Petrone, 2022[48]). Over a 100 000 people today are registered in Estonia on E-residencies, making it a large part of the population of 1.3 million. The introduction of this transparent and accessible visa has had a major positive impact on Estonian economic growth.

The transition towards a global economy

This chapter will look at the effects of globalisation and outsourcing on the regional labour market. It will show that globalisation has increased net output and economic growth. However, it has also posed risks to certain occupations and regional economies. These risks, if unmanaged, can lead to further regional economic divergence. The case study of Oulu will show how economies can seize opportunities that globalisation is creating.

What are the effects of globalisation?

The impact of globalisation differs across countries and amongst regions within countries. For some countries, globalisation increased trade, information exchange, the availability of capital, and a strong rise in innovation. (Zeibote, Volkova and Todorov, 2019[49]). Trade has led to growth and lifted millions of people out of poverty (OECD, 2022[50]). However, some countries have faced challenging transitions as local businesses lost out to global competitors. Within countries, the costs and benefits of open trade policy and deregulation are not equally shared. In developed economies, some areas dependent on manufacturing have seen the disappearance of important employers without equivalent alternatives (OECD, 2007[51]). Other regions witnessed an increase of high-skilled service demand and steady GPD growth (Stiglitz, 2002[52]; OECD, 2017[11]). In Europe, the benefits of globalisation for the EU have been widespread, whilst the costs were often geographically concentrated (European Commission, 2019[53]). In the US, regions that traded a lot with China recorded greater job losses in manufacturing than regions with lower trade exposure to China (Pierce and Schott, 2016[54]; Autor, Dorn and Hanson, 2013[55]). In many cases these jobs were replaced by jobs in the service industry, requiring a different skillset. Hence, amongst different people with varying levels of skills the impact of globalisation was also diverse. High-skilled individuals were often more resilient and managed to adapt, whilst low-skilled individuals especially in the worst-hit regions struggled to adjust (WTO, 2019[17]).

What are the local drivers of successful policy for globalisation?

Monitor the demand for and supply of skills at the local level, to ensure matching. To create better employment, a holistic approach is required. Just upskilling is in many cases not enough, as there might be a low demand for high-skill jobs. An integrated approach is therefore required. This involves creating incentives for workers to partake in upskilling programmes. In addition, investments in innovation, technology and business development are required to allow firms, especially SMEs, and local employers to create jobs for higher-skilled individuals (OECD, 2014[56]; OECD, 2016[57]). This requires better coordination in investment, innovation and labour market policies at the local level (OECD, 2019[58]).

Proactive initiatives can increase institutional trust and decrease negative economic effects of structural adjustment. If a clear and holistic restructuring plan is presented to workers before they are made redundant, their level of institutional trust might be salvaged, which could motivate them to participate in re-skilling programs (Bailey et al., 2008[59]; Bailey et al., 2014[60]). Furthermore, this type of strategy can mitigate the negative economic effects of industries that are being shuttered (see Box 3.3) (World Bank, 2022[13]).

Engage with a wide range of local stakeholders to get a full grasp of the skills that are needed in the workplace. Local training associations, employers, universities, unions, and civil society actors, often hold much expertise, knowledge and resources regarding the local labour markets. Actively engaging with those stakeholders can improve the identification of skills gaps. If done properly, successful dialogue among stakeholders at the local level can lead to swift and targeted rollouts of up-skilling programmes. Such dialogue requires an active and leading role by regional policy makers (OECD, 2019[58]). This could help identify areas with a high concentration of low skilled and low paid jobs, which is often referred to as a low-skills equilibrium. Furthermore, understanding skills mismatches, either a skill surplus or a skill deficit,

is vital to determine whether the focus of future policies should prioritise the investment in skills supply or demand (Froy, Giguère and Meghnagi, 2012[61]).

Look critically at niches to exploit opportunities and comparative advantages of communities and regions. Local governments can assess available skills and ensure they are properly used by local employers**.** Often, the presence of dominant industries has created infrastructures and knowhow in a specific region of a country. Exploring options to make use of the existing human capital can attract new industries and employers efficiently, and lower adjustment costs. However, the existing skills may be used in new industries. Supporting old industries can cause a harmful lock-in effect. Injecting public credit into ailing business models and outdated technologies is not a sustainable model to boost local employment (OECD, 2019[58]).

Invest to improve the quality of education to foster adoption of new technology and increase resilience and adaptability in communities. There are both market and non-market benefits of good quality education provision. Industrial transitions such as globalisation, and the green transition, require workers to adapt to new circumstances and work with new technologies. Quality initial education and return-to-school policies can help ease the transition to new work opportunities. Active labour market policies provide workers with additional skills that they will need to stay competitive and engaged in emerging sectors. However, good initial education increases the effectiveness of such policies as participants will be quicker to learn new skills, increasing the adaptability and resilience of the general workforce (see Box 3.4) (Heckman, Humphries and Veramendi, 2018[62]; WTO, 2019[17]).

Improved connectivity between urban and rural areas can strengthen the labour market. SMEs and local employers in rural areas benefit from an inward- as well as outward-looking strategy. This can allow local businesses to overcome the problem of remoteness. Connecting local entrepreneurs with resources and strategic actors in urban areas can increase access to knowledge and foreign markets for SMEs in more remote areas. This can be done by creating start-up boot camps, innovation hubs, or similar initiatives (OECD, 2019[7]).

Learning from Oulu, Finland: excelling amid globalisation

In Oulu, external forces led to the collapse of Nokia as an employer in the region, but today employment is higher than before. The information and communication technology (ICT) cluster led by Nokia was vital to the Oulu regional economy. At its peak, Nokia was the world market leader in wireless and mobile ICT, and 16% of regional employment depended on its success. Due to increased globalisation, regional development is now increasingly prone to external shocks (Martin and Gardiner, 2019[63]; Simonen et al., 2016[64]). In the span of just a couple of years, Nokia lost market share to Apple, Samsung, and other producers. This caused a drastic reduction in the Nokia workforce in the Oulu region. However, thanks to an approach based on knowledge creation, entrepreneurship, and communal spirit, employment is now higher than ever. Policy makers had a strong focus on measures exploiting the regional cooperation network and existing human capital that became available because of the Nokia collapse (Simonen, Herala and Svento, 2020[65]).

The success of a single industry in a region can foster complacency and reduce resilience to large-scale shocks. The growth of Nokia was mainly in the specialised sector of manufacturing of mobile and wireless communication devices. This made the economy of the region overly dependent on the success of one company. Easy and successful collaboration with Nokia caused many subcontractors to ignore global business strategies. Between 2008 and 2014, Nokia, its successor Microsoft, and Broadcom, had all downsized causing the unemployment rate in the region to jump to 18% (Simonen, Herala and Svento, 2020[65]).

Local and regional actors formed alliances to anticipate the economic downturn. Essential local actors anticipated the massive structural changes that occurred between 2009 and 2014. Many actors

created coalitions to coordinate structural adjustment and economic diversification at the local level. The Oulu Innovation Alliance (OIA) was created in 2009,[12] pledging to invest in agreed areas, concentrating on diversification of expertise in the tech sector. Another important alliance was the Tar Group,[13] which functioned as an informal discussion platform for all relevant stakeholders in the region. They oversaw the funding made available for structural adjustments. Tar Group decided to fund new agents and to avoid subsidising outdated business models. Moreover, business development was reorganised into BusinessOulu, a strategic hub for boosting start-up-ecosystems in the area. All coalitions showed the willingness to take risks. This facilitated a start-up boom, in which over 600 start-ups were created (Simonen, Herala and Svento, 2020[65]). Finland made good use of the European Globalisation Adjustment fund to finance employment and innovative initiatives (OECD Local Development Forum, 2022[66])

High standards of infrastructure and quality of life avoided mass outmigration of highly skilled workers. Despite the high unemployment rates, and economic downturn between 2008 and 2013, only about 200 out of the 3 500 recently unemployed workers decided to leave the area, reflecting the local population's willingness to remain in the area (Simonen, Herala and Svento, 2020[65]). This is partly due to the presence of high-quality transport infrastructure, education institutions, and healthcare services. In return, the presence of a high-skilled and available workforce attracted some businesses to the area (Simonen, Herala and Svento, 2020[65]). Preventing outmigration of the working population provided the region with the skills needed to fuel the success of other firms.

The high average level of education of the population in Oulu increased workers' resilience and adaptability during the downturn. The high degree of specialisation in the Oulu region initially made it hard for employees to find new job opportunities. However, education levels, which are in general quite high, facilitated a smoother transition from high-tech manufacturing to the high-tech service sector. The presence of related industries in a region also improves the likelihood that workers will find new work (Hane-Weijman, Eriksson and Henning, 2018[67]; Boschma, Eriksson and Lindgren, 2014[68]). Regional authorities realised the potential of the recently laid-off highly skilled workforce. This was both a challenge and an opportunity as PES had to learn to work with this type of redundant workers. The initial mentality is that those highly skilled workers can manage well for themselves. However, with the number of redundancies in Oulu, this became problematic (OECD Local Development Forum, 2022[66]). The Tar group was responsible for developing re-skilling programmes reflecting a variety of aspects, including the interests of employees, the expertise of education centres, and demand from employers. For this reason, education was fitted towards areas in which new jobs would emerge, reducing the risks of unemployment (Simonen, Herala and Svento, 2020[65]). As a result, the high-tech sector of Oulu is more diverse. SMEs are much more independent and no longer live off the success of Nokia on the international market. In other words, a shock to the essential member of the regional economy does not affect all industries to the same extent as it did in the early 2000s (Crespo, Suire and Vicente, 2014[69]). The Oulu region has bolstered its resilience considerably, and its resistance and robustness to potential external economic shocks (Simonen, Herala and Svento, 2020[65]).

Box 3.3. Building institutional trust among affected workers, by acting swiftly. West-Midlands, (United Kingdom)

The Midlands in the UK is one of the regions that have faced both gradual and sudden layoffs in car manufacturing resulting from supply chain relocation or automation between 1960 and 2008. During the 1960s, the car manufacturing and dependent industries comprised 65% of total employment in the wider West-Midlands. Ever since, their share of employment has been shrinking. Between 2005 and 2009, several large employers shut down their production, including Jaguar and Peugeot (Coventry, 2006), MG Rover (Birmingham, 2005) and LDV (Birmingham, 2009). Overall, the industry witnessed a 34% employment reduction between 1997 and 2007, with spill-over effects in other industries.

After setbacks related to the financial crisis, the industry grew again between 2011 and 2018. With an increase in output production by roughly 50% and employment by 18.6%, the automotive industry is regaining importance as an economic engine in the midlands. Moreover, electric vehicles increasingly contribute to this growth.

Between 1997 and 2010, the UK government set up multiple taskforces to cope with car manufacturing plants closing down. The government used temporary, non-statutory partnerships with multi-stakeholders and selective membership taskforces as a response to regional shocks caused by car manufacturing closures. The aim of such taskforces was the rapid mobilisation of expertise and resources of national and regional stakeholders in response to the economic challenges.

In Birmingham the high geographic concentration of manufacturing jobs made the region vulnerable economically. At the time of the collapse of the Longbridge plant in Birmingham, it provided more than 6 000 jobs. An estimated 12 000 jobs in the automotive industry and their dependant suppliers were expected to be lost.[1] Moreover, the jobs lost in the car manufacturing industry were relatively good jobs, paying a weekly salary of GBP 514 compared to the regional average of GBP 404 for a full-time worker. The unemployment rate in 2008 in Birmingham (9.4%) was the second highest in the UK, making economic policies in this region particularly challenging.

The regional government took a proactive stance and set up diversification and adjustment programmes early on. Programmes incentivising economic diversification started in the early 2000s, as a response to a decline in manufacturing employment. To deal with economic shocks, such as the carmaker MG Rover's shutdown, the workforce was incentivised to be more resilient before they lost their jobs. Regional stakeholders made efforts to ensure that employees had the necessary skills to cope with industrial change by providing flexible training, education, and information programmes. Thanks to this early intervention, many workers were already reskilled and replaced before the final shutdown, limiting its negative effects.

Authorities created a multi-stakeholder taskforce named Second Rover Taskforce (RTF2) that was mandated with securing re-employment.[2] Objectives of the task force were: (i) keeping suppliers operational in the short term, whilst supporting and assisting diversification, (ii) aiding those suffering from joblessness to find new work, (iii) supporting the local community.[3] The funding for the diversification programme of MG Rover's suppliers was effective. As MG Rover collapsed, 4 000 fewer jobs than originally forecast were lost, both in the short and long term.

Despite the challenging situation, 90% of the MG Rover employees found employment by 2008, albeit often for lower wages. Yet, after three years, 90% of the ex-MG Rover employees found some form of employment.[4] At first sight, the policy approach created for MG Rover employees was thus very successful. However, the need to acquire an entirely new skillset resulted in significant wage loss, GBP 5 640 annually in real terms by 2008. Two-thirds of the workforce suffered wage losses, whilst

one-third reported an increase.[5] High-quality manufacturing jobs are not easily replicable, especially if skills do not transfer well into new employment. In general, reusing available skills is more effective. However, skills reproduction in this case would require continuity in skills demand, which can be unlikely in the long run.

The availability of training has helped workers both in acquiring skills to switch sectors and in providing the tools to look for new opportunities. Many workers who moved from manufacturing to the service sector required an entirely new skillset. Among them, 60% had undergone some form of education or training course. Two-thirds of them utilised the training schemes offered by local agencies, whilst many others underwent training in their new workplace. Workers reported that training helped them gain confidence to find new employment. Moreover, roughly one-third of workers had managed to upskill, reporting a higher occupational level than at MG Rover. Yet, another third reported a lower occupational level.

The swift and resolute response helped retain employed people, motivate unemployed workers to participate in programmes and build trust in the adjustment policies. In the immediate aftermath, the public employment service brought 160 extra staff members to the Longbridge office, in order to register more than 5 000 employees eligible for benefits within a week. The RTF2 was operational the day of the closure announcement. Such preparation builds confidence in the organisation by those negatively affected. In comparison, a "firefighting" approach after the fact might have resulted in suspicion or lack of confidence in the taskforce, significantly lowering motivation to utilise the assistance provided.

Note:
1 In this similar timeframe, the US, Australia, Germany, France, Belgium, and Japan have all seen closures and mass layoffs in the automotive industry.
2 In this task force, there were members from different levels of government as well as different regions. Agencies represented included the Department of Trade and Industry, local members of parliament, local authorities such as the city council of Birmingham, employers, trade unions, skills agencies, and universities.
3 To this end, GBP 176 million was made available. GBP 50 million for retraining and upskilling, 40 million for redundancy payments, 24 million in the form of loans to dependent businesses, 21.6 million to help suppliers diversify and maintain trade, and 40 million to sustain suppliers trade in the short term.
4 Of these workers, 11% were self-employed, 5% percent part-time employed, and 5% percent still unemployed and looking for work.
5 These were mainly workers that found new work in manufacturing and thus did not need to change sector.
Source: (Bailey et al., 2014[60]; OECD, 2018[9]; MacNeill and Bailey, 2010[70]; Office for National Statistics, 2021[71]; Bailey et al., 2008[59])

Box 3.4. Leveraging existing comparative advantages to create a global industry in Riviera del Brenta (Italy)

To overcome competition from cheap labour in the global market, the Riviera del Brenta area in the Veneto region capitalised on the "Made-in-Italy" brand to capture high-end markets for textiles. The Riviera del Brenta area had traditionally traded on the global markets in medium-range quality textiles, clothing, leather and footwear (TCLF) products. The low- and mid-tier fashion industry in developed economies faced increased pressure from trade liberalisation and cheap labour in the developing world. To stay competitive, Brenta effectively skilled up and became a leader in high-quality TCLF design and production with a focus on leather footwear and accessories, utilising the Made-in-Italy brand to their advantage. Due to greater value added in this segment of the industry, the region could absorb the higher labour costs. Manufacturing, which had dominated employment, dropped to 50% of total employment in design and only 40% in manufacturing during the process.

Bundling local resources allowed employers to market the high quality of the region's products. The challenges and barriers experienced when entering a new global market are sizeable. The employers' organisation *Associazione dei calzaturieri della Riviera del Brenta* (ACRIB) played a decisive role in expanding the brand of the Brenta district. The ACRIB functions as a representative body for employers in wage negotiations and in expanding the brand name globally. Furthermore, the ACRIB also became a hub for sharing business innovation ideas. Combining local resources allowed producers to afford the costs related to entering the global market.

Local education and training institutions played an important role in upskilling the labour force, allowing the transformation to higher value-added market strategies. Originally, the region had a strong craftwork tradition based on informal knowledge transfer. The school of arts and crafts gathered informal knowledge to codify and institutionalise their traditions. In 2003, a public-private partnership funded the institute to evolve into the *Politiecnico Calzaturiero.* This institute specialised in footwear design, and helped promote initiatives in training, research and technological transfer, development and operational safety. The school enjoyed: (i) a strong tradition exploiting the two hundred years of experience in the region, (ii) cooperation with the private sector, regional governments, and unions, (iii) employing teaching staff comprising entrepreneurs, stylists, designers, experts and workers, and (iv) a strong integration of the offered training courses with increases in skill utilisation and demand. The multi-stakeholder setup of the institution reduced entrepreneurs' fears of sharing knowledge with regional competitors. This widespread knowledge sharing was fundamental in establishing regional quality control and entering the global high-end market.

Regional unions allowed workers to benefit financially from up-skilling, creating incentives to pursue training. The higher value added in high-end markets allowed for bigger profit margins. Unions negotiated so that such increases in margins went hand-in-hand with increases in wages, benefits, and improved working conditions. As productivity in the industry increased, so did the prosperity of the workers. The strong relationship between the Unions and the ACRIB established the idea that workers and employers both shared in the success of the industry creating incentives on both sides to maintain the high-quality standards.

A tripartite approach helped align the interests of different stakeholders and create the necessary coalitions to manage the difficult economic adjustment processes. Despite the upskilling and rebranding of the region, job losses to Romania and China were still significant. Combined with the financial crisis and increased pressure from automation and digitalisation, many former leatherworkers found themselves unemployed. A pact, formed by the regional governments, employers and unions, with the common goal of better reintegrating former leatherworkers, youth and women into the regional labour force helped tackle these problems. The pact promoted better skills

utilisation. However, temporary forms of employment doubled in the area between 2004 and 2012. This development is problematic as there is a strong relationship between adult learning, training, and skill utilisation to the nature of employment contracts.

Source (Froy, Giguère and Meghnagi, 2012[61]).

The transition out of coal

This section will look into the effects of automation, competition, and renewable energies on the coal industry. When societies wean themselves off coal, it often has far reaching consequences as coal generally provides well-paying jobs in economically challenged regions. The case study of the Ruhr region will show that managing such a process well can lead to sustainable economic growth in former coal regions.

What are the effects of phasing out coal?

Phasing out coal is an ongoing transition that is part of most OECD countries' policy to achieve net zero in 2050. Due to a combination of climate goals, automation and innovation, and competing energy sources, much coal employment in OECD countries is already lost. The trend of phasing out coal is likely to continue as globally, 21 countries have pledged to phase out coal (International Energy Agency, 2021[72]). Some evidence suggests that the coal phase-out will yield substantial local health and environmental benefits that might outweigh the loss of economic activity in the extraction industry (Rauner et al., 2019[73]).

The outsized impact of coal mining jobs in small and/or remote communities makes them vulnerable to significant displacement in the event of mine closure, which poses a risk of destabilising local economies. The costs of phasing out coal are strongly geographically concentrated. Energy transition in coal regions will impact workers directly engaged in mining operations and along the coal supply chain, but also workers with indirect connections to coal activity, such as retail, restaurants, and recreation service providers to coal miners and their families. In this context, government planning is essential to mitigate the negative effects on livelihoods and the sustainability of local economies. Where coal is an important employer, political considerations can delay the energy transition, but delays may in fact increase existing distortions and exacerbate segmentation, making future transitions even more challenging (World Bank, 2022[13]; OECD, 2022[5]).

Direct unemployment due to the exit from coal can lead to larger spill-over effects. The level of coal mining jobs in OECD countries is modest, but the effects of phasing-out coal might include job losses in complex coal supply chains and dependent communities and industries. The effect and range of job losses outside the industry itself is significantly harder to calculate as little data is available (World Bank, 2022[13]). Research has shown varying estimates of the size of those ripple effects of losses of coal mining jobs, ranging from less than one to almost four other jobs lost per mining job. Coal mining jobs often provide economic stimulus to otherwise underfunded remote areas, many of which have above average poverty rates (OECD, 2021[74]).

So far, most policies have focused on miners themselves. Many policies for regional labour market transitions fall short of including workers that are dependent on coal further down the supply chain or in coal communities (World Bank, 2020[75]).

Economic diversification is essential for managing a transition successfully. A commonly observed mistake is that many regions support existing industries in a vain attempt to cling to current employment configurations. This can cause a lock-in effect, in which a too strong focus on current business and

employment causes capital to flow into the dominant industries. Market forces or the desire for a clean environment are likely to make many of those industries obsolete in the long term. Investments in ailing industries such as clean coal are not future proof. Economic diversification of the region and the development of new industries increase the resilience of regions in the long term. Successful diversification requires proactive planning, investment in infrastructure, and attracting private investment. Institutional capacity is vital to effectively execute complicated strategies involving a multitude of stakeholders (World Bank, 2020[75]; OECD, 2022[5]; OECD, 2019[76]).

What are the local drivers of successful policy for the transition out of coal?

Clear, ambitious, actionable, and anticipatory policies with a long-term vision, can help to build strong coalitions and gain widespread support. For many businesses, especially those in heavy industry, structural adjustments require large-scale investments. On an individual level, re-skilling bears high transaction costs that will only pay off in the long run. Both for business and for individuals, clarity is needed about where economic opportunities are going to be, in order to make relevant long-term investments. This also means that different levels of government, vertically as well as horizontally, need to agree on objectives and ambitions. At the sub-national level, there is a need to stipulate in a clear way what the ambitions and policy objectives are in a region, this was done well in Spain for instance (Ministery for Ecological Transition and Demographic Challange, 2020[77]; Instituto para la Transición Justa, 2022[78]).

Consolidate collaboration among stakeholders operating at different levels of government. Helping regions to shift to a different economic structure requires commitment at all government levels. It is important that on a national level, there is a clear and proactive ambition. This includes well-communicated goals and a matching budget to achieve those goals. It also requires good organisation and cooperation on a regional and local level (see Box 3.6). In particular, investments in new industries and the exploitation of local comparative advantages are increasingly successful if communities have a strong say in their future direction (Harrahill and Douglas, 2019[79]). Not only different levels of government but also different parts of government (e.g., ministries of environment, energy, infrastructure, education, and finance) may cooperate and align their objectives in making a coherent plan (International Energy Agency, 2021[80]).

Invest in strengthening local re-skilling and up-skilling programmes. The extent to which employees and regional economies are capable to economically diversify depends on the success of re-skilling and re-education programmes (Harrahill and Douglas, 2019[79]). Local, bottom-up organised training to leave brown industries are necessary to: (i) help most affected workers transit into new career opportunities, (ii) make the human capital needed for the green transition available, (iii) include more disadvantaged groups in new emerging sectors. To mitigate the economic effects of phasing out coal, a long-term focus is needed on reskilling and re-skilling coal communities (International Energy Agency, 2021[80]; World Bank, 2022[13]).

Set up responsive career guidance to help workers identify sustainable career alternatives. It is often very unclear for former coal industry workers to identify sectors where ‘future-proof employment’ is likely to be found. Unemployment agencies, employers and educational institutions can work together to create easily accessible and relevant information for workers. Initiatives could include career fairs, networking events or personal counselling services (see Box 3.6). Career guidance can help streamline re-employment as workers can acquire the skills they need for future work security (OECD, 2019[81]).

Include workers and their communities in the process of structural changes to create strong coalitions and bolster effective social dialogue. Workers and employers can organise a transition much more smoothly if they work together (ILO, 2016[82]). Employees value an early and open conversation in good faith, in which they are provided with the opportunity to participate in the decision-making process concerning their future (Sartor, 2018 p.27 in (Harrahill and Douglas, 2019[79]; World Bank, 2022[13]). Social dialogue can be established by directly talking to workers, or by regular contact with workers’ representatives. Other stakeholders, such as unions, employers, as well as academics, wider communities and youth could be involved in the process (International Energy Agency, 2021[80]). When done well, sites

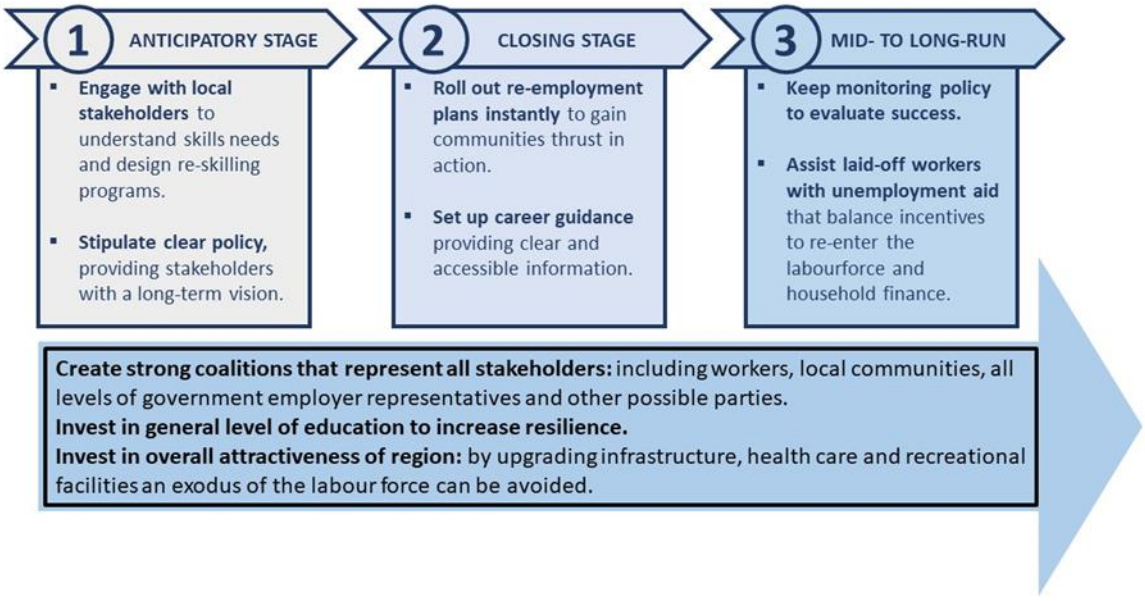
can be closed, either slowly or more quickly, without creating major social or political unrest. Alternatively, if employees are not heard, and their needs unmet, it could result in distrust towards political coalitions and the decarbonisation process (Abraham, 2017[83]; Harrahill and Douglas, 2019[79]). In Spain, coal phase-out strategies have been designed in collaboration with worker representatives, which have largely been pleased with the outcome (see Box 3.5) (Ministery for Ecological Transition and Demographic Challange, 2020[77]; Instituto para la Transición Justa, 2022[78]).

Continue or boost local investment to avoid mass outmigration of workers. This does not only entail investing in universal infrastructure such as transportation (road, rail, air and water), but rather general investments in quality of life in regions. This includes education, healthcare, and public spaces such as cultural heritage sights, national parks and sport facilities. If an area remains attractive despite its economic downturn, an exodus of human capital can be avoided. If the workforce remains in the area, employers will be better able to regroup and avoid further impoverishment of the area. Furthermore, tailored investment in infrastructure supporting SMEs and start-ups can help offset a lack of sufficient capital, capacity and resources that more remote areas might experience. If workers with relevant skills leave the area where they work, a regional economy might implode (see Learning from Oulu, Finland: excelling amid globalisation).

Assist laid-off workers with unemployment aid packages. Opinions on aid packages are mixed. There is almost unanimous agreement that a form of wage-loss compensation is desirable. However, compensation will likely not be enough on its own. If coal miners are given severance or unemployment compensation that is on par with their wages, then they will have little incentive to switch careers, because—as mentioned previously—wages in the coal industry tend to be relatively high. In some cases that mimic the example above, 35-46% of former coal miners exited the labour market rather than undergoing reskilling and re-employment, causing a significant loss of both tax money to pay benefits and human capital in the local labour market (see Box 3.6) (World Bank, 2022[13]).

Figure 3.2. Introducing the right policy at the right moment is essential

Timing of policy options for local communities facing a transition



Source: Author's elaboration.

Learning from the Ruhr, Germany: successfully phasing out coal

The Ruhr, an essential area for European industry, produces large quantities of coal, steel and chemical products, but offers valuable insights into dealing with structural labour market changes. The Ruhr has a long history of coal mining and steel power plants dating back to the industrial revolution, which made it a centre for extraction and heavy industry. Between 1957 and 2016, the workforce in the coal extraction industry declined from more than 600 000 to less than 6 000, due to automation and large productivity gains and competition from other energy sources. These factors made many workers obsolete (Institut Arbeit und Technik, 2019[84]). While the Ruhr is still reliant on heavy industry, there are many jobs in chemical, steel, and aluminium production (Rhine-Westphalia, 2021[85]). Between 1960 and 2001, 839 000 jobs disappeared in the heavy industries, but they were compensated by 801 000 jobs that were created in the service industry. Moreover, by the mid-2000s, the R&D sector grew, thanks to the creation of 100 000 jobs. By 2009, 24 000 people worked in one of the 3 400 companies specialising in renewable energy, creating a total revenue of EUR 7 billion (World Resources Institute, 2021[86]; Harrahill and Douglas, 2019[79]).

In the late 1980s and 1990s, policy makers allowed more space for local actors, resulting in a more bottom-up, or regionalised policy approach. The 1970s saw a steady decline in coal-related employment. At first, German government agencies responded with top-down structural policies.[14] Policy makers did not sufficiently include the representation and interests of smaller actors in the region. Industries were reluctant to recognise the decline of resource-based production and together with unions lobbied for large-scale investment to maintain competitiveness. This approach hindered efforts of structural reforms and thereby caused a harmful lock-in effect. Later, trade unions started to recognise the inevitability of a gradual phasing-out of coal employment due to a combination of emission reduction goals and market-driven factors. This provided an opportunity for local actors to engage effectively, leading to the adoption of a bottom-up approach. A good example is the creation of the International IBA Emscher Park, where local initiatives could combine public and private input and resources to start new business, scale-up existing ones, or design climate projects. This park led to the creation of 5 000 new jobs in the region (Harrahill and Douglas, 2019[79]; World Resources Institute, 2021[86]).

Putting education at the centre of long-term employment allowed the Ruhr area to become a frontrunner in renewable energy production and green industry technology. In the 1960s and 70s, there was a common belief that the Ruhr *"*did not need brains, it required muscle" (Galgóczi, 2014[87]). Between 1990s and 2014, large-scale investment in education, especially aimed at youth changed this image. The Ruhr area exploited its large urban population to create a knowledge hub for the chemical and green industries. By 2014, the Ruhr area had 22 universities with more than 250 000 active students. The large investment was very successful in creating a high skilled workforce that built an innovation-led economy, attracting companies and new employment (Institut Arbeit und Technik, 2019[84]).

Investment in education was supplemented by regulation and subsidies encouraging the development of innovative industries. As early as the 1970s, the German administration tightened laws on environmental policy. This caused the dominant industrial employers of coal, steel and chemical production to take an interest in environmental innovation. In the early 1980s, policy makers made broad investments in infrastructures to avoid mass outmigration and large-scale human capital flight. Investments were made in cultural development to maintain the Ruhr identity, urban and rural planning, ecological preservation for recreational use, and transportation infrastructure (McMaster and Novotny, 2006[88]; Harrahill and Douglas, 2019[79]; Institut Arbeit und Technik, 2019[84]).[15] This boosted innovation and support R&D, which matched with the newly available high skilled workforce. Moreover, it avoided employment in technological development from being outsourced, thereby allowing for a boom in employment in the environmental industry. Now, the Ruhr area employs more workers in environmental related jobs than in the coal and steel industry, which became almost irrelevant (Institut Arbeit und Technik, 2019[84]). Together

these policies managed to relocate 80% of workers into new industries and kept the unemployment rates low (Galgóczi, 2014[87]).

Social dialogue at the regional and community level became a cornerstone of adjustment policy. In Germany, the boards of all major industrial firms must comprise 50% employers and 50% employee delegates, which gives workers a strong voice in the gradual downscaling of employment (Abraham, 2017[83]; Galgóczi, 2014[87]). Agreements between workers and employers led to positive outcomes for communities. Collaboration between national and local government led to a widely supported plan for transitioning out of coal. Local communities, regional government, and local stakeholders have an active say in how to allocate investment to boost economic growth (Institut Arbeit und Technik, 2019[84]; Harrahill and Douglas, 2019[79]).

Thanks to the lessons learned from the coal transition, the Ruhr area is a frontrunner in the green transition. In the Ruhr area, the production of heavy industry products is still largely concentrated. In line with the net zero 2050 goals, the regional government has announced plans and investment schemes to turn this production green. Challenges faced in the Ruhr area to achieve net zero 2050 are tackled using a multi-stakeholder approach. New plans have been developed to create the world's first net zero steel and aluminium industries, avoiding carbon leakage. Contributing to the success in this plan is cooperation, as well as an ambitious and clear industrial strategy (Institut Arbeit und Technik, 2019[84]).

Box 3.5. Institutional and social capital, and investment in infrastructure, determined the success of some counties in the Appalachia region, United States.

The Appalachia region in the US has been a major coal-producing area for almost 200 years, but today less than 6% of the former employment in coal remains. At its height in 1919, coal mining employed more than 800 000 workers directly. The decline of the coal industry exposed many communities to challenging shocks. Populations in Appalachia were often aware of the transition process that their communities faced. Yet, "coal culture" and occasional promises to bring back coal made many deny and reject this reality and slowed the adjustment process. Economic readjustment was complicated by three factors: (i) the large degree of geographic remoteness, (ii) the dearth of alternative economic opportunities, and (iii) the high share of vulnerable population with low educational attainment.

Transitioning has proven to be extremely challenging in Appalachia; however, a few counties were nevertheless successful. A study conducted comparing the economic outcome of 222 mining dependant counties concluded that only four managed to successfully transition out of coal

Successful policy of those counties in Appalachia was built on institutional and social capital, and investment in infrastructure. Counties with high institutional capacity managed to transition more successfully whilst counties that lack institutional capacity were actively hampered in their progress. Furthermore, social capital and strong inter-group relationships within a county was found to increase resilience and lesser experienced degrees of negative impacts on quality of life. The combination of local institutional capacity and social capital allowed successful regions to design, finance, and implement economic development programmes. Investments in infrastructure have helped successful counties increase connectivity to metropolitan areas and manufacturing chains while increasing economic opportunities from larger urban centres for example by means of tourism, recreational opportunities, and affordable housing.

Sources: (Haggerty et al., 2018[89]; Douglas and Walker, 2017[90]; Deaton and Niman, 2012[91]; Lobao et al., 21[92]) (World Bank, 2022[13]; Carley, Evans and Konisky, 2018[93]) (Besser, Recker and Agnitsch, 2008[94]).

Box 3.6. Reduce the impact of the closure of a coal powered plant in the Netherlands

In order to limit the negative effects of the closure of the *Hemweg* coal-powered plant, stakeholders and social partners together designed the *Westhaven arrangement*, which was a comprehensive plan to guide the 1 500 employees who lost their jobs as they sought new jobs and avoid unemployment.

In 2018, the Dutch government announced the early closing of a coal power plant. As a result, many employees faced job losses much earlier than anticipated. Unions protested the decision and called for a comprehensive work-to-work scheme to leave no one behind. External research concluded that the closure of the *Hemweg* power plant would cause job losses for 1 500 workers in and around the power plant. Unions and the responsible ministry agreed that new work for those affected was a prerequisite to the closure.

When this agreement was signed, the *Mobiliteitscentrum Kolenketen Westhaven* (MCKW) was developed by a wide range of stakeholders including (i) FNV, the largest union representing the workers, (ii) Vattenfall and OBA Bulk Terminal, the largest employers, (iii) The Ministry of Social Affairs and Welfare, and (iv) UWV, the national unemployment agency. The Centre cooperated with workers to identify new career opportunities and the two biggest employers offered new employment for many workers whilst others indicated a desire to change to a new sector. For those staying in the industry but changing function, the MCKW provided the necessary reskilling courses. Simultaneously, those leaving the industry participated in re-skilling programmes offered by the MCKW to make it easier to find employment in a new industry. The budget used for this initiative was EUR 22 million *(Kamerstukken II 2018/2019, 35 167)*.

Building on experience obtained during the closing of the extraction industry in the south of the Netherlands, the income support programme was enlarged to include income support for affected workers struggling to find a new job. Workers received, for three years, 100% income support in case of unemployment, underemployment, or employment, which led to lower income. This allowed people to take the time to upskill or re-skill and find decent work. As a result, already in 2020, the vast majority had found a job.

Source: Research Institute Bureau&Beleid in Parliamentary documents of the Dutch Government. Kamerstukken II 2018/2019, 35 167, pp. 1-2, Parliamentary documents of the Dutch Government. Kamerstukken II 2018/2019, 35 167, pp. 2-3. Kamerstukken II 2018/2019, 35 167, p. 6. Government letter informing parliament about the progress in the "Westhaven Arrangement": Stand van zaken Westhavenarrangement | Kamerstuk | Rijksoverheid.nl.

Conclusion

Past transitions can provide insight into how to handle economic readjustment in regions that are strongly impacted by the green transitions. Past transitions have forced regions and communities to diversify their economic models. In this regard, they bear many similarities to the green transition.

Successful policies mostly used a bottom-up approach, encouraged social dialogue, were proactive, monitored both the demand and the supply of skills in a region, and exploited niche industries and local comparative advantages. Other success drivers included investment in resilience through initial education and vocational skills and training courses and ensuring that clear and ambitious policy is communicated and shared by stakeholders at all levels of government. General investments to increase the attractiveness of a region also help avoid the outmigration of the working-age population.

Apart from the similarities, there are also differences between the past and the current green transition. Most importantly, the current green transition is policy-driven, which allows policy makers to take better control of the supply and demand effects in labour markets and draft proactive plans to ensure optimal outcomes are achieved.

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Notes

[1] Between 1995 and 2018, the value of exports increased from 19.3% to 30.1% of GDP in OECD countries, before falling during the COVID-19 pandemic (OECD, 2022[73]).

[2] Recently, the OECD has studied good policies to manage megatrends (OECD, 2019[6]).

[3] Arguably, due to the war in Ukraine and spiralling energy costs and the wider availability of increasingly cheaper renewable energy sources, the green transition is becoming, at least partially, also market driven.

[4] Mobile data usage in the OECD quadrupled whilst the average cost of mobile data went down by 60% between 2013 and 2019. Furthermore, in regions in nine different OECD countries, 5G has been available since 2020 (OECD, 2020[24]).

[5] Data from the US shows regional discrepancies in the degree of digitalisation. On a scale from 1 to 100, District of Colombia scored 51 points whereas Nevada only scored 41. Moreover, large-metro areas differed from 47 in San Jose to 36 in Las Vegas. This showcases a sharp divide in the degree of digital integration between regions. The higher a region scored in 2002 data, the more likely it was to record larger increases in digital integration by 2016 (Muro et al., 2017[20]).

[6] A survey of German steel workers found that 77% of workers thought that digitalisation is leading to new forms of stress. Further research conducted for the good work index of the German Trade Union Confederation (DGB) reported that “work intensification was strongly associated with the level of digitalisation.” About 60% of workers in highly digital environments reported higher levels of stress and time pressure (Haipeter, 2020, p. 245[35]). Similar results were found for working conditions (physical and mental workload), job intensification, stress and work strain, working time, autonomy, stress generated by overtime working, and lastly ergonomic problems.

[7] An explanation for the automation of mid-skills ranged jobs is the cost efficiency of replacement. High-skilled jobs are often too complex to automate, whilst low wage jobs are not cost efficient to replace. This would also suggest that were wages in low paid industries to increase, by for example a minimum wage, the odds of them becoming automated would increase.

[8] In the gig economy, workers offer a service on an online platform. The price of this service is often established by curves of supply and demand. In this manner a relationship is established between the worker or supplier, the buyer, and the platform as an intermediary.

[9] A survey in 14 OECD countries reported that only 10% of workers had ever used a platform, 8% used it frequently and less than 6% used platforms to earn over 25% of their income (Warhurst and Hunt, 2019[22]).

[10] The vast majority of research expects growth; however, some recent research suggests that growth will soon plateau, and that platforms will shrink after such work is regulated.

[11] Basic digital skills are things like typing in Microsoft Word, sending an e-mail and browsing the web.

[12] In it were the City of Oulu, the University of Oulu, Applied University of Oulu, State Technological institute and Technopolis.

[13] Founded by the City of Oulu.

[14] As a response, the German government developed the Ruhr Action Program (Harrahill and Douglas, 2019[79]).

[15] The investments were made as part of the Ruhr Action Programme with a budget of DM 6.9 billion.

4 Locally relevant actions for green jobs and skills

This chapter examines how local skills systems need to adapt to enable a green transition and, at the same time, deliver it in a socially just way. The chapter focuses on four skills policy dimensions that complement local economic development efforts and are vital to achieve these goals. First, it lays out strategies for building effective green skills coalitions through improving collaboration across government and beyond. Second, it discusses the importance of sound regional labour market intelligence that reflects the impact of the green transition. Third, it offers recommendations on tailoring local adult learning systems to produce green skills and talent. Fourth, it examines the role of Public Employment Services in their local actions to promote a just transition that supports displaced workers and other vulnerable groups.

In Brief

National and local governments need to step up efforts to ensure that local skills systems are ready to enable a green transition and deliver it in a socially just way

- **Skills and labour market policies need to keep up and be well-aligned with environmental regulations.** So far, environmental policies, which drive the demand for green skills, have typically been developed in isolation from skills and labour market policies, which drive the supply of skills. This needs to change (i) to help ensure that workers who are negatively affected by the green transition are not left behind, and (ii) to avoid green skills shortages that could hinder the achievement of climate goals. Alignment of these policy areas requires close collaboration between the responsible ministries.
- **Local and national governments need to develop a forward-looking and comprehensive adult learning strategy to help workers acquire skills required in a green economy.** That includes a systematic review of educational curricula to reflect the shift in skills demand, driven by the green transition. In addition, tailored training offers may be needed in sectors and regions most affected by the green transition – both those that face displacement of a significant share of workers, and those that are at the forefront of the green transition. Given that a high share of adult learning happens at the workplace, policy makers should also support and incentivise employers to up-skill and re-skill staff.
- **Public Employment Services (PES) have an important role to play by supporting vulnerable groups to support a just green transition.** Workers in polluting jobs, who tend to have lower educational attainment and hold medium-skilled occupations, will be the most negatively affected by the green transition. Supporting these workers early on through a tailored mix of career guidance, training, and income support maximises chances of re-employment and helps to reduce social resentment. At the same time, it is important that the services offered by PES overall reflect the impact of the green transition. Without that, unemployed individuals are less likely to benefit from the employment opportunities brought on by the green transition.
- **Local skills systems can only be effective if they are based on timely labour market intelligence that is aligned with policy use.** To achieve that, assessments of skills needs would ideally (i) reflect the impact of environmental regulation on skills demand, (ii) be available at a sufficient level of sectoral and regional disaggregation, and (iii) be developed with data users. In regions with a high share of polluting jobs, additional analysis of the characteristics and skills of workers at risk of displacement may be needed.
- **The impact of the green transition will differ across regions, which amplifies the role of local governments and stakeholders.** Engagement of regional and local governments can help officials design policies tailored to local needs. Local governments are also well-placed to act as initiators of local skills coalitions that improve the design and delivery of local policies and secure public buy-in for the green transition.

Introduction

The green transition will have a profound impact on local labour markets, requiring some workers to switch jobs and re-skill. Achieving the goals of the Paris agreement requires a shift towards less polluting and more resource-efficient activities. This process, referred to as the green transition, implies a transformation of the labour market. It will have profound implications for workers in polluting jobs who, without developing new skills, will be at risk of becoming unemployed. However, the need to master new skills goes beyond this group. Broader re- and up-skilling efforts are necessary, to avoid green skills shortages that could hamper the achievement of climate goals, especially in the context of unprecedented labour shortages in many OECD countries (OECD, 2022[1]).

This labour market shift is happening at a time when the world of work is already changing rapidly and many local labour markets are struggling to keep up. Technological progress, globalisation, and demographic changes are already putting pressure on people to change career paths and re-skill (OECD, 2018[2]; OECD, 2019[3]). The impact of these trends has a strong regional dimension. While over the past two decades a convergence in terms of per-capita GDP was observed across countries (especially in Europe), the within-country differences remained large or even increased (OECD, 2018[4]; OECD, 2022[5]).

If no action is taken, the green transition may deepen the divide across regions. Communities dependent on polluting jobs are most exposed to the negative impact of the green transition. These jobs are often geographically concentrated in large sites such as mining operations, refineries, and aluminium smelters. Such regions are often already underdeveloped with lower average income and skill levels (World Bank, 2022[6]). Furthermore, workers in polluting industries are often less likely to attend training courses (see chapter 2), and thus less likely to successfully reskill for the green transitions. Green-task jobs have been created in some pollution-intensive regions, yet places at the forefront of the green transition tend to be the ones that have few polluting jobs and are already well placed to manage the transition. This also corresponds to the finding that most green jobs are located in urban, capital-rich areas, with generally higher skill levels (see chapter 2). As green jobs are generally better paid and polluting jobs face high risk of disappearance, non-intervention could potentially worsen existing divergence between regions.

Local skills systems are already struggling to keep pace with changing labour market needs. National and local governments need to step up their efforts to help people seize green employment opportunities. The extent to which economies can benefit from, and deliver, the green transition will depend on the pace at which the labour force can develop new skills. Active engagement will be necessary from (i) workers - updating their skills, (ii) employers - offering learning and internal mobility opportunities to workers, and finally (iii) public actors – supporting the occupational and sectoral transitions in the labour market (European Commission, 2021[7]). An important challenge for the coming years is to ensure that skills systems, which are already under pressure, have the capacity to support the green transition. In the last decade, training participation has not kept up with the rapidly changing demand for skills (OECD, 2018[8]). Those who needed training the most were the least likely to get it (OECD, 2022[9]). Therefore, policy makers face a two-pronged challenge. They need to strengthen the overall capacity of the skills systems and, at the same time, ensure that they are ready to respond to the impact of the green transition.

The green transition is largely policy- rather than market-driven, which calls for decisive policy responses, including rapid implementation of skills policies. The increasing demand for green skills is mainly a result of environmental regulations. This means that labour market changes may be more abrupt than in the case of other, market-driven transitions, where new technology is adopted gradually and demand evolves more smoothly. Therefore, policy makers need to act faster to ensure that the environmental regulations are accompanied by appropriate skills policies.

For skills policies to be effective, they will need to be tailored to local challenges and opportunities. Regions with a high share of polluting jobs at risk of displacement will require policies that support the creation of new employment opportunities and a smooth reallocation of workers from declining to emerging industries and occupations. This should include programmes to increase green skills to reap the benefits of the green economy (OECD, 2017[10]). In contrast, regions with a high share of green jobs will need to invest in development of green skills to avoid potential labour market shortages as demand grows and allow further growth of their green task job market. In general, policies should be geared towards viewing the green transition as an opportunity, and appropriate skills systems and incentives for green businesses should be put in place to attract new, green investment.

This chapter examines how sound skills and labour market policies can prepare regions for the impact of the green transition on the local labour market. It first examines two cross-cutting issues that form the basis of an effective skills response: (i) multi-level and multi-stakeholder collaboration, and (ii) labour market intelligence. Subsequently, the sections focus on the two main policy pillars of a systemic response to the skills needs created by the green transition: (iii) adult learning, and (iv) Public Employment Services.

Building green skills coalitions

Collaboration across ministries is needed to coordinate environmental and labour market policies

Alignment of environmental and labour market policies is critical to avoid skills mismatches and shortages. The green transition is largely policy - rather than market - driven. Regulations and incentive schemes introduced as part of energy and environmental policies were found to be a major driver of demand for green occupations and the corresponding skills (Cedefop, 2012[11]). In other words, governments have considerable control of the levers that stimulate skills demand during the transition. That implies (i) greater responsibility for policy action, but also (ii) better predictability of sectors and regions that will be affected, which allows forward-planning, retraining, and setting up redistribution mechanisms (OECD/Cedefop, 2014[12]).

Alignment of environmental and labour market policies requires effective collaboration across ministries. In most countries, the part of the government responsible for stimulating green skills demand is separate from the part responsible for skills and labour market policies that influence supply. Weak connections between these bodies are a common feature of institutional setups. As a result, environmental policies are often designed in isolation from skills and labour market policies, and do not take into consideration skills availability and labour market implications (Cedefop, 2019[13]).To ensure that supply and demand policies go hand-in-hand, ministries and bodies responsible for both policy areas need to work closely together.

There are some good examples of coordination of environmental and labour market policies. In France, in 2007 the government initiated the *Grenelle de l'environnement*, a multi-party debate on public

policy related to environmental and sustainable development. These roundtables involved representatives of national and local governments, trade unions, representatives of employers, and non-governmental organisations, who participated on an equal footing (Cedefop, 2019[13]) and designed a comprehensive strategy to prepare the workforce for the green transition: the *National Mobilisation Plan for Green Jobs* (see Box 4.1). In the Netherlands, numerous ministries and other stakeholders jointly developed *the Action plan on green and digital jobs,* which aims to address labour shortages identified as a barrier in the green transition (see Box 4.1). In Spain, the Ministry of Ecological Transition and the Ministry of Labour, Migrations and Social Security - together with affected employers and trade unions - signed an *Agreement for a Just Energy Transition for thermal power plants in closure* (see Box 4.15).

Box 4.1. Collaborative approach to supporting the green transition in France and the Netherlands

The French National Mobilisation Plan for Green Jobs

In 2009, France launched a National Mobilisation Plan for Green Jobs bringing together a wide range of stakeholders to anticipate, support and accelerate the green transition. The plan entails (i) analysing the impact of the green transition on occupations and skills they require, (ii) sharing statistics, (iii) updating existing training programmes and qualifications to meet environmental challenges, and (iv) creating new qualifications where necessary.

Initially, the mobilisation plan focused on eleven sectors deemed most promising in terms of green jobs creation, e.g., automotive industry, construction, renewable energy.[1] For each sector a committee in charge of analysing the sector's skills and training needs was created. The work was gradually extended to cover other sectors, such as finance, trade, and distribution.

The mobilisation plan takes a collaborative approach. The steering group includes representatives of relevant ministries, social partners, chambers of commerce, local authorities, bodies concerned with training, Public Employment Services, and a research centre. The subnational angle is taken into account. Regional agreements were signed between the Ministry of Environment and four pilot regions, Alsace, Corsica, Nord-Pas-de-Calais and La Réunion, to analyse the impact of the green transition on occupations and training needs from a regional perspective.

The Dutch Action Plan for Green and Digital Jobs

The Action Plan on Green and Digital jobs is a response of the Dutch government to labour shortages identified as a barrier in the green transition. The combined plan to tackle the green and digital transition reflects the Dutch government views these two megatrends in tandem rather than as stand-alone developments. The government anticipates that shortages in both green and ICT skills could significantly slow down efforts to reach the country's 2030 and 2050 climate goals.

To address these shortages, the Dutch government is working with many stakeholders and government bodies. At the inter-ministerial level, the ministries of Education Culture and Science, Economic Affairs and Climate, and Social Affairs and Wellbeing are involved. Regional governments, municipalities and representatives of the private sector participate in stakeholder input meetings.

Note: [1] The full list includes: agriculture and forest industries; automobile industry; biodiversity and ecosystem services; construction; electromechanics, electric construction and networks; fuel and "green" chemistry; renewable energies; maritime trade; transportation; tourism; water, sanitation, waste and air.
Source: (Cedefop, 2019[13]) (ILO, 2011[14]) Brief van de ministers van Economische Zaken en Klimaat en voor Klimaat en Energie Nr. 1120, Inzet op arbeidsmarktkrapte voor de klimaat- en digitale transitie.

Vertical collaboration helps address the differential impact of the green transition across regions

Local and regional governments are often already involved in skills and labour market policies, although the level of responsibilities differs. Many models of local and regional engagement in adult learning exist. Some have limited responsibility or operate on an ad hoc basis only (9% of respondents). Others have limited legal responsibilities but actually operate beyond their legal competences (22%). The most engaged models take a leading role in designing and delivery of adult learning systems (25%).[1] Around nine out of ten cities and regions allocate a portion of their budget to adult learning. In short, while the level of responsibility differs, in most OECD countries there is at least some regional or local role in education and training systems (OECD, 2022[9]).

The geographical differences in the impact of the green transition will increase the importance of engaging regional and local governments in skills and labour market policy. The disparities in terms of availability and quality of employment opportunities and skills across local labour markets, which exist in all OECD countries, call for a tailored approach to local challenges and strengths (OECD, 2016[15]). Environmental policies may result in further divergence across regions – leading to job losses in some regions and skills shortages in others – magnifying the need for targeted interventions. Place-based policies could be, in principle, designed at the national level. However, engagement of local governments can improve their effectiveness. Firstly, local governments are typically more familiar with local labour market needs and priorities. Secondly, designing selected services at the local level may give more space for experimentation with innovative approaches optimised to local needs. Thirdly, local governments are well-placed to act as a centre and initiator of local skills coalitions (OECD, 2022[9]). Therefore, engaging local and regional governments in skills and labour market policies can improve the effectiveness of responding to local skills needs, including those driven by the green transition.

The role of regional and local governments in the green transition goes beyond skills initiatives and includes other local economic development efforts such as investment in infrastructure. For example, in the European Union municipalities are responsible for around one-third of all public investment. Many municipalities are already taking action to address climate change and increase environment sustainability. These efforts are, however, less common in less developed regions. While municipalities in less developed regions have ambitious plans that could push their green transition to the same level as developed regions, they face barriers to implement them. Among the main obstacles to deliver the investment plans is limited access to expert knowledge and lack of right skills. For almost 70% of municipalities lack of environmental skills is a barrier to investment. This barrier is more prevalent in less developed regions (EIB, 2023[16]).

The engagement of regional and local governments in skills and labour market policies and local economic development efforts for the green transition, calls for effective collaboration across levels of government. Vertical collaboration helps ensure that the government as a whole sends a coherent message. It informs the national government about the specific skills needs in the local area, and at the same time, helps regional actors understand and support national policies. In addition, collaboration encourages exchange of local experiences and helps build capacity at the local level (OECD, 2022[9]). Finally, it creates a sense of ownership, which supports policy implementation (OECD, 2020[17]). Overall, developing effective mechanisms for collaboration across the levels of government can make policies more coherent and effectively implemented.

Regional and local governments could also consider forming partnerships with other cities and regions that are affected in a similar way by the green transition. Governments can pool resources, benefit from economies of scale when developing services (OECD, 2022[9]), and increase their leverage with national governments and cross-national institutions. For example, the European Committee of the Regions initiated the Automotive Regions Alliance, which brings together regions in the EU committed to a successful green transition of the automotive and supply industry. The Alliance aims to establish a

European mechanism to support a just and successful transition of the automotive and supply industry regions, including through streamlining various funds. It intends to undertake a territorial impact assessment, support reskilling and upskilling of the workforce, and advocate measures that promote the use of electric and low-carbon vehicles through public procurement and improved accessibility of refuelling and recharging stations (European Committee of the Regions, 2022[18]).

Engagement of training institutions, PES, and social partners can inform policies and facilitate their implementation

Engagement of local stakeholders can help design better-informed responses to the green transition and secure buy-in from labour market actors. Firstly, collaborative approaches bring diverse expertise to the table. The involvement of training institutions and PES in policy design helps address implementation challenges observed on the ground. Strong linkages with employers promote services and curricula that are demand-driven and meet employers' needs (OECD, 2022[9]). This is especially important at the early stage of the green transition, when collaboration with firms can fill information gaps about new tasks and skills needs. Moreover, collaborative approaches help promote buy-in from labour market actors (OECD, 2019[19]). Involvement of training institutions and PES, from policy development to implementation, strengthens their sense of ownership, which facilitates the implementation of policies. Bringing employers on board can raise their awareness of environmental regulations and increase their investment in up-skilling their workers. Finally, engagement of social partners reduces the risk of triggering the feeling of anger and resentment, and instead, helps secure buy-in from employers and workers for actions required to protect the environment.

Governments take different approaches to including stakeholders in developing a response to the green transition. Some governments have focused on employer engagement. In the United Kingdom, the role of employers in addressing the growing demand for green skills has been emphasised in the national skills strategy. A "skills for a green economy" group composed of sector skills councils was established as a measure of supporting green skills development (Cedefop, 2019[13]). In Korea, two skills councils focused on the green economy were created: one on the renewable energy sector, and the other one on green industry trends, risk analysis and green finance (ILO, 2011[14]). Other initiatives focused on engaging a broader range of stakeholders. Examples include Centres of Vocational Excellence, which was established to deliver high quality vocational education in the EU and the TRACER programme, which supports the transition towards sustainable energy in nine coal-intensive regions in Europe (see Box 4.2).

Box 4.2. Engaging local stakeholders in the implementation of the green transition in Europe

Centres of Vocational Excellence in the European Union

Centres of Vocational Excellence (CoVE) are networks of partners that develop local "skills ecosystems" to deliver high quality vocational education. They take a bottom-up approach by involving a wide range of local stakeholders that share a common interest in (i) specific sectors or industrial ecosystems, (ii) innovative approaches to tackle economic and societal challenges, or (iii) innovative approaches to increasing the outreach, quality, and effectiveness of CoVE.

CoVEs have been involved in developing a vocational training response to the green transition:

- *CoVEs on Urban Greening established by the European Platform for Urban Greening (EPLUG):* this initiative aims to improve collaboration between VET, Research & Development institutions and employers to develop high quality curricula and qualifications focused on urban greening skills. To achieve that goal, EPLUG intends to establish 6 CoVEs, develop a training offer for VET teachers, and prepare innovative curricula in the field of urban green landscaping.
- *CoVEs on green economy established by 3LoE:* this initiative aims to upgrade skills of young professionals and entrepreneurs and strengthen the competitiveness of SMEs in the green economy. To this end, CoVEs plan to implement a dual vocational training through partnership with companies and support the development of the green skills of SME professionals and managers.

One of the important drivers of success of CoVEs is that they are based on strong and enduring relationships between stakeholders, including providers of vocational education and training, universities of applied sciences, employers, research centres, development agencies, and PES.

TRACER programme that supports a collaborative approach in nine coal regions

TRACER is a programme that supports former coal regions in establishing collaborative governance of their transition towards sustainable energy. The programme is currently active in nine regions in Europe.[1] At the core of the programme is the objective of getting all relevant stakeholders to agree on a common vision and priorities for diversification and energy transition. Based on the mandate obtained from the national and regional government, TRACER sets up a board of stakeholders including employers, trade unions, PES, training institutions, research and innovation institutions, universities, and experts.

Note: [1] Southeast BUL, North West Bohemia CHR, Lusatia region GER, Jiu Valley ROM, Kolubara region SER, Upper Silesia POL, Wester Macedonia GRE, Donetsk Region UKR, Wales UK.
Source: Centre of Vocational Excellence: description of the network; website of the European Platform Urban Greening, website of 3LoE; Analytical report on the outcomes of the mobilisation process in TRACER target regions. TRACER Best practice report on labour markets, social issues and tourism.

Using data to avoid green skills mismatches and shortages

Timely and reliable labour market information helps labour market participants make better decisions and allows policy makers to design more effective policies

Rapid labour market changes, driven by the green transition and other megatrends, mean that timely and high-quality information about skills supply and demand is needed now more than ever. Fast changes in the world of work, which affect the skills required in the labour market, could shape the coming "reskilling revolution" (World Economic Forum, 2021[20]). The green transition will further accelerate the pace with which workers need to adapt their skills. While there are various policy tools that can support this process, they will only be effective if labour market participants and policy makers know: (i) what skills are available in the local labour market, (ii) what skills are in demand, and finally (iii) how local skills demand will change in the future to anticipate reskilling needs. In addition, effective mechanisms and procedures need to be in place so that such information feeds into policymaking, career guidance, content of training, and individual education and career choices (OECD, 2018[8]).

Timely information can guide choices for students, workers, and employers and reduce the risks of skills mismatches and shortages. For skills demand to match supply, workers can adjust their career choices and training decisions, and firms can adapt production processes through their investment decisions and HR policies (Hartog, 2000[21]) (Cedefop, 2021[22]). However, such a supply/demand equilibrium assumes that workers and employers have perfect information about skills requirements. Without timely and precise labour market information, this is less likely to happen - students, workers, and employers will make sub-optimal choices leading to skills mismatches and shortages. For the economy, this means (i) lower productivity growth resulting from slower technology adoption, (ii) lost production due to unfilled vacancies, and (iii) unemployment (OECD, 2016[23]).

Training providers and policy makers also need timely and reliable labour market intelligence to put in place policies and services that enable the green transition. Identification of current and future skills imbalances supports training providers and policy makers responsible for education, employment, and migration. For example, in education policy, skills-needs information feeds into the design of career guidance and curricula and helps decide which programmes to promote. In employment policies, skills-needs information helps design and target active labour market policies offered by public employment services. Finally, in some countries, skills needs information is used in migration policy, to identify migrants that possess skills in high demand and fast track their application (OECD, 2016[23]).

To support a just green transition, it is also critical to develop a better understanding of the characteristics of workers at risk of displacement due to the green transition. The cost of the green transition will be unequal across workers (see Chapter 2). Individuals at high risk of displacement are

predominantly male, have lower educational attainment and medium-skill levels. They also tend to have lower training participation rates than other workers. To provide them with effective support in transitioning to other occupations and sectors, the responsible agencies will need detailed information on their age, educational attainment, work experience, skills, employment barriers and income.

Box 4.3. National Observatory for Jobs and Occupations of the Green Economy in France

France established a National Observatory for Jobs and Occupations of the Green Economy (Onemev) in 2010. Onemev aims to monitor the sectoral and macroeconomic impact of the green transition, with special attention to its implications for jobs and skills. It also develops relevant methodologies and produces statistics (OECD, 2016[23]).

Onemev has a strong collaborative approach, bringing together a broad range of institutions, including representatives of the National Statistics Office, Ministry of Ecology, Public Employment Services, institutions in charge of adult learning, regional labour market observatories, and research units and institutions ((Cedefop, 2018[24]) (Onemev, 2020[25])). It also engages with individual institutions on specific projects (European Commission, 2021[7]) (OECD, 2016[23]).

One of the first responsibilities of the observatory was to arrive at a commonly accepted definition of green and greening occupations. Onemev is also responsible for providing forecast and statistics on the impact of the green transition on the jobs, tasks, and education needs. In addition, the observatory identifies required competences and appropriate reskilling/upskilling programmes to facilitate the transition (BusinessEurope, 2021[26]).

Skills-needs exercises could be improved to inform the transition towards a green economy

Skills assessment and anticipation exercises need to reflect the impact of environmental regulations on the labour market

Skills assessment and anticipation (SAA) exercises do not always account for the impact of environmental policies. Virtually all OECD countries collect information on current and future skills needs by carrying out SAA exercises (OECD, 2016[23]). However, SAA exercises often do not reflect the impact of environmental policies on the labour market. Ad hoc plans and strategies on green jobs and skills, including future forecasts, seem to be a feature of the policy landscape (Cedefop, 2019[13]). Due to the lack of well-established classifications and measurements of green jobs, many countries rely on qualitative information (ILO, 2011[14]). However, there are also examples of systematic quantitative analysis of the impact of the green transition on skills and occupations, such as the work of the National Observatory for Jobs and Occupations of the Green Economy in France (see Box 4.3).

Reflecting the impact of the green transition in regular SAA exercises and occupational classifications, rather than studying it in isolation, helps take into account the interactions between labour market trends. The green transition is happening in parallel with multiple other trends affecting current and future skills requirements. These trends can overlap or interact (e.g., the green and digital mutually reinforcing 'twin transitions' (Muench, 2022[27])), and therefore, they cannot be studied in isolation. Instead, dynamic economic system models, such as dynamic general equilibrium models, which reflect the impact of the green transition and other megatrends, are needed (OECD, 2017[10]). Occupational classifications also need to be updated to account for the changing skills and educational requirements in occupations affected by the green transition. Without that, the results of SAA exercises will not reflect the new skills required in the existing occupations and in new occupations created by the green transition.

Labour market information must be sufficiently disaggregated at sectoral and regional level

An important barrier to designing policies based on skills-needs information is the insufficient granularity of available data. National-level data can be useful in designing broad training policies and monitoring labour market dynamics. However, they may hide large local shortages and mismatches or mask the specific skills needs of regions and sectors (Shah, 2005[28]) (OECD, 2022[9]). Even before the green transition, there was evidence of region-specific labour market shortages and mismatches (OECD, 2016[23]) (OECD, forthcoming[29]). Policy makers across the OECD emphasise the need for more disaggregated data. Two-thirds of Ministries of Labour and Education in the OECD countries indicated insufficient disaggregation of results as the most constraint in effectively using SAA information for policy (OECD, 2016[23]).

Significant differences in the impact of the green transition across sectors and regions magnify the need for disaggregated information on skills demand and shortages. At the aggregate level, employment growth is forecast to be higher by 2030 than if the European Green Deal emission target was not met. The expected 1.2% additional employment by 2030 associated with meeting the EGD targets translates into approximately 2.5 million additional jobs in the EU (Cedefop, 2021[30]). However, this number fails to reveal significant differences across sectors. Employment in water supply and waste management is expected to increase by over 900 000, while in coke and refined petroleum, gas, steam and air conditioning, and mining and quarrying 286 000 extra jobs (on top of the baseline forecast) are expected to be lost (Cedefop, 2021[30]). While forecasts at the regional level are not available, there are initial signs of divergence across regions – the presence of polluting jobs that are likely to disappear is regionally concentrated and the share of green jobs in the labour market differs geographically (see Chapter 2). The variation in the impact of the green transition across regions and sectors underscores the importance of targeted education, training and skills policies, which requires sufficiently disaggregated data. In France, effort has been made to reflect the place-specific impact of the green transition through the work of regional observatories and targeted projects (see Box 4.4).

Box 4.4. Reflecting regional skills needs in the analysis of green jobs and skills in France

In France, a network of Regional Observatories for Employment and Training (OREFs) collects and analyses information on employment and training programmes at the regional level. OREFs have published studies on green jobs and skills needs. For example, the OREF for Provence, Alpes, and Côte d'Azur studied the number of people in green or greening professions in the region, as well as the gender and qualifications of employees in green jobs (OECD, 2017[31]) (Cedefop, 2019[13]).

France has also developed regional projects to analyse and anticipate skills needs. One example is ECECLI project (*Evolution des compétences emploi climat*), which supports ecological and energy transition in Ile-de-France. The project involved collaboration between representatives of the Ministries of Employment and Ecology, the regional authorities, and the Seine-Normandie Water Agency. The evolution of skills in 35 professions affected by the green transition was analysed. The study included new professions, such as ecologists specialised in the restoration of natural environments, and existing professions that will require new skills, such as bus drivers, to take just one example, who will have to master eco-driving (Cedefop, 2019[13]).

Data collection should be aligned with policy use

Better alignment of data collection with policy use can be achieved by including the users of SAA exercises in their development (OECD, 2022[9])**.** Skills are difficult to measure and they are, therefore, often approximated by the demand for occupations, qualifications (e.g., technical/vocational, university),

field of study, or, to a lesser extent, by the demand for some cognitive or non-cognitive skills (e.g., numeracy, literacy etc.) (OECD, 2016[23]). As a result, the information collected through SAA exercises is not always well-aligned with the potential policy use.[2] Linking SAA exercises to specific policies helps ensure that the approach taken to measure skills is well-aligned with the policy use but reduces its wider relevance (OECD, 2016[23]). One way of ensuring that the data collected through SAA are applicable more broadly, and at the same time, well-aligned with policy use, is through engagement of data users (e.g., regional governments, educational and training institutions, and PES) in the governance structure of SAA. A good example is the National Observatory for Jobs and Occupations of the Green Economy in France that brings together a variety of institutions to develop methodologies and produce statistics on the impact of the green transition on jobs and skills (see Box 4.3).

Including regional and local governments in the structure of SAA exercises is particularly important. Given the differences in the skills needs across regions, local governments often need to complement the countrywide labour market and skills policies with additional programmes tailored to local needs. Yet, so far, across OECD countries, only 41% of regional governments and 31% of regional development agencies are involved in the development of SAA exercises. Sub-regional governments are rarely involved - exceptions include Canada, Italy, and Portugal (OECD, 2016[23]), despite the fact that skills-needs exercises can ensure that the information collected meets their needs and is available at the appropriate level of disaggregation. Moreover, the regional angle helps reflect the differences in the labour market structure across regions, validate the results at the local level, and bring nuance to the conclusions reached. Finally, multi-level governance of SAA exercises may spur vertical collaboration on identification of policy targets and formulation of policy responses, making the local and national policies more coherent (see section Building green skills coalitions).

Targeted analysis of workers in polluting jobs and information about career transition pathways can help support workers displaced by the green transition

Targeted studies to identify the characteristics of individuals at risk of displacement due to the green transition can complement regular labour market intelligence. Carrying out such analyses in advance would allow Public Employment Services (PES) and other institutions to proactively target affected workers and tailor services to their needs, and as a result, reduce the risk of long-term unemployment. For example, in Germany, the Federal Employment Agency's research institute IAB carried out a study to identify the number and characteristics of workers at risk of displacement due to the coal phase-out. The results informed the development of a package of support offered by the PES (see Box 4.14).

Digital tools can help identify career transition pathways for workers in polluting industries. The green transition will require workers to transition into other occupations, sometimes across industries. The adjustment costs are significantly reduced if, in the new job, the worker utilises skills that they acquired in previous professions. Digital tools can help achieve that by identifying occupations with similar skills and comparable compensation. Efforts to develop such tools have been made by public and private actors, although the existing tools differ in their level of sophistication (see Box 4.5).

Box 4.5. Identification of career transition pathways for displaced workers: examples from France, the United Kingdom and the Netherlands

Pathways to occupational transitions, France

The Ministry for Ecological Transition and the Labour Ministry in France developed a tool that identifies five occupations at risk of displacement, and eight "green" and "greening occupations" together with eight pathways of occupational transitions. For each transition pathway, a comparison of tasks, competences, skills, qualifications, and wages are provided. The information is based on occupational profiles prepared by the French PES. The tool also includes an assessment of how challenging a transition is and information on whether training related to the new occupation can be found in the region/local area. The details of upskilling possibilities are left open, as they need to be designed and decided on a case-by-case basis (MEDDE, MFTEFPD, 2015[32]).

Mapping Career Causeways by Nesta, the United Kingdom

Mapping Career Causeways is a project that uses machine learning to create a map that captures similarities between over 1 600 occupations based on the skills and work activities that they entail. Based on the current occupation of the worker, the tool identifies "viable transitions", i.e., roles that require similar skills, education, and level of experience, as well as "desirable transitions" which is a sub-set of "viable transitions" that leads to jobs with comparable or higher pay. In addition, this tool can identify new skills that workers need to develop for a successful transition and skills that would expand their set of "viable transitions". While the tool was developed to help workers in jobs at risk of automation transition into other employment opportunities, an analogical method can be applied to workers at risk of displacement due to the green transition. The tool is still at an early stage of development and will be verified and tested in the coming years, but it is a promising approach to facilitating worker transitions across occupations and industries (Nesta, 2020[33]).

Passport4Work in Eindhoven, the Netherlands

Another approach to helping workers identify transition pathways is offered by Passport4Work, an online job matching platform aimed to alleviate skills mismatches by increasing labour market transparency and providing highly personalised and gamified online counselling. The tool engages jobseekers in a gamified assessment to build their "passport for work", an overview of their skills and attributes. Employers are guided in identifying the skills their company needs. This information is used for algorithm-based matchmaking. The platform relies on a collaboration of a wide range of stakeholders, including the regional administration, employment agency, and local university, among others (OECD, n.d.[34]).

Reskilling revolution: local adult learning systems and the green transition

The green transition magnifies the need for effective local adult learning systems

A green transition that benefits most workers requires effective and future-proof adult learning systems. The transition to a low carbon and resource-efficient economy, as well as the effects brought about by other megatrends, require a workforce capable of acquiring skills throughout their lives. After developing foundation skills during their initial education (see Box 4.6), young people consolidate them and test them in practice at the workplace. Subsequently, mature workers maintain and upgrade their existing skills, develop new skills, and certify the skills acquired on-the-job (ILO, 2010[35]). The last step, referred to as adult learning, becomes increasingly important in a rapidly changing labour market, in which the skillset gained through initial education quickly becomes insufficient or obsolete.

Effective and inclusive adult learning systems can help workers remain employable and productive throughout their careers, despite changing skills needs. If such systems are in place, the green transition can be delivered effectively and benefit most workers. Otherwise, skills shortages may hinder its implementation and inequality will likely increase.

Effective adult learning systems can become a comparative advantage that regions can leverage to attract investment from green businesses. While many factors are taken into account in firm location decisions, research shows that innovative capabilities and human capital play an important role (Crescenzi, 2018[36]). This is especially relevant in the context of the green transition as green skills are unequally distributed across regions and some of them are in short supply. Regions with an already high share of green jobs have a comparative advantage in attracting green investment given the availability of workers and other firms with which they can collaborate. Other regions can leverage their adult learning systems to attract investment by offering support in re-training and up-skilling for green jobs.

Many local adult learning systems need to be strengthened to help workers adapt to labour market changes that are beingdriven by the green transition and other megatrends. Across OECD countries, workers who need training the most are least likely to get it. These groups include the low skilled, older adults, displaced workers, as well as self-employed, part-time, and temporary workers (OECD, 2019[3]). Training rates also differ across sectors. Some sectors are heavily affected by the green transition. These include construction, wholesale and retail trade, and administrative and support services, where training rates tend to be relatively low (OECD, 2019[3]). Finally, training is not always of good quality or aligned with the needs of the labour market (OECD, 2019[3]). Therefore, there is a need to strengthen local adult learning systems so that they can support the green transition. Three pillars to focus on are: i) broadening access to adult learning offers, with a special focus on vulnerable groups; ii) getting employers on board to ensure training meets local labour market demand and employers' needs; and iii) putting in place strong governance systems that build synergies between adult learning policies and programmes and leverage the expertise of a broad range of stakeholders (OECD, 2022[37]; OECD, 2022[9]; OECD, 2021[38]).

Box 4.6. Initial education and the green transition

Initial education forms a foundation for future training and builds labour force resilience to the ongoing and future megatrends, such as the green transition. Initial education and training can provide learners with two critical skills (i) willingness to learn, and (ii) ability to learn. These two skills enable individuals to adapt to the new skills requirements throughout their working lives, making the workforce resilient to the green transition and future labour market trends that we cannot yet predict. Moreover, the green transition has, so far, been skills-biased, with most green jobs held by high-skilled and highly educated individuals. Other megatrends, such as technological change, also favoured workers with higher level of education and skills. If the net impact of the megatrends increases the demand for high-skilled workers, then a general policy to raise educational levels may be required (OECD, 2017[10]).

Education institutions can spark interest in developing green skills by raising environmental awareness. Many secondary schools already include the topics of climate change and global warming in the curricula – about 9 out of 10 schools (OECD, 2021[39]). For example, Sønderborg Municipality in Denmark developed a learning initiative called House of Science to attract pupils and students to science, while educating the wider population about climate issues, innovation and sustainability. The initiative was implemented through collaboration with the local utility company and the University of Southern Denmark and included educational courses and materials on the topic of sustainability, with a particular focus on encouraging girls to consider higher education in science (Global Opportunity Explorer, 2018[40]). To build links between the theoretical knowledge and practical implementation, education institutions can also engage learners through active participation in environmental issues in the local community. The benefits of raising environmental awareness go beyond encouraging eco-friendly behaviour and include helping students make study and career choices that are better aligned with the future green skills demand.

Action is needed to increase the interest in science and engineering to avoid exacerbating the deficit in technical skills that may hinder the "greening" of the economy. While more research is needed to understand which curricula should be promoted to support the green transition, there is evidence that the green economy is associated with higher demand for education in engineering, manufacturing, and construction, as well as, in natural sciences, mathematics and statistics (see Chapter 2). Major skills shortages are already well-entrenched in these fields. In computers and electronics, skills shortages are more acute than in all other knowledge domains. Significant skills shortages are also recorded in mathematics knowledge and engineering, mechanics, and technology (OECD, 2020[41]). These shortages are likely to be deepened by the green transition. Effective career guidance can challenge misconceptions that are often influenced by young people's social background (OECD, 2021[42]) and stimulate interest in the fields of knowledge required for a successful green transition. Education institutions can, for example, offer career advice that includes information about green career pathways, invite entrepreneurs and professionals employed in the green economy as guest speakers, and increase the number of apprenticeships and job shadowing opportunities in green jobs (UNEP, 2021[43]).

Extra attention should be paid to increasing the participation of women in fields of study required in the green economy, such as Science, Technology, Engineering, and Mathematics (STEM). There are large gender differences in the fields of study chosen in higher education. While women represent 58% of graduates in OECD countries, they constitute less than 25% of graduates in engineering, manufacturing, and construction and less than 20% in computing. Women are under-represented in these fields in almost all OECD countries (OECD, 2017[44]). The divergence is observed at a strikingly young age. Already at the age of 15, more than four times as many boys expect to work

in engineering professions (7.7% of boys and 1.8% of girls) (OECD, 2021[42]). This gender gap is also present among top performers in mathematics and/or science, where girls are less likely to see themselves pursuing a career in science and engineering in most OECD countries (Mann et al., 2020[45]). Increasing female representation in STEM is not only a matter of gender equality, but also a way to alleviate labour market shortages in green jobs. One reason for gender differences in this field of study are the stereotypes about the careers that are suitable for women and men. Research shows that parents are more likely to expect their teenage son than their daughter to pursue STEM occupations (OECD, 2015[46]). Such stereotypes are passed on to children by family, teachers, and society at large. See (OECD, 2014[47]) for examples of programmes to improve female participation in STEM.

How can local adult learning systems become enablers of a green future?

Developing a forward-looking and comprehensive strategy for local adult learning is the first step to tackle skills needs driven by the green transition

Tackling the changing demand for skills caused by the green transition requires a comprehensive strategy and a systematic review of local adult learning systems. Comprehensive strategies that explicitly address the changing demand for skills and lead to an extensive review of curricula are rare (Cedefop, 2019[13]). The existing plans and strategies that tackle green skills needs tend to be produced ad-hoc and focus on specific sectors and regions where skills shortages have already materialised. That results in reactive and fragmented training delivery. Existing initiatives that alleviate immediate needs could be complemented with a more structured and systematic approach that (i) builds synergies between the initiatives, and (ii) anticipates and responds to medium- and long-term needs. A good example of a comprehensive approach to greening adult learning, based on solid labour market intelligence, is found in France (see Box 4.7).

Box 4.7. Comprehensive strategy for greening adult learning in France

France has carried out a comprehensive review of curricula to reflect the changing demand for skills driven by the green transition. Since the Grenelle round tables in 2007, almost all curricula have been updated. An important enabler of the adaptation of vocational adult training to the green transition was solid labour market information produced by Onemev (see Box 4.3). Green skills have been adopted in training courses in two ways (Cedefop, 2018[24]):

1. First, general courses that increase awareness of environmental issues were developed. These training programmes are provided mainly to workers in jobs that are unlikely to be severely impacted by the green transition. They include good practises for the preservation of the environment.
2. Second, education programmes for workers in industries likely to be heavily affected by the green transition underwent significant adaptation. The objective was to change professional practises to ensure that they are in line with green transition objectives. This approach was applied to training in industries such as renewable energy, construction, agriculture, etc.

Some challenges were identified during the process. Even though the approach does not require a new training or training system, the adaption to curricula takes time, in some cases up to a year and a half (Cedefop, 2018[24]). Moreover, once the new curricula are ready, an important barrier to delivery identified in France is lack of competence on the side of trainers and training institutions.

Prioritisation of sectors heavily affected by the green transition and development of sector-specific programmes can be an effective way of adapting adult learning systems. While nearly all sectors are impacted by the green transition and a comprehensive strategy to adapt adult learning is needed, the extent to which sectors are affected differs (see Chapter 2). That calls for prioritisation of sectors at the frontier of the green transition and those threatened by it (Cedefop, 2021[30]). Moreover, sectors differ in the type of training that needs to be offered. For example, while the shift to clean energy is expected to drive demand for mining rare earths, overall, in mining, the transition to net zero calls mainly for mobility-oriented re-skilling that allows workers to shift into other occupations and sectors. In contrast, the construction sector, which is expected to grow, will mainly require up-skilling and re-skilling of existing and new workers (ILO, 2019[48]). Finally, sectors face different challenges in terms of how training is delivered. For example, construction is increasingly fragmented through self-employment and subcontracting (Cedefop and OECD, 2022[49]). Micro and small enterprises, which represent 99% of firms in the construction sector, tend to have limited capacity and resources to offer work-based learning, which presents a significant challenge for adult learning in the sector (Cedefop and OECD, 2022[49]). For these reasons, the sectors most affected by the green transition must be given priority. A tailored adult learning offer must reflect the specific needs of the sector. In Denmark, this is achieved through the involvement of National Trade Committees, which represent sectors, in the revision of training and qualifications. Another example of a sectoral approach is the Ecobuild.brussels cluster of firms in sustainable construction and renovation initiated by the Brussels-Capital Region in Belgium (see Box 4.8).

Box 4.8. Examples of sectoral approaches to adapting adult learning from Denmark and Belgium

Sectorial Trade Committees in Denmark

In Denmark, The Ministry of Education is responsible for approving VET certificates and implementing rules for quality control. The ministry is guided by the recommendations from the Advisory Council for Initial Vocational Education and Training and individual trade committees. There are over 100 trade committees with each focusing on a specific sector. Stakeholders in the committees are representatives of industry and workers, each making up half of the committee members.

The committees provide advice on specific VET qualifications in their field of expertise and have a mandate to intervene in the regulatory framework, duration, evaluation, and structure of programmes and courses. Municipalities often provide VET courses in Denmark. Advice provided by the committees helps institutions pick courses for their constituency, making the system both sectorally and regionally focussed. The committees prioritised green skills (Danish Agency for Education and Quality, 2017[50]), which led to their inclusion in many courses in Denmark.

Ecobuild.brussels in Brussels, Belgium

Ecobuild.brussels is a cluster launched in 2006 by the Brussels-Capital Region with the aim of making Brussels a low-carbon city by 2050 and building energy efficient buildings that fulfil the legal standards in Brussels. The cluster brings together 200 members of the sustainable construction and renovation value chain to provide a platform for networking and to promote collaboration. It helps spread innovative practices and supports construction firms in developing new sustainable business models. In addition, Ecobuild.brussels offers individual support to sustainable construction companies that includes: analysis of financial and business plans, identification of competitive position, support in finding regional subsidies available to the firm, and support in obtaining planning and environmental permits.

Source: Sector Councils on Employment and Skills at EU level, report by ECORYS; ecobuild.brussels, the sustainable construction and renovation cluster (hub.brussels).

Targeted and tailored adult learning programmes are especially needed in regions that are heavily reliant on polluting industries. In these regions, a significant share of the labour force will have to switch occupations and sectors. To ensure that these communities and individuals are not left behind, a significant investment in re-skilling, with a training offer tailored to the characteristics of displaced workers, will be needed. Therefore, in some countries, additional training for regions dependent on polluting industries will need to complement the national adult learning systems. A good example of targeted support for regions with a heavy reliance on polluting jobs is the EU Just Transition Fund, which provides grants for a variety of interventions, including up-skilling and re-skilling activities and training, to Member States with territories expected to be the most negatively impacted by the green transition (see Box 4.9).

Box 4.9. European Union funds to ensure a just transition

The Just Transition Fund

The Just Transition Mechanism was set up in 2019 by the European Commission with the objective to support territories, industries, and workers most affected by the transition towards climate neutrality. It aims to prevent increasing regional disparities whilst achieving the net zero 2050 objective. This initiative seeks to raise EUR 55 billion over the period 2021-2027.

The Just Transition Fund is the largest of the three pillars of the Just Transition Mechanism and mobilises EUR 17.5 billion. The fund sets out to alleviate the socio-economic costs associated with the climate transition, providing tailored support to economic diversification and reconversion of territories most at risk of negative economic impact. This includes support to SMEs, creation of new firms, investment in R&D, clean energy, environmental rehabilitation, up- and reskilling of workers, and job-search assistance.

The territories in which the Fund will be used are defined by Territorial Just Transition Plans, which are drafted by Member States together with the relevant local and regional authorities of the most-affected territories. Eligibility is based on their dependence on fossil fuels or greenhouse gas-intensive activities, and the social, economic, demographic, and environmental challenges arising from the transition.

The Modernisation Fund

The Modernisation Fund is a programme that supports modernisation of energy systems and improvement of energy efficiency in 10 Member States.[1] The Fund is financed from the auctioning of 2% of the total allowances for 2021-2030 under the EU Emissions Trading System and additional allowances transferred from Member States. The total revenues of the Fund will depend on the carbon price – if the price is EUR 75 / tCO2, the revenues will amount to EUR 48 billion from 2021 to 2030.

At least 70% of the resources of the Fund must be invested in priority areas, which cater to workers in carbon-dependent regions and include re-skilling, up-skilling, education, redeployment support, jobseeking initiatives and support for start-ups. Other priority areas are generation and use of electricity from renewable sources, improvement of energy efficiency, energy storage, and the modernisation of energy networks.

Note:
[1] Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia
Source:https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en; How it works - Modernisation Fund; Modernisation Fund (europa.eu);

Regions and cities at the forefront of the green transition may also require dedicated strategies. The empirical analysis presented in this report reveals significant differences in how well regions capture the benefits of the green transition. While, on average, around 18% of workers in the OECD hold green-task jobs, this statistic stands at 35% in the Vilnius Region, 32% in Stockholm and Luxemburg, and 30% in Île-de-France, Greater London and Oslo and Viken. Regions at the forefront of the green transition have great opportunities to attract further investment in green technology, given that proximity to existing green businesses may offer benefits such as access to a pool of suppliers and skilled workforce. However, to capture this opportunity fully, these regions need to tackle the skills shortages that may develop. Already 58% of companies indicate the shortage of a skilled workforce as a major barrier to making their business model greener (Eurochambers, 2022[51]). Copenhagen, Denmark is addressing skills gaps through a strategy that involves career guidance and rebranding of TVET to encourage young people to choose

green careers, support for employers to reskill their employees, and incorporation of green skills in programmes targeted at unemployed people. In Navarre, Spain the increasing demand for renewable energy specialists was addressed by establishing a specialised training centre, CENIFER. In New York, the development of green skills is supported through a range of subsidised training and internships (see Box 4.10).

Box 4.10. Tackling green skills shortages at the local level: examples from Denmark, Spain and the United States

Strategy to close the green skills gaps in Copenhagen, Denmark

To support sustainable growth and development, the City of Copenhagen collaborated with a range of local and regional actors to develop an ambitious strategy to close "green skills gaps". The strategy includes several initiatives structured around three tracks:

1. *Demand for skilled labour and highly specialised non-skilled labour.* Initiatives to demonstrate green career opportunities offered by vocational education institutions to attract young people; improve career guidance on "green education" for youth; increase female participation in relevant professions; and support businesses in reskilling their employees.
2. *Demand for new green skills.* Initiatives to develop green upskilling courses; collaboration with firms to offer green internships to unemployed people; guidance for unemployed people to steer them into green upskilling courses and internships.
3. *Demand in the "green experience economy".* Initiatives to re- and upskill workers laid-off during the COVID-19 crisis, focussing on, for example, green cooking, reduction of food waste, and re-branding the industry to increase its attractiveness among young people.

A training centre with a focus on green skills in Navarre, Spain

At the end of the 1990s, the Spanish region of Navarre started to invest heavily in renewable energy. Its electricity production from renewable sources expanded from zero in 1994 to 65% in 2009. That resulted in increased demand for renewable energy specialists, such as wind power maintenance staff. A lack of skilled workers became a barrier to further expansion of renewable energy industry.

In response, the regional government, in collaboration with the Navarre Confederation of Entrepreneurs and the Navarre Industry Association, set up CENIFER, a public training centre for renewable energies and energy efficiency. The centre helped address skills shortages in the region by offering training adapted to firms' needs that differed in length and included strong practical components. CENIFER now offers a wide range of courses for professions such as technicians in power plants, water management, thermal and fluid installations, solar thermal energy, etc.

Workforce Development and Training in New York, United States

The Workforce Development and Training programme of the New York State Energy Research and Development Authority aims to support an equitable transition to a clean energy economy through:

- *For jobseekers and students* – paid internships for students and recent graduates at clean energy businesses in New York State; year-long fellowship with funding for salaries and professional development for individuals from historically underserved communities, wage subsidy and support with the development of a training plan for individuals hired through the New York State Department of Labour, and free online training and tools.

- *For businesses, building owners and property managers* – funding to develop a training offer for jobs in clean energy economy, support to train employees in offshore wind industry, and the manufacturing and distribution of heat pumps.

Source: https://www.kk.dk/sites/default/files/2021-06/groenne_job_groenne_kompetencer_arbejdskraft_til_groen_omstilling.pdf; (ILO, 2011[14]) (OECD, 2017[52]) https://www.cenifer.com/, https://www.nyserda.ny.gov/All-Programs/Clean-Energy-Workforce-Development-and-Training.

The extent to which curricula need to be adapted differs across occupations

Local adult learning systems need to be proactive in identifying and reacting to future local skills needs driven by the green transition. Offering training only after skills bottlenecks have developed means job vacancies will go unfilled and technology uptake will be slower, which will weigh on production levels. Instead, local and national government can take advantage of labour market information to proactively adapt adult learning systems. In particular, information on occupations for which demand will increase can be used to decide which programmes to promote. Labour market information can also help identify curricula to be scaled down or discontinued. Moreover, information on new occupations created by the green transition can guide the development of new curricula. Finally, information on the change in the task composition driven by the green transition could inform a comprehensive review of curricula for affected occupations. For more detail, see the section titled “Using data to avoid green skills mismatches and shortages”.

Career guidance for adults can be a tool to raise awareness of the new skills and occupations that are emerging as part of the green economy. Many adults who do not train point to a lack of appropriate training offer as a barrier. This is not always due to an absolute lack of offer, but often due to a lack of information on the utilisation of such courses. Career guidance can be a tool to help adults navigate the changes in the labour market brought on by the green transition and other megatrends. Counselling can help workers decide which available courses will increase their employability. However, participation in career guidance differs across workers. On average, 40% of adults have spoken to a career guidance advisor in the previous five years,[3] but this share was lower among older workers, individuals in rural areas, and workers with lower educational attainment (OECD, 2021[53]). Reflecting the impact of the green transition in career guidance and increasing its inclusiveness can raise awareness of the employment opportunities in the green economy, direct workers to appropriate training, and as a result help workers benefit from the green transition.

Increasing career guidance for employees in SMEs can help close the gap in adult training participation between SMEs and large firms. Currently, employees of SMEs do not often have access to career guidance as in-house career guidance is rare in SMEs and micro firms. Moreover, most PES career guidance is focused on the young, the old and the unemployed, leaving many employees in SMEs un-attended. Career guidance in SMEs can help employees develop steps and attend courses to up-skill, and thus should be further developed. This can be done by: (i), increasing the outreach of PES to include employed workers, (ii) encouraging company career guidance provision as firms inform their employees of growth steps within the firm and courses to attend to achieve such growth (iii), creating an online career guidance platform that all workers can access to gain information on possible future career steps and skill development (OECD, 2020[54]).

Infographic 4.1. Training needs differ across occupations

Effect	Training response
Jobs disappear and skills become obsolete (e.g., coal mining)	Transition oriented re-skilling
Increased demand for established green and other occupations (e.g., solar panel installers, electricians)	Training offered to sufficient number of new labour market entrants and others
New green occupations (e.g., in production of hydrogen energy, carbon trading analysts)	Development and delivery of a new curriculum
Occupations with modest skills changes (e.g., in automotive sector to produce electric cars)	Upskilling of workers – can be sometimes done by employers (e.g., pilots trained on more fuel-efficient procedures)

Source: Author's own elaboration based on (Cedefop, 2021[30])

The impact of the green transition will require development of new curricula. There are four main effects of the green transition on regional labour markets. Each of them requires a different training offer (see Infographic 4.1). Firstly, some jobs will disappear and skills associated with them will become obsolete. This effect, a prominent example being the mining sector, is the most disruptive for workers. For them to smoothly transition into other occupations and sectors, timely, targeted, and effective transition-oriented re-skilling will be needed.The green transition will also create new occupations, for example in the production of hydrogen energy and carbon trading analysis.

These occupations will require new curricula to be developed and delivered. Short but focused courses can be used to teach subject-specific green skills or general skills relevant for the transition, depending on the profession. Additional modules are relatively easy and fast to develop. In some professions they might be sufficient, in others they can pave the way for a more extensive update of the curriculum (Cedefop and OECD, 2022[49]).

In the case of other occupations, increased delivery of existing curricula or up-skilling at the workplace may be sufficient. The third impact of the green transition is through increased demand for some non-green occupations, such as electricians, and for well-established green occupations, such as solar panel installers. In the case of these occupations, curricula are often already developed, but effort needs to be made to train a sufficient number of new labour market entrants and workers willing to re-skill. Finally, many occupations will undergo modest changes in terms of the skills they require. This effect, while perhaps less disruptive for workers, will affect a significant share of the workforce. Upskilling of workers, which can often take place on-the-job, may be sufficient to tackle this effect of the green transition (Cedefop, 2021[30]). Some employers have already invested in such upskilling activities. For example, pilots of Virgin Atlantic were trained to use more fuel-efficient procedures for take-off and landing, while Coca-Cola trained its designers to develop lighter packaging (GHK, 2009[55]). However, there is a role for policy makers in encouraging and supporting employers to invest in the upskilling of their workers.

Involvement of employers in designing and delivering training can help reflect the growing demand for green skills in the curricula and improve their alignment with market needs

Establishing strong links between vocational education and employers can help ensure training meets demand in the local labour market. Getting employers on board has long been recognised as necessary to ensure that skills and competencies that workers acquire are relevant, timely, and well-targeted (OECD, 2022[9]) (OECD, 2022[37]) (OECD/Cedefop, 2014[12]). In the context of limited data on skills required in a green economy, collaboration with employers that can partly fill the information gap becomes even more important. Engaging with employers' associations throughout the planning, design and implementation phase of training can boost the responsiveness of education and training to the constantly evolving demand for green skills (OECD/Cedefop, 2014[12]). In addition, training on new green technologies may require costly technical infrastructure in training, which is often lacking in vocational

schools. Here, too, cooperation with companies can be beneficial. Therefore, the green transition calls not only for a change in the content of training, but also in its structure and organisation: how curricula are designed and delivered, and who is involved in this process (Cedefop and OECD, 2022[49]). The GT VET initiative in the steel industry implemented jointly by steel companies in Germany, Italy, Poland, and United Kingdom is a good example of an employer-driven review of the VET system (see Box 4.11).

Box 4.11. Greening Technical-Vocational Education and Training initiative

The Greening Technical-Vocational Education and Training (GT VET) initiative developed an industry-driven environmental sustainability training module, which serves as a blueprint that can be adapted to other sectors. The project involved collaboration of steel companies and research institutes from Germany, Poland, the UK, and Italy. It included identification of the impact of environmental legislation on the work of mechanics, industrial technicians and electricians, and development of a training module to complement existing technical VET curricula. The module was tested in four participating steel companies. Beyond its application in the steel industry, GT VET module was designed to serve as a blueprint for other industries. An example of that was the adaptation of the module in the automotive supplier industry as part of the Green Star project.

Source: OECD/Cedefop (2014), Greener Skills and Jobs, OECD Green Growth Studies, OECD Publishing. http://dx.doi.org/10.1787/9789264208704-en; http://www.greenskills-project.eu/project_en.html

It is also important to engage with universities and other research institutes at the forefront of green innovation. In some fast-changing industries, employers may be too conservative with regard to the challenges that their companies will have to face. Institutions at the forefront of innovation may be better placed to advise on the future skills demand in their field of expertise. A good example is the energy sector in which renewable energy technology is often developed by subsidised innovation institutions such as universities, which makes them well placed to support development of training to use these technologies (The European Week of Regions and Cities Webinar, 2022[56]).

Apprenticeships can serve as enablers of the green transition, by not only helping participants develop green skills, but also through facilitation of mutual learning between TVET schools and employers. Apprenticeships can serve as a mechanism to address green labour market shortages, by helping participants develop the right skills that are directly employable. At the same time, dual apprenticeship systems, in which learning takes place, both in a company and at a vocational school, offer an opportunity to build close linkages between education providers and employers. Close linkages facilitate mutual learning and, as a result, contribute to the greening of both firms and education institutions. Collaboration between firms and training providers increases the chance that firms express their needs related to the green transition in a timely manner when curricula are updated[4]. Therefore, apprenticeships are well-placed to quickly respond to labour market needs driven by the green transition. Moreover, apprenticeships facilitate mutual learning through collaboration of TVET teachers and in-company trainers. They provide an opportunity for TVET schools to learn about new green technologies used by companies. Finally, apprentices can carry their knowledge between employers and training providers fostering cross-fertilisation that can lead to eco-innovation[5] (Cedefop and OECD, 2022[49]; Cedefop, 2022[57]).

The ability to deliver green skills training relies on a sufficient number of qualified trainers

Ensuring availability of a sufficient number of trainers with knowledge of the environment and green technologies should be part of adult learning strategies. In some sectors, such as construction, the lack of qualified teachers has been identified as a bottleneck preventing firms from meeting rising demand for green products and services. A survey conducted[6] to investigate the cause of trainer shortages

revealed that lack of clarity on what knowledge and qualifications are required in green VET training is an important barrier (Erasmus+, 2017[58]). This shows that there is a need for a comprehensive approach to training-of-trainers that includes clear guidance on the knowledge and qualifications needed to deliver green training and a training offer that helps prepare new trainers as well as upskill existing trainers. The BuS.Trainers project is an example of efforts to alleviate the shortage of trainers (see Box 4.12).

Box 4.12. BuS.Trainers project in the construction sector in Europe

The Building up Skills (BuS).Trainers project focuses on improving the quality of green training for trainers, with the ultimate objective of increasing the number of qualified green construction workers. The project involves eleven partners from Spain, Italy, Portugal, Greece and Malta and is a joint initiative of Erasmus+ and the Intelligent Energy Europe (IEE) programme.

BuS.Trainers improves the regulatory environment for trainers and training provision to mentors, quality coaches and VET trainers in the construction sector. The activities include development of a new standardised European qualification for green VET trainers in the construction sector,[1] certification of competence following the green tag accreditation, and setting up a platform to support peer-to-peer learning amongst teachers. BuS.Trainers intends to continuously improve the training courses with a special emphasis on utilising IT skills.

Note: [1] following the European Qualifications Framework's (EQF) learning-outcome oriented methodology) and underpinned with European Credit System for Vocational Education and Training (ECVET) and European Quality Assurance Reference Framework (EQAVET) principles.
Source: (Goncalves et al., 2018[2]; Erasmus+, 2017[1])

Local and national governments can raise awareness of the impact of the green transition among firms and encourage on-the-job training, with a special focus on SMEs

Employers may under-provide green skills training compared to the training level that would maximise their productivity and performance of the economy as a whole. The main reasons firms may fail to provide the optimal level of training include (i) information barriers, including underestimation of the returns from training, (ii) liquidity constraints, and (iii) concerns that the employee may leave the company before the investment in training pays off. Moreover, even when the firm provides an appropriate level of training from the business perspective, it may be below the socially optimal[7] level of training, because of positive externalities of training related to greater innovation, productivity, and equality concerns (OECD, 2021[59]). In the context of the green transition, the gap between the optimal level of training from the employer and social perspectives is more likely to occur, given that the benefits of climate change action are felt at the social or even global, rather than firm level (OECD, 2021[60]). These considerations may justify policy interventions that encourage employers to provide green skills training.

SMEs are especially likely to under-prepare their employees for the impact of the green transition, given the additional barriers they face in delivering training. SMEs are less likely to provide formal and non-formal training to their employees than large firms. In the EU, almost all (91%) of large firms offered at least one continuing vocational training course in 2015, compared to 77% of medium and 57% of small firms (OECD, 2021[61]). The gap in training provision between SMEs and large firms stems from several barriers faced by SMEs. For example, in addition to the barriers identified above, SMEs have, on average, (i) less time and fewer resources to devote to training, (ii) more limited access to credit, and (iii) often lack the capacity to identify skills requirements and assess the benefits of investing in training (OECD, 2021[61]). The low participation in training rates is likely to lead to lower adoption of green practices and processes by SMEs. This can significantly slow down the "greening" of the economy given that SMEs

account for 60% of total employment in the OECD (OECD, 2021[62]). Moreover, in the economy organised into global supply chains, the impact of slower adaptation of green technology falls not only on SMEs, but also hampers the pace of "greening" of large firms that rely on supplies from SMEs (OECD/Cedefop, 2014[12]).

There are five main policy levers, which local and national governments can use to increase employers' investment in developing green skills at work. The first one is information and guidance. In the context of the green transition, this may entail awareness raising campaigns that aim to inform employers about the new environmental regulations and their labour market implications. The second lever is capacity building of specific actors within firms to help them make more effective and efficient training decisions. The third one are financial incentives such as subsidies, tax incentives, training levies and loans, which help overcome liquidity/credit constraints and align objectives between the firm and society. However, so far, subsidies to stimulate the development of green skills have not been a prominent feature of the policy landscape (Cedefop, 2019[13]). The fourth lever is public provision of training. Finally, governments can also introduce regulations that impose a minimum level of training with a specific content (OECD, 2021[60]). In Ireland, Skillsnet, a public-private network partnership involving the Irish Government, offers a range of services that help firms prepare for the impact of the green transition, including awareness raising, networking opportunities, and a range of free-of-charge workshops, courses, webinars, and mentoring (see Box 4.13).

In addition, governments can offer support that addresses the specific barriers faced by SMEs. To address the limited capacity of SMEs to identify skills needs, governments can offer access to self-assessment tools or more comprehensive, in person, support in assessing firms' skills gaps relative to current and future needs. That can help businesses apply the general knowledge of environmental policies and green technology to their specific business case (Koirala, 2019[63]). In addition, governments can facilitate collaboration across firms to help SMEs adapt green technology and upskill staff. SME networks can make training more affordable when costs are bundled and benefits shared. In addition, bringing together SMEs and firms at the vanguard of green production can lead to know-how sharing and provide inspiration for SMEs, thus leading to faster adoption of green technology (Cedefop, 2019[13]). In recognition of the specific barriers faced by SMEs, the government of the Netherlands launched the MKB! Dee competition. The project provides subsidies for the best solutions to address challenges in human capital development faced by SMEs, with a particular focus on skills for the green transition (see Box 4.13).

Box 4.13. Supporting firms to prepare for the impact of the green transition: examples from Ireland and the Netherlands

Climate Ready initiative developed by Skillsnet in Ireland

Skillsnet is a public private network partnership of the Government of Ireland that helps Irish enterprises anticipate labour market changes and upskill their workforce, including in the context of the green transition. Skillsnet has wide coverage, with a special focus on SMEs. In 2016, it provided training to 14 300 companies, roughly 6% of all Irish companies. About half of participating firms had 10 employees or less. Skillsnet supports firms by providing labour market intelligence and subsidised vocational training (ILO, 2017[64]).

In recognition of the transformative change ushered in by the green transition, Skillsnet developed a Climate Ready initiative. It offers leadership and skills support to enterprises to help them prepare for the impact of the green transition. This is done through:

1. Climate Ready Academy – that aims to support businesses in developing talent required to mitigate the effects of climate change through a blended approach of workshops, classes, online

courses, mentoring and interactive webinars. The programmes are fully funded, with the financing coming from the Irish government.

2. Climate Ready Cluster - a business network that specialises in renewable energy, sustainable finance, green tech, and clean water.
3. Climate Ready Insights - a platform that helps businesses develop their knowledge and awareness of sustainability practises and climate change.

Supporting skills development in SMEs through the MKB! Dee project in the Netherlands

The MKB! Dee is a subsidy scheme launched in 2018 by the government of the Netherlands to support solutions that stimulate human capital development in SMEs. SMEs and partnerships (industry organisations composed at least 65% of SMEs) are invited to submit solutions to address challenges encountered by SMEs when investing in skills. Applicants with the best plan receive a subsidy from EUR 25 000 to EUR 124 999 in the case of individual participants, and EUR 25 000 to EUR 200 000 for partnerships.

In 2020, funding was used to support 47 projects with priority given to projects that contributed to: (i) ensuring the availability of personnel in technical and ICT sectors, (ii) developing human capital for digitalisation, (iii) developing human capital for the climate transition, and (iv) improving the learning culture in small businesses.

An example of a project related to the green transition that was funded under the scheme was the Climate Case initiative, proposed by the innovation agency Suit-case. The initiative included (i) the creation of a digital tool that helps organisations quickly and easily assess whether their internal business decisions are climate- and energy-neutral, and (ii) support for young people trained in the climate and energy field to develop practical business knowledge.

Source: Climate Ready | Talent for Ireland's Green Economy (skillnetireland.ie); https://mkbideenetwerk.nl/; (OECD, 2021[61])Source: Climate Ready | Talent for Ireland's Green Economy (skillnetireland.ie); MKB!dee Climate Case initative; (OECD, 2021[61])

Just transition and the role of Public Employment Services

Public Employment Services have an important role to play in facilitating the transition of workers at risk of displacement into other occupations and sectors

Public Employment Services (PES) can promote a green transition that happens in a fair and inclusive way. The benefits of moving to a climate-neutral and sustainable economy will be felt at society level, while its costs will fall disproportionately on individuals employed in polluting sectors and regions heavily dependent on such jobs. The experience of past transitions shows that if no action is taken, mass layoffs can spill over to other sectors and have detrimental long-term effects on local communities. For example, decades after a mine has shut down, many coal-dependent regions continue to lag socially and economically (World Bank, 2018[65]). For dismissed workers, a layoff may mean a long unemployment spell associated with income loss or significantly lower wages upon re-employment, potentially resulting in negative social and mental health impacts for the worker and his/her family and intergenerational lock-in effect in which poverty is passed on from parents to children.

For example, (Rud et al., 2022[66]) find that miners displaced by the dissolution of the UK coal industry that accelerated in 1980s who found a new job experienced a 40% wage drop in the first year after displacement and their wages remained around 20% below the wages of the control groups 15 year later. The unconditional earnings losses (i.e., including workers who remained unemployed for longer than a year) were even larger (see also (OECD, 2019[67]) for a review of earlier literature and (Vermeulen, 2022[68]) for a discussion of the consequences of the phase-out of coal in mining regions). A comprehensive, targeted, and well-funded strategy that involves a set of active labour market policies (ALMPs) and appropriate income support can help limit the negative socio-economic consequences of the green transition.

PES can help prevent widespread resentment that endangers political support for the green transition. During past transitions, perceived unfairness of policies led to negative socio-economic consequences, combined with a lack of decisive action to overcome economic hardship, led to strong expressions of resentment (OECD, 2017[69]). Such resentment can turn into lack of participation in re-employment programmes at best, or at worst disruptive political movements. There are signs that this mechanism may apply to the green transition. Perceived increases in inequality due to environmental policies is one of the variables most impacting the support for the transition (Dechezleprêtre et al., 2022[70]). PES that anticipate the potential negative impact of the green transition and proactively engage with affected communities and regions can gain the trust of the community and overcome resentment.

Public Employment Services can act proactively in anticipating layoffs

PES should anticipate job displacement driven by the green transition and establish coalitions with social partners to target affected workers before they become unemployed. A key lesson from past

transitions is that post-layoff services (e.g., ALMPs, income support packages, and social assistance) should be designed before, not after, closures (World Bank, 2021[71]). Proactive initiatives create trust with workers and communities, and, as a result, increases participation in re-skilling courses. In addition, offering some of these services prior to layoffs can help workers explore new employment opportunities before the displacement takes place (OECD, 2019[67]). Employers also tend to favour applications from workers who are still employed (OECD, 2018[8]). Therefore, early intervention maximises chances of re-employment. It may be desirable for PES to engage with workers at the worksite (European Commission, 2020[72]), to maximise outreach and increase the effectiveness of their services. Providing these services on-site requires close collaboration with the employers as well. Bringing on board social partners, who can provide assistance to workers at risk of displacement can also be desirable at this stage. For example, Swedish Job Security Councils provide transition services in the case of collective redundancy, such as advice to employees, individual counselling, career planning, job-search assistance, and retraining (OECD, 2019[67]).

Box 4.14. Anticipatory approach to support workers displaced by the coal phase-out in Germany

In 2020, the German government signed two acts, the coal phase-out law and the structural development act, that will regulate the final phase-out of coal. The phase-out law requires the progressive exit from all coal activities, whilst the structural development act provides support for regions and communities that is conditional on the phase-out of coals. The transition away from lignite mining will affect 20 000 jobs directly in mining and energy production, and 36 000 more jobs that depend on coal.

In anticipation of this transformation, the Federal Employment Agency's research institute IAB conducted a labour market analysis in one of the regions affected by the shift away from coal, Rheinische Revier, providing detailed information on the number and characteristics of workers employed in mines or directly depending on them .

Local PES developed a package of placement support, unemployment benefits, and advanced vocational training for younger employees to support re-employment. However, an important challenge is that over 70% of the workers in the industry are more than 45 years old.

Source: (Institute for Employment Research, 2019[73]; Roth, Kropp, P and Sujata, U, 2020[74]; RWI – Leibniz-Institut für Wirtschaftsforschung, 2018[75])

Support to displaced workers is more effective when it is based on their characteristics, labour market demand, and feasibility of career transitions

The first step to supporting workers displaced by the green transition is to understand their characteristics and skills. Information about the age, level of education, prior experience, and any employment barriers faced by workers, is essential for designing an effective package of ALMPs and income support. Age of workers at risk of displacement may be a determinant of their eligibility for early retirement. Information about worker's qualifications, skills and mobility can help determine an appropriate re-employment pathway. One way of collecting such information is through an individual skills assessment that includes both skills developed through formal education and those learnt on-the-job, with the aim of identifying skills transferable to other occupations (European Commission, 2020[72]).

Information about proximity of occupations and career transition pathways can guide the advice provided by PES. A major challenge faced by PES is matching displaced workers with new opportunities in a way that leverages their existing skills (European Commission, 2021[7]). The costs of the green

transition in terms of time and forgone earnings are minimised when the skills acquired in previous occupations are utilised as much as possible in the new job. For this purpose, the Ministry for Ecological Transition and the Labour Ministry in France developed a tool that identifies occupations at risk of displacement, "green" and "greening occupations", and pathways for occupational transitions. Digital tools can help identify occupations with similar skillset requirements in a more systematic way. For example, Nesta, an innovation foundation based in the UK, used machine learning to create a map that captures similarities between occupations. It also identifies "viable transitions", i.e., roles that require similar skills, education, and level of experience, as well as "desirable transitions" which is a sub-set of "viable transitions" that lead to jobs with comparable or higher pay (see Box 4.5). While this tool is at an early stage of development, it is an illustration of how PES could use data to inform the career transition of workers in polluting occupations.

PES need to be aware of current and future labour market demand at the local level to guide workers towards sustainable employment. It is important to consider the demand for occupations at the local level, given that the mobility of some workers might be limited. Not all career transition pathways attainable in terms of skills and qualifications are feasible in the local labour market. Moreover, it is important to consider the long-term prospects of the occupation. While finding employment in the same or similar occupation may be the easiest option, such employment may not be sustainable. Experiences from past transitions shows that, for example, transferring a redundant miner to other mining operations was successful only in the short-run, but was no longer possible once large-scale mine closures took place (World Bank, 2021[71]). Renewable energy markets require mining for rare earths; however, such mining might not be in the same geographic location. Even so, it will not provide as many jobs as coal. In the context of the green transition, the displacement of workers is not a one-off event, limited to a particular company, but is a process that significantly reduces demand for some occupations. Therefore, placing a worker in a similar job, while easy, may end in another redundancy. Depending on individual worker characteristics, re-skilling into another occupation that leads to more sustainable employment, while more demanding in the short run, may be a good investment from an individual and public finance perspective.

Support measures are more likely to be effective if they are developed through collaboration between PES and employers. In the context of simultaneous job losses and job creation driven by the green transition, collaboration between PES and employers can help identify employment reallocation opportunities. For example, in the automotive industry, the push for green transportation leads to job losses in the production of combustion engine cars and job creation in electric and hydrogen-fuelled cars, with many skills being transferable. Therefore, helping workers previously involved in the production of fossil-fuelled cars transition into green employment in the automotive industry can significantly lower adjustment costs for workers and communities. For example, in Germany the federal government responded to the planned transformation of automotive suppliers by negotiating a package of subsidies and retraining facilitation for 30 000 employees, instead of the planned layoffs and hiring of new staff with new skills (BusinessEurope, 2021[26]).

An individualised transition pathway maximises the chances of sustainable re-employment. The green transition will significantly reduce the demand for some occupations in a geographically concentrated way. Therefore, it is important that displaced workers consider a broad range of new employment opportunities, including those that require changing sector, region, developing new skills, or a combination thereof. PES can support workers in identifying the new employment opportunity by (i) helping workers reflect on their skills, (ii) supporting them in exploring employment opportunities that they might have not considered otherwise, and (iii) directing them towards careers with better long-term prospects. Subsequently, once the new employment opportunities have been identified, PES can support the transition process by offering an individualised upskilling and re-employment pathway tailored to workers' needs. The package of services may include counselling, training, placement services, and relocation assistance, among others (European Commission, 2020[72]). See Box 4.15 for examples of services offered to workers displaced by coal phase-out in Canada and Spain.

Box 4.15. Support for workers displaced by coal phase-out: examples from Canada and Spain

Support for workers affected by coal phase-out in Alberta, Canada

Coal power generation in Alberta is being gradually phased out. To support the affected workers, the provincial government has put in place a Coal Workforce Transition Program, which includes a range of re-employment and financial support measures.

Career counselling services are offered at each affected worksite to help workers determine most suitable new career opportunities. Counsellors help workers develop personalised job search plans, offer workshops on job search strategies, CVs and cover letters, and interview preparation. They also direct workers towards publicly funded retraining programmes. Laid-off workers who want to train for new careers can take advantage of the Coal and Electricity Transition Tuition (CETT) Voucher, which provides a maximum of CAD 12 000 for post-secondary education.

The type of financial assistance offered to the displaced worker depends on their age. Younger workers are offered a bridge to re-employment relief grant, which provides financial assistance while they search for a new job. When combined with Employment Insurance benefits, workers receive support of up to 75% of their previous weekly earnings for a maximum duration of 45 weeks. In addition, Alberta offers relocation assistance (up to a lump sum of CAD 5 000) for workers who move at least 40km to start a new job. Workers who are at least 53 years old have access to the same relief grant but for up to 72 weeks or until the worker receives a pension.

Measures for a just transition in areas affected by coal phase-out in Spain

In line with the commitment to lower greenhouse emissions, Spain started a gradual phase-out of all coal mines and coal-fired thermal power plants. To support affected workers and communities, the government developed two major plans, one for coal mining and one for thermal power plants, which were negotiated with trade unions and affected companies.

The measures used to support displaced workers included:

- Counselling to improve workers' employability and support search for a new job. This includes a personalised analysis of workers' characteristics and employment barriers, identification of training needs and designing a personal learning pathway. In the case of workers employed in thermal power plants, electricity companies play an important role in designing the support package for the displaced workers (EUR 1.9 million with additional EUR 20 million for future support measures that are being designed).
- Creation of job banks to support workers displaced by the transition into employment in dismantling operations, environmental restoration projects, and other activities supported by the government as part of the transition.
- Social support provided in the form of early retirement or incentivised leave (EUR 166 million).

Other measures to improve the attractiveness of affected areas include: grants for investment initiatives that generate employment and promote development in mining areas; funding for municipal and infrastructure projects; funding for restoration of polluted areas; and support for R&D projects related to energy storage and green hydrogen.

Source: https://www.alberta.ca/support-for-coal-workers.aspx; (Ministery for ecological transition and demographic challange, 2020[76]; Instituto para la Transición Justa, 2022[77])

Financial support for displaced workers can alleviate disproportionate costs of the green transition

Additional safety nets could help sustain family finances in a situation where regular legislation is insufficient. Financial support programmes for workers displaced by the green transition are a common feature of support packages, see examples in Alberta, Canada (Box 4.15), Germany (Box 4.14), and Spain (Box 4.15). Workers need to be informed about the benefits that they are eligible for and the application process. Trade unions may be well-placed to support workers in this process. The relevant institution could consider processing applications for benefits at the workplace, which is a more sensitive way of handling this process that may be difficult for some individuals (European Commission, 2020[72]).

Welfare benefits would ideally be designed to better incentivise re-employment. To achieve that, welfare benefits can be designed in conjunction with activation measures (OECD, 2019[67]). Income support can be complemented by travel assistance to support seeking employment and relocation assistance for workers who move to start a new job, see example in Alberta, Canada (Box 4.15). The duration and eligibility criteria for welfare benefits would ideally be set to minimise the disincentives to returning to work, while ensuring a sufficient standard of living. If early retirement schemes are put in place, they could be designed to reduce financial penalties for combining income from work and pension.

Public Employment Services can support job seekers in securing employment in the green economy

PES can direct job seekers towards emerging industries and occupations, taking into account the impact of the green transition. It is desirable that, where possible, PES staff orient unemployed people towards sectors and jobs that have positive long-term prospects. This requires career guidance and information based on a thorough demand analysis that reflects the impact of the green transition. For example, in Austria, France, Germany and Spain, the information provided to job seekers includes green jobs and skills, and the impact of the green transition is reflected in the digital tools developed by PES in Austria, Germany, and France (European Commission, 2021[7]).

Existing ALMPs should be adapted to help job seekers to develop green skills. So far, ALMPs offered in OECD countries do not have a specific focus on green skills (Cedefop, 2019[13]). Given the increasing push to reduce emissions, it will become more important to offer unemployed people support in capitalising on new green job opportunities. For example, in the Hauts-de-France region, PES identified increasing demand for jobs in the wind power sector, and in response, directed job seekers towards specialised training in wind turbine maintenance (Cedefop, 2019[13]). In general, adaptation of existing ALMPs can go a long way in achieving a smooth transition (European Commission, 2021[7])**.** In the case of globalisation, an in-depth analysis concluded that general ALMPs should be relied upon as much as possible, given that issue-specific programmes increase administrative complexity (OECD, 2017[10]). This is likely to hold true in the context of the green transition.

Adaptation and development of training programmes in sectors and occupations where shortages have already materialised could be a priority. Offering support to unemployed people in developing skills in short supply has a triple benefit – (i) it helps them secure employment, (ii) it reduces welfare expenditure for the government and (iii) it addresses the needs of employers. In Austria, labour foundations, a mechanism to respond to mass layoffs and shortages, was activated to address the impact of the green transition (see Box 4.16).

Box 4.16. Re-training workers in face of mass layoffs or labour market shortages in Austria

Labour foundations (Arbeitsstiftung) in Austria are a mechanism used mainly to address (i) mass layoffs (outplacement foundation), and (ii) skills shortages in the region (inplacement foundation). The mechanism involves a wide variety of counselling and skills development opportunities. An important component of labour foundations is collaboration of the company, regional labour market actors, and territorial authorities (Federal Ministry of Labour (BMA), 2020[78]).

In response to the impact of the green transition on the labour market, an environmental inplacement foundation was started by the Austrian Trade Union Federation, the Austrian Federal Economic Chamber, and the Public Employment Service. The foundation has a budget of EUR 10 000 000 and aims to support 1 000 unemployed individuals with no vocational training to acquire qualifications required in the environmental sector. The available support includes training, apprenticeships, and mobility packages (subsidies for relocation costs, housing, and travel expenses of up to EUR 17 000).

Source: Environmental Foundation - Aufleb.

While the creation of demand for green jobs may not be a direct responsibility of PES, placing workers in green jobs has a double-dividend. It supports re-employment of workers, and at the same time, contributes to the achievement of climate goals. Therefore, PES should consider including a green component when designing employment subsidy schemes. For example, in Slovenia, PES designed a pilot subsidy scheme for jobs in the green economy. In Luxemburg, a scheme for young unemployed people that included training and an employment subsidy targeted the green construction sector (see Box 4.17).

Box 4.17. Wage subsidies for green jobs in Slovenia and Luxemburg

Green jobs subsidy scheme for unemployed people in Slovenia

Slovenia piloted an employment incentive scheme, called Green Jobs, which offers employment subsidies to employers that hire an unemployed person for a permanent green job. The wage support could be up to EUR 340 per month for 2 years, for a maximum of EUR 8 160. The programme was designed and implemented through cooperation between PES and the Ministry of Environment and Spatial Planning.

One of the main challenges identified in the project, was the lack of a commonly accepted and workable definition of a green job. This challenge was addressed through leveraging the expertise of a range of stakeholders to develop a definition of job “greenness” based on (i) occupation and activity, (ii) workplace activities, (iii) certificates and qualifications needed, (iv) production and services. In addition, the pilot revealed a need for better outreach to employers and effective communication of the green job definition and eligibility for the subsidy.

FIT4 Green & Build Jobs training and subsidy scheme for unemployed people in Luxemburg

In Luxemburg, NEETs between 18 and 29 years old, who are registered with the PES, are eligible for a training course and placement in subsidised employment in green construction. After a short training

course, including both practical and theoretical classes, participants are offered a job or further vocational training in a green construction company, with 50% of the wage covered by the programme.

Initially, the project lasted from 2015 to 2017 and trained 270 NEETs. The initial budget was 1.8 million EUR. About 80% of the participants found sustainable employment in the construction sector after participating in the programme. The scheme was developed by the Employment Development Agency (ADEM) and the Building Sectorial Training Institute (IFSB), and its success was driven by the good reputation and high quality of teaching offered by the training institute, which helped build trust with employers.

Source: (European Commission, 2021[79]); Fit4Green & Build Jobs training for neets.

PES staff needs to be more aware of the impact of the green transition on the labour market to be able to guide job seekers towards green jobs and offer them relevant training. This can be achieved through a range of measures, from best practice sharing that helps PES offices learn from each other, through short online modules, to more comprehensive training. For example, the French PES (Pôle emploi) has developed online training on green and greening occupations for its staff. It also provides incentives to PES staff to implement innovative practices in supporting the green transition. Best practice examples are then shared on internal websites (European Commission, 2021[7]). Romania has also invested in training of its PES staff. Under a project funded by the European Social Fund, 83 PES staff were trained on the identification of green opportunities and qualifications, and on the measures to encourage employers to create green jobs (European Commission, 2012[80]).

The social economy can be an alternative driver for a just green transition

National and local policy makers, as well as practitioners, recognise the potential of the social economy to contribute to a just and inclusive green transition. The social economy refers to organisations and enterprises that are typically driven by societal objectives and tend to follow democratic and participative governance practices (see Box 4.18). Initiatives at the international level, including the OECD Recommendation on the Social and Solidarity Economy and Social Innovation (OECD, 2022[81]) as well as the EU Social Economy Action Plan (European Commission, 2021[82]), acknowledge the role of the social economy in the green transition. Likewise, new policies, strategies and funds are being established in many countries to support the green transition, with the social economy being referenced in circular economy, environmental and rural development policies.

Social economy organisations have been engaged in green value chains acquiring valuable experience. They develop activities to protect the environment as well as to mitigate the consequences of climate change and the degradation of natural ecosystems (International Cooperative Alliance, 2021[83]). They have been involved in: (i) low-carbon and renewable energy systems, (ii) the circular economy, (iii) shortening agricultural supply chains, (iv) encouraging green mobility, (v) the sustainable management of natural resources, (vi) ecological education, (vii) and sustainable finance. Knowledge acquired in these fields can be shared and used to fasten the greening of value chains.

Through their engagement in the green transition, social economy actors can be a source of decent job creation while providing work and training opportunities for vulnerable groups. The social economy can contribute to reconciling economic, environmental and social agendas and advancing "triple dividend" actions, which is a way to improve social justice in the green transition (Osinski et al., 2020[84]). Triple dividend actions can be taken in several areas, such as energy, construction, food and mobility. They enable societies to reduce their ecological footprint while simultaneously creating work opportunities (even for people with low levels of qualification) and making sustainable goods and services more affordable and accessible (Osinski et al., 2020[84]).

Box 4.18. What is the social economy?

The social economy refers to the set of associations, cooperatives, foundations, mutual organisations, and social enterprises whose activity is driven by values of solidarity, the primacy of people over capital, and democratic and participatory governance (OECD, 2022[9]). Social economy organisations primarily address societal needs and pursue a social purpose while implementing specific business models based on collaboration and proximity. The social economy is made up of a diversity of entities, non-profit and not-for-profit, often operating at the local level. It is a significant economic and social actor in many countries. According to the latest available data, there are 2.8 million social economy entities in the EU, accounting for 6.3% of the EU workforce on average, with important disparities among regions and countries (CIRIEC, 2017[85]).

A good example of a social economy initiative is RREUSE. It is an international network that includes 31 members across 29 countries, mostly in Europe, federating a wider network of approximately 1 000 enterprises through reuse, repair, and recycling activities. These social enterprises have a wide diversity of legal forms and business models and tend to operate at the local and regional levels. These organisations collectively handle around 1.2 million tonnes of goods and materials annually, with the aim of being reused, repaired, or recycled. They operate in sectors ranging from textiles, furniture and electronics to construction materials, food distribution and composting.

Note: The figures relating to the environmental impact have been calculated via AERESS CO2 calculator in relation to Eurostat data on greenhouse gas emissions per capita.
Source: (RREUSE, 2021[86]; RREUSE, 2021[87]; RREUSE, 2021[88]).

Conclusion

In many OECD regions, skills systems are not ready for the re-skilling needs brought by the green transition and other megatrends. Local skills systems are often already struggling to keep up with the changing labour markets. Individuals who need training the most, tend to be the least likely to get it. The green transition will put further strain on local skills systems, and if no action is taken, the achievement of climate goals may be hindered by the shortage of green skills. At the same time, the benefits and the costs of the green transition are distributed unequally across individuals. So far, the green transition has been skill-biased, with workers in green-task jobs being predominantly high skilled and highly educated. The opposite is true for workers at risk of displacement. Therefore, without appropriate guidance and access to training for disadvantaged groups, the green transition could exacerbate social inequality.

Despite the prominence of the green transition in the public discourse, skills and labour market policies to address the impact of environmental policies are limited. Most efforts focus on workers at risk of displacement, in particular those employed in mining and coal power generation. Even here, regions differ in how advanced the phase-out of coal and associated policies are. Regions with a high concentration of polluting jobs that have not yet developed strategies for supporting workers at risk of displacement will need to step up their efforts. Acting fast can reduce the cost of the green transition and minimise social resentment. It is also important to recognise that policies to support displaced workers will need to be extended to other affected sectors, such as manufacturing and transport.

Additional research and digital tools could help support displaced workers more effectively. Training institutions and PES need better tools to assess transferable skills and help workers identify new career opportunities, including in different occupations and sectors (see Table 4.1). More research is also needed to understand which ALMPs work for individuals with different characteristics. While PES tend to use profiling tools to identify job seekers at highest risk of long-term unemployment and ALMPs are often evaluated, less is known about which ALMPs are most effective for specific job seeker groups.

In terms of preparing workers to capture the benefits of the green transition, progress has been limited. Environmental policies that drive the demand for green skills were mostly developed in isolation from skills and labour market policies that drive their supply. Existing programmes typically respond to skills shortages that have already materialised, instead of anticipating future demand for green skills. In many OECD countries, more can be done to ensure that local skills systems are prepared to support the green transition. That includes availability of timely and reliable labour market intelligence, appropriate career guidance, and access to training that supports the development of green skills. However, action needs to go beyond publicly provided services and requires strong engagement of employers. Local and national governments should send a coherent message and ensure clarity on the long-term evolution of climate regulation to create an environment that encourages investment in green skills. In addition, special attention, in the form of awareness raising and targeted services, could help groups that are under-represented in green jobs, such as women, and those groups that are least likely to train, such as low-skilled individuals or older workers.

Better information about the types of skills that will be needed in a green economy and new approaches to training delivery could help more workers reap the benefits of the green transition. A better understanding of the relevance of different green skills and of where green skills shortages or mismatches exist in local labour markets is crucial for designing effective policy. Furthermore, better information and analysis of possible skills and career transitions of workers based on their skillset and the similarity to the skills required in green or non-polluting jobs can support more effective and fair labour market outcomes. It is also important to explore the barriers that women face in accessing green occupations, for example, in terms of participation in STEM. Finally, effective communication channels and new methods of training delivery adapted to the challenges faced by vulnerable groups are necessary to ensure that the green transition does not leave disadvantaged workers further behind.

Table 4.1. Main policy recommendations

Multi-level and multi-stakeholder collaboration to align environmental policies with labour market interventions	1. Align environmental and labour market policy through collaboration across responsible ministries
	2. Engage regional and local governments in skills and labour market policies to reflect the place-specific impact of the green transition
	3. Build local green skills coalitions, including with training institutions, PES, and social partners, for better-informed policy response and to secure buy-in for the green transition
Labour market intelligence that informs effective green policies	4. Reflect the impact of environmental policies in models used to produce LMI
	5. Collect regional and sectoral data to reflect the differential impact of the green transition
	6. Include users of LMI in their development to align data collection with policy use
	7. Carry out complementary, targeted studies on individuals at high-risk of unemployment and others
Initial education that helps students develop skills demanded in a green economy	8. Provide career guidance during initial education that reflects the impact of the green transition on the labour market
	9. Promote participation in STEM to avoid further deficit in technical skills, with a particular focus on women
Local adult learning systems that help workers adapt to the changing labour markets	10. Develop a comprehensive strategy to systematically review the curricula
	11. Take a sectoral approach – prioritise sectors heavily affected by the green transition
	12. Develop complementary strategies for regions that are dependent on polluting jobs and at the forefront of the transition
	13. Support and incentivise employers to train their workforce, with a particular focus on SMEs
Public Employment Services that support a just green transition	14. Proactively identify workers at risk of displacement and, if possible, offer support before they become unemployed
	15. Develop a career guidance and training offer for workers at risk of displacement based on workers' characteristics, local labour market demand, and feasibility of career transitions
	16. Use up-to-date LMI to reflect the impact of the green transition in services and provide green skills training, with a particular focus on sectors with shortages

Note: PES – Public Employment Services, LMI – Labour Market Information, STEM – Science, Technology, Engineering, and Mathematics, SMEs – Small and Medium-Sized Enterprises
Source: Author's own elaboration

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Notes

[1] OECD/Eurocities survey on adult learning systems in cities and regions, 2021.

[2] When skills are approximated by measuring the changes in demand for occupations, it is not always clear what qualification or field of study is most appropriate to meet the skills needs in the identified occupations. Using qualification or field of study as a proxy for skills also comes with challenges. This approach leads to results that are more easily applied to planning in the education system, but the demand for educational credentials is not always easily translated into the demand for skills required on the job (OECD, 2016[23]).

[3] Based on an online survey carried out in 2020 by the OECD in Chile, France, Germany, Italy, New Zealand, and the United States.

[4] How much employers can influence the curricula of schools depends on the national or regional system.

[5] It must be noted that some countries strictly separate the apprentice's time in training and on the job. Therefore, the possibility of cross-fertilisation depends on regional or national systems.

[6] The survey, conducted by Erasmus+, aimed to identify green skill gaps for trainers in efficiency energy and renewable energy sources in the construction industry. Participating country: Italy, Spain, Greece, Portugal, and Malta.

[7] Private optimum, i.e., the point where benefits to those engage in the private transition are maximised, can differ from the social optimum, i.e., the point where benefits to the society are maximised, when the transition has externalities.

Job Creation and Local Economic Development 2023

BRIDGING THE GREAT GREEN DIVIDE

The green transition is changing jobs, skills, and local economies. It poses new challenges but also opportunities, both of which will differ across places within countries. This report, *Job Creation and Local Economic Development 2023: Bridging the Great Green Divide*, provides novel evidence on those risks and opportunities across regions in 30 OECD countries. It examines the geography of green-task and polluting jobs and examines the impact of the green transition on gender and socioeconomic inequality by identifying the characteristics of workers in those jobs. Furthermore, the report tracks the progress regions have made in greening their labour market over the past decade. The report provides actionable policy recommendations that can help deliver a green and just transition. It looks at past and other ongoing labour market transitions and identifies local success drivers that can help communities prepare for and manage the impact of the green transition. Finally, it points out actions for ramping up and adapting local skills development systems to meet the demands of the green transition and equip their workforce with the right skills for the future.

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