OECD Employment Outlook 2024

THE NET-ZERO TRANSITION AND THE LABOUR MARKET

OECD

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BETTER POLICIES FOR BETTER LIVES

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Foreword

The *OECD Employment Outlook* provides an annual assessment of key labour market developments and prospects in OECD member countries. Each edition also includes several chapters that focus on specific aspects of the functioning of labour markets and the implications for policies to promote more and better jobs. The 2024 edition of the *OECD Employment Outlook* examines the characteristics of the jobs that are likely to thrive because of the net-zero transition, including their attractiveness in terms of job quality, and compares them with jobs in high-emission industries that tend to shrink. The cost of job displacement in these latter industries is assessed along with the trajectories of workers from these industries to new opportunities, and the labour market policies that can facilitate job reallocation. The distributive impact of climate change mitigation policies is also examined. The first chapter assesses recent labour market developments, but also provides an update of the OECD Job Quality indicators.

The *OECD Employment Outlook 2024* is the joint work of staff of the Directorate for Employment, Labour and Social Affairs (ELS). The staff of the Centre for Tax Policy and Administration contributed extensively to the preparation of Chapter 5. The Outlook as a whole has also greatly benefitted from comments from other OECD Directorates and contributions from national government delegates and national institutions. However, the Outlook's assessment of the labour market prospects for each country does not necessarily correspond to those made by the national authorities and institutions concerned.

This report was edited by Andrea Bassanini. The lead authors for individual chapters were: Sandrine Cazes, Sebastien Martin and Andrea Salvatori (Chapter 1); Andrea Bassanini, Andrea Garnero and Agnès Puymoyen (Chapter 2); César Barreto, Jonas Fluchtmann, Alexander Hijzen and Agnès Puymoyen (Chapter 3); Dzana Topalovic and Michele Tuccio (Chapter 4); and Assia Elgouacem, Herwig Immervoll, Anasuya Raj, Jules Linden, Cathal O'Donoghue and Denisa Sologon (Chapter 5). All chapters have also benefitted from specific contributions from other ELS staff members, in particular Satoshi Araki, Julie Lassebie and Ian Whiton. Specific contributions to Chapter 3 were also made by Stefano Lombardi, Patrick Bennett, Antoine Bertheau, Winnie Chan, Andrei Gorshkov, Jonathan Hambur, Benjamin Lochner, Jordy Meekes, Tahsin Mehdi, Balázs Muraközy, Gulnara Nolan, Oskar Nordström Skans, Kjell Salvanes and Rune Vejlin.The whole report also benefitted from extensive comments from Stefano Scarpetta (Director of ELS), Mark Pearson (Deputy Director of ELS) and Stéphane Carcillo (Head of the Jobs and Income Division of ELS). The infographic is based on contributions from Alastair Wood. Pascal Marianna was responsible for the statistical annex. Statistical support was provided by Sébastien Martin, Agnès Puymoyen, Dana Blumin and Isac Olave Cruz. Editorial assistance was provided by Marie-Aurélie Elkurd, Hagai Glebocki and Lucy Hulett.

Editorial: From fear to action: Making labour and social policy central to the net-zero transition

At its core, the green transition to an environmentally sustainable society is a political choice. The 2015 Paris Climate Agreement was the moment the world came together to make that choice, responding to the most urgent public policy challenge of our time. Nearly a decade later, we know that reversing climate change will require many more such choices – at the local, national and international levels. It has also become clear that safeguarding the planet must include a simultaneous commitment to taking care of people affected by the green transition.

Indeed, the world stands at a pivotal juncture of climatic and societal forces. According to the Intergovernmental Panel on Climate Change (IPCC), maintaining the current emission levels until 2030 will irremediably compromise the chances of keeping global warming below 1.5 degrees. Yet such urgent warnings to governments to accelerate the transition come amid growing fears that the environmental policies to curb emissions and set global temperature limits will inflict a direct cost on people's livelihoods. The economic impact of the transition towards zero emissions also comes as other so-called "mega-trends" and societal transformations are piling up, including the lingering impacts of the cost-of-living crisis and scarring effects of the COVID-19 pandemic, along with the ongoing, deep and rapid digital transformation and acceleration of demographic change.

These multiplying challenges mean that governments must design and implement public policy solutions that respond to the economic and social impact of environmental policies. Such an approach that puts addressing the social impact at the core of the net-zero strategies – and not at the periphery as an after-thought – is not only the right thing to do, but also essential to ensuring the long-term public support that is vital for the net-zero transition to continue to move forward.

Still, despite the uncertainty and delays in reaching climate targets, there are reasons to be hopeful. Above all, the transition toward net-zero is in motion, and the economy in many sectors and locations is shifting to account for climate objectives. Moreover, data and informed analysis now exist that not only helps to measure the transition's impact on the environment, but also on society.

The *OECD Employment Outlook 2024* offers a unique evidence base and tool to gauge how environmental policies have begun to change the labour market, and foresee the best policy responses to address the challenges for those affected both by climate change and climate change mitigation policies.

Until now, forecasts about the employment impact of the transition have been divided between the enthusiastic promise of bountiful new "green jobs," and grim layoff forecasts as emission-intensive activities are phased out. However, the evidence presented in the Outlook is both more balanced and more far-reaching. We focus on "green-driven jobs", which include new jobs that emerge due to the green transition, those whose demanded skills and tasks will be changing because of the transition and those producing goods and services that are key inputs for lower-emission activities. With this holistic view of green-driven jobs, we estimate that more than 25% of existing jobs will be strongly affected by net-zero policies, in both positive and negative ways. The transition will impact jobs well beyond the energy sector, touching many professions, from bus drivers to construction workers to farmers.

Policy makers should see this broader employment assessment as an opportunity to raise awareness and impart agency across the wide portion of the workforce that has a direct stake and role to play in achieving climate-mitigation objectives. At the same time, the transition will inevitably have its labour market “winners” and “losers,” which policy makers must respond to directly. That means being transparent with citizens and ensuring that climate change mitigation action is accompanied by social and economic policies that ease the negative consequences on individual jobs and households, while ensuring sustainable growth that is fair and equitable.

The net-zero transition will include a major reallocation of jobs across certain industries, occupations and regions. Some activities will thrive, notably those that directly contribute to reducing emissions and those that provide essential goods and services for low-emission activities. Other industries that have been historically high-emission producers will have to restructure, with some forced to downsize or even exit the market.

OECD projections suggest that, by 2030, employment in EU industries such as fossil fuel energy supply, transport services, mining and manufacturing of energy-intensive products – which account for 80% of emissions (although only 7% of employment) – is expected to decline by 14%. That is 9 percentage points more than in the business-as-usual scenario in which the planned policy trajectory is not implemented. On average, across OECD countries, workers displaced from high-emissions industries face a 24% larger decline in annual earnings in the six years following dismissal than people losing jobs in low-emission industries. They need support to facilitate their transition to emerging jobs via well-targeted training and mobility measures.

The potential economic weight of the net-zero transition extends beyond jobs, most notably in the knock-on effects of carbon price measures that can cut into household finances across the economy. The risk of sector-specific job and salary losses combined with a broader rise in the cost of living may prompt policy makers to slow down the pace of the transition – or simply renounce it altogether.

Tangible measures

When discussing how to promote a fair green transition, one point should be clear: scaling back climate ambitions is not a viable option, with the long-term costs of rising temperatures sure to be far more serious. Some experts calculate that global GDP per capita could be 37% higher today if there had been no global warming after 1960. Looking to the present and future, estimates hold that each day that the temperature is above 40 degrees Celsius increases the risk of workplace accidents by more than 10%. Life expectancy is also at stake: with inaction against climate change, elderly mortality in a country like the United States could increase by more than 2% by the end of this century.

Looking at the estimated impact of the net-zero transition on the labour market, there are reasons to be optimistic. In OECD countries, 20% of workers are already in green-driven jobs. This is a tangible measure of the transition already well underway, and leaves the OECD member countries well-positioned to forge new economic opportunities, as well as help formulate the right policy responses.

Looking to the future, the transition is unlikely to trigger a major net decline or increase in the total number of jobs. Virtually all simulations based on comprehensive macroeconomic models forecast a close-to-zero change in the number of people employed due to the net-zero transition in the short term (by 2030), although these outcomes depend on the complementary policies that are put in place. In the long run (e.g. by 2050), if the cost of inaction is taken into account, it is estimated that we may even add jobs to the economy.

But there are obvious large disparities in the job prospects of workers in the broadly defined green-driven occupations and those in the GHG occupations which should be duly taken into account. For many of those laid off from high-emitting activities there are alternative job opportunities provided they are supported in the transition by well-targeted policies. Indeed, one encouraging finding is that almost all vanishing jobs in high-emission industries have high-growth alternatives with similar basic competence requirements.

There are also regional disparities, with high-emission industries heavily concentrated in specific – mostly rural – regions. By contrast, the fastest-growing occupations boosted by the net-zero transition are skill-intensive and predominantly located in urban areas. Without policy action, low-skill workers and households in rural areas would bear most of the burden of the transition, while high-skilled urban workers would be in the best position to reap the benefits.

The urban-rural divide and skills gap raise questions of basic fairness, while adding to the tensions that can undermine the political support necessary for the net-zero transition.

Addressing these disparities in the impact of the net-zero transition is crucial for the success of the transition itself and especially to ensure it is fair. A recent study shows that, in all OECD countries, three main factors determine whether individuals will support climate mitigation policies. First is whether they believe that policy is effective in reducing carbon emissions; second is what they might gain or lose in the process; and third is how much they perceive the distribution of costs to impact vulnerable households. When people perceive that both the burdens and opportunities of a net-zero transition are not shared equally, they oppose climate action.

There is an interesting dynamic in public attitudes from recent surveys: workers fear both climate change and climate change mitigation measures. Citizens understand that the net-zero transition is “policy-induced” – in other words, it’s a choice taken by their elected leaders, and thus expectations are high that it will be managed well. And if it’s mismanaged, so that the negative side effects weigh heavily, the choice to halt the transition is always an option.

Targeted action

So what are the ways to manage the social and employment impact of the net-zero transition?

First, we need to further develop the knowledge base about the potential new jobs and related skill sets to design training policies that are responsive to emerging needs. One method is the use of skills assessment and anticipation exercises (SAAs), which generate information about the current and future skill needs of the labour market and the skilled workers available to take on new jobs. Once parallels and similarities in skillsets are identified through “green” SAAs, public employment services and other actors who accompany workers through job transitions can use this information to identify feasible training pathways from the high-emission sector toward jobs that will be in demand.

Currently, only a minority of OECD countries report financially supporting employers to offer training or career guidance to facilitate the transition into green jobs. At the same time, workers in emission-intensive jobs at heightened risk of downsizing undertake less training than other workers. Strengthening career guidance by increasing its quality and coverage, as well as raising awareness of potential opportunities, is crucial to connect workers with training for, and career openings brought about by, the net-zero transition.

Evidence also suggests that, in the case of low- and medium-skilled workers, green-driven jobs that require no or limited training are often unattractive because they offer lower pay and poorer working conditions than other potential alternatives. Beyond striving to equip these workers with the skills demanded by good jobs with high-growth potential, policies to improve wages and working conditions are needed.

Second, OECD evidence suggests that collective bargaining and social dialogue among different stakeholders can have a positive impact on working conditions, and yet the evidence suggests that workers in low-emission activities are less well represented in collective bargaining. Initiatives to foster collective bargaining and social dialogue in these industries and companies would therefore play an important role and may improve their attractiveness for low and medium-skilled workers.

A successful example of stakeholder involvement is the Job Security Councils in Sweden, which are established through collective agreements between employers and employees in different sectors. They provide an example of preventative measures that generally lead to rapid re-employment of most displaced workers. The Councils are actively involved in all stages of the process of firm restructuring and generally intervene before displacement has even occurred. Their intervention hinges on providing advice to both employers and workers at an early stage in the restructuring process.

Third, policies to ensure attractive wages for workers losing their jobs in high-emission industries could include time-bound wage insurance schemes. While evaluation must be carried out to hone the scope of application in the context of the net-zero transition, it would be important to carefully target such schemes. It would be important, for example, to limit the duration of wage insurance eligibility, or progressively reduce payment generosity, to reduce the risk of benefit dependency. As workers gain experience and develop job-specific competencies in their new activity, they will also gain efficiency and wage insurance will be less needed.

Fourth, as downsizing activities are concentrated in specific regions, place-based policies are also essential to address the disproportionate vulnerabilities that arise. For example, through the Inflation Reduction Act of 2022, the United States has planned to direct investments and incentives to enhance the net-zero transition in areas where people are most vulnerable due to dependency on high-emission activities.

In some cases, however, regions most affected by the downsizing of high-emission industries may have a limited comparative advantages in attracting emerging green activities. In such cases, complementary geographic mobility policies may supplement other policy support. Such initiatives would require an integrated approach to overcome different barriers to mobility, which might include job-search support, housing assistance and childcare support, among other forms of assistance. Available evidence indeed suggests that financial incentives for mobility alone may be insufficient and result in bad-quality and unstable jobs in the new location.

Fifth, beyond jobs and salaries, attention must also be paid to the impact on consumers. Within broad climate-mitigation packages, certain policy instruments like carbon pricing generate a considerable flow of government revenue. Channelling part of this revenue back to affected households would allow governments substantial scope for cushioning losses and shaping distributional outcomes. Linking transfers to effective household support needs will be crucial, however. In particular, such transfers should target low-income and rural households, who are particularly exposed to those climate-mitigation policies that raise the relative cost of carbon because they spend more on necessary goods and services with a larger carbon footprint, such as energy and food.

Finally, the other fundamental characteristic of the net-zero transition is that it must be a global process. National policy towards net-zero emissions and to support those affected by it should be integrated globally to be effective. Similar to the need to bridge the disparities within OECD countries, those between countries must also be accounted for – and developing countries will require additional structural adjustments and aid to move forward with a viable net-zero transition.

This is a moment to both renew and adjust the focus of Paris 2015: redoubling the world's commitment to cap emissions and limit global temperatures, forging policies that protect both the planet and its people.

Stefano Scarpetta,

Director for Employment, Labour and Social Affairs,

OECD

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Executive summary

Labour markets have proved resilient in the wake of adverse shocks

Labour markets have continued to perform strongly in the past year, with many OECD countries seeing historically high levels of employment and low levels of unemployment. In most countries, employment rates improved more for women than for men, compared to pre-pandemic levels. With few exceptions, labour force participation rates continued to increase, especially among older adults. Labour market tightness is easing but remains generally elevated.

Real wages are growing but remain below 2019 levels in several OECD countries

Real wages are now growing in most OECD countries, generally driven by a decline in inflation. Yet, they are still below their 2019 level in several countries. Thanks to significant nominal increases in statutory minimum wages, real minimum wages are above their 2019 level in virtually all OECD countries. As real wages are recovering some of the lost ground, profits are beginning to buffer some of the increase in labour costs. Yet, in many countries, there is room for profits to absorb further wage increases, especially as there are no signs of price-wage spiral.

Job quality was generally better in 2022 than in 2015

Both earnings quality, which accounts for the level and distribution of earnings, and labour market security, which accounts for the role of public unemployment insurance in mitigating the cost of being and staying unemployed, improved across the OECD between 2015 and 2022. However, these data do not yet fully include the effect of the cost-of-living crisis on real wages, which materialised especially in 2023. Job quality data also show that in 2021 some 13% of workers experienced job strain (insufficient job resources to face job demand) on average.

The net-zero transition will reshape the labour market

OECD countries are adopting ambitious climate change mitigation packages aimed at achieving net-zero greenhouse gas (GHG) emissions by 2050. This transition will have profound impacts on the labour market and on the jobs of millions of workers. Aggregate employment effects are estimated to be limited in the short run, but many jobs will be lost in the shrinking GHG-intensive industries, while many others will be created in expanding low-emission activities. Many jobs will also be transformed as tasks and working methods become greener. Climate change will also affect labour demand and working conditions, mainly through rising temperatures and more frequent extreme weather events.

About 20% of the workforce is in jobs that will likely expand due to the net-zero transition

Across the OECD, about 20% of the workforce is employed in green-driven occupations – i.e. occupations that will likely be positively impacted by the net-zero transition. These also include jobs that do not directly contribute to emission reductions but produce intermediate goods and services for environmentally sustainable activities. Green-driven occupations are a heterogenous group of jobs: new and emerging occupations are typically high-skill jobs (i.e. managers, professionals and technicians) and employ highly educated workers in urban areas, while the other green-driven occupations employ many more low-educated workers in rural areas. High-skill green-driven jobs usually pay higher than average wages, but low-skill green-driven jobs tend to have worse job quality than other low-skill jobs, suggesting that, currently, they may be a relatively unattractive option for low-skilled workers.

Job displacement from high-emission industries is costly

Workers in shrinking high-emission industries – which account for 80% of the GHG emissions but only 7% of employment – face 24% larger earnings losses over six years after job displacement than those dismissed in other industries. This is due to the specific composition of firms and workers in these sectors, including a larger proportion of routine-manual work and firms that pay higher wages than what displaced workers can find elsewhere. Cross-country differences in displacement costs mainly reflect structural differences in the difficulty of finding another job and the functioning of labour markets, which are related to the presence (or absence) of effective and coherent labour market policies that facilitate labour market transitions.

Skill requirements between GHG-intensive and green-driven occupations are similar, but low-skilled workers need substantial retraining

The most required skills for green-driven occupations are those linked to the knowledge economy, such as critical thinking, monitoring, active learning, complex problem solving and decision making. Furthermore, newer jobs emerging because of the transition demand higher proficiency across all skills compared to established green-driven occupations. While most high-skill GHG-intensive jobs share similar skill requirements with occupations in non-polluting industries, this is less the case for low-skill jobs. Low-skilled workers will, therefore, require substantially more reskilling efforts than high-skilled workers to move out of emission-intensive occupations.

Developing policies to facilitate job transitions and support workers is key

Policy makers have various tools at their disposal that can help facilitate job transitions, foster job opportunities, and support displaced workers. Beyond well-designed out-of-work income-support schemes, early intervention measures targeted at workers at risk of dismissal can limit the incidence and consequences of job displacement. Effective training programmes are needed to enable transitions out of emission-intensive occupations or into green-driven occupations and to upskill existing workers faced with new tasks, as businesses move towards sustainable production processes. Targeted policy attention is, however, needed to address diversity in training needs. Targeted in-work support approaches, such as wage insurance schemes, may also be a complementary tool when workers are offered lower wages than before displacement.

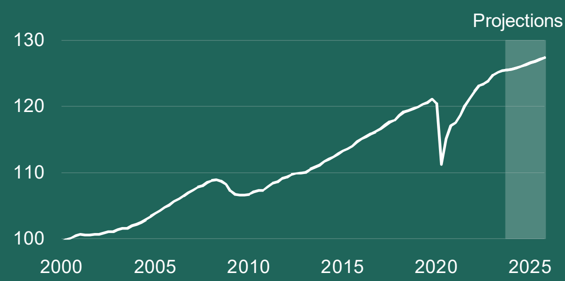
Workers and households will also be affected as consumers, but carbon pricing does not need to have adverse distributional outcomes

Low-income and rural households usually spend more on goods and services with larger carbon footprints, such as energy and food, because they are typically necessary goods. Therefore, climate-mitigation policies, by increasing the relative price of carbon-intensive goods, will tend to affect these households as consumers disproportionally, with a strong impact on the real value of their income and wages. Recent carbon pricing reforms in many countries have indeed proved regressive. Recycling the revenue of carbon taxes in the form of transfers to households, however, can make this type of reforms progressive. Yet targeting these transfers to household needs is key for cost efficiency.

Infographic 1. Key facts and figures

Employment growth remains strong but expected to slow

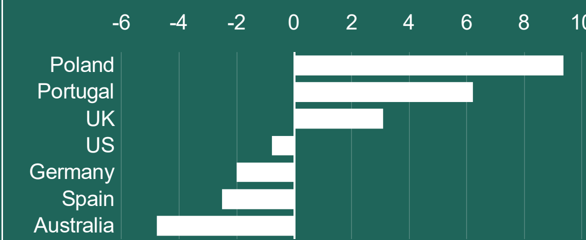
OECD-wide employment, index base 100 in 2000



The OECD-wide employment is expected to increase, but growth is projected to slow from 1.7% in 2023 to around 0.7% per year over 2024-25.

Real wages are growing but remain below pre-COVID levels in many OECD countries

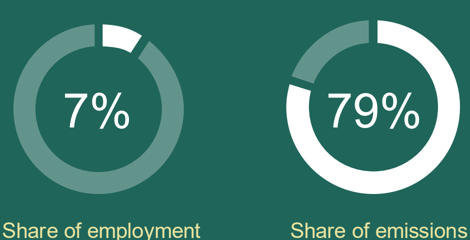
Cumulative % change in real wages between Q4 2019 and Q1 2024



In Q1 2024, yearly real wage growth was positive in 29 of the 35 countries for which data are available. However, real wages were still below their Q4 2019 level in 16 of them.

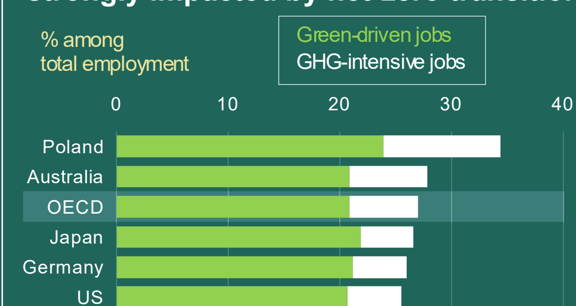
High emission industries represent a small share of overall employment

% of total greenhouse gas (GHG) emissions and total employment of high emission industries, 2019



High emission industries account for almost 80% of GHG emissions, but represent only about 7% of overall employment.

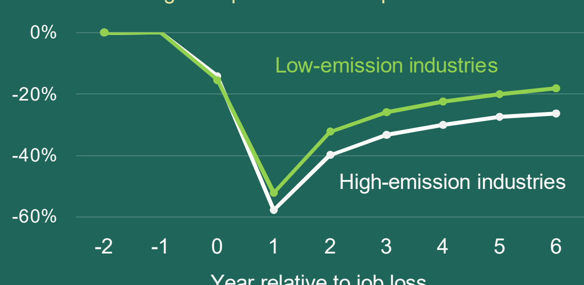
More than a quarter of jobs will be strongly impacted by net-zero transition



20% of workers are in green-driven jobs (incl. jobs that support 'green' activities). Adding jobs in high-emission industries means that over 25% of all jobs are set to be significantly impacted by the net-zero transition.

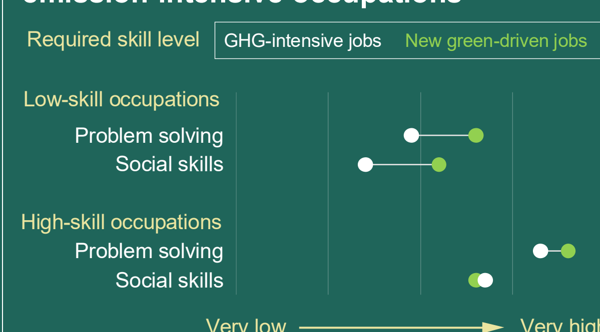
The cost of losing jobs in high-emission industries is substantial

% loss of earnings compared to non-displaced workers



Workers in high-emission industries who lose their jobs experience an average drop in annual earnings of 36% over six years, compared to 29% in other industries.

Reskilling is key for moving away from emission-intensive occupations



Skill similarities across jobs make transitions feasible for all workers, although low-skilled adults need more retraining.

1 Steady as we go: Treading the tightrope of wage recovery as labour markets remain resilient

Sandrine Cazes, Sebastien Martin and Andrea Salvatori

This chapter provides an overview of recent labour market developments, with a focus on wage dynamics. The resilience of OECD labour markets is analysed, focussing especially on the evolution of labour market tightness and gender gaps. Real wage growth, including at the minimum wage, is also examined and compared with the dynamics of profits, to investigate whether the latter have started to buffer some of the increases in labour costs as wages recover their purchasing power. Beyond wages, the chapter also provides an update of the three key indicators of the OECD job quality framework across countries.

In Brief

Labour markets have proven resilient in the wake of adverse shocks and continued to perform strongly, with many countries seeing historically high levels of employment and low levels of unemployment. Amidst tight labour market conditions and a decline in inflation, real wages are now growing on an annual basis in many countries, although they are below their 2019 levels in about half of them.

The latest available evidence at the time of writing suggests:

- **Employment growth has flattened, and unemployment remains at historically low levels in most countries.** In May 2024, total employment was 3.8% higher than before the COVID-19 crisis, while the OECD unemployment rate was at 4.9%, after a record low of 4.8% in September 2023. Global GDP growth is projected to remain unchanged in 2024 from 2023 and strengthen modestly only in 2025, with inflation returning to target in most countries by the end of 2025. The OECD-wide unemployment rate is projected to rise marginally over 2024-25, with employment growth expected to slow over the same period.
- **Labour force participation rates continued to increase in the OECD and reached a record high.** In Q1 2024, participation rates were 1.3 percentage points higher than at the end of 2019 on average across the OECD, with more than half of that increase occurring since early 2022.The increase affected all age groups, with older workers (aged 55 to 64) experiencing the highest increase. The OECD labour force participation rate reached 73.9% in Q1 2024 – the highest level since the series began in 2005. Record levels were reached for both men and women.
- **Gender gaps in employment rates and labour force participation are narrowing in many OECD countries since 2019.** In most OECD countries, the rise in the female employment rate in the four years to Q1 2024 outperformed that of men. Gender differences in the change in unemployment rates were generally small over the same period.
- **Labour market tightness is easing but remains generally high.** In Q4 2023, vacancy-to-unemployed ratios were below their peak in all countries where they increased significantly in the wake of the COVID-19 crisis. While low-pay industries played a significant role in driving the growth of overall imbalances in the past, latest data suggest that this no longer the case. Tensions remain however particularly high in the health sector.
- **Real wages are now growing on an annual basis in many OECD countries but remain below 2019 levels in about half of them**. In Q1 2024, yearly real wage growth was positive in 29 of the 35 countries for which data are available, with an average change across all countries of +3.5%. However, in Q1 2024, real wages were still below their Q4 2019 level in 16 of the 35 countries.
- **Statutory minimum wages are above their 2019 level in real terms in virtually all countries.** In May 2024, thanks to significant nominal increases in statutory minimum wages to support the lowest paid during the cost-of-living crisis, the real minimum wage was 12.8% higher than in May 2019 on average across the 30 OECD countries that have a national statutory minimum wage. The median increase, which is used because the average figure is affected by the particularly large increases in some countries, was at 8.3%. Both figures are quite significant compared to the increase in average/median wages.
- **Wages of low-pay workers have performed relatively better in many countries.** In 17 of the 33 countries with available data, real wages performed relatively better in low-pay industries than in both mid- and high-pay industries between 2019 and 2023. Results by education and occupation from selected countries also point to better performance of wages for the lower-paid groups.

- **While wages are recovering, unit profits growth has slowed down and turned negative in some countries.** After growing considerably and making unusually large contributions to domestic price pressures in 2021 and 2022**,** unit profits decreased in 14 of the 29 countries with available data over the last year – an indication that they have started to absorb some of the inflationary impact of increasing unit labour costs. In most countries, there is further room for profits to provide some buffering, given their significant growth over the past three years.

A special emphasis is placed in this chapter on job quality in OECD countries, as other aspects of jobs, beyond wages, need to be monitored to assess what has happened to workers' overall well-being following the COVID-19 pandemic and the recent cost-of-living crisis.

- **Earnings quality,** one of the three key indicators of the OECD Job Quality framework, **was generally better across the OECD in 2022 than in 2015.** Yet, data for 2022 show that, because of the acceleration in inflation and slow wage adjustment, earnings quality decreased between 2021 and 2022 in 26 of the 32 countries for which data are available. Earnings quality measures the extent to which the earnings received by workers contribute to their well-being, by taking account of the average level of earnings and the way earnings are distributed across the workforce.
- **Labour market security** (which measures the extent to which public income support for the unemployed mitigates the expected earnings loss associated with unemployment) **generally improved across the OECD between 2015 and 2022.** This positive pattern was driven by a decline in unemployment rates and improvements in unemployment insurance since 2015.
- **The quality of the working environment,** the third key indicator of job quality, is measured by job strain, a situation where workers have insufficient job resources to meet job demands. Results are only available for 2021, when **some 13% of workers experienced job strain on average for the 25 OECD European countries for which data are available**.

Looking ahead, it will continue to be important to strike a balance between allowing wages to make up some of the ground they have lost in terms of purchasing power and limiting further inflationary pressures. The most recent data are reassuring as they do not show signs of further acceleration in nominal wage growth, with some indicators even suggesting that it has slowed down. Some firms will find it more difficult to absorb further wage increases than others, with small and medium-sized firms likely to face greater constraints than large companies. Collective bargaining and social dialogue, when well-designed and implemented, can help identify solutions tailored to sectors and firms' different abilities to sustain further increase in wages and to promote policies and practices to enhance the growth in productivity needed to sustain real wage gains in the longer term.

Introduction

The last few years have been tumultuous, with significant negative shocks hitting the global economy in the aftermath of the COVID-19 crisis. Yet, labour markets in OECD countries have proven resilient, even when living standards came under intense pressure as inflation reached levels not seen in decades in many countries. This chapter reports on the latest developments in labour market indicators across the OECD and provides an update on the impact of the cost-of-living crisis on wages, leveraging a range of diverse national data sources.

Non-wage aspects of jobs also need to be monitored to understand trends in job quality in the wake of the COVID-19 pandemic and the recent cost-of-living crisis. Drawing on the conceptual framework developed by the OECD (Cazes, Hijzen and Saint-Martin, 2015[1]; OECD, 2014[2]) and then adopted by the G20 (G20, 2015[3]), the chapter also provides an update on the three key indicators of job quality across countries – earnings quality, labour market security and quality of the working environment.

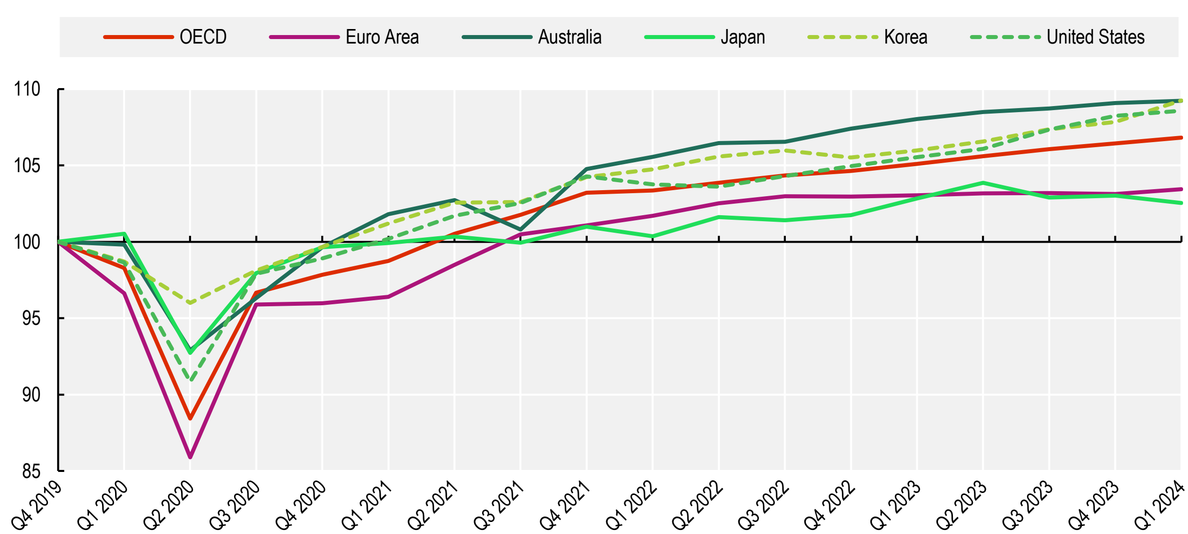
The chapter is organised as follows: Section 1.1 reviews recent labour market developments across the OECD countries; Section 1.2 reports on recent wage developments, including an update on statutory minimum wages and negotiated wages; and finally, Section 1.3 presents the latest OECD job quality indicators and analyses trends in these indicators since 2015. Section 1.4 concludes with policy recommendations.

1.1. Labour markets have proven resilient in the wake of adverse shocks

Global GDP growth has been moderate, but relatively resilient in 2023 despite the negative shocks from Russia's war of aggression against Ukraine and the sharp tightening of monetary policy to tackle high inflation. Growth was particularly strong in the United States and many emerging-market economies but saw a slowdown in most European countries (Figure 1.1). The attacks on ships in the Red Sea that started in Fall 2023, have raised shipping costs sharply and lengthened delivery times, disrupting production schedules and raising price pressures. According to the latest indicators, global GDP growth is projected to continue growing at a modest pace of 3.1% in 2024, the same growth as the 3.1% in 2023, followed by a slight pick-up to 3.2% in 2025 as financial conditions ease (OECD, 2024[4]).

Figure 1.1. GDP growth has been moderate with significant divergence between countries

Real GDP indexed to 100 in Q4 2019 in selected OECD countries, seasonally adjusted data



Note: Euro Area refers to the 20 Eurozone countries.
Source: OECD (2024), "Quarterly National Accounts", OECD National Accounts Statistics (database), https://doi.org/10.1787/data-00017-en (accessed on 12 June 2024).

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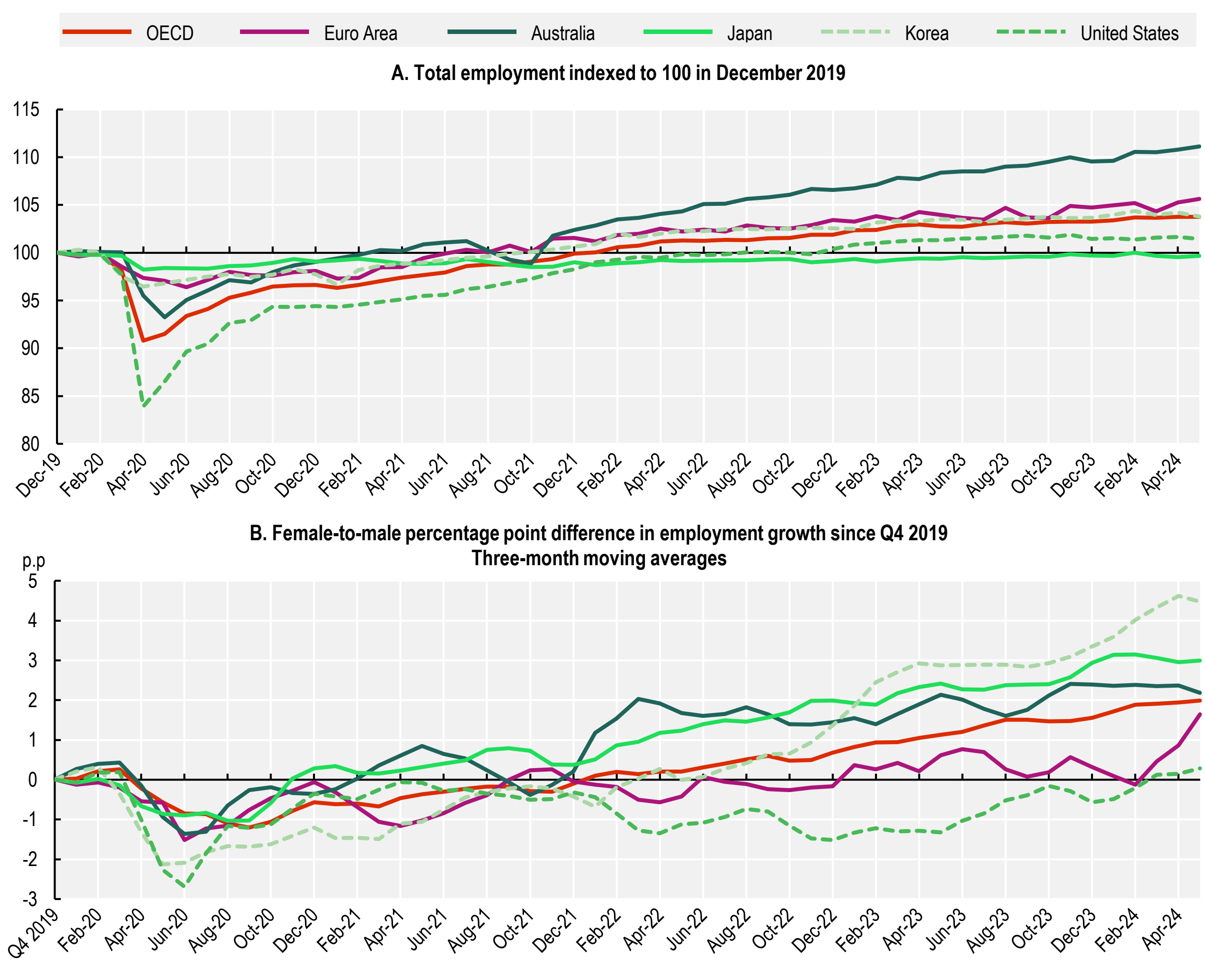
1.1.1. Employment growth has flattened and unemployment remains at historically low levels in most countries

Employment growth for the OECD area flattened over the course of 2023 and early months of 2024, with total employment reaching a level 3.8% higher than before the COVID-19 crisis by May 2024 (Panel A of Figure 1.2). While remaining positive year on year, total employment growth slowed down in all major OECD economies in recent months. Across the OECD, employment grew more for women than for men continuing a trend seen throughout the recovery from the COVID-19 crisis. By May 2024, on average across the OECD, women's total employment had grown about 2 percentage point more than men's, reaching 5.3% above its pre-crisis level. Women's employment performed particularly well in Australia, Japan, and Korea (Panel B of Figure 1.2).

Figure 1.2. Total employment stabilised in 2023 in the OECD

Series seasonally adjusted data, selected OECD countries



Reading: Panel B shows the difference in the growth rate of total employment between men and women since Q4 2019. By May 2024, on average across the OECD, women's total employment had grown about 2 percentage points more than men's, reaching 5.3% above its pre-crisis level.

Note: Euro Area refers to the 20 Eurozone countries. The OECD average and the Euro Area are derived from the OECD Monthly Unemployment Statistics estimated as the unemployment level times one minus the unemployment rate and rescaled on the LFS-based quarterly employment figures.

Source: OECD (2024), "Labour: Labour market statistics", *Main Economic Indicators* (database), https://doi.org/10.1787/data-00046-en (accessed on 9 July 2024).

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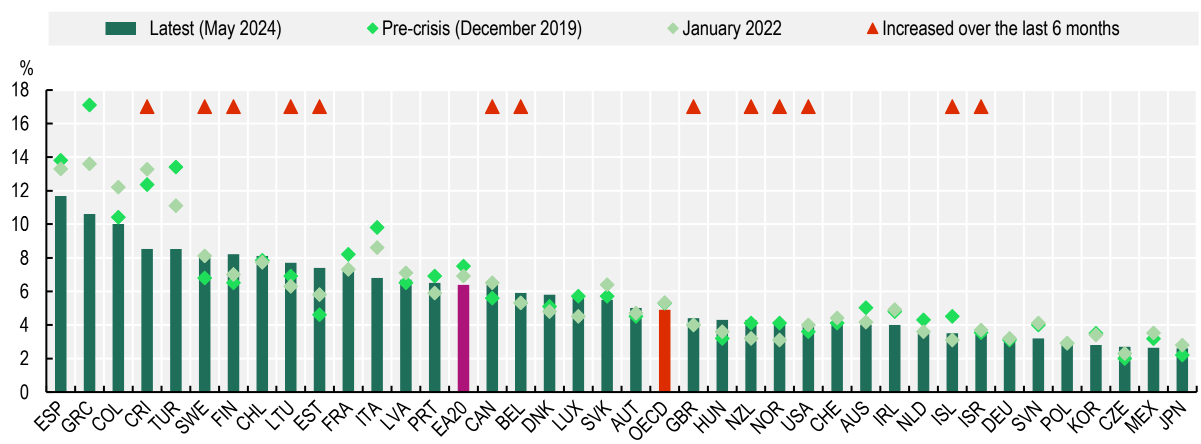
As for employment rates, they progressed more for women than for men in most OECD countries compared to pre-pandemic level, indicating that gender gaps in employment rates are narrowing in many OECD countries. Interestingly, data suggest that the higher the employment gender gap in Q4 2019, the greater was the growth in women's employment rate between Q4 2019 and Q1 2024 (Annex Figure 1.A.1).

Unemployment rates remain at historically low levels in many OECD countries (Figure 1.3). The unemployment rate for the OECD was already at its pre-COVID-19 level in January 2022 – before Russia's full-scale invasion of Ukraine. Since then, the unemployment rate declined by a further 0.4 percentage points and stood at 4.9% in May 2024 after a record low of 4.8% in September 2023. Unemployment rates are below their levels of January 2022 in 17 OECD countries, and above that level by more than 0.5 percentage points in 10 countries.

The most recent data also suggest stable unemployment rates across countries, with only 13 OECD countries having experienced an increase of more than a quarter of a percentage point over the past six months. Gender differences in the changes in unemployment rates between December 2019 and May 2024 are generally small: while not shown here, the gender gap in unemployment rates was rather stable on average for the OECD area except for Colombia, Costa Rica and Greece where it decreased by more than 2 percentage points.

Figure 1.3. Unemployment rates remain at historically low levels in many countries

Unemployment rate (percentage of labour force), seasonally adjusted data



Note: The labour force population includes all those aged 15 or more. Euro Area refers to the 20 Eurozone countries. The labour force population includes all those aged 15 or more. The latest month refers to **Q1 2024** for New Zealand and Switzerland; **February 2024** for Iceland, **March 2024** for the United Kingdom; **April 2024** for Chile, Costa Rica and Türkiye; and **June 2024** for Canada and the United States.
Source: OECD (2024), "Unemployment rate" (indicator), https://doi.org/10.1787/52570002-en (accessed on 9 July 2024).

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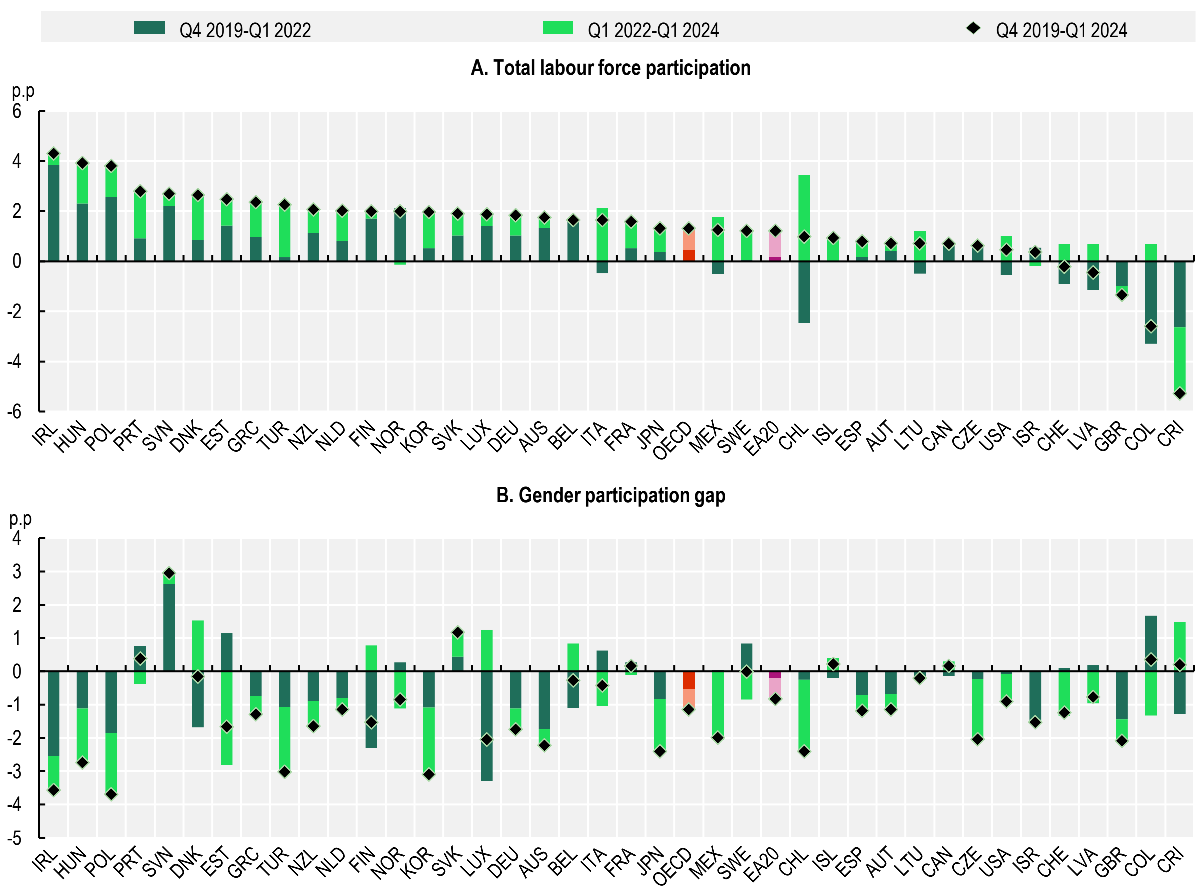
1.1.2. Labour force participation rates continue to increase while average hours worked are slightly below their pre-COVID-19 levels in several countries

Labour force participation rates among the working age population have continued to increase in most of the OECD countries over the past year or so[1] (Figure 1.4, Panel A). In Q1 2024, labour force participation rates were 1.3 percentage points higher than at the end of 2019 on average across the OECD. More than half of that increase occurred since the first quarter of 2022 as 32 of the 38 OECD countries continued to see their participation rates increase. Colombia, Costa Rica and the United Kingdom are the only three OECD countries where the labour force participation rate is below its pre-COVID-19 level by more than a percentage point. Within the working age population (aged 15-64), labour force participation rates have increased for all age groups, with older workers (aged 55 to 64) experiencing the largest increase on average across the OECD (1.9 percentage points since early 2022, for a total of 3.5 percentage points since the start of the COVID-19 crisis).[2]

Similarly to employment rates, labour force participation rates progressed more for women than for men compared to pre-pandemic level, so the gender gaps in participation rates narrowed in almost all OECD countries by 1.1 percentage point between Q4 2019 and Q1 2024 for the OECD area (Figure 1.4, Panel B).

Figure 1.4. Labour force participation rates have continued to increase over the past year

Percentage point change in labour force participation rates (persons aged 15-64), seasonally adjusted data



Note: The gender participation gap is defined as the male-to-female difference in the labour force participation rates. OECD is the unweighted average of the 38 OECD countries shown in this chart. Euro Area refers to the 20 Eurozone countries. p.p: percentage point. Countries are ordered by descending order of the percentage point change in labour force participation rates in Q4 2019-Q1 2024 (Panel A).

Source: OECD (2024), "Labour: Labour market statistics", Main Economic Indicators (database), https://doi.org/10.1787/data-00046-en (accessed on 25 June 2024).

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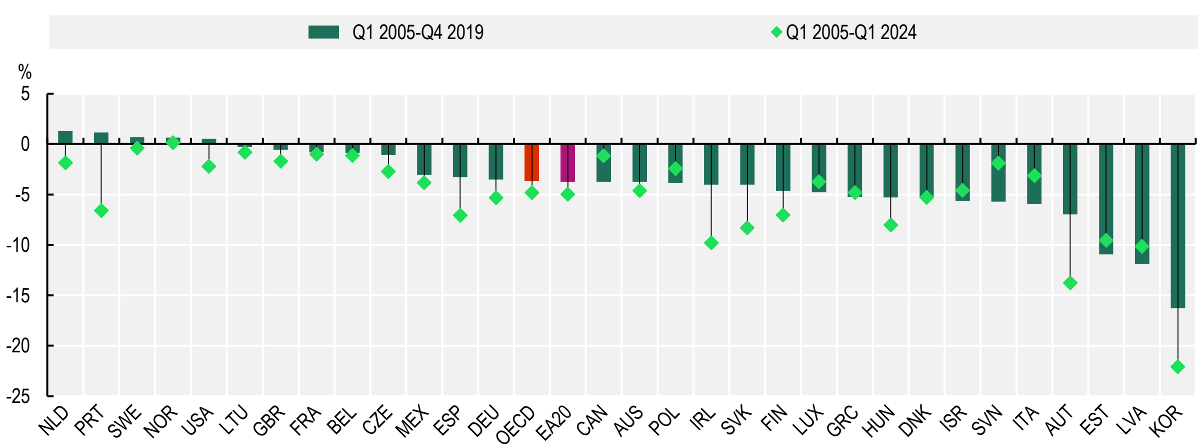
In Q1 2024, hours worked per employed person were below their pre-COVID-19 levels in 20 of the 31 countries with recent data available (Figure 1.5). The average decline in hours worked since Q4 2019 across all countries with available data is rather small – just above 1%.[3] In most countries, this decline follows a trend that pre-dates the COVID-19 crisis, though with some notable accelerations in Austria, Finland, Hungary, Ireland, Korea, the Slovak Republic and Spain. Among the five countries where hours worked had been increasing before the COVID-19 crisis, only the Netherlands, Portugal and the United States, saw a decline of more than 1% in the aftermath of the pandemic.

Evidence for Europe indicates that the decline in hours worked over the past 20 years is largely driven by an increase in part-time and a reduction in hours within jobs (as opposed to a compositional shift to jobs typically requiring fewer hours) (Astinova et al., 2024[5]; ECB, 2021[6]). However, the decline in average hours worked since the COVID-19 crisis has not been associated with widespread up-ticks in part-time employment. On the contrary, annual data for 2022 point to a slight decrease in the incidence of part-time in most OECD countries relative to 2019.[4]

Overall, the cross-country comparison does not lend support to the hypothesis of a generalised post-COVID change in preferences over work-life balance that might have reduced willingness to work, but more evidence is needed to understand patterns observed in specific countries.

Figure 1.5. The post-pandemic decline in average hours worked per worker is generally consistent with long-term trends

Percentage change, seasonally adjusted data



Note: Average hours worked per worker is defined as the total hours worked divided by total employment, except for **Belgium** where it refers to the average hours worked of employees, **Korea,** where it refers to the average usual weekly hours worked per employed, **New Zealand**, where it is defined as the total paid hours divided by filled jobs, and the **United States** where it refers to the average usual weekly hours worked per wage and salary workers. Statistics are not seasonally adjusted for Canada and Mexico and periods reported for those countries refer to Q4 2004-Q4 2019 and Q4 2004-Q4 2023, and Q4 2005-Q4 2019 and Q4 2005-Q4 2023, respectively. The latest quarter available refers to Q3 2023 for Israel, and to Q4 2023 for Belgium and the United Kingdom. OECD is an unweighted average of the 31 OECD countries shown in this Chart (not including Chile, Colombia, Costa Rica, Iceland, Japan, Switzerland and Türkiye). Euro Area refers to the 20 Eurozone countries.

Source: OECD (2024), "Quarterly National Accounts", *OECD National Accounts Statistics* (database), https://doi.org/10.1787/data-00017-en (accessed on 21 June 2024) for all countries except Australia, Korea, New Zealand, and the United States; Australian Labour Account (Australian Bureau of Statistics) for Australia, Economically Active Population Survey (Statistics Korea) for Korea, Quarterly Employment Survey (QES – Tables QEM034AA and QEM025AA, Stats NZ) for New Zealand, and Current Population Survey (CPS, Bureau of Labor Statistics) for the United States.

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For the United States, evidence suggests that people's willingness to work did decline significantly during the pandemic, as *potential hours worked* (i.e. a measure of hours people are willing to work) declined much more than the overall participation rate – an anomaly relative to other recessions. However, by mid-2022 *potential hours worked* began to increase more quickly than labour force participation suggesting that the impact of the pandemic – while prolonged – might have only been temporary (Bognar et al., 2023[7]). Similarly, it is too early to establish whether the increase in sick leave that took place in Europe after the pandemic can be seen as a permanent change (Arce et al., 2023[8]). On the demand side, labour hoarding by firms might have contributed to keeping average hours down in the last year or so as, faced with a slowdown in activity in some countries, firms might have preferred reducing hours to laying-off workers due to the expected difficulties in re-hiring workers (see Section 1.1.3).

1.1.3. Labour market tightness is easing but remains generally elevated

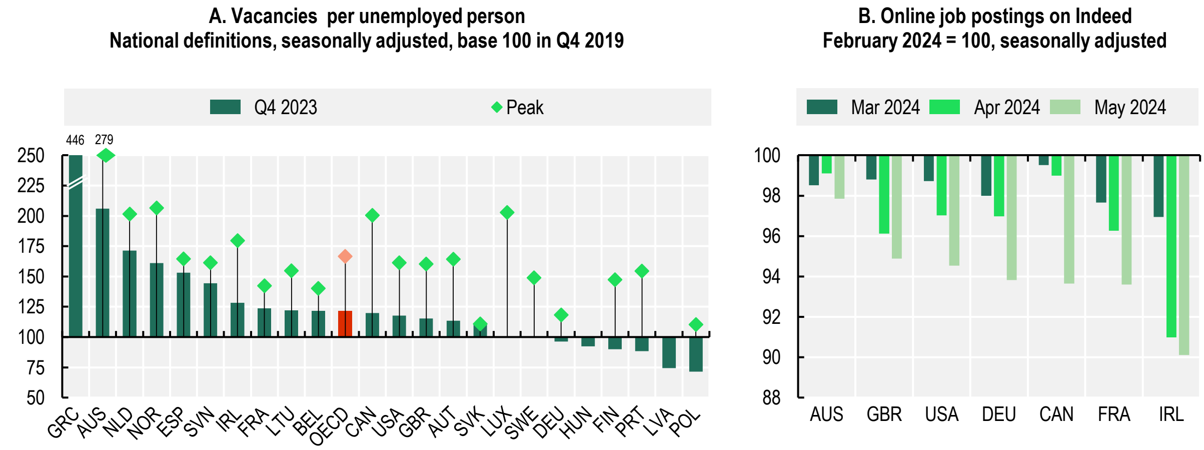
Amid the general slowdown in economic growth, labour market tightness (i.e. the number of vacancies per unemployed person) has eased in recent quarters but remains above pre-COVID-19 levels in many countries (Figure 1.6, Panel A). In Q4 2023, among the countries with available data, vacancy-to-unemployed ratios were below their peak in all countries where they had increased considerably after the COVID-19 crisis.

This picture drawing on vacancy-to-unemployment ratios[5] is completed with data on job postings to get information on the latest developments of labour demand: data on the online platform *Indeed* confirm a continued easing over the last months (Figure 1.6, Panel B). In May 2024, online job postings were below their February 2024 level in all seven countries with data available.

Imbalances between demand and supply have been widespread across industries. While low-pay industries played a significant role in driving the growth of overall imbalances in the past (OECD, 2023[9]), the latest data suggest that this is no longer the case. The visualisation, for 26 OECD countries with available data, of the increase in vacancy rates in each industry relative to the change at the country level shows indeed that the distribution of the red squares (i.e. sectors with high increases in vacancy rates relative to the country average) are not concentrated among low-pay industries anymore (Annex Figure 1.A.2). Tensions remain however particularly high in the health sector – which is the only one with higher-than-average increases in vacancy rates in over two thirds of the countries with data available (as shown in the far right column in Annex Figure 1.A.2).

Tight labour markets can push employers to offer better job packages, such as stable jobs or with a set of benefits (OECD, 2023[9]), but also to adjust wages, as evidenced by the pick-up in nominal wage growth over the past year or so (Section 1.2). They can also stimulate the participation of groups with lower labour market attachment. Moreover, lasting labour shortages may create incentives for firms to invest in technology and automation, which can have positive effects on productivity and wages. At the same time, labour shortages can also lower production and its quality, hinder innovation, and adoption of advanced technologies – at least if they concern high skill workers – and provide incentives for outsourcing and offshoring that are hard to reverse.

Figure 1.6. Labour markets remain tight in many countries even as pressure is easing



Note: OECD is the unweighted average of the 23 OECD countries shown in Panel A of this chart (not including Chile, Colombia, Costa Rica, Czechia, Denmark, Estonia, Iceland, Israel, Italy, Japan, Korea, Mexico, New Zealand, Switzerland and Türkiye). The peak (Panel A) refers to the maximum value of the number of vacancies per unemployed reached in Q4 2019-Q4 2023. For Hungary and Latvia, the number of vacancies per unemployed remains always below its Q4 2019 level and consequently there is no peak during the period considered. For Greece, the peak refers to Q4 2023.

In Panel A, statistics refer to the number of vacancies (see description below) divided by the number of unemployed (ILO definition). The definition of vacancies is not harmonised across countries. For **European countries** (except Austria, France, Germany, Hungary and Portugal – see below), a vacancy is defined as a paid post that is newly created, unoccupied, or about to become vacant for which the employer is taking active steps and is prepared to take further steps to find a suitable candidate from outside the enterprise concerned; and which the employer intends to fill either immediately or within a specific period. For **Australia**, a vacancy is defined as a job available for immediate filling and for which recruitment action has been taken by the employer. For **Austria**, a vacancy is defined as a job notified by firms to employment agencies which remain unfilled at the end of the month. For **Canada**, a vacancy is defined as a job meeting the following conditions: it is vacant on the reference date (first day of the month) or will become vacant during the month; there are tasks to be carried out during the month for the job in question; and the employer is actively seeking a worker outside the organisation to fill the job. The jobs could be full-time, part-time, permanent, temporary, casual, or seasonal. Jobs reserved for subcontractors, external consultants, or other workers who are not considered employees, are excluded. For **France**, a vacancy is defined as the monthly number of vacancies posted by companies in France Travail. For **Germany**, a vacancy is defined as a job of seven days' duration or more reported by employers to employment agencies to be filled within 3 months and remaining unfilled at the end of the month. For **Hungary**, a vacancy is defined as the number of vacancies notified to local labour offices as part of the central government territorial administrative unites. For **Portugal**, a vacancy is defined as the number of vacancies reported by employers to be still vacant at the last month of the quarter. For the **United Kingdom**, a vacancy is defined as a position for which employers are actively seeking recruits from outside their business or organisation (excluding agriculture, forestry, and fishing) based on the estimates from the Vacancy Survey. For the **United States**, a vacancy is defined as a job that is not filled on the last business day of the month and a job is considered open if a specific position exists and there is work available for it, the job can be started within 30 days, and there is active recruiting for the position.

In Panel B, online job postings on Indeed are indexed to 100 in January 2024.

Source: OECD (2024), "Labour: Registered unemployed and job vacancies (Edition 2023)", Main Economic Indicators (database), https://doi.org/10.1787/cee89a15-en (accessed on 29 May 2024) for Australia, Austria, Germany, Hungary, Portugal and the United Kingdom; Eurostat, Job vacancy statistics by NACE Rev.2 activity (Table jvs_q_nace2) for Belgium, Finland, Greece, Ireland, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, the Slovak Republic, Slovenia, Spain and Sweden, Job vacancies, payroll employees, and job vacancy rate (Statistics Canada) for Canada, Les demandeurs d'emploi inscrits à France Travail (DARES) for France; Job Openings and Labor Turnover Survey (Bureau of Labor Statistics, retrieved from FRED) for the United States; Indeed, Online Job Posting Tracker, https://github.com/hiring-lab/job_postings_tracker (accessed on 12 June 2024).

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Hence, addressing labour shortages requires unpacking the many and interconnected factors behind them − and whether they differ from pre-COVID labour markets. For instance, the working conditions in some segments of the health sector – such as the long-term care one – have received considerable attention in the wake of the pandemic with a renewed interest in policy solutions to improve the quality of jobs that are already facing significant recruitment difficulties and are expecting further growth in demand as a result of population ageing (OECD, 2023[9]). Box 1.1 presents some possible factors behind labour shortages.

Overall, a comprehensive multifaceted policy approach is needed to address labour shortages and the complex and interrelated factors driving them, stimulating labour supply among groups with lower participation rates, improving the working conditions of certain sectors and the skill and geographical match between labour demand and supply, as well as the efficiency of the matching process when there are workers with the right skills in the right place.

Box 1.1. Labour shortages in the post-COVID-19 era: Are they different?

Labour shortages have been a distinctive feature of post-COVID labour markets. While shortages initially appeared in sectors that were more heavily affected by the pandemic, they seem to have since spread to broad swathes of the labour force. Labour shortages are driven by a number of structural and cyclical interrelated factors. In several sectors (mostly high-skill ones) and countries, labour shortages had been steadily increasing *well before* the COVID-19 pandemic − at least since the Global Financial Crisis.

Factors driving shortages in the long term include demographic trends shaping the size and composition of the labour force; geographical and skill mismatches between labour demand and supply which can be exacerbated by the diffusion of AI and the digital and green transitions (see also Chapter 2); changes in workers' preferences concerning job quality and working conditions; and the efficiency of the matching process between labour demand and supply.

The significant increase in labour shortages in the post-COVID labour markets – especially in the low skilled, low pay sectors in the first years – appeared to be linked mostly to the surge in labour demand to catch-up after the COVID-19 crisis. While there is no indication of new significant mismatches induced by the recent crisis (Duval et al., 2022[10]), the rapid increase in labour market tightness might have contributed to a self-reinforcing mechanism whereby a strong labour market encourages workers to quit their jobs and leads to further vacancies being opened (Bognar et al., 2023[7]).

By contrast, there is little indication on the impact of labour supply changes on the rise of labour shortages: as reported in Section 1.1.2, labour force participation rates have increased for all age groups and the overall size of the labour force generally continues to grow. It is however possible that there might be changes in workers' preferences over different types of jobs, as well as changes in the composition of the workforce, with young workers not necessarily being willing to perform some of the jobs left by those who have retired.

The OECD webinar "Labour Shortages, today and tomorrow" organised on 18 March 2024 discussed labour shortages patterns across OECD countries. One important insight was the significant differences in the short-term patterns across the United States, the United Kingdom and Germany [1.] In the first two countries, workers seemed to have moved away from certain sectors with low pay and strenuous conditions, such as retail trade, food and hospitality and manufacturing, which led to important workers' turnover. Further indication for the United Kingdom suggests indeed that workers might have directed their search away from sectors that were badly hit during the COVID-19 crisis [2.] In Germany, such reallocation did not occur. As labour market tightness remains elevated in many OECD countries, more evidence will be needed about these patterns: further research will be typically important to understand the nature of ongoing workers turnover and identify the factors influencing mobility across jobs, notably those that might hinder flows towards occupations and sectors facing labour shortages.

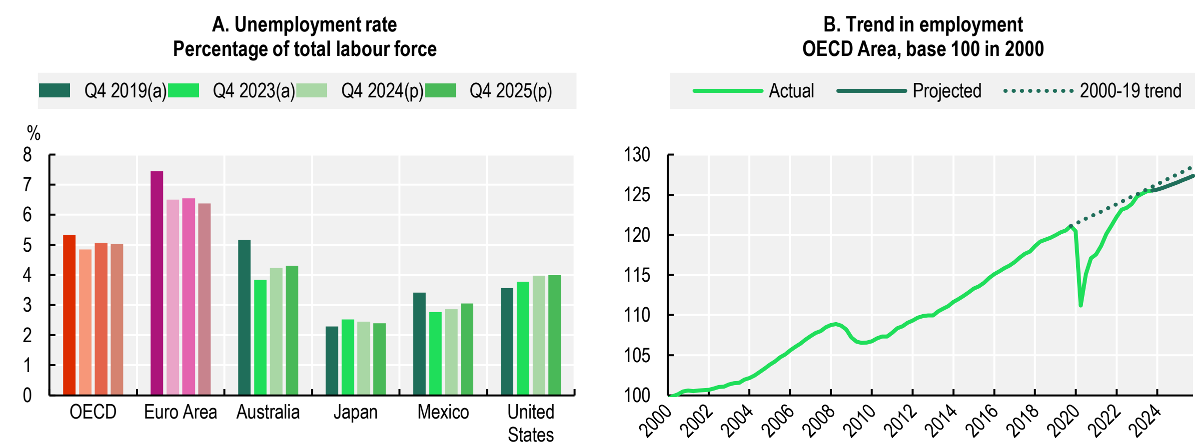
1. This draws on the panel discussion of the first session of the OECD webinar "Workers, wherefore art thou? Labour shortages, today and tomorrow", organised on 18 March 2024, as part of the Working Party on Employment Webinar Series, with the respective presentations by Nick Bunker, Director of North American Economic Research, *Indeed*, "Labour Demand and posted wage growth in the United States", Carlos Carillo-Tudela, Professor of economics at the University of Essex in the United Kingdom, "Job search and sectoral shortages in the United Kingdom" and Bernd Fitzenberger, Director of the IAB and Professor of Quantitative Labor Economics at Friedrich-Alexander - Universität-Erlangen-Nurnberg in Germany "Labour shortages in Germany".
2. https://covidjobsresearch.co.uk/labour-shortages/.

1.1.4. Economic growth in the OECD is expected to remain unchanged in 2024 and strengthens modestly in 2025, with marginal increase in unemployment and slowdown of employment growth

Global growth, which slowed in the second half of 2023, is expected to stabilise and then pick up slightly through 2024-25. In part, this reflects better momentum than expected in the United States and some emerging-market economies. Annual OECD GDP growth is projected to be at 1.7% in 2024 and edge up to 1.8% in 2025 (OECD, 2024[4]).

The OECD-wide average unemployment rate is projected to rise marginally over 2024-25 to 5% in the fourth quarter of 2025 (Figure 1.7). The OECD-wide employment growth is expected to slow from 1.7% in 2023 to around 0.7% per annum on average over 2024-25, below its 2000-19 trend (Figure 1.7).

Figure 1.7. Employment in the OECD is projected to continue to grow in 2024 and 2025, with the unemployment rate also inching up slightly



Note: (a) Actual value. (p) OECD projection. Euro Area refers to the 17 EU member states using the euro as their currency which are also OECD Member States. The 2000-19 trend refers to the average quarterly employment growth rate prevailing in Q1 2000 to Q4 2019.
Source: OECD (2024[4]), *OECD Economic Outlook, Volume 2024 Issue 1: Preliminary version*, https://doi.org/10.1787/69a0c310-en.

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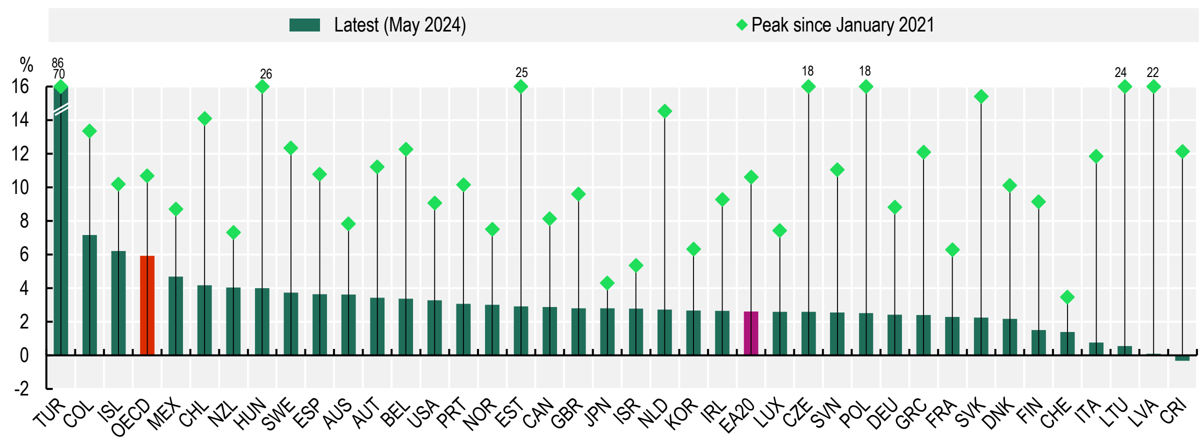
Significant uncertainty remains, however. Inflation may stay higher for longer, resulting in slower-than-expected reductions in interest rates and leading to further financial vulnerabilities. Growth could be disappointing in China, due to the persistent weakness of property markets or smaller than-anticipated fiscal support over the next two years. Another key downside risk to the outlook relates to the high geopolitical tensions, notably the uncertain course of Russia's war of aggression against Ukraine, the evolving conflict in the Middle East, and the associated risks of renewed disruptions in global energy and food markets. On the upside, demand growth could prove stronger than expected, if households and firms were to draw more fully on the savings accumulated during COVID-19 (OECD, 2024[4]).

1.2. Real wages are now growing in a number of countries but often remain below 2019 levels

Headline inflation has fallen virtually everywhere primarily because of the partial reversal of the very large rise in energy prices over the previous two years and is expected to further ease.[6] After peaking at over 10.7% in October 2022, OECD inflation almost halved reaching 5.9% in May 2024. However, inflation remained above the 2% target of central bank for 31 OECD countries – above 8% in Türkiye, and above 4% in five other OECD countries (Figure 1.8).

Figure 1.8. Inflation remains high but has declined significantly since the peak of 2022

Inflation defined as annual percentage change in the consumer price index (CPI), May 2024



Note: For Australia and New Zealand, statistics refer to year-on-year changes in Q1 2024. Values on top refer to peaks of inflation above 16%. Euro Area refers to the 20 Eurozone countries.
Source: OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 02 July 2024).

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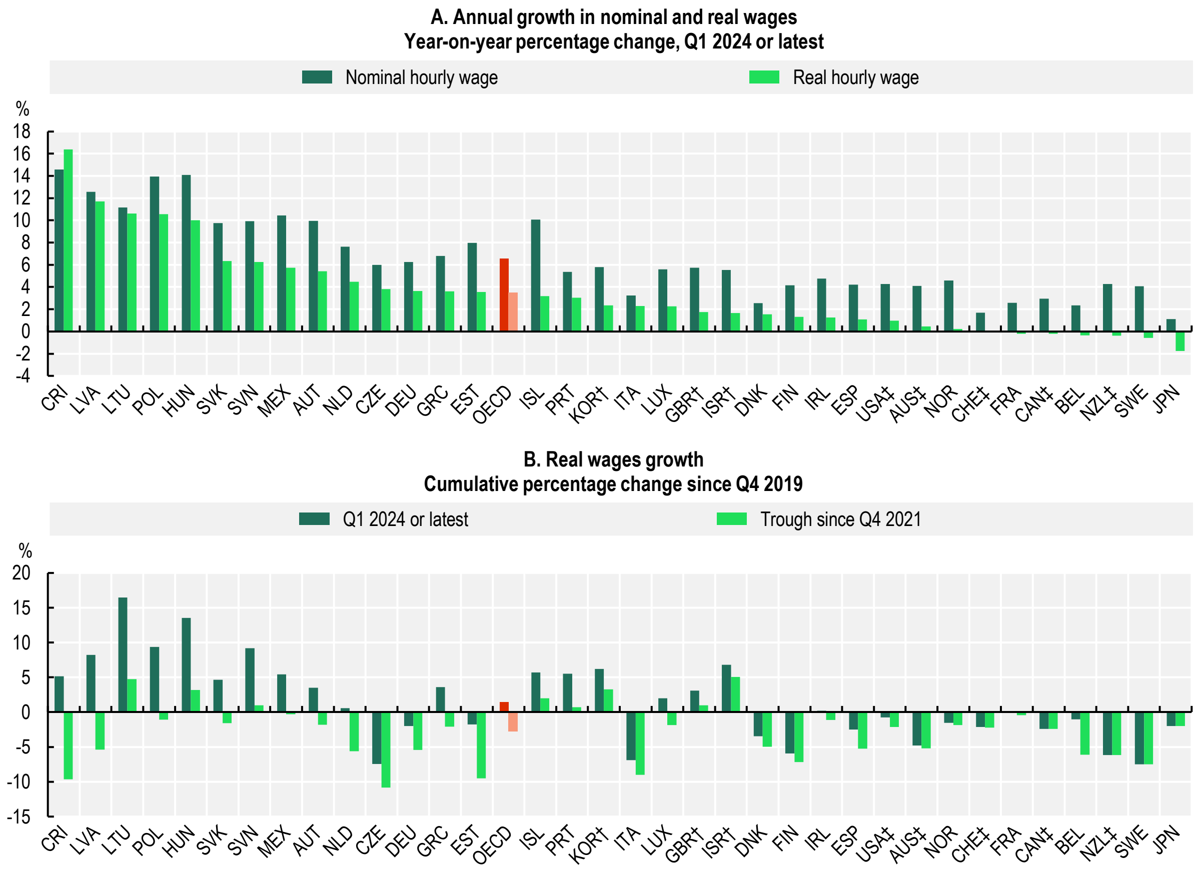
1.2.1. Real wages are now growing year-on-year, but they remain below 2019 levels in many countries

Year-on-year real wage growth turned positive in an increasing number of countries over the last year, as inflation declined and nominal wage growth picked up.[7] According to the latest data for Q1 2024, yearly real wage growth was positive in 29 of the 35 countries with available data, with an average change across all countries of +3.5%. In Belgium, Canada, France, Japan, New Zealand and Sweden, the annual real wage growth was still negative in Q4 2024 but relatively moderate – with real wages decreasing less than 1% over the year except for Japan[8] (Figure 1.9, Panel A).

Data on selected countries for different wage indicators and posted wages in online vacancies suggest that real wage growth has continued to improve in the first months of 2024. This is generally the result of moderating inflation while nominal wage growth has remained stable with some indication of a possible deceleration in posted wages (Box 1.2).

Several factors contributed to the general improvement in annual real wage growth over the last year, including tight labour markets (Section 1.1.3), increases in statutory minimum wages (see Section 1.2.2), and the adjustment of negotiated wages (catch-up process and new collective agreements being renegotiated – Box 1.3).

Figure 1.9. While real wage growth has turned positive in 2023, it remains below 2019 levels in several countries



Note: Otherwise indicated, nominal hourly wages refer to a constant-industry-structure “wages and salaries” component of the labour cost index. Statistics refer to the private sector only for Costa Rica, Japan, Korea, Mexico and the United States. Nominal wage series are seasonally adjusted for all countries except for Canada, Costa Rica, Israel, Japan, Korea, Mexico, New Zealand and Switzerland. Nominal hourly wage presents a significant amount of unreported income for Mexico.

†: Nominal hourly wage refers to the actual wage i.e. without any adjustment for sources of compositional shifts for Costa Rica, Israel, Korea, Mexico and the United Kingdom, and thus comparing these results with the other countries requires caution. Moreover, nominal hourly wage refers to the average monthly wages per employee job for Israel, and to the average weekly earnings for the United Kingdom.

‡: Nominal hourly wage controls for additional sources of compositional shifts, such as regions for Australia, Canada and New Zealand, job characteristics and workers’ characteristics for Australia and New Zealand, gender for Switzerland, and occupations for the United States. For Switzerland, the quarterly estimates refer to the annual Swiss wage index.

Real hourly wage is estimated by deflating the nominal hourly wage by the consumer price index (CPI-all items) which is adjusted, for the purpose of this analysis, using the X-13ARIMA-SEATS Seasonal Adjustment Method. Cumulative percentage changes in real wages since Q4 2019 (Panel B) obtained with these adjustments do not differ substantively from those obtained without any adjustments as reported in the Annex Figure 1.A.3.

Countries are ordered by descending order of the year-on-year change in real hourly wages (Panel A). OECD is the unweighted average of the 35 OECD countries shown in this chart (not including Chile, Colombia and Türkiye). The trough (Panel B) refers to the quarter where real hourly wages were at their lowest value for the indicated country since Q4 2021. The annual growth in nominal and real wages (Panel A) refers to Q3 2023 for Israel, and Q4 2023 for Canada, Costa Rica, Japan, Korea, Mexico and New Zealand, and the cumulative percentage change (Panel B) refers to Q3 2019-Q3 2023 for Israel and Q4 2019-Q4 2023 for Canada, Costa Rica, Japan, Korea, Mexico and New Zealand.

Source: OECD calculations based on the Wage Price Index (Australian Bureau of Statistics) for **Australia**; the Fixed weighted index of average hourly earnings for all employees (Statistics Canada) for **Canada**; the Encuesta Continua de Empleo (Instituto Nacional de Estadística y Censos) for **Costa Rica**; the Labour cost index by NACE Rev. 2 activity (Eurostat) for the **European countries** except the United Kingdom; the Wages and Employment Monthly Statistics (Central Bureau of Statistics) for **Israel**; the Monthly Labour Survey (Ministry of Health, Labour and Welfare) for **Japan**; the Labour Force Survey at Establishments (Ministry of Employment and Labour) for **Korea**; the Encuesta Nacional de Ocupación y Empleo y Encuesta Nacional de Ocupación y Empleo Nueva Edición (Instituto Nacional de Estadística y Geografía) for **Mexico**; the Labour Cost Index (Stats NZ) for **New Zealand**; the Swiss Wage Index (Federal Statistical Office) for **Switzerland**; the Monthly Wages and Salaries Survey (Office for National Statistics) for the **United Kingdom**; and Employment Cost Index (Bureau of Labor Statistics, retrieved from FRED) for the **United States**. OECD (2024), “Prices: Consumer prices”, Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 18 June 2024).

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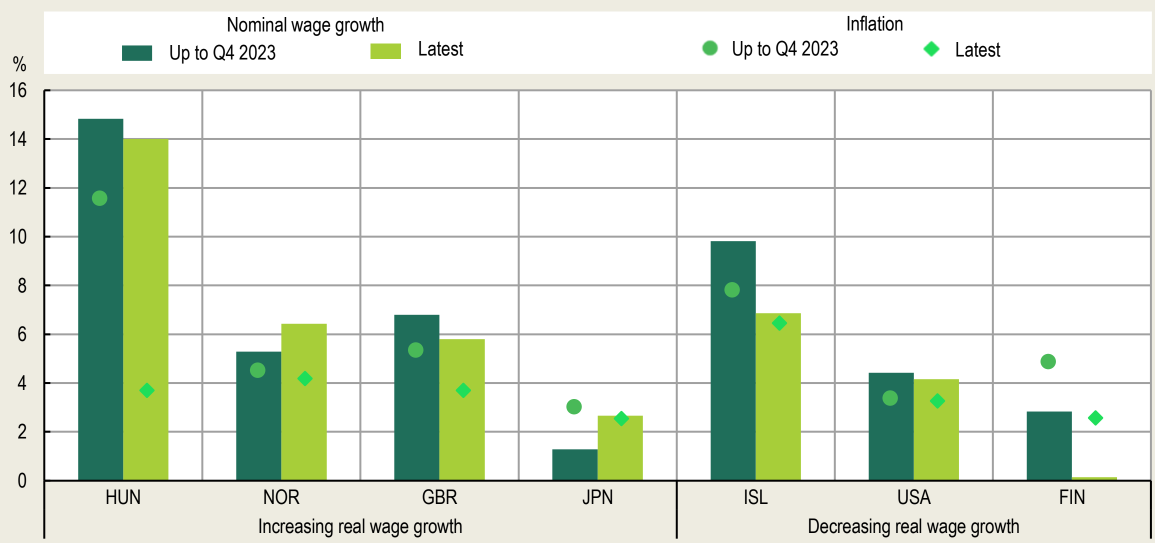
Despite the recent pick-up in their year-on-year growth, real wages remain below their pre-COVID-19 levels in most countries, even though the average change across all 35 countries with available data is positive (Figure 1.9, Panel B).[9] By Q1 2024, real wages had recovered at least some of the lost ground in 23 of the 27 countries in which they fell in the aftermath of the COVID-19 crisis – rising above pre-pandemic levels in 11 of them. However, real wages remained well below their pre-pandemic levels in virtually all countries where they fell the most. Overall, in Q1 2024, real wages were still below their Q4 2019 level in 16 of the 35 countries with available data.

Box 1.2. Data for selected countries point to continued improvement in real wage growth in recent months generally driven by declining inflation

For a limited number of countries, it is possible to gain insights on very recent wage developments using monthly data. This analysis is subject to the caveat that the underlying measures differ between countries (and from those used in the main analysis in Figure 1.10) and are generally not seasonally adjusted.

Figure 1.10. Monthly data point to continued improvement in real wage growth

Year-on-year percentage change



Note: Up to Q4 2023 refers to the average of the monthly observations of the six months ending to December 2023. Latest refer to the average of all monthly observations available after December 2023. The last available data point is April 2024 for Finland, Hungary, Japan, Norway and the United Kingdom; and May 2024 for Iceland and the United States. For Norway, earnings observed in April 2024 corresponds to the preliminary value. Real wage growth is "increasing" ("decreasing") where the year-on-year percentage change in the average real wage over January to April 2024 is higher (lower) than the year-on-year percentage change in the average real wage over July to December 2023.

Source: OECD calculations based on the Wage and salary indices by industry (Statistics Finland) for **Finland**; the Main earnings data (Central Statistics Office) for **Hungary**; the Wage indices by sector and month (Statistics Iceland) for **Iceland**; the Monthly Labour Survey (Ministry of Health, Labour and Welfare) for **Japan**; the Number of employment and earnings (Statistics Norway) for **Norway**;; the Monthly Wages and Salaries Survey (Office for National Statistics) for the **United Kingdom**; and the Current Employment Statistics (Bureau of Labor Statistics, retrieved from FRED) for the **United States**; OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 26 June 2024).

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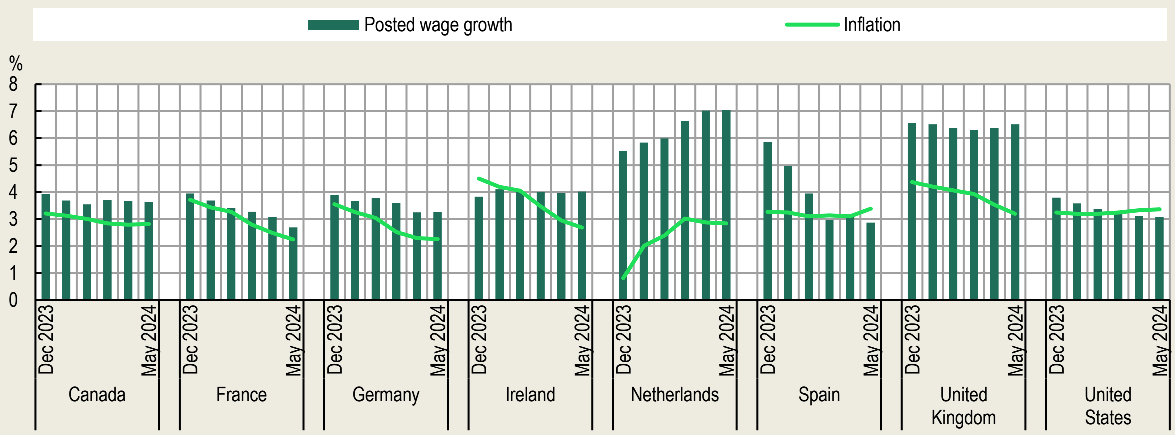
That being said, the data for the months since the end of Q4 2023 point to an improvement in annual real wage growth in four of the seven countries with available data. This is generally driven by a decline in inflation rather than an increase in nominal wage growth.

Data from wages advertised in job postings on the online platform *Indeed* show improving or stable real wage growth in all countries with available data, except Spain and the United States (Figure 1.11). Consistently with the results above, where real wage growth is increasing, this is mainly driven by a fall in inflation rather than a significant up-tick in nominal wage growth. In fact, these data point to a decrease in nominal wage growth in five of the eight countries with available data (Canada, France, Germany, Spain, and the United States).

Figure 1.11. Posted wages point to a recent slowdown in nominal wage growth

Year-on-year percentage change, three-month moving averages, from December 2023 to May 2024



Note: The posted wages are the average year-on-year percentage changes in wages and salaries advertised by job postings on Indeed.
Source: Indeed Wage Tracker (https://github.com/hiring-lab/indeed-wage-tracker); OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 25 June 2024).

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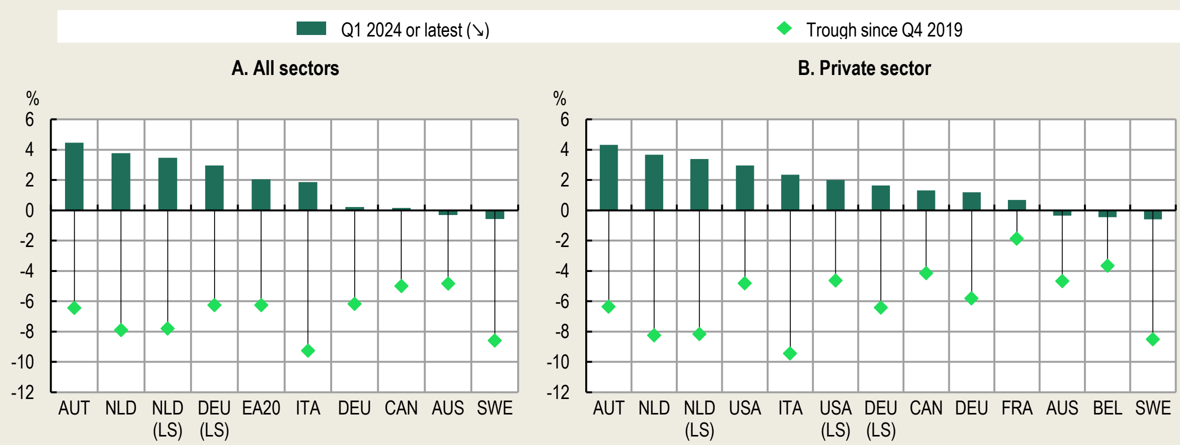
Box 1.3. Year-on-year growth in real negotiated wages has improved and remained negative only in a few countries in early 2024

Real growth in negotiated wages has improved over the course of 2023 and remained negative only in a few countries (Figure 1.12). In Q1 2024, negotiated wages were increasing in real terms on an annual basis in Austria, Canada, the Euro Area, Germany, Italy, the Netherlands, and the United States but continued to slightly decline in Australia and Sweden and stabilised, after one year of steady growth, in Belgium (Annex Figure 1.C.2). These developments reflect a combination of factors, including the staggered and infrequent nature of collective bargaining, the delay between the date of completion of negotiations and the effective revisions of pay, the infrequent use of automatic indexation to inflation, and the strength of workers' bargaining power (Araki et al., 2023[11])). Overall, as more rounds of negotiation take place affecting an increasing number of workers, real growth in negotiated wages turns positive in more countries for some time, recovering some of the lost ground.

For Europe, the European Central Bank (ECB) indicator of future wage growth embedded in agreements reached in the latest quarter points to continuing growth in nominal wages, without signs of acceleration (Lane, 2024[12]). In fact, the latest release saw an increase in negotiated wage growth in the first quarter of 2024 to 4.7% – after it slightly moderated from 4.7% in the third quarter 2023 to 4.5% in the fourth quarter of 2023. Further agreements are expected to be renewed in 2024 which might have a significant impact on the dynamics of negotiated wages in the coming quarters.

Figure 1.12. Real negotiated wages in selected OECD countries

Year-on-year percentage change in real negotiated wages (i.e. resulting from collective agreements)



Note: International comparability of data on negotiated wages is affected by differences in definitions and measurement. Statistics are representative of all employees covered by a collective wage agreement for Austria, Belgium, the Euro Area (20), France, Germany, Italy, the Netherlands, Sweden, and the United States. In Canada, statistics refer to collective bargaining settlements of all bargaining units covering 500 or more employees (units of 100 or more employees for the Federal Jurisdiction). For Australia and Canada, statistics refer only to employees affected by an increase of the negotiated wage at date. Wage increases in Austria, Belgium, the Euro Area (20), Germany, Italy, the Netherlands, Sweden, and the United States refers to the average increase in negotiated wages (wages of union workers for the United States) weighted by the employment composition for a reference year (Laspeyres index). The reference year of the employment composition used is 2009 for Sweden, 2010 for Belgium and the Netherlands, January 2015 for the Euro Area (20), 2015 for Germany and Italy, 2016 for Austria, and 2021 for the United States. For Australia, Canada and France, wage increases refer to the average increase in negotiated wages weighted by the number of employees affected in the period considered. In Panel B, private sector for Germany refers to all industries excluding agriculture, public administration, education, health, and other personal services (Sections B to N of the NACE rev. 2).
LS: wages including lump sums and/or special payments. The **trough** refers to the quarter where the year-on-year percentage change in real negotiated wages was at its lowest value for the indicated country and series (basic wage or wage including lump sums) since Q4 2019.
Source: OECD calculations based on national data on negotiated wages, see Annex Table 1.C.3.in (Araki et al., 2023[11]) for further details; and OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 28 June 2024).

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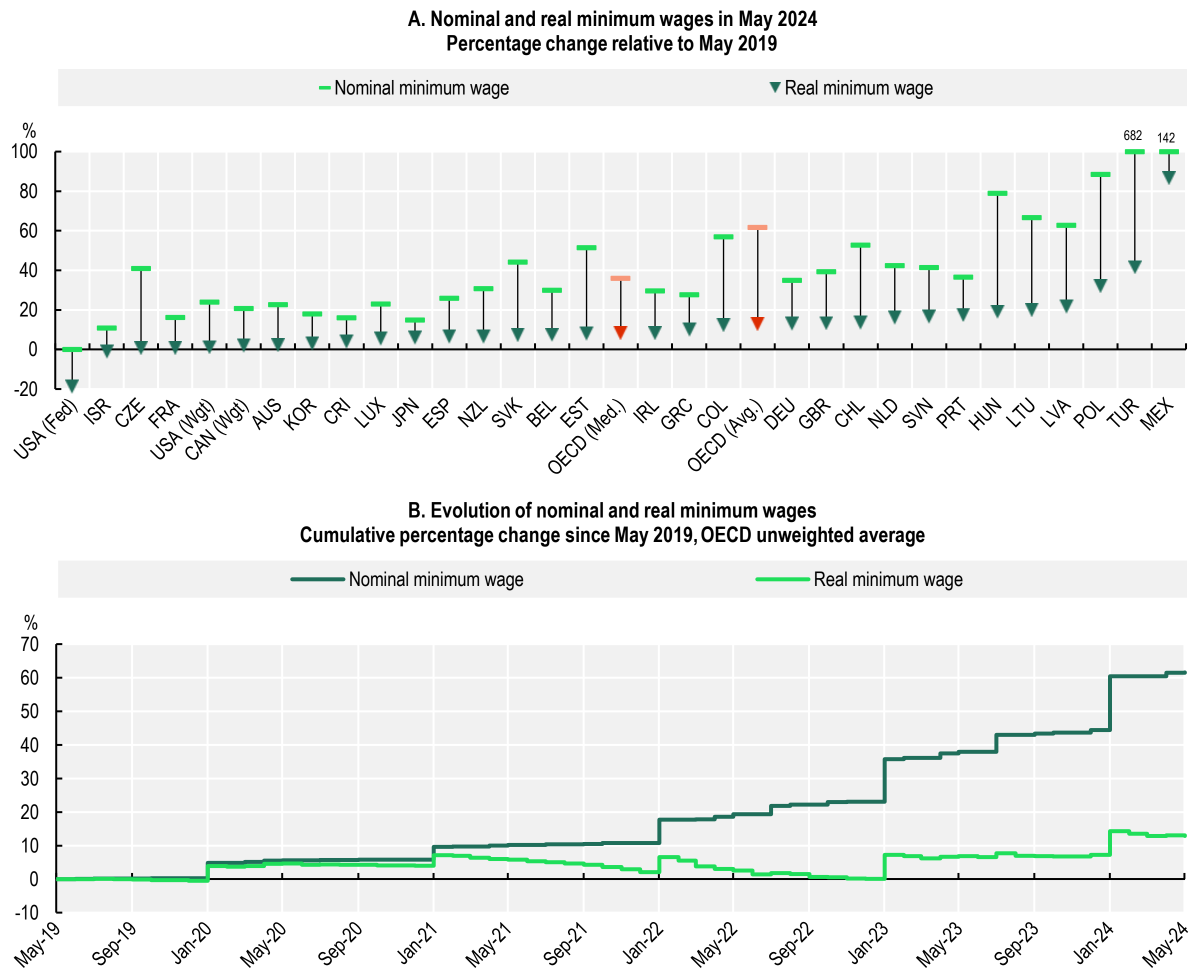
1.2.2. Wages of low pay workers have performed relatively better in many countries

Statutory minimum wages in real terms are above their 2019 level in virtually all countries

In May 2024, thanks to significant nominal increases of statutory minimum wages to support the lowest paid during the cost-of-living crisis, the real minimum wage was 12.8% higher than in May 2019 on average across the 30 OECD countries that have a national statutory minimum wage in place. This average figure is heavily influenced by the increases of more than 20% in Latvia, Lithuania, Mexico, Poland and Türkiye. However, the median increase, which is unaffected by outliers, was 8.3%, which is still quite significant compared to the increase in median wages.

The real value of the statutory minimum wage was below its level of 2019 in two countries – Israel and the United States. In the United States the federal minimum wage has not changed since 2009, but state-level minimum wages have often increased in recent times raising the employment-weighted average real value of the minimum wage (Figure 1.13, Panel A).

Figure 1.13. Real minimum wages are above 2019 levels in virtually all countries



Note: "OECD (Avg.)" is the unweighted average of 30 OECD countries with a statutory minimum wage shown in this chart, except the United States (weighted); "OECD (Med.) is the median values across the same countries. Canada (weighted) is a Laspeyres index based on minimum wage of provinces and territories (excluding the Federal Jurisdiction) weighted by the share of employees of provinces and territories in 2019. United States (weighted) is a Laspeyres index based on minimum wage of states (not including territories like Puerto Rico or Guam) weighted by the share of nonfarm private employees by state in 2019. Change in real minimum wage for New Zealand (Panel A) is estimated by assuming that the CPI in May 2024 is the same as in Q1 2024. For further details on the minimum wage series used in this chart, current and planned minimum wage uprating in 2024, and the evolution of nominal and real minimum wages since May 2019 by country, see Annex 1.C.
Source: OECD Employment database, www.oecd.org/employment/emp/onlineoecdemploymentdatabase.htm, OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 02 July 2024), and Australian Bureau of Statistics (May 2024), Monthly Consumer Price Index Indicator, ABS Website, accessed on 02 July 2024) for Australia.

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Minimum wages have been able to keep up with inflation thanks to either automatic or discretionary increases introduced by countries (Araki et al., 2023[11]). Over the course of 2021 and 2022, the real gains from these adjustments quickly vanished on average across countries as inflation continued to increase (Figure 1.13, Panel B). In early 2023, many countries implemented significant nominal increases in the minimum wage that brought its average real value around 8% above its 2019 level. As inflation moderated, these real gains generally persisted over 2023 and were then strengthened by the new wave of nominal adjustments of January 2024.

There are indications of an increase in wage compression at the bottom of the wage distribution as proxied by industry and education

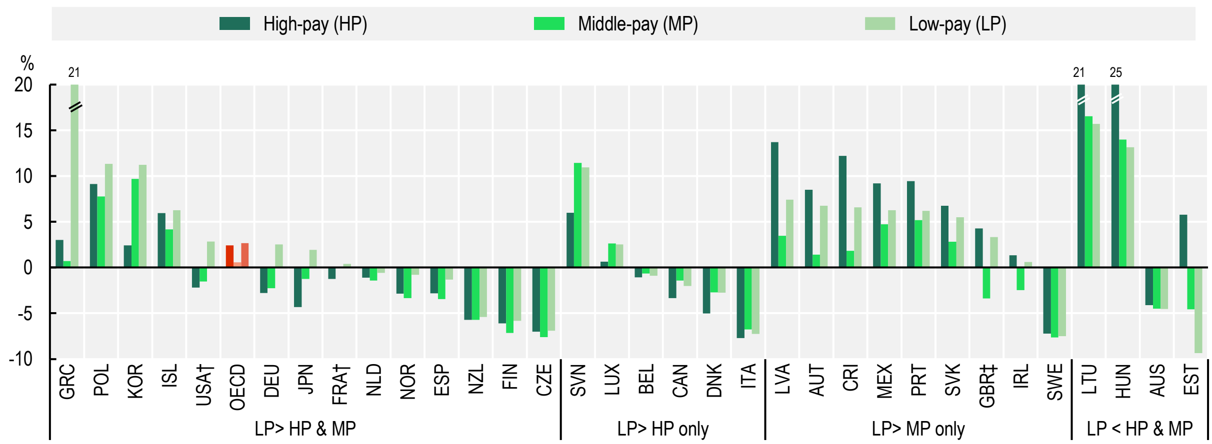
Since data on individual wages become available only with a significant lag for most countries, it is not yet possible to assess comprehensively how the recent wage crisis has affected wage inequality across countries. To provide some preliminary insights on how workers of different pay levels have fared, it is however possible to look at the evolution of wages by industry for most OECD countries and by , education, and percentiles of the wage distribution for five countries with data already available.

To offer an overview of wage developments by industry between Q4 2019 and Q1 2024, Figure 1.14 reports changes in real wages by industries aggregated in three broad groups: low-pay industries (accommodation and food services, administrative and support services, arts, entertainment and recreation, wholesale and retail trade); mid-pay industries (transportation and storage, manufacturing, other services, real estate activities, and construction); and high-pay industries (human health and social work, education, professional activities, information and communication, and finance and insurance). Industries are weighted by employment shares within each group.

Across the OECD, there is a pattern of compression of wages across workers of different pay levels, as proxied by industry wages, particularly at the bottom of the distribution. In 17 of the 33 countries with available data, real wages performed relatively better in low-pay industries than in both mid- and high-pay industries – either because they grew more or fell less. In nine other countries, real wages in low-pay industries outperformed mid-pay industries but not high-pay ones. Low-pay industries had the worst wage performance only in four countries, losing more than 1 percentage point relative to both mid- and high-pay industries only in Estonia.

Figure 1.14. Real wages in low-pay industries have performed relatively better in most countries

Percentage change in real hourly wages between Q4 2019 and Q1 2024



Note: Real wages are obtained by deflating nominal wages by consumer price inflation (all items) which are adjusted, for the purpose of this analysis, using the X-13ARIMA-SEATS Seasonal Adjustment Method. Industries are ranked by the median wage in 2019 in the European Structure of Earnings Survey (SES). The ranking of industries is broadly consistent when 2019 data on median wages from the Current Population Survey of the United States are used. **Low-pay industries (LP)** include Accommodation and food service, Administrative and support service, Arts, entertainment and recreation and Wholesale and retail trade. **Middle-pay industries (MP)** include Transportation and storage, Manufacturing, Other service, Real estate activities and Construction. **High-pay industries (HP)** include Human health and social work, Education, Professional activities, Information and communication and Finance and insurance. Average employment shares by industry over the four quarters of 2019 are used for aggregation and thus small inconsistencies between changes in wages by industry and changes in average wages are possible. Statistics refer to the percentage change in real hourly wages between Q4 2019 and Q4 2023 for Australia, Canada, Costa Rica, Japan, Korea, Mexico, the Netherlands, New Zealand, the United Kingdom and the United States. OECD is the unweighted average of the 33 OECD countries shown in this chart (not including Chile, Colombia, Israel, Switzerland and Türkiye).

†: There are missing industries: Arts, entertainment and recreation is not included for the United States; Human health and social work and Education are not included for France.

‡: Average weekly earnings are used for the United Kingdom. Moreover, wages in the public sector are excluded for Costa Rica, Japan, Korea, Mexico, the United Kingdom and the United States.

Source: OECD calculations based on the Wage Price Index (Australian Bureau of Statistics) for **Australia**; Fixed weighted index of average hourly earnings for all employees (Statistics Canada) for **Canada**; Encuesta Continua de Empleo (Instituto Nacional de Estadística y Censos, Costa Rica) for **Costa Rica**; the wages and salaries component of labour cost index by NACE Rev. 2 activity (Eurostat) for **European** countries; Monthly Labour Survey (Japanese Ministry of Health, Labour and Welfare) for **Japan**; Labour Force Survey at Establishments (Korean Ministry of Employment and Labour) for **Korea**; Nacional de Ocupación y Empleo, Encuesta Telefónica de Ocupación y Empleo, Encuesta Nacional de Ocupación y Empleo Nueva Edición (Instituto Nacional de Estadística y Geografía, Mexico) for **Mexico**; Labour Cost Index (Statistics New Zealand) for New Zealand; Swiss Wage Index (Swiss Federal Statistical Office) for **Switzerland**, Monthly Wages and Salaries Survey (UK Office for National Statistics) for the **United Kingdom**; and Employment Cost Index (U.S. Bureau of Labor Statistics, retrieved from FRED) for the **United States**; OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 18 June 2024).

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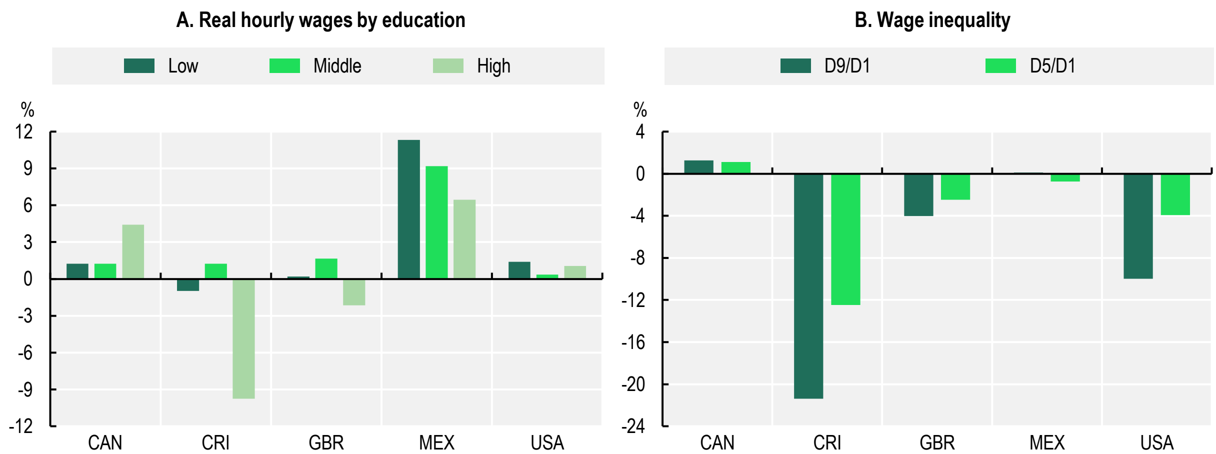
Results by education for the five countries with available data also provide additional support for a general pattern of wage compression, especially at the bottom of the distribution (Figure 1.15). Between 2019 and 2023, real wage growth was stronger for the low- and mid-pay groups by education in four of the five countries (Costa Rica, Mexico, the United Kingdom, and the United States). Canada was the only country among those with available data where real wages grew more for the highest educated.

Figure 1.15. Changes in real wages by education and wage inequality

Percentage change between Q4 2019 and Q4 2023



Note: The level of education is classified according to the International Standard Classification of Education (ISCED 2011) as follows: **"Low"** (ISCED 0-2: early childhood education, primary education, and lower secondary education); **"Middle"** (ISCED 3-4: upper secondary education and post-secondary non-tertiary education); **"High"** (ISCED 5-8: short-cycle tertiary education, bachelor's or equivalent level, master's or equivalent level, and doctoral or equivalent level). **D9/D1**: ratio of the top (9th decile) and the bottom of the earnings distribution (1st decile). **D5/D1**: ratio of the median (5th decile) and the bottom of the earnings distribution (1st decile).
Source: OECD estimations based on the Labour Force Survey (Statistics Canada) for **Canada**, the Encuesta Continua de Empleo (Instituto Nacional de Estadística y Censos) for **Costa Rica**, the Encuesta Nacional de Ocupación y Empleo, Encuesta Telefónica de Ocupación y Empleo, Encuesta Nacional de Ocupación y Empleo Nueva Edición (Instituto Nacional de Estadística y Geografía) for **Mexico**, the Labour Force Survey (Office for National Statistics) for the **United Kingdom**, and the Current Population Survey (Bureau of Labor Statistics) for the **United States**. OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 15 May 2024).

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Among the same five countries, there is some indication that overall wage inequality might have decreased since 2019 in Costa Rica, the United Kingdom, and the United States, but not in Canada and Mexico (Figure 1.15, Panel B). The largest reductions in inequality occurred in the two countries with the highest initial level of inequality – Costa Rica and the United States.

More granular data on wages are necessary to provide a comprehensive assessment of changes in wage inequality and their determinants. Wage dynamics could vary across the wage distribution due to several factors, including developments in labour demand and supply, minimum wage laws, collective bargaining, and employer monopsony power. Cross-country analysis attempting to explain differences in wage dynamics across industries over the past two years has been inconclusive and is hindered by limited sample sizes and the presence of many confounding factors (Araki et al., 2023[11]).

To date, the only detailed country-specific study is that by Autor et al. (2023[13]) on the United States who document a significant reduction in wage inequality in line with the results presented above. In fact, they report a reduction in the college premium and a remarkable compression of the wage distribution which counteracted almost 40% of the four-decade increase in aggregate inequality between the 10th and 90th percentile. They find that the pandemic increased the elasticity of labour supply to firms in the low-wage labour market, reducing employer market power and spurring rapid wage growth at the bottom. Among the possible drivers, the authors mention a decrease in work-firm attachment spurred by the large number of separations that occurred during the pandemic. By contrast, they find that the fall in inequality is not explained by (state-level) changes in minimum wages.

Lower wage inequality can lead to a mix of social and economic benefits and challenges. On the positive side, lower wage disparities tend to reduce overall income inequality which can increase social cohesion, reduce social tensions, and enhance economic growth by allowing more people to develop their human capital (OECD, 2015[14]; OECD, 2018[15]). However, high wage compression can pose efficiency challenges if wages do not reflect productivity or the demand for specific skills (OECD, 2018[15]; OECD, 2018[16]).

It is nevertheless critical to bear in mind the specific context in which the recent wage developments have taken place. Most notably, the recent increases in minimum wages relative to average wages were generally aimed at providing some protection for the most vulnerable workers against the cost-of-living crisis, spreading the cost of inflation equitably between firms and workers, but also among workers of different pay levels. In several countries, significant increases in tightness in low-pay sectors have also likely contributed to upward wage pressures for workers in the lower part of the wage distribution. Looking forward, with inflation expected to decline, labour market conditions stabilising and labour market tightness easing especially in low-pay industries, wages are likely to continue to adjust along the distribution as they recover the purchasing power lost in the past two years. Hence, whether the recent signs of an increase in wage compression will lead to a persistent reduction in wage inequality remains an open question.

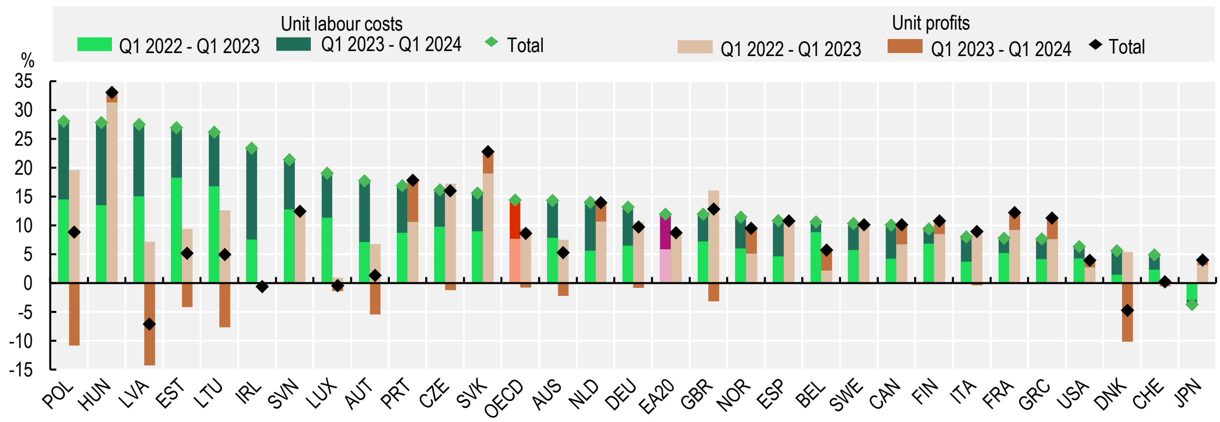
1.2.3. As real wages recover, unit profit growth has slowed down and even turned negative in some countries

In the aftermath of the COVID-19 crisis, unit labour costs[10] increased in most OECD countries as growth in nominal wages exceeded productivity growth. Unit profits also generally increased, indicating that firms were able to increase prices beyond the increase in the cost of labour and other inputs. In fact, between 2019 and 2022, unit profits increased more than unit labour costs in many countries and sectors, making an unusually large contribution to domestic price pressures and driving down the labour share of income (Araki et al., 2023[11]).

The most recent data point to a change in the relative dynamics of unit profits and unit labour costs in several countries. Between the beginning of 2022 and Q1 2024, unit labour costs grew more than unit profits in about two-thirds of the countries with data available (19 out of 29) (Figure 1.16). This pattern has become more pronounced in 2023, when unit labour costs increased more than unit profits in 25 countries. In fact, in 14 countries, unit profits even declined in 2023, an indication that they have started to buffer some of the inflationary impact of rising labour costs (ECB, 2023[17]).

Figure 1.16. Profits are beginning to buffer some of the increase in labour costs

Cumulative percentage change since Q4 2021, seasonally adjusted data



Note: OECD is the unweighted average of the 29 OECD countries shown in this chart (not including Chile, Colombia, Costa Rica, Iceland, Israel, Korea, Mexico, New Zealand and Türkiye). Euro Area represents the 20 Eurozone countries. For Norway, the data are based on mainland Norway. Unit labour costs and unit profits are calculated by dividing compensation of employees and gross operating surplus respectively, by real GDP. For Japan and Norway, gross operating surplus is approximated by deducting compensation of employees from nominal GDP – and hence also include unit net taxes.

Source: OECD (2024), "Quarterly National Accounts", OECD National Accounts Statistics (database), https://doi.org/10.1787/data-00017-en (accessed on 21 June 2024), Cabinet Office, Government of Japan, Economic and Social Research Institute (ESRI) Quarterly Estimates of GDP, www.esri.cao.go.jp/en/sna/sokuhou/sokuhou_top.html, for Japan, and Statistics Norway, Quarterly National Accounts, www.ssb.no/en/nasjonalregnskap-og-konjunkturer/nasjonalregnskap, for Norway.

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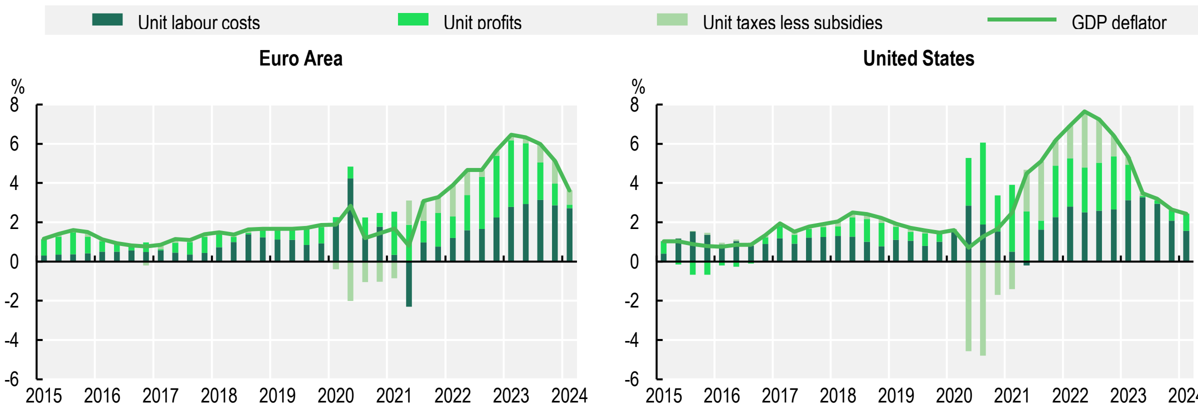
As a result of the recent changes in the relative dynamics of unit labour costs and unit profits, the contribution of unit profits to domestic price pressures has decreased, but remaining higher than prior to the pandemic in the Euro Area (Figure 1.17) – see also (OECD, 2023[18]). In addition, these results imply a reduction in the profit share of income after its growth between 2019 and 2022 (Araki et al., 2023[11]).

These developments were largely expected as they reflect the ongoing recovery of purchasing power by wages described above, rather than a warning sign of wage-price spirals (Araki et al., 2023[11]). Indeed, the contribution of unit labour costs to domestic price pressures is likely to remain sustained for some time as this catch-up process continues, unless labour productivity growth picks up. Reassuringly, however, there are currently no signs of further acceleration in nominal wage growth (Box 1.2). Moreover, in many countries, the growth in unit profits over the last three years allows for more buffering against the inflationary pressures stemming from the recovery of real wages (Lane, 2024[12]).[11] In the medium term, however, labour productivity growth is essential to ensure sustainable increases in wages that do not generate increases in unit labour costs and further inflationary pressures.

Figure 1.17. The contribution of labour costs to domestic price pressures has been increasing

Contribution to the GDP deflator, year-on-year percentage changes, seasonally adjusted data



Note: Euro Area refers to the 20 Eurozone countries. Unit labour costs, unit profits and unit taxes less subsidies are calculated by dividing compensation of employees, gross operating surplus and taxes less subsidies on productions and imports, respectively, by real GDP. For the United States, statistical errors are removed. Compensation of employees, gross operating surplus, taxes less subsidies on productions and imports, gross domestic products and deflators are denominated in local currencies. For the United States, changes in the GDP deflator are reported net of statistical discrepancies.
Source: OECD (2024), "Quarterly National Accounts", OECD National Accounts Statistics (database), https://doi.org/10.1787/data-00017-en (accessed on 21 June 2024).

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1.3. An update on job quality

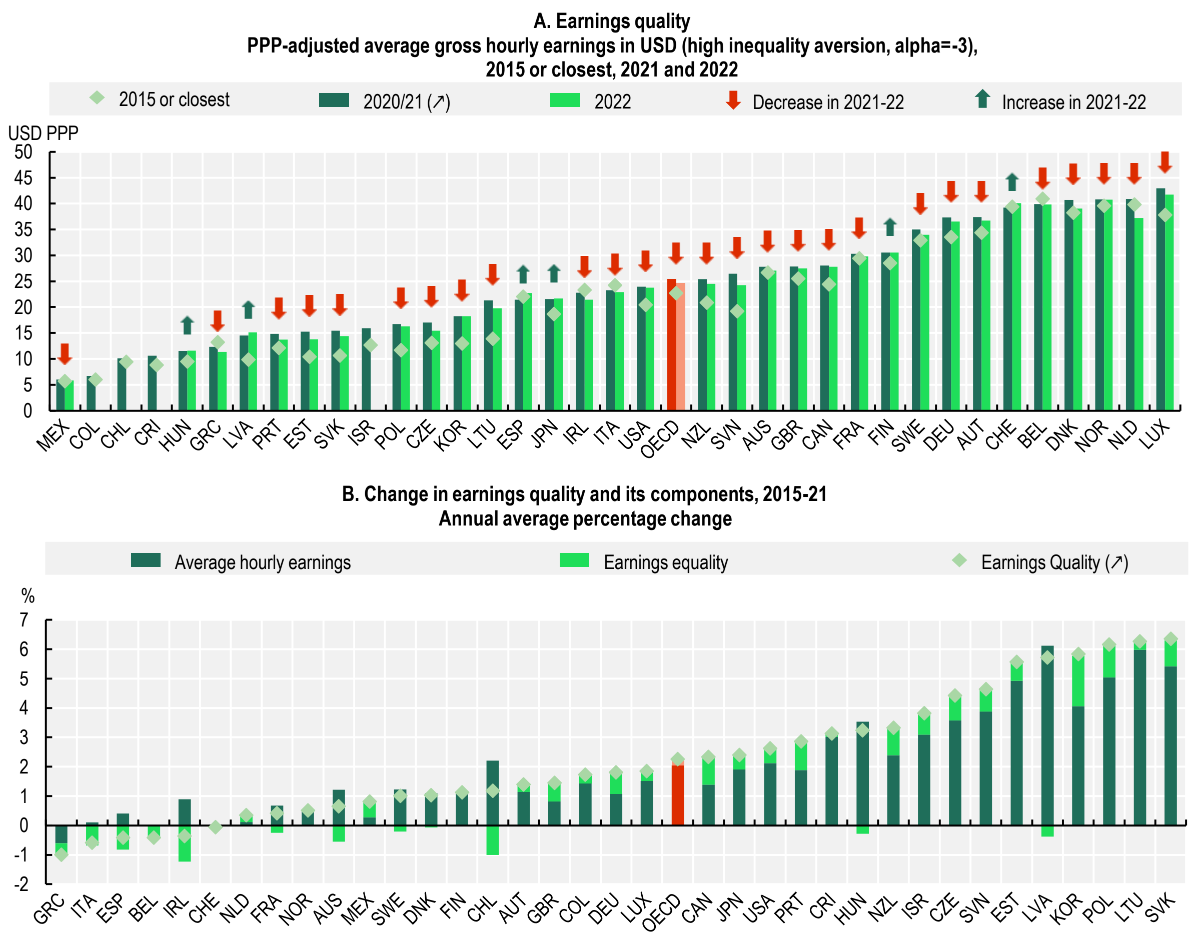
As other aspects of jobs, beyond wages, need to be monitored to assess what has happened to workers' overall well-being following the COVID-19 pandemic and the recent cost-of-living crisis, this section provides an update on job quality drawing on the conceptual framework developed by the OECD, which was then adopted by the G20. Job quality is defined along three main complementary dimensions that have been shown to be particularly relevant for workers' well-being in the existing literature on economics, sociology and occupational health (OECD, 2014[2]; Cazes, Hijzen and Saint-Martin, 2015[1]):

- *Earnings quality.* This measures the extent to which the earnings received by workers contribute to their well-being by taking account of the average real level of earnings and the way earnings are distributed across the workforce.[12]
- *Labour market (in)security.* This is defined in terms of the unemployment risk[13] and unemployment insurance; it measures the expected monetary loss associated with becoming and staying unemployed as a share of previous earnings by taking account of the mitigating role of public unemployment insurance (in terms of coverage of the benefits and their generosity).
- *The quality of working environment*. This captures non-monetary aspects of job quality, such as the nature and content of work performed, working-time arrangements and workplace relationships; it measures the incidence of workers experiencing job strain, a situation where workers have insufficient resources in the workplace to meet job demands.

Job quality indicators are updated with the latest available data (2022 or 2021). They are also compared to 2015 values – the last time that the OECD job quality framework was updated − except for the third dimension, the quality of the working environment, due to significant methodological changes, which makes job strain indicators not comparable over time (see below).

Both earnings quality and labour market security generally improved across the OECD. Between 2015 and 2021,[14] earnings quality indicators show generally positive patterns across the 36 OECD countries for which data are available:[15] gross hourly earnings expressed in 2022 USD purchasing power parity (PPP) adjusted by inequality[16] increased from USD 22.7 to USD 24.7 between 2015 and 2021 for the OECD average (Figure 1.18, Panel A). The increase in earnings quality was largely driven by higher average earnings. Yet, higher *equality* of earnings also played a role − notably in countries which had the highest increase in the overall earnings quality (above 3 annual average percentage change), such as Czechia, Estonia, Israel, Korea, Lithuania, New Zealand, Poland, Slovenia and the Slovak Republic, but also in other countries, such as Canada, Germany, Japan, the United Kingdom and the United States (Figure 1.18, Panel B). Finally, in the few countries where earnings quality was stable or slightly decreased between 2015 and 2021 (Belgium, Ireland, Italy, Spain and Switzerland) the pattern was mainly due to a slight increase in wage inequality that was not offset by the rise in average earnings, except for Greece where lower average earnings between 2015 and 2021 drove the decrease in earnings quality.

Figure 1.18. Earnings quality in OECD countries, 2015, 2021 and 2022



Note: Calculations based on the OECD Earnings Distribution Database and the average hourly earnings per full-time equivalent employee at constant prices and 2022 USD PPPs derived from the OECD Annual National Accounts Database. 2015 refers to 2014 for Estonia, France, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain and Switzerland. 2021 refers to 2020 for Poland. No data in 2022 for Chile, Colombia, Costa Rica and Israel. OECD is the unweighted of the 32 OECD countries with data available in 2022 shown in this chart (not including Chile, Colombia, Costa Rica, Iceland, Israel and Türkiye).
Source: OECD calculations based on the OECD Earnings distribution database, www.oecd.org/employment/emp/onlineoecdemploymentdatabase.htm and the OECD Annual National Accounts Database.

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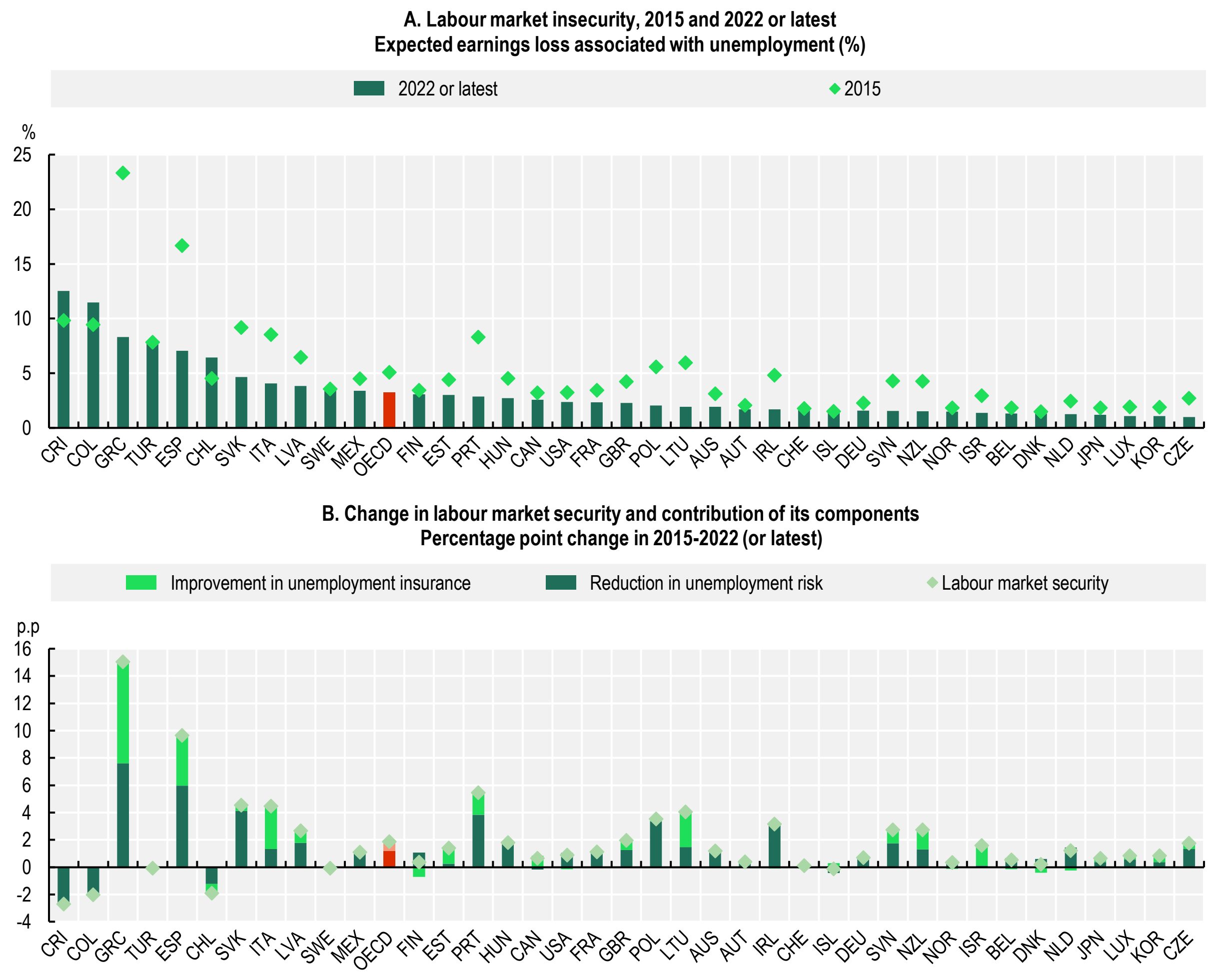
However, updates for 2022 show that earnings quality decreased between 2021 and 2022 in 26 of the 32 countries for which data are available (Figure 1.18, Panel A). This deterioration reflects the significant impact of inflation on real wages and wage distribution discussed in Araki et al. (2023[11]) and Section 1.2. These declines in earnings quality are generally driven by a reduction in average real earnings – even if higher earnings inequality also played a role in Estonia, Ireland, Luxembourg, the Netherlands,[17] New Zealand and Portugal. Conversely, in Hungary, Latvia and Spain, earnings quality increased due to a significant decrease in earnings *inequality*,[18] which counterbalanced the decline of average earnings.

Finally, the comparison of the gender gaps in average earnings show a general improvement across the OECD of women's earnings quality relative to men's one[19] between 2015 and 2022 (Annex Figure 1.B.1).

Labour market security generally improved across the OECD between 2015 and 2022: in most of the 31 OECD countries[20] for which 2022 indicators are available, labour market security increased since 2015 (Figure 1.19, Panel A). This positive pattern was driven by both lower unemployment rates and higher unemployment insurance: on average, the expected monetary loss associated with unemployment decreased by 1.9 percentage points between 2015 and 2022 for the OECD area. This reflects the combined impact of lower unemployment inflows in most OECD countries, as well as the widespread use of job and income support measures as a response to the COVID-19 pandemic across the OECD (OECD, 2021[19]; 2022[20]).[21] The sharpest drop in labour market insecurity (above 8 percentage points) occurred in Greece[22] and Spain, due to the significant declines of unemployment rates and generous income protection measures during the COVID-19.[23] It also reflected the effect of more structural measures, such as the 2021 labour market reform in Spain and the introduction of the Guaranteed Minimum Income in Greece. In contrast, the increase in labour market insecurity observed in Chile, Colombia and Costa Rica was driven by higher unemployment risk and no unemployment benefit schemes to mitigate the monetary loss associated to it in the two latter countries. In other OECD countries, the improvement in labour market security indicators was rather modest except for Italy, Lithuania, Portugal and the Slovak Republic where it was above 4 percentage points (Figure 1.19, Panel B).

As for labour market security by gender, data show little change between 2015 and 2022 in the differences in unemployment risk[24] between men and women except for a few countries (Annex Figure 1.B.2).

Figure 1.19. Labour market (in)security in OECD countries, 2015 and 2022



Note: Unemployment risk refers to the annual unemployment rate. Unemployment insurance refers to the coverage rate of unemployment insurance (UI) times its average net replacement rate among UI recipients plus the coverage rate of unemployment assistance (UA) times its net average replacement rate among UA recipients plus the share of those not covered by unemployment benefits [or the ratio of the number of social assistance (SA) recipients to the number of unemployed if this is lower] times the SA replacement rate. The average replacement rates for recipients of UI and UA take account of family benefits and social assistance if eligible. Labour market insecurity is estimated as the unemployment risk times one minus unemployment insurance, which may be interpreted as the uninsured average expected earnings loss associated with unemployment as a share of previous earnings. OECD is the unweighted average of the 38 OECD countries shown in this Chart. Countries are ordered by descending order of the labour market insecurity in 2022 (Panel A). The latest year refers to 2021 for Canada, Greece, Hungary, Iceland, Israel, Italy, and Slovenia. p.p: percentage point.

Source: OECD calculations based on the OECD Labour Market Statistics (database), http://dx.doi.org/10.1787/data-00322-en, the OECD Benefit Recipients (database), the OECD Labour Market Programmes (database), http://dx.doi.org/10.1787/data-00312-en and the OECD Taxes and Benefits (database), http://dx.doi.org/10.1787/data-00201-en.

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Comparable measures of the quality of the working environment are limited by the diversity of countries' approaches to collecting information and the general paucity of available data on working conditions.[25] Still, comparable data are available for 25 OECD European countries in the European Working Conditions Telephone Surveys (EWCTS) carried out by Eurofound in 2021. As defined in the OECD conceptual framework,[26] the quality of the working environment is measured by the incidence of workers experiencing job strain – i.e. a situation where the job demands (those aspects of jobs which require sustained physical and psychological efforts, and may negatively affect workers' well-being) exceed the job resources (those attributes of jobs that may induce a motivational process) that workers have at their disposal (see Annex 1.B). The key features of the job strain indicators are sketched in Table 1.1. Unlike the two other job quality dimensions, only 2021 results are discussed for the quality of the working environment due to important methodological changes introduced in the 2021 EWCTS edition.[27]

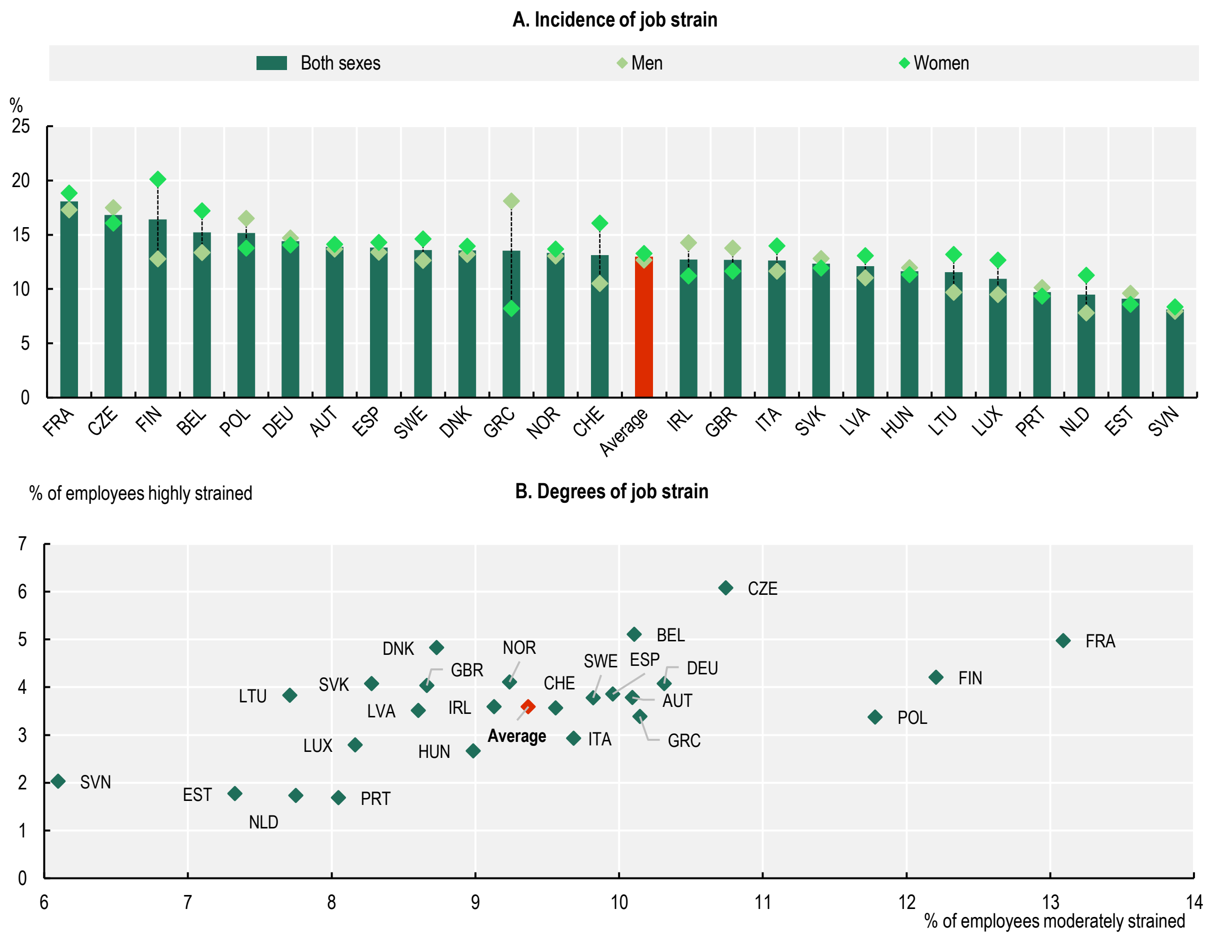
Table 1.1. Job demands, job resources and job strain

Job strain, as the result of…			
… too many job demands		… and too few job resources	
Physical risk	• Handling or being in skin contact with chemical products or substances. • Handling or being in direct contact with materials which can be infectious.	Social support at work	• Help and support from colleagues.
Physical demands	• Tiring and painful positions. • Carrying or moving heavy loads.	Task discretion and autonomy	• Can choose or change methods of work. • Can take an hour or two off during usual working hours to take care of personal or family matters.
Work intensity	• Working at very high speed. • Working to tight deadlines. • Usually working 50 hours or more per week. • Working during free time to meet work demands.	Learning opportunities	• Learning new things at work.

On average for the 25 OECD European countries for which data are available, 13% of workers experienced job strain in 2021 (Figure 1.20, Panel A). More women than men experienced job strain, but the differences are small (13.3% on average for women against 12.7% for men), except for a few countries where further analysis would be necessary to explore the factors driving the gap, notably composition effects (see below). Broken down further by degree of strain, the results show that 3.6% of workers experienced high strain (i.e. where the number of job demands exceeds by at least two the number of job resources), while 9.4% of them experienced moderate strain (i.e. where the number of job demands exceeds by one the number of job resources) (Figure 1.20, Panel B). While a few countries clearly performed better than others, in three-quarters of the countries reviewed, the share of strained workers ranged between 11% and 15%. Yet, it was below 10% in Estonia, the Netherlands, Portugal, and Slovenia and around 17% in Czechia and Finland, and up to 18% in France. Overall, work intensity was the most common job stressor, with 73% of workers reporting they had to cope with this type of constraint at work. Turning to job resources, the lack of social support at work appeared to be the main area of concerns in 2021, as being reported by workers as insufficiently provided to them.[28]

Figure 1.20. Job strain in OECD European countries, 2021

Percentage of employees aged 16-64 in OECD European countries, 2021



Note: Countries are ordered in Panel A by descending order of the incidence of job strain. "Average" is the unweighted average of the 25 OECD European countries shown in this Chart. Figures in Panel B refer to the difference between job demands and job resources, capturing the degree of strain. **Highly strained**: Cases where the number of job demands exceeds by at least two the number of job resources. **Moderately strained**: Cases where the number of job demands exceeds by one the number of job resources.
For further details on methodology, see Annex 1.B.
Source: OECD calculations based on the European Working Conditions Telephone Survey (EWCTS) 2021 of the European Foundation for the Improvement of Living and Working Conditions (Eurofound).

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Country differences in the share of workers' experiencing job strain are likely to reflect different factors, such as different sectoral and occupational structures, different labour and employment policies,[29] as well as different phases of the pandemic and policy responses to it. Moreover, as data display results for 2021, i.e., a year after most OECD European countries implemented lockdown measures and social distance requirement, results may also be affected by teleworking. For instance, those who were able to work from home fared best, while frontline workers during the COVID-19 pandemic fared poorly on several fronts and reported much higher exposure to physical risks than those working from home (Eurofound, 2022[21]). Controlling for a number of observable factors, such as individual characteristics, occupation structures and teleworking, explains some of the country variation[30] in job strain, notably in the case of Luxembourg, Spain and Switzerland.[31] Yet, significant cross-country variation remains unexplained that might be attributed to differences across countries in policy, norms, expectations, or attitudes towards job.

1.4. Concluding remarks

Labour markets have been resilient in recent years despite suffering a sequence of negative shocks, including the COVID-19 crisis, Russia's war of aggression against Ukraine and the upsurge of inflation, which triggered a sharp tightening of monetary policy. Many countries are now experiencing historically high levels of employment and low levels of unemployment. The resilience of OECD labour markets is also shown by the fact that several aspects of job quality improved during, or immediately after, the COVID-19 crisis. Labour market tightness is easing but remains generally high. Tensions remain however particularly high in the health sector.

In this context and following a quicker-than-expected fall in inflation, real wages are now growing in many countries even though they remain below 2019 levels in about half of them. There is some indication that on average across countries, the real wages of low-pay workers fared better than those of mid-pay and high-pay workers during the cost-of-living crisis. In particular, in almost all countries the real value of statutory minimum wages is already above its 2019 level thanks to either automatic or discretionary adjustments.

Nevertheless, unit labour costs have increased considerably over the past year or so, while unit profits – which had seen significant growth in the previous two years – appear to have begun to absorb some of the inflationary impact of increasing labour costs.

Looking ahead, it will continue to be important to strike a balance between allowing wages to make up some of the ground they have lost in terms of purchasing power and limiting further inflationary pressures. The most recent data are reassuring as they do not show signs of further acceleration in nominal wage growth, with some indicators even suggesting that it has slowed down.

Collective bargaining and social dialogue, when well-designed and implemented, can help identify solutions tailored to sectors and firms' different abilities to sustain further increase in wages and to promote policies and practices to enhance the growth in productivity needed to sustain real wage gains in the longer term.

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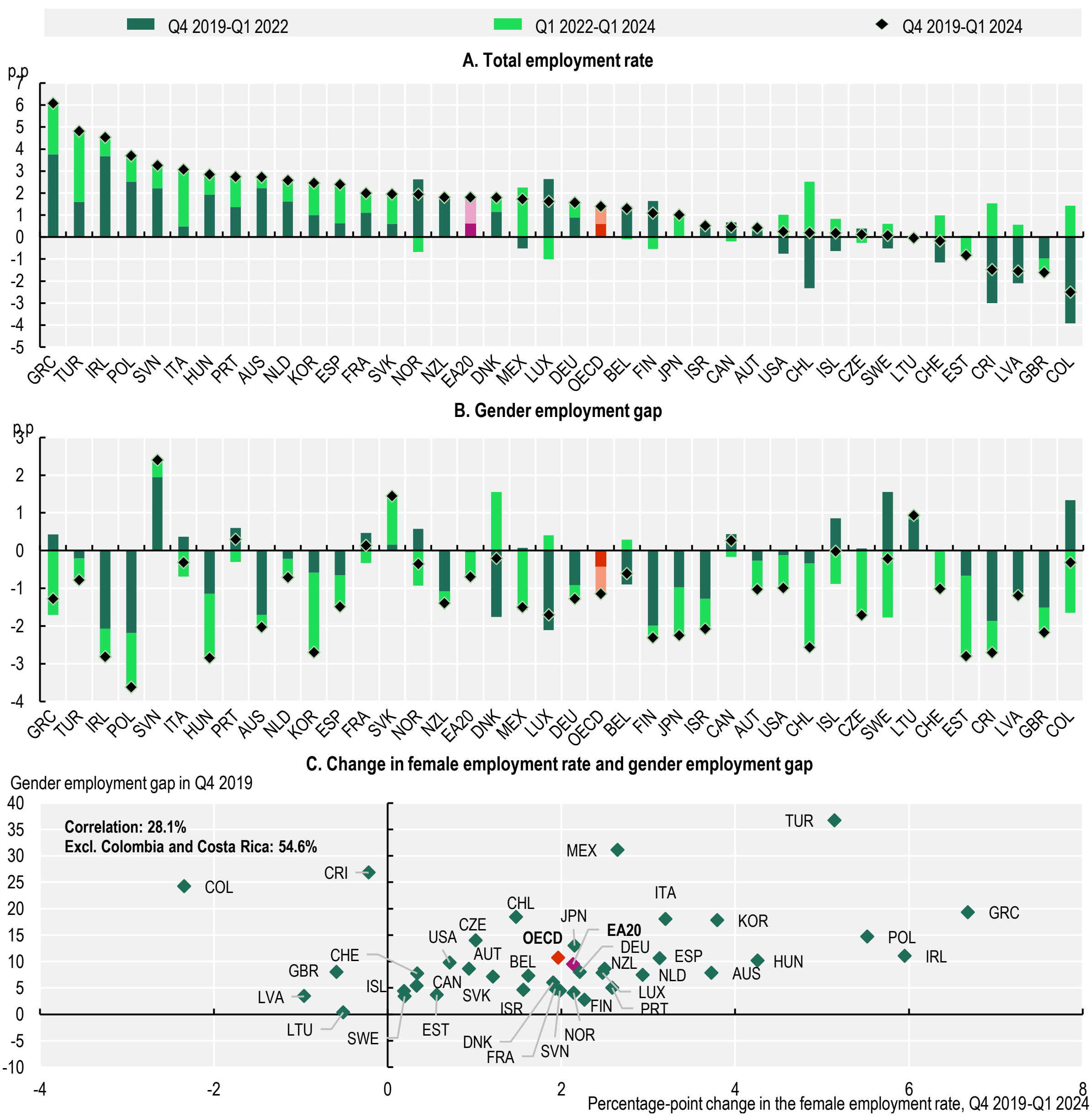
Annex 1.A. Additional results

Annex Figure 1.A.1. Gender employment gap narrowed in almost all countries

Percentage point change in employment rates (persons aged 15-64), seasonally adjusted data



Note: The gender employment gap is defined as the male-to-female difference in the employment rates. OECD is the unweighted average of the 38 OECD countries shown in this Chart. Euro Area refers to the 20 Eurozone countries. p.p: percentage point.

Source: OECD (2024), "Labour: Labour market statistics", Main Economic Indicators (database), https://doi.org/10.1787/data-00046-en (accessed on 25 June 2024).

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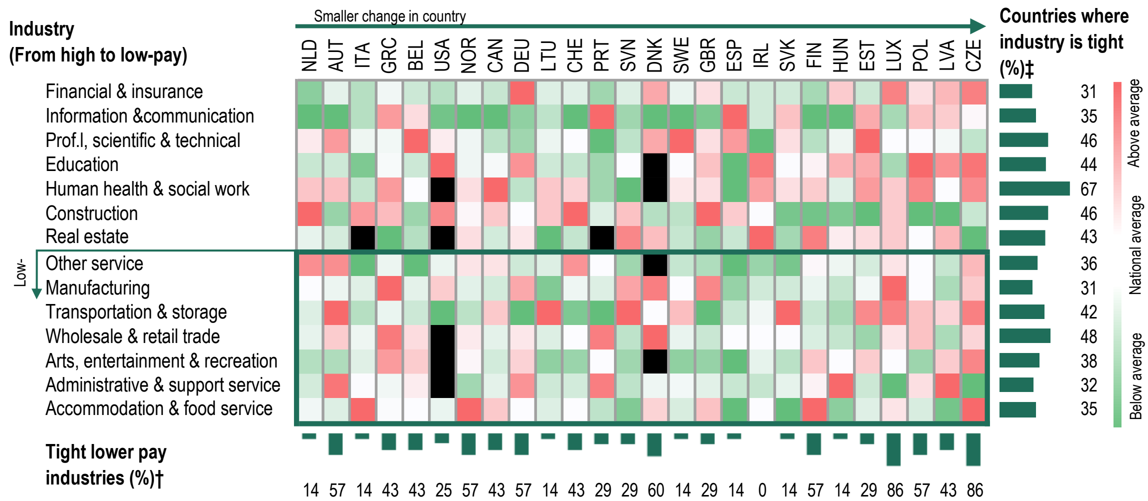
Annex Figure 1.A.2. Changes in vacancy rates by industry

Changes in vacancy rates by industry relative to the country average, Q4 2023 vs. Q4 2019



Reading: Each column visualises the percentage point change in job vacancy rates in each industry (row) relative to the national average. Darker shades of red indicate a larger increase in job vacancy rates than the national average, while darker shades of green indicate a smaller increase in job vacancy rates than the national average. Countries are ranked (from left to right) by the national average percentage point change in job vacancy rate (from largest to smallest). Industries are ranked from high to low pay (from top to bottom). For instance, the national vacancy rate for Austria was 4.3% in Q4 2023 and 3.3% in Q4 2019 which represents a 1 percentage point change in the national average. The vacancy rate for the same country in education increased from 1.5% in Q4 2019 to 1.9% in Q4 2023, a change below the change in the national average.

Note: The definition of vacancy rate is not harmonised across countries. For **Canada**, the job vacancy rate is the number of job vacancies expressed as a percentage of labour demand; that is, all occupied and vacant jobs. For the **European countries** (except Italy and the United Kingdom), a vacancy is defined as a paid post that is newly created, unoccupied, or about to become vacant for which the employer is taking active steps and is prepared to take further steps to find a suitable candidate from outside the enterprise concerned; and which the employer intends to fill either immediately or within a specific period. The job vacancy rate is the number of job vacancies expresses as a percentage of the sum of the number of occupied posts and the number of job vacancies. For **Italy**, it refers to paid jobs (new or existing, if they are vacant or about to become vacant) for which the employer is looking (actively and outside the company) for a suitable candidate and is willing to make additional efforts to find one. The vacancy rate is the percentage ratio of the number of vacancies to the sum of vacancies with filled job positions. For the **United Kingdom**, the vacancy rate is calculated as the number of vacancies per 100 jobs. For the **United States**, a vacancy is defined as a job that is not filled on the last business day of the month and a job is considered open if a specific position exists and there is work available for it, the job can be started within 30 days, and there is active recruiting for the position.

† Average proportion of industries where the vacancy rate increased more than the national average as a share of the bottom seven industries in the pay rank (below the industry other services).

‡ Number of countries where the vacancy rate for a given industry increased more than the national average as a share of the total number of countries with information available. Black cells indicate missing data.

Industries are ranked by the median wage in 2019 in the European Structure of Earnings Survey (SES). The ranking of industries is broadly consistent when 2019 data on median wages from the Current Population Survey of the United States are used.

Source: Job vacancy statistics by NACE Rev.2 activity for **European countries** except Italy and the United Kingdom (Eurostat), Job vacancies, payroll employees, and job vacancy rate by industry (Statistics Canada) for **Canada**, Posti vacanti (National Institute of Statistics) for **Italy**, Vacancies by industry (Office for National Statistics) for the **United Kingdom**, Job Openings and Labor Turnover Survey (Bureau of Labor Statistics, retrieved from FRED) for the **United States**.

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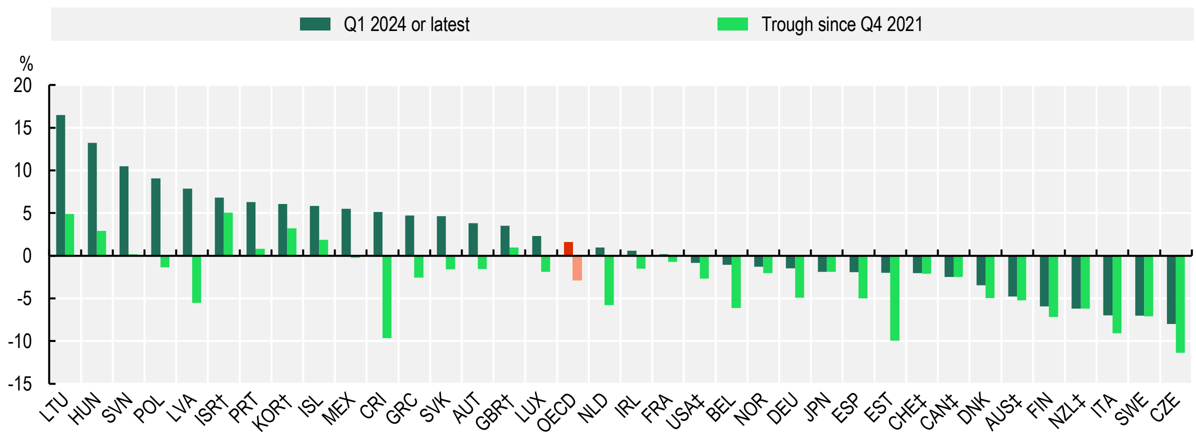
Annex Figure 1.A.3. Real wages remain below 2019 levels in several countries

Cumulative percentage change in real hourly wage since Q4 2019



Note: This Chart is a version of Figure 1.9 (Panel B) without any adjustments for seasonality in the CPI series. Otherwise noted, nominal hourly wages refer to a constant-industry-structure "wages and salaries" component of the labour cost index. Statistics refer to the private sector only for Costa Rica, Japan, Korea, Mexico and the United States. Nominal wage series are seasonally adjusted for all countries except for Canada, Costa Rica, Israel, Japan, Korea, Mexico, New Zealand and Switzerland. Nominal hourly wage presents a significant amount of unreported income for Mexico.

†: Nominal hourly wage refers to the actual wage i.e. without any adjustment for sources of compositional shifts for Costa Rica, Israel, Korea, Mexico and the United Kingdom, and thus comparing these results with the other countries requires caution. Moreover, nominal hourly wage refers to the average monthly wages per employee job for Israel, and to the average weekly earnings for the United Kingdom.

‡: Nominal hourly wage controls for additional sources of compositional shifts, such as regions for Australia, Canada and New Zealand, job characteristics and workers' characteristics for Australia and New Zealand, gender for Switzerland, and occupations for the United States. For Switzerland, the quarterly estimates refer to the annual Swiss wage index.

Real hourly wage is estimated by deflating the nominal hourly wage by the consumer price index (CPI-all items).

Countries are ordered by descending order of the cumulative percentage changes in real hourly wages in Q1 2024 compared to Q4 2019. OECD is the unweighted average of the 35 OECD countries shown in this chart (not including Chile, Colombia and Türkiye). The trough refers to the quarter where real hourly wages were at their lowest value for the indicated country since Q4 2021. The latest date available refers to Q3 2023 for Israel, and Q4 2023 for Canada, Costa Rica, Israel, Japan, Korea, Mexico and New Zealand.

Source: OECD calculations based on the Wage Price Index (Australian Bureau of Statistics) for **Australia**; the Fixed weighted index of average hourly earnings for all employees (Statistics Canada) for **Canada**; the Encuesta Continua de Empleo (Instituto Nacional de Estadística y Censos) for **Costa Rica**; the Labour cost index by NACE Rev. 2 activity (Eurostat) for the **European countries** except the United Kingdom; the Wages and Employment Monthly Statistics (Central Bureau of Statistics) for **Israel**; the Labour Force Survey at Establishments (Ministry of Employment and Labour) for **Korea**; the Monthly Labour Survey (Ministry of Health, Labour and Welfare) for **Japan**; the Encuesta Nacional de Ocupación y Empleo y Encuesta Nacional de Ocupación y Empleo Nueva Edición (Instituto Nacional de Estadística y Geografía) for **Mexico**; the Labour Cost Index (Stats NZ) for **New Zealand**; the Swiss Wage Index (Federal Statistical Office) for **Switzerland**; the Monthly Wages and Salaries Survey (Office for National Statistics) for the **United Kingdom**; and Employment Cost Index (Bureau of Labor Statistics, retrieved from FRED) for the **United States**. OECD (2024), "Prices: Consumer prices", Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en, (accessed on 21 June 2024).

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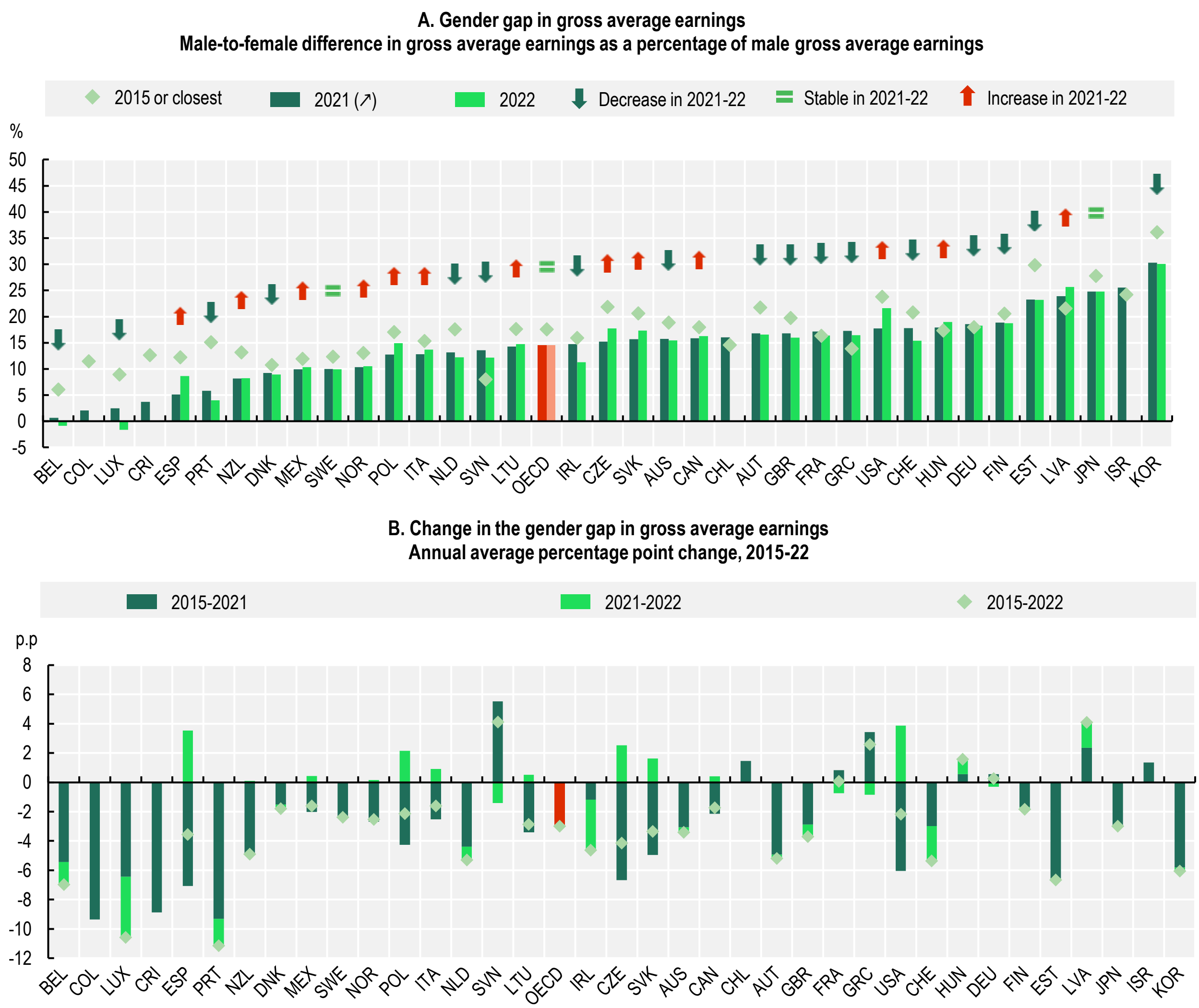
Annex 1.B. Additional material on Job quality

Annex Figure 1.B.1. Gender gap in gross average earnings of full-time workers



Note: 2015 refers to 2014 for Estonia, France, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain, and Switzerland. 2021 refers to 2020 for Poland and Switzerland. No data in 2022 for Chile, Colombia, Costa Rica and Israel. OECD is the unweighted of the 32 OECD countries with data available in 2022 shown in this Chart (not including Chile, Colombia, Costa Rica, Iceland, Israel and Türkiye). p.p: percentage point.

Source: OECD calculations based on the unpublished data from the OECD Earnings Distribution database.

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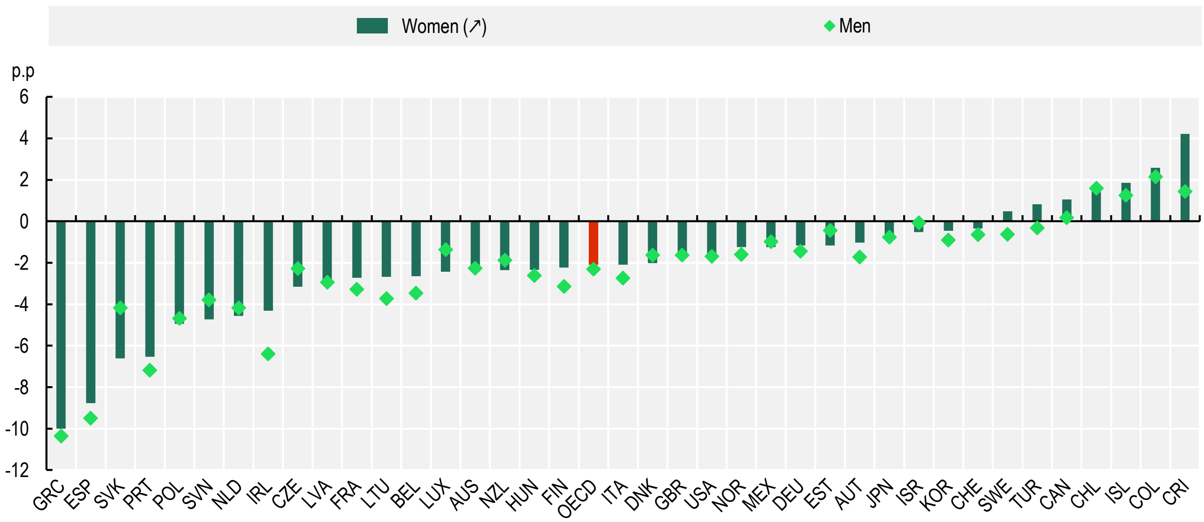
Annex Figure 1.B.2. Change in unemployment risk by gender

Percentage point change in unemployment rate by gender, 2015-22



Note: OECD is the unweighted average of the 38 OECD countries shown in this Chart. Statistics for Canada, Greece, Hungary, Iceland, Israel, Italy, and Slovenia, refer to the percentage point change in 2015-21, to be consistent with the data shown in Figure 1.19. p.p: percentage point.
Source: OECD calculations based on the OECD Labour Market Statistics (database), http://dx.doi.org/10.1787/data-00322-en (accessed on 24 April 2024).

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Existing psychometric scales and indices of job strain provide critical guidance on the type of survey questions that can be used for measuring the various components of total job demands and that of total job resources. Yet, the precise set of questions to be selected among the many included in the EWCTS 2021 inevitably relies on judgment and depends on the purpose of the exercise. Since the approach followed in this chapter gives prominence to objective features of job quality, the questions chosen were those seeking objective and precise information (e.g. whether an individual can choose or change their methods of work), as well as readily interpretable in terms of the quality of the working environment (QWE). Annex Table 1.B.1 reports: i) the set of qualitative variables (i.e. EWCTS 2021 questions) retained to measure the various aspects of QWE; ii) the normalisation procedure used to compare these variables, initially measured on different scales; iii) the way these variables have been aggregated into a reduced number of components, which refer to broad categories of job demands or job resources.

Annex Table 1.B.1. Job demands and job resources based on the European Working Conditions Telephone Survey (EWCTS 2021)

Job demands				
Dimension	Item	EWCTS question	Possible answers	Recoding
JD1. Physical risks	JD1A. Handling or being in skin contact with chemical products or substances	How often are you exposed at work to handling or being in skin contact with chemical products or substances?	5 Always 4 Often 3 Sometimes 2 Rarely 1 Never	Yes, if always or often No if sometimes, rarely, or never
	JD1B. Handling or being in direct contact with materials which can be infectious	How often are you exposed at work to handling or being in direct contact with materials which can be infectious?	5 Always 4 Often 3 Sometimes 2 Rarely 1 Never	Yes, if always or often No if sometimes, rarely, or never
	JD1=1 (Yes) if JD1A=1 or JD1B=1 JD1=0 (No) if JD1A=0 and JD1B=0			
JD2. Physical demands	JD2A. Carrying or moving heavy loads	How often does your main paid job involve carrying or moving heavy loads?	5 Always 4 Often 3 Sometimes 2 Rarely 1 Never	Yes, if always or often No if sometimes, rarely, or never
	JD2B. Lifting or moving people	How often does your main paid job involve lifting or moving people?	5 Always 4 Often 3 Sometimes 2 Rarely 1 Never	Yes, if always or often No if sometimes, rarely, or never
	JD2=1 (Yes) if JD2A=1 or JD2B=1 JD2=0 (No) if JD2A=0 and JD2B=0			
JD3. Work intensity	JD3A. Working at very high speed	Does your main job involve working at very high speed?	5 Always 4 Often 3 Sometimes 2 Rarely 1 Never	Yes, if always or often No if sometimes, rarely, or never
	JD3B. Working to tight deadlines	Does your main job involve working to tight deadlines?	5 Always 4 Often 3 Sometimes 2 Rarely 1 Never	Yes, if always or often No if sometimes, rarely, or never
	JD3C. Long working hours	How many hours do you usually work per week in your main paid job?	# Number of hours per week	No if 1-49 hours Yes if 50-168 hours
	JD3D. Working during free time to meet work demands	How often have you worked in your free time to meet work demands?	1 Daily 2 Several times a week 3 Several times a month 4 Less often 5 Never	Yes, if daily, several times a week or several times a month No if less often or never
	JD3=1 (Yes) if JD3A=1 or JD3B=1 or JD3C=1 or JD3D=1 JD3=0 (No) if JD3A=0 and JD3B=0 and JD3C=0 and JD3D=0			
Job resources				
Dimension	Item	EWCTS question	Possible answers	Recoding
JR1. Social support at work	JR1A. Help and support from colleagues	Still thinking about your main job, please tell me how often the following applies to your work situation? Help and support from colleagues	1 Always 2 Most of the time 3 Sometimes 4 Rarely 5 Never	Yes, if always No if most of the time, sometimes, rarely, or never
	JR1=1 (Yes) if JR1A=1			

	JR1=0 (No) if JR1A=0			
JR2. Task discretion and autonomy	JR2A. Can choose or change methods of work	In your main job, are you able to choose or change your methods of work?	1 Never 2 Rarely 3 Sometimes 4 Often 5 Always	Yes, if always, often, or sometimes No if rarely or never
	JR2B. Possibility to take an hour or two off during usual working hours to take care of personal or family matters	In your main job would you say that for you arranging to take an hour or two off during your usual working hours to take care of personal or family matters is...?	1 Very easy 2 Fairly easy 3 Fairly difficult 4 Very difficult	Yes, if very easy or fairly easy No if fairly difficult or very difficult
	JR2=1 (Yes) if JR2A=1 or JR2B=1 JR2=0 (No) if JR2A=0 and JR2B=0			
JR3. Learning opportunities	JR3A. Learning new things at work	Does your main job involve learning new things?	1 Always 2 Often 3 Sometimes 4 Rarely 5 Never	Yes, if often or always No if never, rarely, or sometimes
	JR3=1 (Yes) if JR3A=1 JR3=0 (No) if JR3A=0			

Annex 1.C. Evolution of statutory minimum wages and negotiated wages by country

Annex Table 1.C.1. Reference minimum wage series and 2024 uprating

Country	Name	Official source	Rate	Minimum wage series	Revision(s) in 2024
Australia	National Minimum Wage	Fair Work Commission	Hourly	Employees aged 21 and over	1 July 2024: AUD 24.10 (+3.75%).
Belgium	Revenu Minimum Mensuel Moyen Garanti / Gewaarborgd gemiddeld minimummaandinkomen	Conseil National du Travail (CNT) / Nationale Arbeidsraad (NAR)	Monthly	Employees aged 18 and over under CCT No. 43[1]	1 April 2024: EUR 2029.88 (+1.8%). 1 May 2024: EUR 2070.48 (+2%).
Canada (Federal)	Minimum wage	Government of Canada	Hourly		
Canada (Weighted)	Minimum wages of Provinces and Territories	Government of Canada	Hourly	Laspeyres index weighted by the share of employees of provinces and territories in 2019.	As of 1 April 2024, 5 Provinces will increase their minimum wage, and one province and one territory on 1 October 2024.
Chile	Ingreso Mínimo Mensual	Ministerio del Trabajo y Previsión Social, Dirección del Trabajo	Monthly	Employees aged 18-65 for a 45-hour week.	1 July 2024: CLP 500 000 (+8.7%)
Colombia	Salario Mínimo	Ministry of Labour	Monthly	Basic wage excluding transport allowance.	1 January 2024: COP 43 333 (+12.1%).
Costa Rica	Salarios Mínimos del sector privado	Ministry of Labour and Social Security	Monthly	Generic unskilled workers (Trabajador en Ocupación No Calificada (Genérico), TONC).	1 January 2024: CRC 358 609.5 (+1.8%)
Czechia	Minimální mzdy	Ministry of Labour and Social Affairs	Hourly	Individual work of the same kind (private sector).	1 January 2024: CZK 112.5 (+8.4%)
Estonia	Töötasu alammäär	National collective agreement on minimum wage	Hourly		1 January 2024: EUR 4.86 (+13%). The minister added that according to the goodwill agreement concluded with the social partners in spring 2023, the goal is that in 2027 the minimum wage would be 50% of the average wage in Estonia. In 2024, this percentage is 42.5.
France	Salaire Minimim Interprofessionnel de Croissance	Ministry of Labour, Health and Solidarity	Hourly		1 January 2024: EUR 11.65 (+1.1%). Possible increases along the year depending on the evolution of the CPI for the first quintile of the distribution of living standards.
Germany	Mindestlöhne	Minimum Wage Commission	Hourly		1 January 2024: EUR 12.41 (+3.4%) On 1 January 2025, the minimum wage will be raised again to EUR 12.82 (+3.3%) according to the recommendations of the Minimum Wage Commission.
Greece	Κατώτατος Μισθός	Ministry of Labor and Social Security	Daily	General Workers.	1 April 2024: EUR 37.07 (+6.4%).

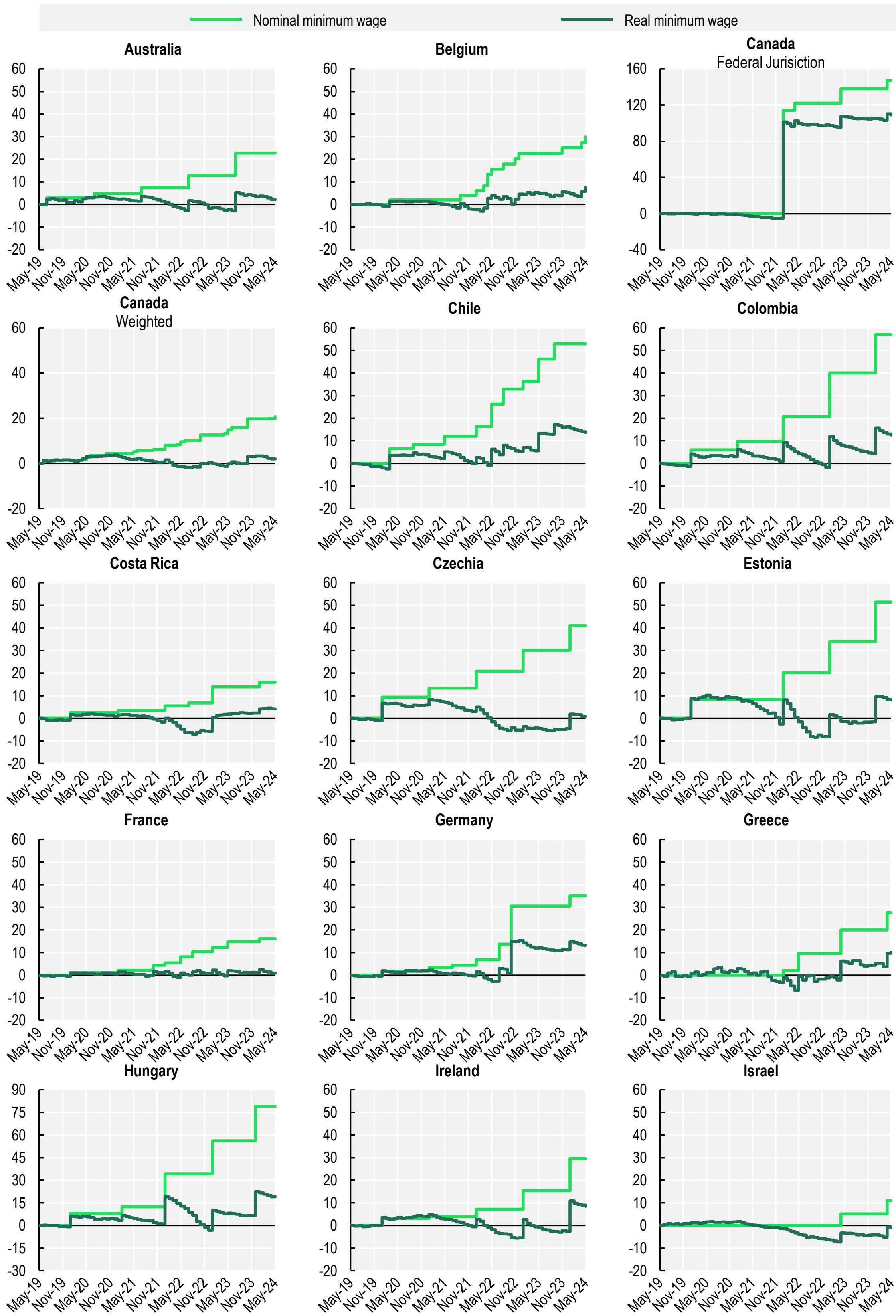
Country	Name	Official source	Rate	Minimum wage series	Revision(s) in 2024
Hungary	Minimálbér	Government of Hungary	Hourly		1 December 2023 (for the 1 January 2024): HUF 1 534 (+14.6%)
Ireland	National Minimum Wage	Workplace Relations Commision	Hourly	Employees aged 20 and over.	1 January 2024: EUR 12.7 (+12.4%)
Israel	שכר מינימום	Ministry of Labor	Hourly		1 April 2024: ILS 32.3 (+5.5%).
Japan	地域別最低賃金の	Ministry of Health, Labour and Welfare	Hourly	Weighted average of prefectural minimum wages calculated by the Ministry of Health, Labour and Welfare.	Next revision in October 2024.
Korea	최저 임금	Minimum Wage Commission	Hourly		1 January 2024: KRW 9 860 (+2.5%)
Latvia	Minimālā darba alga	Ministry of Welfare	Monthly		1 January 2024: EUR 700 (+12.9%)
Lithuania	Minimalusis valandinis atlygis	Ministry of Social Security and Labour	Hourly		1 January 2024: EUR 5.65 (+9.9%)
Luxembourg	Salaire Social Minimum	Agency for the Development of Employment (ADEM)	Hourly	Unskilled workers aged 18 and over.	No decision taken at date.
Mexico	Salario Mínimo General	National Minimum Wage Commission	Daily	Generic workers (excluding the Zona Libre de la Frontera Norte or “Free Tarde Zone” since 2019).	1 January 2024: MXN 248.93 (+20%). Minimum wage is increased every December, at least by the same percentage as inflation. Can be updated through the year if requested.
Netherlands	Minimumloon	Government of the Netherlands	Hourly[2]	Employees aged 21 and over.	1 January 2024: EUR 13.27 (+15.3%) 1 July 2024: EUR 13.68 (+3.1%)
New Zealand	Adult minimum wage	Ministry of Business, Innovation & Employment	Hourly	Employees aged 16 and over (excl. training and starting-out minimum wages).	1 April 2024: NZD 23.15 (+2%).
Poland	Płaca minimalna	Chancellery of the Prime Minister	Monthly	Employees with more than one year of services.	1 January 2024: PLN 4 242 (+21.5%) 1 July 2024: PLN 4 300 (+1.4%)
Portugal	Retribuição Mínima Mensal Garantida[2]	Directorate-General for Employment and Labour Relations (DGERT)	Monthly	Employees in Portugal continental.	1 January 2024: EUR 820 (+7.9%).
Slovak Republic	Minimálna mzda	Ministry of Labour, Social Affairs and Family	Hourly		1 January 2024: EUR 4.31 (+7.1%)
Slovenia	Minimalna plača	Ministry of Labour, Family, Social Affairs and Equal Opportunities	Monthly		1 January 2024: EUR 1 253.9 (+4.2%)
Spain	Salario Mínimo Interprofesional	Ministry of Labour and Social Economy	Daily	General employees aged 18 and over.	1 January 2024: EUR 37.8 (+5%)
Türkiye	Asgari Ücret	Ministry of Labour and Social Security	Monthly		1 January 2024: TRY 20 002.5 (+49.1%)
United Kingdom	National Living Wage	Government of the United Kingdom	Hourly	Employees aged 21 and over (aged 22, 23 or 25 and over before 2024).	1 April 2024: GBP 11.44 (+9.8%)

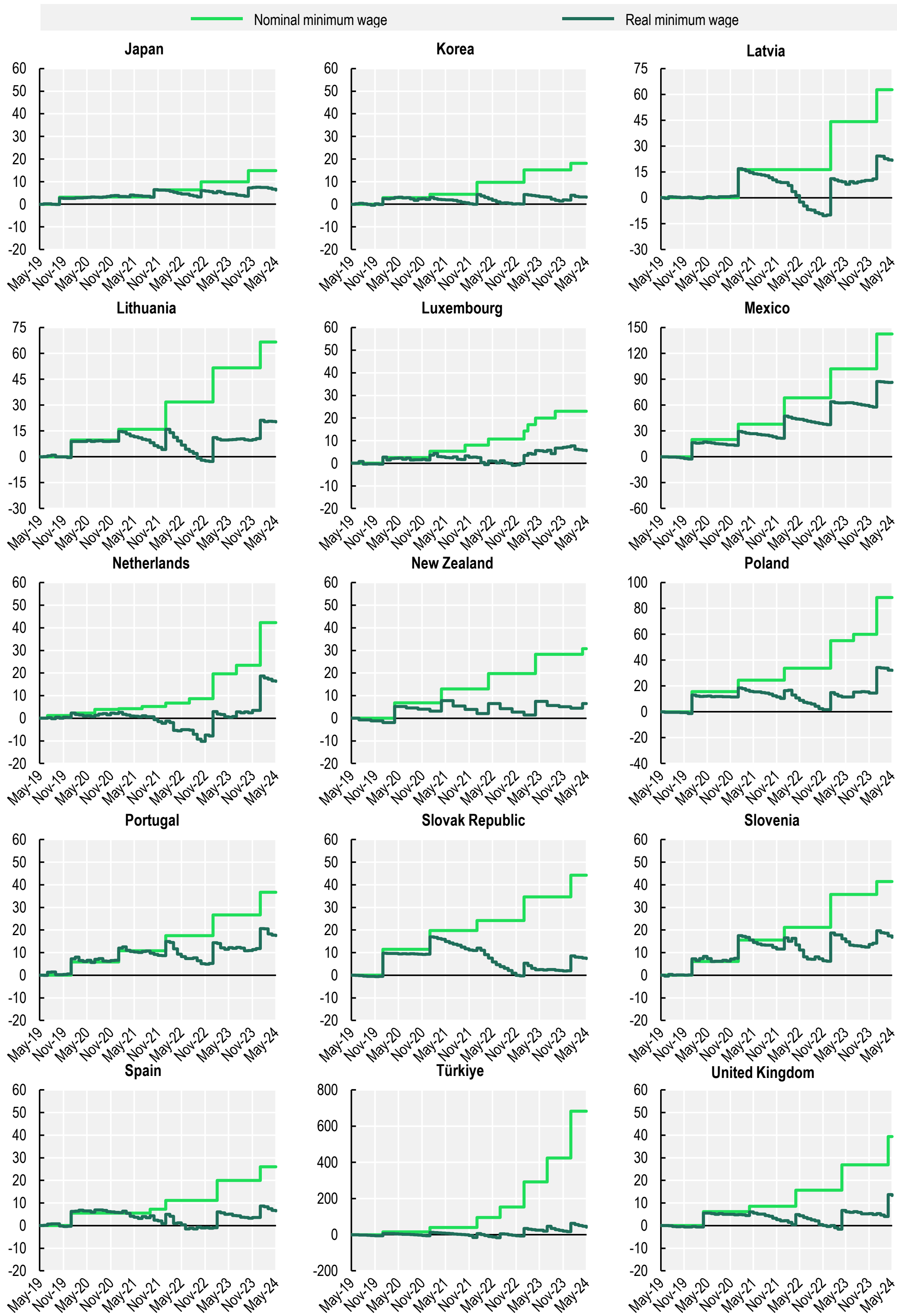
Country	Name	Official source	Rate	Minimum wage series	Revision(s) in 2024
United States (Federal)	Federal minimum wage	Department of Labor	Hourly		
United States (Weighted)	Minimum wage at State level	DoL and information from States	Hourly	Laspeyres index based on minimum wage of 50 states weighted by the share of nonfarm private employees by state in 2019.	1 January 2024: 23 States have increased their minimum wage.

Note: Canada (weighted) and the United States (Weighted) are OECD estimates used to illustrate the aggregate evolution of minimum wage rates based on the minimum wage rates at the sub-national level. These estimates do not, however, consider special exemptions and rates in force in the provinces and states of the countries concerned. In particular, the minimum wage applying to the employees working under the Federal Jurisdiction in Canada are excluded. The weighted minimum wage for Canada is based on minimum wages of province and territories weighted by the number of employees in provinces and territories in 2019 from the Survey of Employment, Payrolls and Hours (SEPH); and for the United States, on the minimum wage of states weighted by the number of nonfarm private employees by state in 2019 from the State and Metro Area Employment, Hours, & Earnings published by the BLS. For the five US states where no minimum wage is required (i.e. Alabama, Louisiana, Mississippi, South Carolina and Tennessee), the federal minimum wage is included in the estimation.
For Greece, Portugal and Spain, in addition to monthly or daily minimum wages, employees are legally entitled to annual extra payments in the form of a 13th and 14th months bonuses. In Greece, this includes one-month pay as a Christmas bonus; half a month pay as an Easter bonus; and half a month pay as an annual holiday bonus. In Portugal and Spain, this includes one-month pay as a vacation pay in Summer and one-month pay as Christmas pay.
For Slovenia, there is no statutory requirement to pay annual bonus in addition to the monthly minimum wage. However, employees are generally entitled to a 13th month bonus where the employer is bound to pay by a collective agreement, an individual agreement, or the employer himself.
1. Reduced rates of the RMMMG applies to employees aged under 18 with an employment contract, and to workers aged 18, 19 and 20 with a student contract under the CCT No.50 (collective agreement on the guarantee of a minimum average monthly income for workers under the age of 21). For further details, see https://emploi.belgique.be/fr/themes/remuneration/salaire#toc_heading_2.
2. As of 1 January 2024, employers are required by law to pay workers at least the hourly minimum wage. Before 2024, minimum wage was defined on daily or monthly basis. To ensure comparison over time, daily minimum wage before that year is divided by a standard workday of 8 hours.

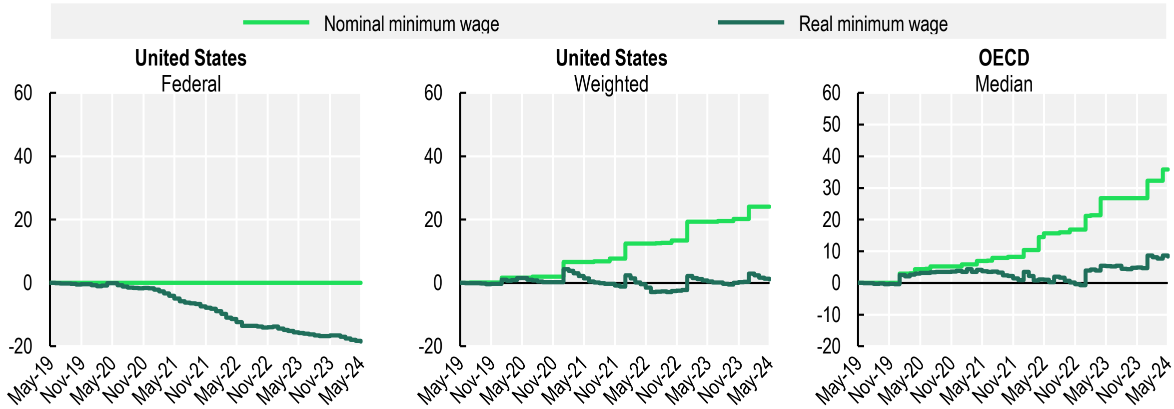
Annex Figure 1.C.1. Minimum wage evolution, May 2019 to May 2024

Nominal and real minimum wage, cumulative percentage change since May 2019





Nominal minimum wage
Real minimum wage
Japan
Korea
Latvia
Lithuania
Luxembourg
Mexico
Netherlands
New Zealand
Poland
Portugal
Slovak Republic
Slovenia
Spain
Türkiye
United Kingdom
May-19
Nov-19
May-20
Nov-20
May-21
Nov-21
May-22
Nov-22
May-23
Nov-23
May-24



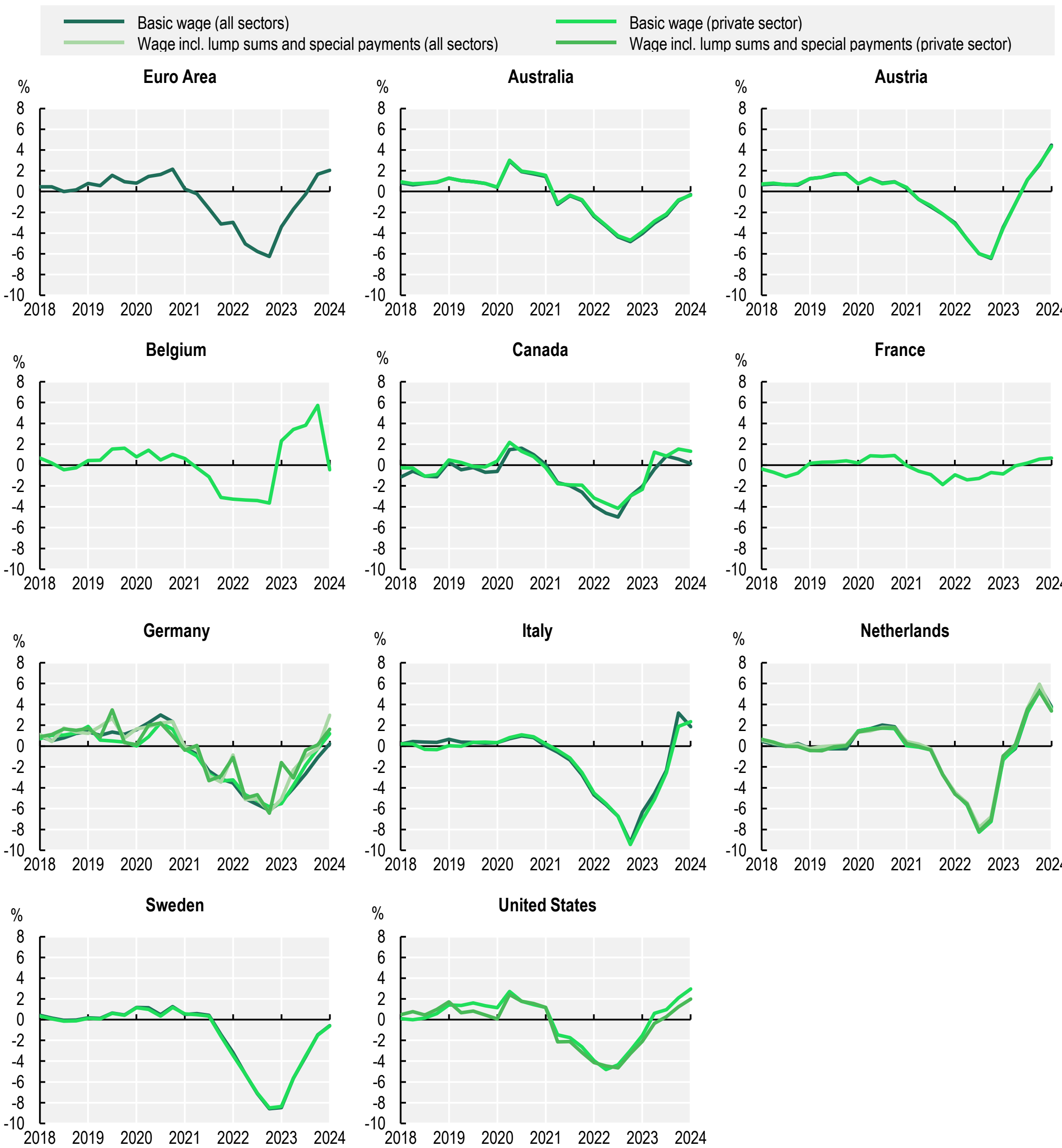
Note: Canada (weighted) is a Laspeyres index based on minimum wage of provinces and territories (excluding the Federal Jurisdiction) weighted by the share of employees of provinces and territories in 2019. United States (weighted) is a Laspeyres index based on minimum wage of states (not including territories like Puerto Rico or Guam) weighted by the share of nonfarm private employees by state in 2019. Changes in nominal minimum wage in Belgium in April and May 2022 relate to the transition to a single rate for workers aged 18 and over. OECD is the unweighted median across the 30 OECD countries with statutory minimum wage (not including the Canada Federal Jurisdiction and the weighted average for the United States). Changes in real minimum wage in April and May 2024 for New Zealand are estimated by assuming that the CPI remains the same as in Q1 2024.

Source: OECD Employment database, www.oecd.org/employment/emp/onlineoecdemploymentdatabase.htm, OECD (2024), “Prices: Consumer prices”, Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 02 July 2024), and Australian Bureau of Statistics (May 2024), Monthly Consumer Price Index Indicator, ABS Website, accessed on 02 July 2024) for Australia.

StatLink https://stat.link/brvmly

Annex Figure 1.C.2. Real wages in selected OECD countries resulting from collective agreements

Year-on-year percentage change, Q1 2018 to Q1 2024



Note: International comparability of data on negotiated wages is affected by differences in definitions and measurement. Statistics are representative of all employees covered by a collective wage agreement for Austria, Belgium, the Euro Area (20), France, Germany, Italy, the Netherlands, Sweden, and the United States. In Canada, statistics refer to collective bargaining settlements of all bargaining units covering 500 or more employees (units of 100 or more employees for the Federal Jurisdiction). For Australia and Canada, statistics refer only to employees affected by an increase of the negotiated wage at date. Wage increases in Austria, Belgium, the Euro Area (20), Germany, Italy, the Netherlands, Sweden, and the United States refers to the average increase in negotiated wages (wages of union workers for the United States) weighted by the employment composition for a reference year (Laspeyres index). The reference year of the employment composition used is 2009 for Sweden, 2010 for Belgium and the Netherlands, January 2015 for the Euro Area (20), 2015 for Germany and Italy, 2016 for Austria, and 2021 for the United States. For Australia, Canada and France, wage increases refer to the average increase in negotiated wages weighted by the number of employees affected in the period considered. Private sector for Germany refers to all industries excluding agriculture, public administration, education, health, and other personal services (Sections B to N of the NACE rev. 2).

Source: OECD calculations based on national data on negotiated wages, see Annex Table 1.C.3.in (Araki et al., 2023[11]) for further details; and OECD (2024), “Prices: Consumer prices”, Main Economic Indicators (database), https://doi.org/10.1787/0f2e8000-en (accessed on 28 June 2024).

StatLink https://stat.link/wz8xun

Notes

[1] The size of the active population (or labour force) has also continued to grow in absolute terms in virtually all OECD countries. On average across all members, in Q1 2024, the active population grew year-on-year by 1.3%, with an overall increase since Q4 2019 of 3.9%.

[2] Results for older age groups are less clear. In the United States, the labour force participation rate of individuals aged 65 and over was around 19-19.5% in 2023 (after dropping from a record high of 20.8% just before the COVID-19 crisis (https://fred.stlouisfed.org/series/ LNU01300097). For the European countries, Eurostat data for individuals older than 65 show a labour force participation rate increasing by 0.9 percentage point in Q1 2024 compared to Q4 2019. Analysis for the broader age group 55 to 74 in Euro Area countries, show an increase in participation of over 2 percentage points between Q4 2019 and Q2 2023 (Berson and Botelho, 2023[24]). More generally, there is little indication of a significant increase in retirement after the COVID-19 crisis – see Araki et al. (2023[11]) for a summary of the evidence.

[3] The relatively large decline in hours per employed in Korea can be partly explained by the progressive lowering of the statutory limit on total weekly working hours from 68 to 52 (Carcillo, Hijzen and Thewissen, 2023[22]). However, the change in the hours worked per employed is likely to be affected by other elements such as shifts in the industrial and employment structure and higher awareness on work-family balance.

[4] The share of part-time employment in total employment was slightly down in 2022 relative to 2019 both in the European Union and most non-EU OECD countries – including Canada, New Zealand, the United Kingdom, and the United States. In the European Union, the share of part-time employment had declined more for women than for men.

[5] Different indicators can be used to document labour shortages: *vacancy-to-unemployed ratios,* defined as the number of unfilled jobs relative to the number of unemployed, provide an indication of the tightness of the labour market; but other indicators are used to gauge the extent of labour shortages, such as the *vacancy rate*, defined as the share of unfilled jobs relative to all jobs available, the *quit rate*, defined as the share of workers who recently left their job voluntary, relative to total employment, as well as the share of firms reporting labour shortages as a factor limiting their production as collected and used by the European Commission (e.g. https://economy-finance.ec.europa.eu/document/download/5b9a6678-a424-46e0-8056-eeb6d5b47737_en?filename=tp059_en.pdf.

[6] Average annual headline inflation in the OECD is projected to gradually ease from 6.9% in 2023 to 5% in 2024 and 3.4% in 2025. By the end of 2025, inflation is expected to be back on central bank targets in most major economies (OECD, 2024[4]).

[7] Most of the data used in this section refer to the “wages and salaries” component of the Labour Cost Index (i.e. excluding employer’s social security contributions) produced by Eurostat – or similar measure for non- European countries (see notes to the figures for the details on the countries for which different wage measures have been used). In addition to separating wages from other labour cost components, these indicators have two main advantages relative to measures of compensation per hour worked derived from National Accounts. First, they are generally constructed to follow the evolution of hourly nominal wages for a constant industry structure, therefore minimising the potential impact of compositional changes on aggregate wage dynamics. Second, they are available at a more detailed sectoral breakdown than

measures of compensation of employees from National Accounts, allowing the analysis on wage dynamics by industry of different pay levels of section 1.2.2.

[8] However, the overall decline in real wages for Japan since 2019 has been much smaller than in most other countries (Figure 1.9, Panel B).

[9] Seasonally adjusted series for nominal wages are available for all countries except for Canada, Costa Rica, Israel, Japan, Korea, Mexico, New Zealand, Norway, and Switzerland. CPI series are generally not available with seasonal adjustment and are adjusted for the purpose of this analysis using the X-13ARIMA-SEATS Seasonal Adjustment Method. The results on the cumulative changes in real wages obtained with these adjustments do not differ substantively from those obtained without any adjustments reported in the Annex Figure 1.A.3.

[10] To allow a comparison of dynamics between labour costs and a measure of profits, this section uses indicators from the National Accounts (see note to Figure 1.16). Using the income approach, nominal GDP can be decomposed as $PY = NCE + GOS + TAXN$ where P is the GDP deflator, Y is real GDP, NCE is nominal compensation of employees, GOS is gross operating surplus, and $TAXN$ is nominal taxes. This illustrates the interpretation of GOS as profit margin, i.e. the difference between total revenue and total costs (labour costs, which are part of value added, and intermediate inputs, which are not part of total value added). This is a timely measure of profits that is commonly used in this type of analysis but does not fully correspond to the notion of corporate profits. Unit labour costs and profits are derived by dividing the two relevant GDP components by real GDP. Equivalently, unit labour costs can be expressed as compensation per hour worked divided by real GDP per hour worked (i.e. labour productivity). This latter formulation illustrates that unit labour costs will increase when growth in compensation per hour worked exceeds growth in labour productivity. This measure of unit labour costs differs in some important respects from the measure of hourly wages based on the “wages and salaries” component of the labour cost index used in the previous sections (see footnote 7). Most notably, unit labour costs include employer’s social security contributions and do not control for changes in the sector composition of the economy.

[11] Overall, between Q4 2019 and Q1 2024, unit profits grew, often significantly, in all 29 countries with available data – growing more than unit labour costs in 15 countries. See Lane (2024[12]) for other indicators for the Euro Area also pointing to further room for profits to buffer the inflationary pressure arising from the ongoing increases in labour costs.

[12] The need to take into account both aspects reflects their empirical importance for well-being. While the average level of earnings provides a key benchmark for assessing the extent to which having a job ensures good living conditions, a large body of empirical research has shown that earnings inequality also matters for life satisfaction so that overall well-being tends to be higher the more equal is its distribution, see OECD (2014[2]).

[13] The unemployment risk is approximated in this chapter by the actual unemployment rate to extend country coverage and enhance consistency with group level data – see, for example, Chapter 2. Indeed, while measured in the *Employment Outlook 2014* as the product of the probability of becoming unemployed and the average duration of completed unemployment spells in months, it can be shown that the risk of unemployment can be proxied by the actual unemployment rate in the absence of any strong exogeneous shock (OECD, 2014[2]).

[14] Data are shown for 2021 to document a maximum of countries and to single out the effect of the Cost-of-living crisis in 2022.

[15] The 38 OECD countries, except Iceland and Türkiye for which only 2018 data available.

[16] To take into account both the level and distribution of earnings in the aggregate measure of earnings quality, the general means approach is used as an aggregation tool. General means place greater weight on certain parts of the distribution, and less on others, depending on the assumed degree of inequality aversion (alpha). In the OECD Job quality framework a coefficient of -3 is used (strong aversion for inequality aversion), which gives a weight of 85% to the bottom tercile of the distribution − see Box 3.3. of Chapter 3, OECD (2014[2]) for more details.

[17] Part of the increase of earnings inequality in the Netherlands can be explained by the indexation of the minimum wage to the predicted wage developments for the next six months using a basket of collectively agreed wages: with the significant increase of inflation in 2022 and the delayed adjustment of the minimum wage, the minimum wage significantly lost ground in real terms, until it was increased by 10.2% in January 2023, to limit the purchasing power losses of low-paid workers – see Annex Figure 1.C.1.

[18] Spain's minimum wage was increased in 2022 and, in real term, has been keeping up with inflation better than the average wage. Even before the surge in inflation, the increases in Spain's minimum wage were substantial, placing the country among those with the most rapid growth in statutory minimum wages – see Annex Figure 1.C.1.

[19] The comparison however only refers to the level of average earnings and does not take account of the distribution due to data availability.

[20] The 38 OECD countries, except Canada, Greece, Hungary, Iceland, Israel, Italy, and Slovenia for which only 2021 data available.

[21] The majority of OECD countries took measures to ensure widespread use of job-retention schemes and extend unemployment benefits entitlements by improving access, notably for workers with insufficient contribution records, lengthening maximum durations and raising generosity to account for the great difficulty of finding work during the COVID-19 crisis. Yet, most of these measures were temporary, and only a few of them were still in place in 2022.

[22] As data for Greece are for 2021, this very positive pattern may have changed in 2022, since labour market security in 2022 is likely affected by the phasing out of income support measures that were temporarily implemented as a response to the COVID-19 pandemic.

[23] Beyond job retention schemes, Spain extended the unemployment benefit entitlements along several dimensions by improving access to unemployment insurance (unemployment insurance coverage increased significantly in 2020 due to the suspension of the minimum contribution requirements), but also by extending benefit duration and raising benefit generosity. All these were however temporary measures which were suspended in March 2022. In Greece, the duration of unemployment benefits was extended in 2020 but this measure was then phased out in 2021.

[24] The overall labour market security indicator cannot be computed, as information is only available for unemployment risk.

[25] The main challenges include the combination of infrequent or one-off surveys at different dates, the small sample sizes, as well as the diversity of questions and coding across OECD countries. For instance, the International Social Survey Program (ISSP) Work Orientation module used in previous OECD publications to extend the country coverage of the quality of the working environment beyond European countries has not been updated. The main source of European data, the European Working Conditions Survey, was only conducted by telephone with a reduced format in 2021 (EWCTS 2021) and an update of the full survey is not planned before 2025. In the same vein, it is not possible to use the Korean Working Conditions Survey (2020) since the questions are not comparable with the EWCTS 2021.

[26] The OECD Job quality framework builds on the Job-Demands and Resources model developed by Bakker and Demerouti (Bakker and Demerouti, 2007[23]). See details in OECD (2014[2]) and Cazes, Hijzen and Saint-Martin (2015[1]).

[27] Indicators of the quality of the working environment in previous OECD publications have been relying for OECD European countries on the European Working Conditions Surveys (EWCS) carried out by Eurofound every five years since 1991. However due to significant methodological changes in the 2021 edition – interviews conducted by phone instead of face- to- face; changes in the range of questions and for some of them changes of the answering scales, different sampling methodology, etc. – Eurofound itself is recommending not to compare EWCTS 2021 with previous EWCS waves.

[28] Results are not shown here but are available on request.

[29] Such as working time regulations, health related labour laws, sickness insurance schemes, occupational healthcare services, labour inspection bodies, vocational training, etc.

[30] A simple analysis with controls for gender, age groups, educational attainment, contract duration, firm size, industry, occupation, with and without teleworking, suggests that controls do explain some of the cross-country variation. In particular, the standard deviation of the country fixed effects is 56% lower when estimating a model with all controls included than a model with no controls – that is, accounting only for the unconditional differences across countries. Results not shown here but available on request.

[31] For Luxembourg and Switzerland, estimates of average job strain conditional on observable characteristics are significantly higher, indicating that these countries have many jobs that are inherently not prone to job strain – such as jobs in high skill sectors. For Spain, the conditional estimates are instead smaller, suggesting that there are many (manual) jobs that are intrinsically candidates for high strain.

2 The jobs that will make the net-zero transition: Who holds them and are they good?

Andrea Bassanini, Andrea Garnero and Agnès Puymoyen

The policies that OECD countries are adopting to achieve net-zero greenhouse gas emissions by 2050 will have a significant impact on labour markets: jobs in high-emission industries will be reduced, new opportunities will emerge in climate-friendlier sectors, and many existing occupations will be transformed. Climate change itself will affect labour demand and working conditions, mainly through rising temperatures and more frequent extreme weather events. This chapter focuses on the jobs that are likely to thrive because of the net-zero transition and compares them with jobs concentrated in high-emission industries. In addition to looking at the characteristics of the workers who hold these jobs and where they are located, the chapter delves into the quality of these jobs by analysing their wages, labour market security and quality of the working environment.

In Brief

Key findings

OECD countries are actively adopting ambitious climate change mitigation packages aimed at achieving net-zero greenhouse gas (GHG) emissions by 2050. The net effects of these policies on aggregate employment are expected to be modest given that employment in high-emission sectors represents only a small fraction of total employment and new opportunities will arise in climate-friendlier occupations, and industries, including those producing intermediate goods and services for environmentally sustainable activities. Nevertheless, significant shifts are expected across industries, occupations, and regions.

The chapter first recalls that the absence of policy action as regards climate mitigation is, and will increasingly have, dramatic consequences for the labour market, largely concentrated on the most vulnerable groups. It shows that 13% of workers in European OECD countries and the United States suffer from significant heat discomfort, typically workers in outdoor occupations and workers in process and heavy industries, with potential negative effects on their health and productivity. Moreover, the regions where the proportion of workers exposed to high temperatures is already higher than average are also the regions projected to experience the largest temperature increases by 2050.

The chapter then focuses on the jobs that are likely to thrive in the context of the net-zero transition and compares them with the jobs most at risk of disruption. To this end, the chapter introduces the concept of "*green-driven occupations*", which goes beyond the usual notion of "green jobs" to include also those jobs that do not directly contribute to emission reductions but are likely to be in demand because they provide goods and services required by green activities.

The key findings of the chapter are as follows:

- Across the OECD, between 2015 and 2019, around 20% of workers are employed in green-driven occupations. Of these green-driven occupations:
  - 46% are existing occupations whose skill set is being altered because of the green transition (referred to here as "green-enhanced skills occupations").
  - 40% are existing jobs that will be in demand because they provide goods and services required by green activities (referred to here as "green increased demand occupations").
  - Only 14% are what can properly be described as "green new or emerging occupations".
- Conversely, over the same period, about 6% of OECD employment is in GHG-intensive occupations, i.e. occupations that are particularly concentrated in high-emission industries. Green-driven and GHG-intensive occupations are not mutually exclusive categories: about 10% of the green-driven occupations are, in fact, concentrated in high-emission industries, mostly in the group of "green-enhanced skills occupations".
- Both green-driven and GHG-intensive occupations are more widespread in rural than in urban areas. However, regions with higher incidence of GHG-intensive occupations are not necessarily the same as those with higher incidence of green-driven occupations. Without policy action, there is a concrete risk of widening regional labour market and economic inequalities.
- Green-driven occupations are heterogeneous: green new and emerging occupations are typically high-skill jobs (i.e. managers, professionals and technicians) and employ highly educated workers in urban areas while the other green-driven occupations are on average more medium- and low-skill and employ more low-educated workers.

- Green new and emerging occupations experienced the fastest growth in the past decade. Between 2011 and 2022, their share in total employment increased by 12.9% on average in European-OECD countries and the United States, while the share of all green-driven occupations in total employment increased by only 2%. The latter figure, however, rises to 5% once green-driven occupations concentrated in high-emission industries are excluded. In the same period, the share of GHG-intensive occupations declined by 18%.
- Green-driven occupations tend to be characterised by higher wages and fewer temporary contracts than other occupations, although workers in these jobs are often exposed to larger unemployment risk. In addition, jobs that are not directly contributing to emission reductions but will likely be in demand because their products or services will be needed by green activities (i.e. green increased demand occupations) tend to be characterised by a higher incidence of job strain (insufficient resources to meet job demands).
- The job-quality advantage of green-driven occupations, relative to other jobs, tends to be concentrated in high-skill occupations, suggesting that those workers who have the specific competences required by these expanding jobs have a competitive edge in the labour market and thrive compared to their peers. By contrast low-skill, green-driven occupations tend to command significantly lower wages and labour market security than other low-skill jobs, suggesting that, absent policy action, these occupations may be a relatively unattractive option for low-skilled workers.
- Even though many workers in high-emission industries are paid relatively well (see Chapter 3), the occupations most concentrated in these industries (GHG-intensive occupations) are, on average, characterised by a higher incidence of low pay as well as a lower quality of the working environment than the average job. In contrast, they do not display, so far, larger unemployment risk than other occupations. This is consistent with the fact that workers in GHG-intensive jobs are often relatively stable jobs (until they are suppressed because of industry downsizing – see Chapter 3). However, workers in GHG-intensive occupations are likely to have fewer options outside the downsizing GHG-intensive industries, which may put additional pressure on their bargaining power, resulting in lower-than-average wages.
- The characteristics of the workers employed in declining GHG-intensive occupations are remarkably similar to those of the workers more exposed to high temperatures. This suggests that while climate change mitigation policies may be costly for some groups of workers, there are also costs to inaction for these groups.

Overall, these results suggest that the net-zero transition is creating and will continue to create good-quality jobs. However, these tend to be concentrated in high-skill occupations and represent an opportunity mainly for highly educated, urban workers who have the competences required for these jobs. In contrast, for low-skilled workers, green-driven occupations may not be a sufficiently attractive alternative to jobs in the rest of the economy (including high-emission industries). This points to the importance of measures to improve the quality of green-driven jobs as well as the critical role of public policies in facilitating and accompanying the transition, such as training policies (Chapter 4), active labour market policies, social dialogue and collective bargaining (Chapter 3).

Going forward, to be able to properly monitor and analyse the effects on the labour market of climate change mitigation policies, more timely and granular data will be necessary. In particular, OECD countries should consider collecting and releasing survey and administrative data at a higher degree of disaggregation, run ad hoc surveys collecting workers' use of green technologies and practices and develop country-specific inventories of green tasks by occupation – such as O*NET for the United States.

Introduction

The urgency of tackling climate change has reached a critical juncture and it represents one of the greatest challenges ahead in all sectors of the economy. The latest report from the Intergovernmental Panel on Climate Change (Arias et al., 2023[1]) leaves no room for doubt: human-driven climate change is advancing rapidly and demands immediate, collective action to swiftly reduce global emissions towards net zero, as well as to confront the escalating impacts of climate-related disruptions.

This will have direct effects on OECD labour markets. Most analyses so far have focused on the effect of the green transition on the quantity of jobs, i.e. whether it will create more or fewer jobs than those that it will destroy. While the precise estimates from macro-models differ, there is a broad agreement that the net effect of the net-zero transition on aggregate employment will be modest – see Box 2.1. But such a question risks concealing the very significant impact that the transition will have in reshaping the labour market: some jobs will disappear, and new opportunities will arise leading to a major reallocation within and across sectors and regions. Moreover, many existing professions will be transformed and redefined as day-to-day tasks and work methods become greener. Finally, climate change itself will impact labour demand and working conditions, primarily through an increase in temperatures and in the frequency of extreme weather events.

While climate change mitigation policies may entail significant economic costs, especially for some groups of workers, absence of climate action indeed implies major costs and may lead to increasing inequalities (OECD, 2021[2]): in a recent paper, Bilal and Känzig (2024[3]) estimate that world GDP per capita would be 37% higher today had no warming occurred since 1960[1] and these high costs of global warming are concentrated among vulnerable groups. For example, the increasing frequency of heatwaves due to climate change poses a significant threat to individuals employed in outdoor settings or those already regularly exposed to elevated temperatures, often comprising middle- and low-income earners – see Box 2.2. Furthermore, some studies have emphasised the adverse effects of outdoor air pollution on indoor workers with lower skill levels (Chang et al., 2016[4]; Adhvaryu, Kala and Nyshadham, 2019[5]; Chang et al., 2016[6]). In addition, the influence of climate change on the productivity of vital sectors for rural economies, such as agriculture and fisheries, could also worsen the urban-rural disparity.

Policy makers, therefore, face a double challenge: they must design policies to facilitate and manage labour reallocation induced by climate change mitigation policies but also enhance the capacity of workers, companies and communities to adapt to increasing temperatures and the escalating severity of extreme weather events (Keese and Marcolin, 2023[7]).

The exact extent of these challenges remains uncertain and hinges on the implementation of policy commitments and goals, as well as the widespread adoption of existing environmentally friendlier technologies and the development of new ones (e.g. carbon capture, utilisation and storage – CCUS hereafter) across various sectors and enterprises. But there is no doubt that climate change and climate change mitigation policies will have a significant impact on OECD labour markets, well beyond their net effects on aggregate employment. Moreover, the transition to net-zero comes at a time when OECD labour markets are experiencing other transitions. Technological advances, including in the area of generative artificial intelligence, the reorganisation of global value chains, and rapid demographic ageing are all affecting households and putting many workers under pressure. But the net-zero transition is unique in its largely policy-driven nature. Policy makers therefore have a heightened responsibility to ensure a just transition that leaves no one behind.

Box 2.1. The effects on aggregate employment of the net-zero transition

The net-zero transition will entail structural macroeconomic and sectoral transformations in production processes and technologies, demand patterns, international trade and competitiveness. One particular concern is what will happen to employment as the transition will imply a reduction of fossil fuel use and related economic activities. Will the employment created in the sectors that will be instrumental to change the energy mix and reduce emissions be enough to compensate for the employment losses in high-emission sectors? The answer depends on a range of factors. Some of these are known or can be anticipated such as the size of the downsizing sectors compared with the sectors that are likely to grow and demographic trends. Other factors are difficult to fully anticipate in the long run, such as technological developments and how existing companies will adapt to changing regulations and demand patterns.

There is a wide range of estimates of the net employment effects based on macroeconomic, general-equilibrium modelling. Under a number of simplifying assumptions (typically, the modelling of the functioning of the labour market tends to be rather simplistic), these models simulate the impact of climate mitigation policies, such as an increase in the carbon tax – see also Chapter 5.

At the OECD, the ENV-Linkages model projects economic activities and emissions several decades into the future to shed light on the medium- and long-term impacts of environmental policies. Using this model, Chateau et al. (2018[8]) simulate the effect of a carbon tax of USD 50 per ton of CO_2 in all regions of the world and find that, despite large impacts on specific sectors, the aggregate effect of decarbonisation policies on employment is generally small and positive, but turns negative when the carbon tax considered exceeds USD 100 per tonne of CO_2 and when the carbon tax revenues are not used to lower labour tax rates. More recently, Borgonovi et al. (2023[9]) used ENV-Linkages to estimate the effects of the EU Fit for 55 package, an ambitious set of measures adopted by the European Union to achieve a 55% reduction in EU greenhouse gas emissions by 2030 compared with 1990 (corresponding to a carbon tax of USD 202 per tonne of CO_2 in the model). They find that employment growth is projected to be somewhat lower than in a scenario without the Fit for 55 package (1.3% employment growth between 2019 and 2030 in the Fit for 55 scenario against 3% in the baseline scenario).

The likely impact of the Fit for 55 package has also been simulated with other models. According to the impact assessment of the package by the European Commission (2020[10]), using the applied general equilibrium model JRC-GEM-E3, the Fit for 55 package would have a small negative effect on aggregate employment by 2030 (-0.26%) compared to the baseline (the existing 2030 climate and energy legislative framework) but if carbon revenues are used instead to reduce labour taxation, the impact may be slightly positive (0.06%). These employment impacts differ across occupations, skill groups, and policy design options – carbon pricing vs. regulatory measures (Weitzel et al., 2023[11]). Using the GEM-E3-FIT model, Eurofound (2023[12]) also finds modest net gains by 2030. Other macro models are somewhat more optimistic: E3ME, a macroeconomic model used to simulate and assess the medium to long-term effects of environmental and economic policies for Europe, projects no change in employment under the assumption of a lump sum transfer of carbon revenues to households. If carbon revenues are recycled to support energy efficiency investment and reduce VAT, the boost to consumption and GDP would generate an increase in employment of up to 0.2% relative to baseline. E-QUEST, a micro-founded multi-region model with energy sectors, estimates an increase of 0.45% if carbon revenues are recycled to reduce labour taxation for low-skilled workers (European Commission, 2020[10]).

Estimates are available also at the country level. For instance, Fontaine et al. (2023[13]) estimate the impact on employment in France of a EUR 100 carbon tax using a simulation model (ThreeMe2) specially developed to analyse the medium- and long-term consequences of energy and environmental policies at the national level. They find a negative effect (-0.6%) by 2030 that becomes positive (+0.3%) if carbon revenues redistributed in full to households (in the form of a reduction in income tax) and companies (via a reduction in social security contributions). In the United States, Finkelstein, Shapiro and Metcalf (2023[14]) estimate the impact of a 35% reduction in carbon emissions (a target broadly consistent with the country's Paris Agreement commitment) and find that, under a scheme where carbon-tax revenue is transferred to households through a lump sum, it can generate mild positive long-run effects on employment, thanks to a boost in consumption and output and an increase in the use of green technologies.

A full review of all studies is beyond the scope of this chapter, but it is fair to conclude that the available estimates based on macro models suggest that the net aggregate effects of the transition to net zero are likely to be modest. Differences in the results can be explained by the type of models used, the climate mitigation policy mix simulated, the stringency of climate action in the rest of the world, and the accompanying measures put in place. On the one hand, models finding slightly negative results tend to assume that carbon revenues are not recycled via lower labour taxes and that international co-ordination in climate mitigation policies leads to a general slowdown of economic growth (even if ensuring a level playing field between companies across the world). Studies finding slightly positive effects, on the other hand, usually assume some degree of revenue recycling that stimulates the labour market. A consistent outcome across models, however, is the finding that the transition to net zero will shift jobs away from fossil fuel sectors towards other economic activities that play an important role in decarbonising the economy, such as renewable electricity generation and construction sector activities that enhance the energy efficiency of buildings, as well as that, if policy commitments are held, these shifts will already become sizeable within a short time horizon (e.g. by 2030).

This chapter focuses on the jobs that are likely to benefit from the net-zero transition and compares them with the jobs that are the most at risk of downsizing. Most analyses in the literature have centred on "green jobs" viewed as jobs which directly contribute to reducing emissions. However, there is no agreement on what a green job is. Moreover, to have the full picture, it is also necessary to identify the jobs at the greatest risk of becoming obsolete because of the net-zero transition (the "high-emission jobs") and the approaches used to define these jobs also differ. Finally, the net-zero transition will have a much larger impact than just on the narrow groups of green and high-emission jobs: other jobs that are neither high-emission nor actively contributing to reduce emissions but that are in demand because of green activities will be impacted. To be able to consider the full extent of the challenge, this chapter takes a broader definition than most previous studies and looks at all *green-driven jobs*, i.e. all those jobs that are likely to be positively affected by the net-zero transition, even those that are not green as such.

Beyond providing a ballpark estimate of the jobs likely to benefit from the net-zero transition and of those most at risk and the characteristics of the workers holding these jobs, this chapter delves into the quality of these jobs. A successful transition towards a low-carbon economy not only will induce greater demand for green-driven occupations but also requires greater workers' willingness to search for, and pick up, job offers in these occupations. Jobs in (downsizing) high-emission industries are typically regarded as relatively good jobs, paying comparatively well and with a prevalence of open-ended, full-time employment contracts. This is less clear for the jobs that will emerge from the net-zero transition. In fact, a key policy issue, which has already led to some industrial disputes and growing concerns among policy makers and social partners, is that downsizing of traditional jobs in high-emission sectors and development of green-driven jobs may result in a worsening of job quality. This chapter will show that some, but only some, of these concerns may be warranted by looking at the quality of green-driven and other jobs.[2]

The remainder of this chapter is structured as follows: Section 2.1 starts by providing an overview of the measurement approaches adopted so far to measure green and high-emission jobs and describes the approach adopted in this chapter. Section 2.2 presents a panorama of green-driven and high-emission jobs, focusing especially on the characteristics of the workers currently holding these jobs and of the areas where they are located. Section 2.3 provides a detailed analysis of job quality in green-driven occupations, focusing on the three dimensions of the OECD Job Quality framework, namely wages, labour market security and the quality of the working environment (OECD, 2014[15]). Section 2.4 concludes by discussing the data and methodological improvement needed to sharpen our understanding of the impact of the net-zero transition on the labour market.

Box 2.2. Increasing temperatures will also have labour market costs

While this edition of the Employment Outlook essentially focuses on the consequences of climate change mitigation policies, OECD labour markets will also be affected by the impacts of climate change itself. In particular, all workers will experience the effects of global warming, but to varying degrees depending on their professional situation and their exposure as well as vulnerability to climate risks.

Climate change is not only gradually increasing temperatures globally but is also increasing the intensity and duration of heatwaves. Heat-stress can lead to fatigue or exhaustion as well as cardio-vascular and respiratory health problems. Heat exposure impairs workers' capacities with a negative effect on productivity, both in complex activities with a high cognitive content or relatively simple, routine activities requiring particular attention and vigilance (Benhamou and Flamand, 2023[16]). Heat has been shown to lower productivity (Day et al., 2019[17]; ILO, 2019[18]), increase absenteeism (Somanathan et al., 2021[19]), heighten the risk of work-related accidents (Fatima et al., 2021[20]; Park, Pankratz and Behrer, 2021[21])[1] as well as the functioning of machinery and infrastructure (Benhamou and Flamand, 2023[16]).

There is limited comprehensive evidence on the share of workers exposed to the risks related to extreme heat events as this requires detailed knowledge on their specific tasks, working conditions and their place of work. Some of this information can be retrieved using working condition surveys to have a ballpark estimate of the workers currently exposed to high temperatures. Building on the analysis for France by Benhamou and Flamand (2023[16]), Figure 2.1, Panel A shows that in European OECD countries and the United States, in 2015,[2] after accounting for the different timing of the interviews,[3] 13% of workers were exposed to high temperatures at least half of their working time, with peaks of 26% in Türkiye, 25% in Spain, and 22% in Greece. On average, an additional 10% of workers were exposed to high temperatures at least one-quarter of their working time.

The sectoral and occupational characteristics contribute to explain much of the variation across countries: everywhere, workers in outdoor occupations (e.g. street vendors, construction workers, farmers and fishers) are particularly affected by heat (as well as cold), as are workers in process and heavy industries. Given the type of occupations and industries concerned, the highest share of workers exposed to high temperatures can be found in rural areas and more among low educated and middle-skilled workers (i.e. sales, skilled agricultural, craft and plant workers) – see Figure 2.1, Panel B. Given their occupational concentration, men tend be more exposed to high temperatures than women, while older workers tend to be slightly less exposed than younger ones – a more in-depth discussion of the results in this box is available in OECD (forthcoming[22]).

Beyond the occupational characteristics and the working environment (typically the presence of air conditioning), the geographic distribution of workers also plays a role: worryingly, regions where workers already report heat-related discomfort, typically many southern regions of Europe, are also those that are predicted to experience higher heat stress in the coming decades as per the projections by Casanueva et al. (2020[23]) and García-León et al. (2021[24]) – see Figure 2.2. However, in other countries and regions where heatwaves are a more recent phenomenon, the effects of heat stress may be just as challenging, if not more so, as buildings and work organisation may be less prepared.

Figure 2.1. One in seven workers report heat-related discomfort in Europe and the United States

Percentage of employment who declare to be exposed to high temperature at least half of their working time, 2015

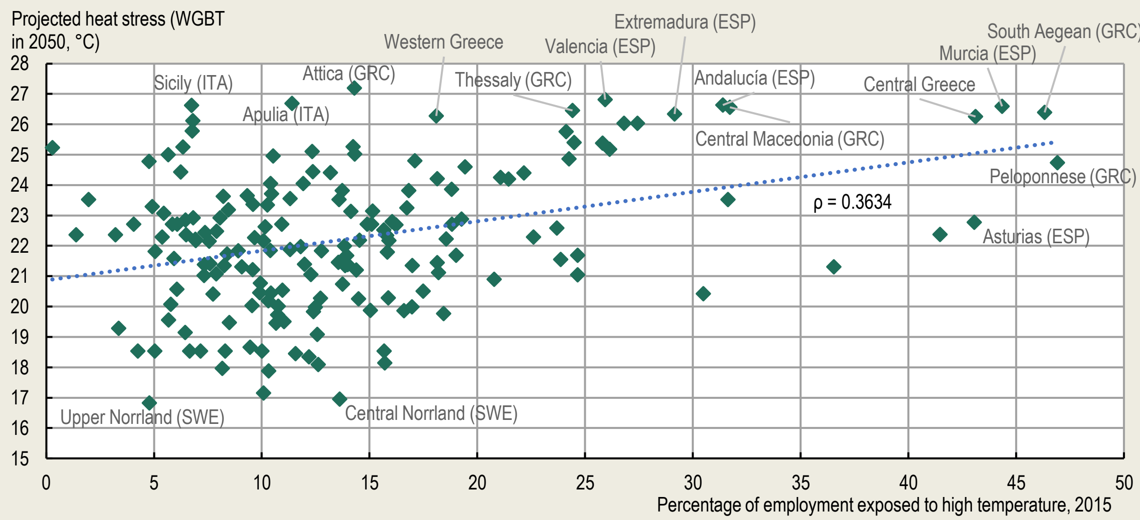
Note: Those who declare to be exposed to high temperature which make them perspire even when not working at least half of their working time are classified as at-risk. The shares are the predictions in May, obtained by running a regression of the exposure to heat at country level on the share of respondents by month of interview. For Panel A, the average is unweighted. For Panel B, averages are unweighted and include Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States. Youth are those aged from 15 to 24, prime from 25 to 54, and senior from 55 and above. For urbanisation, the United States is not included.

Source: Secretariat's calculations based on data from European Working Conditions Survey (Eurofound) and American Working Conditions Survey (RAND Corporation).

StatLink https://stat.link/852oij

Occupational safety and health (OSH) regulations in OECD countries already cover aspects related to temperature, heat stress and extreme weather at work. However, some countries, often with the direct involvement of social partners, have adapted the legislation to the specific challenges related to climate change (e.g. Lithuania) or developed specific OSH programmes and tools (e.g. Germany, Lithuania, Slovenia and Spain). In some countries (e.g. Belgium, Italy, Spain) companies can, under some conditions, use the job retention scheme in case of exceptionally high temperatures. Practical guidance on how to manage risks has been developed by occupational safety and health agencies in several countries (Safe Work Australia, the Canadian CCOSH, EU OSHA, UK HSE and US NIOSH). Specific initiatives have also been taken in some of the most exposed sectors (e.g. agriculture in Lithuania or construction in Austria, Germany and Lithuania), including the development of new tools (e.g. a warning system in Slovenia accessible to employers and employees with site-specific predictions) – for more information on the policies in place see the review by the European Commission (2023[25]).

Figure 2.2. Regions with higher proportions of workers reporting heat-related discomfort are also projected to face higher heat stress in 2050



Note: The X-axis refers to those who work under high temperature at least half of their working time. The shares of workers exposed to high temperatures are the predictions in May, obtained by running a regression of the exposure to heat at country level on the share of respondents by month of interview. Projected heat stress in 2050 is measured using the Wet-bulb Globe Temperature (WBGT) which factors in temperature, dew point temperature, wind speed, and solar radiation to assess heat stress experienced by individuals working outdoors (thus it should not be interpreted in the same way as standard temperatures). The 2050 projection is calculated based on daytime working hours during the summer with the KNMI regional climate model (RACMO), which uses a high-mission scenario of the Representative Concentration Pathway 8.5. The OECD large (TL2) regions of Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden and Switzerland are included. The TL2 regions for which the number of observations is fewer than the bottom 10th percentile (i.e. 30 observations) are removed. For France, the 2010 data are used. The correlation is statistically significant at a 95% confidence level.
Source: Secretariat's calculations based on data from the European Working Conditions Survey (Eurofound); García-León et al. (2021), "Current and projected regional economic impacts of heatwaves in Europe", https://doi.org/10.1038/s41467-021-26050-z; and Casanueva et al. (2020), "Escalating environmental summer heat exposure – a future threat for the European workforce", https://doi.org/10.1007/s10113-020-01625-6.

StatLink https://stat.link/q4b37s

Note: Satoshi Araki contributed to this box. More detailed results can be found in OECD (forthcoming[22]).
1. Park, Pankratz and Behrer (2021[21]) estimate that each day with temperature above 40 degrees Celsius increases the risk of workplace accidents by more than 10% with respect to a day with normal temperatures.
2. Information on exposure to high temperatures is not available in the 2021 wave of the European Working Conditions Survey. In the 2015 wave high temperatures are defined as temperatures which make the respondent perspire even when not working.
3. The information on exposure to high temperatures is self-reported by workers. The cross-country comparison may, therefore, be driven by some degree of cross-country differences in how heat is perceived. Country differences may also reflect differences in the degrees of adaptation to heat, so that it may be more difficult to cope with high temperatures in certain countries than others (Heutel, Miller and Molitor, 2021[26]). Moreover, the timing of the interviews differs across countries and may influence the reported exposure to heat. To correct for the differences in the timing of interview, the estimates presented in this box are the predictions of the exposure to heat in May, obtained by running a regression of the exposure to heat at country level on the share of respondents by month of interview.

2.1. Overview of measurement approaches

2.1.1. What is a "green job"?

Despite some standardisation efforts at international level[3] there is still no universally accepted definition of *green job* in the literature (OECD, 2023[27]; Cedefop, 2019[28]), but the range of used approaches can broadly be labelled as "top-down" and "bottom-up" or a mixture of both (Valero et al., 2021[29]):

- Top-down approaches consider as green all jobs within specific sectors, establishment or activities that contribute substantially to preserving or restoring environmental quality, maintain low emissions or reduce them, and minimise waste creation and pollution. This may be operationalised through a process-based approach, which incorporates direct and indirect emissions and therefore considers as green all production processes and service delivery using more resource-efficient or environmentally friendly technologies, as defined with respect to a defined benchmark (Bontadini and Vona, 2023[30]; Verdolini and Vona, 2022[31]).[4] More common, however, is a top-down, output-based approach, in which environmental activities are restricted to the production and delivery of environment-related goods and services. For example, the United Nations System of Environmental Economic Accounting (SEEA) defines "economic activities related to the environment" as those associated with environmental protection and resource management[5] as well as the production of goods and services strictly connected with these activities (United Nations, 2012[32]). Consistent with this definition, Eurostat collects statistics on the environmental goods and service sector – based on national account data and described as the economic sector that generates environmental products, i.e. goods and services produced for environmental protection or resource management – and estimate its overall employment, referring to all workers employed in the sector (European Commission, 2016[33]; Vandeplas et al., 2022[34]). A similar approach is followed by the UK Office of National Statistics.[6] An alternative top-down approach is to consider as "green jobs" all jobs in expanding sectors as identified using macroeconomic models simulating the impact of green policies – see Box 2.1 and Borgonovi et al. (2023[9]). No matter the method and precise definitions, all jobs in, for example, the renewable energy power generation sector are green according to this class of approaches, including administrative and support jobs.[7]
- Bottom-up approaches start, by contrast, from the characteristics of jobs and occupations independently of the sector of the economy where they operate in. Researchers have applied this approach in different ways, for example by computing the share of green tasks that are specific to a subset of jobs and considering as green only jobs with a reasonably high green-task[8] intensity – e.g. Peters (2013[35]), Elliott et al. (2021[36]), Office of National Statistics (2022[37]) and OECD (2023[27]), which all start from the list of green tasks by occupation as published and regularly updated by O*NET until 2019[9] (see Box 2.3)– or by examining the presence of "green" keywords (such as, for example, "solar", "photovoltaic" or "wind") in online job ads – e.g. Saussay et al. (2022[38]), Curtis and Marinescu (2023[39]) and Curtis, O'Kane and Park (2023[40]). In this approach, a wind turbine service technician is considered a green-job worker even if working for a company mainly active in fossil fuel electric power generation, while a security guard for a company in renewable energy power generation will not be considered green. This approach may also end up in a non-binary measure of greenness, for example based on the intensity of green tasks of each examined job – e.g. Vona et al. (2018[41]), Vona, Marin and Consoli (2018[42]) and Scholl, Turban and Gal (2023[43]).

Many of the attempts to measure green jobs are in practice a mixture of top-down and bottom-up approaches. For example, the, now discontinued, US Green Jobs Initiative of the Bureau of Labor Statistics employed an extensive definition of green jobs encompassing both green output production ("jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources") and jobs involved in greening production processes of neutral or polluting establishments ("jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources") – see BLS (2013[44]). The O*NET Greening of the World of Work Project (Dierdorff et al., 2009[45]; 2011[46]) considers both the sectors and activities "related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy" (Dierdorff et al., 2009, p. 3[45]),[10] and the occupations for which these activities and technologies are likely to increase demand, shape work and workers requirements, or generate new, unique work and worker requirements.

Box 2.3. The O*NET database

The O*NET database was created in 1998 by the U.S. Department of Labor, building on its predecessor the Dictionary of Occupational Titles (DOT), and is updated on a regular basis. O*NET contains a wealth of information on occupations, including tasks characterising work and skill and ability requirements in each of the about 1 000 occupations (Handel, 2016[47]).[1] Most of this information is collected, and updated regularly, from job incumbents and occupations experts through surveys. More information on the O*NET database, and current and archive versions of the dataset can be found online.[2]

As O*NET is developed by the National Center for O*NET Development under the supervision of the Employment and Training Administration in the United States, it is geared towards the content of jobs in the labour market in the United States. Despite this, O*NET has been regularly used for the analysis of countries other than the United States. The assumption that occupational information from one country can be generalised to other countries has been tested and largely holds. For example, Handel (2012[48]) finds that occupational titles refer to very similar activities and skill demands across different countries. As a result, the O*NET information on tasks, skills and abilities has been used extensively in labour market research in high-income countries – see e.g. Deming (2017[49]); Brynjolfsson, Mitchell and Rock (2018[50]); Dingel and Neiman (2020[51]); and Webb (2020[52]) as well as many studies concerning "green jobs", including e.g. Peters (2013[35]), Elliott and Lindley (2017[53]); Vona et al. (2018[41]); Vona, Marin and Consoli (2018[42]); Bowen, Kuralbayeva and Tipoe (2018[54]); and Popp et al. (2021[55]). More caution, however, may be needed about the use of O*NET to describe skills and tasks of occupations in low-income countries, as these could differ significantly in terms of technology and regulatory context compared to the United States – see also Vona (2021[56]).

Note: Julie Lassebie contributed to this box.
1. See O*NET Taxonomy at: www.onetcenter.org/taxonomy.html#latest.
2. www.onetcenter.org/database.html#overview.

One of the reasons for the lack of consensus on the definition of "green job" comes from the fact that the concept is used to try to shed light on very different policy questions. On the one hand, the concept of green job may be used to measure the contribution of the labour market to the transition towards a low-carbon economy (or more generally a low-pollution or "green" economy), as a sort of thermometer of the extent of the transition – e.g. Elliott and Lindley (2017[53]), Georgeson and Maslin (2019[57]). Relatedly, it can be used to identify and characterise jobs in the sectors directly benefitting from climate mitigation policies, including incentives to "clean energy" or "green" products and technologies, or to ask how easily workers move into low-emission activities – e.g. Bluedorn et al. (2022[58]), US White House (2023[59]) and European Commission (2023[60]) – see also Chapter 3. Consistently, in these cases, the definition of "green job" has tended to exclude those support jobs that are not directly involved in the production of green goods or the provision of green services or green processes but whose demand is likely to expand by backward linkages because of the implementation of climate change mitigation policies.[11] The ILO further requires green jobs to be "decent" jobs, adding a requirement related to fundamental principles and rights at work, working conditions including wages, and access to social protection to the green dimension, thereby using the concept of green jobs as a "double thermometer" of the transition towards low-emission and decent employment (ILO, 2016[61]; van der Ree, 2019[62]).[12]

On the other hand, the term "green job" is also used to identify the type of jobs that will likely expand because of the policy-induced transition towards a low-carbon economy (or more generally a low-pollution, or green economy). This approach implies considering both the jobs that are directly involved in green or low-carbon activities, as defined above, and those that are linked to green or low-carbon activities by backward linkages or support activities, and therefore without necessarily involving green tasks. Jobs in expanding sectors and occupations are often identified using macroeconomic models – e.g. Vandeplas et al. (2022[34]); Eurofound (2023[12]); and Borgonovi et al. (2023[9]) – or specific sectoral or occupational analyses – e.g. Dierdorff et al. (2009[45]; 2011[46]); Asikainen et al. (2021[63]); Popp et al. (2021[55]); and Causa, Nguyen and Soldani (2024[64]).

Relatedly, policy makers often ask whether workers hold the skills required by the transition. In order to answer this question, researchers have examined the skills required for the jobs directly involved in the green/low-carbon activities (Consoli et al., 2016[65]; Vona et al., 2018[41]; Tyros, Andrews and de Serres, 2023[66]). Yet, answering this question may require focusing on all types of jobs that will be in demand, insofar as also a lack of adequate skills among the suppliers of intermediate inputs for green products and services may undermine the transition – see Borgonovi et al. (2023[9]) and Chapter 4.

Resulting estimates of the incidence of green jobs in the economy vary greatly, depending on the adopted definition. Top-down, output-based approaches tend to yield low estimates of the shares of green jobs in OECD economies of the order of 2% to 4% – see e.g. Elliott and Lindley (2017[53]), Georgeson and Maslin (2019[57]) and Bluedorn et al. (2022[58]). The same is true for bottom-up approaches relying on "green" keywords or computing continuous measures of task-intensity. For example, Saussay et al. (2022[38]) estimate that less than 1.5% of online job postings in the United States advertised between 2010 and 2019 concern low-carbon, and thus green jobs. Vona, Marin and Consoli (2018[42]) estimate the share of green tasks over total tasks for the same country to be about 3%. Yet, the UK Office of National Statistics, also taking into account the time spent on each task, estimates that around 7% to 8% of hours worked in the United Kingdom were spent on green tasks in 2019 (Office of National Statistics, 2022[37]). At the opposite side of the spectrum, bottom-up, binary approaches relying on occupational characteristics and including jobs that are indirectly green (that is, that will likely be in demand because of the transition without necessarily entailing green tasks) tend to yield higher estimates of the order of 20% – see e.g. Bowen, Kuralbayeva and Tipoe (2018[54]) and Valero et al. (2021[29]).[13] Binary approaches excluding jobs that are indirectly green are somewhat in between these two extremes: OECD (2023[27]), for example, setting a minimum task-intensity threshold at 10%, finds 13% of green jobs in the United States in 2021 while, using a similar approach, Causa, Nguyen and Soldani (2024[64]) find 8% of green jobs in European countries.

2.1.2. The concept of "green-driven jobs" adopted in this publication

This edition of the OECD Employment Outlook focuses on the effect of climate change mitigation policies on employment and incomes, rather than investigating the symmetric issue of the contribution of the labour market to the green transition as an enabling factor. Therefore, this chapter takes a broader operational definition than many previous studies in the literature, including at the OECD (see Section 2.1.1), and considers all jobs that are likely to be affected by the net-zero transition and not just those that may be considered green as such.[14]

Ideally, to identify such broad group of jobs, one would like to use a general equilibrium model to classify expanding and contracting industries and jobs following the introduction of mitigation policies – that is using a top-down approach as defined in Section 2.1.1. However, while many existing macro models allow to identify precisely industries characterised by high levels of greenhouse gas (GHG) emissions, which are expected to downsize, and those occupations that are concentrated in these industries (see Box 2.4 and Chapter 3), the published results of these models are not sufficiently detailed about expanding industries – most of which are bundled together into generic low-emission industries (Borgonovi et al., 2023[9]; Eurofound, 2023[12]; Fragkiadakis, 2022[67]). Considering all jobs concentrated in this large low-emission sector would result in a too large list of positively impacted jobs.[15]

For these reasons, following most of the studies in the literature which try to identify those occupations that are likely to benefit from the net-zero transition, this chapter makes use of the O*NET Greening of the World of Work Project that, as discussed in Section 2.1.1, identifies a set of occupations that are likely to expand and/or being transformed by the transition. More precisely, the O*NET project distinguishes three groups of occupations of this type and a residual category:

- Green new and emerging occupations: new occupations (entirely novel or "spinoffs" from an existing occupation) with unique tasks and worker requirements (e.g. Biomass Plant Engineers; Carbon Trading Analysts; Solar Photovoltaic Installers).
- Green-enhanced skills occupations: existing occupations whose tasks, skills, knowledge, and external elements, such as credentials, tend to be altered because of the net-zero transition (e.g. Arbitrators, Mediators, and Conciliators; Architects; Automotive Specialty Technicians; Farmers and Ranchers). Note, however, that even if the net-zero transition alters the characteristics of these jobs, in non-green sectors of the economy (e.g. certain GHG-intensive industries – such as chemicals, fossil fuel power generation) these occupations may still be associated with the old (non-green) list of tasks, skills, knowledge and credentials and their demand may therefore not necessarily grow in the short term.[16]
- Green increased demand occupations: existing occupations in increased demand due to the net-zero transition but with no significant changes in tasks or worker requirements. Some occupations in this group can be considered as directly contributing to low emissions and clearly involve green tasks (e.g. Environmental Scientists and Specialists; Forest and Conservation Workers) but most are not and should rather be seen as in support of green economic activities (e.g. Construction Workers; Drivers; Chemists and Materials Scientists).
- Other occupations: all other occupations, including jobs associated with high-emission activities (e.g. Gas Compressor and Gas Pumping Station Operators) and low-emission, low-pollution jobs that are not directly or indirectly related to the reduction of the use of fossil fuels, pollution and greenhouse gas emissions, or the increase in the efficiency of energy usage, or material recycling, or the development of renewable sources of energy (e.g. Actuaries; Medical Appliance Technicians).

Box 2.4. Greenhouse gas-intensive industries and occupations

Following the literature (see Chapter 3), this edition of the Employment Outlook defines high-emission industries based on greenhouse gas (GHG) emissions, using 2-digit ISIC rev.4 industry data for EU-27 countries as well as the United Kingdom, Norway, Iceland and Switzerland over the period 2009-20. For all countries (including countries for which data are not available), an industry is labelled "high-emission" if it ranks in the upper two deciles of emissions per unit of value added in at least 10 out of the countries for which data are available. These industries represent at least 70% of the GHG emissions in each OECD country for which data are available. This country invariant group of industries closely corresponds to the group of downsizing industries in the simulation of the effects of the European Union's Fit for 55 (FF55) package through the OECD ENV-Linkages model (Borgonovi et al., 2023[9]). To improve consistency with the ENV-Linkages model, the Sewerage and Waste Collection industry is however omitted from the final list of high emission industries, as it is not projected to downsize – see Chapter 3.[1]

Occupations that are intensive in GHG emissions are defined as those occupations that are particularly concentrated in GHG-intensive industries. To obtain a list of GHG-intensive occupations that is comparable with green-driven occupations, without the comparisons being blurred by aggregation, these occupations are initially defined in the US Standard Occupational Classification (SOC) system in the following way. First, the list of GHG-intensive industries is mapped into the North American Industry Classification System (NAICS) at the 6-digit level, adapting the Dingel and Neiman's method (Dingel and Neiman, 2020[51]) – see Box 2.5 and Annex 2.A for details.[2] Second, data on GHG-intensive industries are aggregated into 4-digit NAICS industries (keeping 6-digit for energy power generation industries) and, at this level of aggregation, the group of GHG-intensive industries is labelled GHG-intensive sector.[3] Third, using 2019 US Occupation Employment and Wage Statistics on the number of employees by industry by 6-digit SOC occupation, a GHG-intensive occupation is defined as an occupation that is highly concentrated in the GHG-intensive sector – operationalised as an occupation for which its share of employees in the GHG-intensive sector is at least 7 times larger than the share of the GHG-intensive sector in aggregate dependent employment, as in Vona et al. (2018[41]). Fourth, for countries other than the United States, SOC-based GHG-intensive occupations are then mapped into other occupational classifications using the same methodology as for green-driven occupations – see Box 2.5 and Annex 2.A.

1. One remaining difference with the FF55 simulation of the ENV-Linkages model is that the agricultural sector is kept in the high-emission category despite not being predicted to downsize in the FF55 simulation. Even if the EU FF55 package does not include significant action in agriculture, it can be argued that, because of the high GHG emissions of this sector, mitigation policies will have to target some of its subsectors in the future to meet the goal of zero net emissions by 2050. See for example the COP28 Declaration on Food and Agriculture, signed by 159 countries, including most OECD countries (www.cop28.com/en/food-and-agriculture).
2. For this step, 2015-19 employment data from European Labour Force Surveys (EULFS), for ISIC, and 2019 employment data from US Quarterly Census Employment and Wage (QCEW) Statistics, for NAICS, are used.
3. To improve consistency with the ENV-Linkages model (and following common sense), the (tiny but rapidly expanding) sector of renewable energy power generation is excluded from the list of GHG-intensive industries at this step (this is possible at the 6-digit level of the NAICS classification, but it would not be possible in the ISIC classification).

Although the impact of the net-zero transition is likely to be heterogeneous, all the first three groups listed above include occupations that are likely to be positively impacted by climate change mitigation policies. Using the latest version of the O*NET database (2019),[17] these occupations will therefore be labelled "*green-driven occupations*" hereafter, to underline the fact that a few of them are not directly contributing to low emissions but, despite this, are still expected to be in demand because of backward linkages.

The approach adopted here, therefore, departs significantly from the task-based approach to green jobs used in most of the literature based on O*NET data. This is done for two reasons. On the one hand, as mentioned above, occupations with expanding demand because of the net-zero transition may have no or limited green-specific tasks. On the other hand, O*NET classifies into green and non-green only the tasks of green new and emerging occupations and green-enhanced skill occupations. Yet, simple inspections of the list of task descriptions (task statements in O*NET terminology) of green increased demand occupations, suggests that a few of them are clearly intensive in green tasks but, nonetheless, are *de facto* arbitrarily excluded by the studies in this literature because O*NET does not provide the green/non-green task classification for this group. For example, at least half of the core tasks of Forest and Conservation Technicians – a green increased demand occupation – are related to forest preservation and therefore maintenance of the forest carbon absorption potential, with an unambiguous, direct positive impact on green objectives. For all these reasons, green-task intensity does not appear ex ante a good predictor of the potential impact of mitigation policies on the growth of occupations. A binary approach – that is classifying occupations into green-driven and other occupations, although also distinguishing the three O*NET categories mentioned above – is therefore preferred here to a cardinal approach.

The grouping of green-driven occupations used for this chapter is defined by O*NET for the US Standard Occupational Classification (SOC) system at a very detailed level (8 digits – about 1 000 occupations). All other OECD countries, however, collect employment data using different classifications (notably the International Standard Classification of Occupations – ISCO), usually at a more aggregate level (4-digit – about 400 occupations – in the case of ISCO). As existing crosswalks between classifications are usually such that each occupation in one classification corresponds to many occupations in another classification and vice versa – a situation often referred to as "many-to-many crosswalk" – this has often resulted in disparate estimates of the amount and characteristics of green-driven occupations outside North America – see Vona (2021[56]) and Section 2.1.1 above. Following previous OECD work (Basso et al., 2020[68]; Scholl, Turban and Gal, 2023[43]; Tyros, Andrews and de Serres, 2023[66]; Causa et al., 2024[69]; Causa, Nguyen and Soldani, 2024[64]), this chapter makes therefore use of the methodology developed by Dingel and Neiman (2020[51]), which allows improving the precision of available crosswalks and obtain unbiased estimates of the proportion of green-driven and other jobs in countries that do not use the US SOC classification system (see Box 2.5).[18]

Box 2.5. Cross-walking occupational classifications

Existing crosswalks between the different occupational classifications used in different OECD countries are typically many-to-many, meaning that each occupation in one classification corresponds to many occupations in another classification, and the correspondence between two couples of occupations is, therefore, only partial. Following previous OECD work, this chapter adapts and applies the methodology originally developed by Dingel and Neiman (2020[51]) for indicators of occupational characteristics that are shared by all jobs in the same occupation as defined in the standard occupational classification of one country (for example the proportion of workers in green-driven jobs, which takes the same value – 0 or 100% – within each 8-digit SOC occupation). This methodology provides a weight to each combination of one occupation in the origin classification (*origin occupation* hereafter) and country (e.g. US SOC in the United States) and another in the target classification (*target occupation*) and country (e.g. ISCO at the 4-digit level and Germany) that partially match each other. The weight is a function of the employment share of the origin and target occupations in their respective countries. The average value of each indicator (that is, continuing the example, the proportion of workers in green-driven jobs) for each target occupation and country is then obtained as a weighted average across all combinations that include the target occupation[1] – see Annex 2.A for details.

One of the advantages of the procedure described above is that, because the employment-weighted average of group averages is the global average, there is no systematic aggregation bias as regards the country averages of each indicator that is invariant within each origin occupation. As a consequence, computing the incidence of green-driven occupations directly on 8-digit SOC data or as a weighted-average of the estimated incidence in each target occupation (for example 4-digit ISCO occupations) would yield the same result – see Annex 2.A for the proof. This is a crucial validation step of the procedure: as argued by Vona (2021[56]), a sensible validation test of the implementation of any crosswalk indeed requires that, for the same country, aggregate indicators constructed from crosswalked and original data are approximately the same.

Obviously, a key assumption and limitation of this approach is that the way occupations will be affected by the net-zero transition is similar across countries. This is a crude assumption, and it is possible to find counter-examples of occupations for which it is unlikely to hold.[2] Concerning average statistics, this assumption, however, is probably less problematic in the case of binary indicators (such as green-driven or other occupations) than in the case of continuous measures of green-task intensity, as the intensity in green tasks is likely to differ according to differences in technology adoption across countries (Biagi, Vona and Bitat, 2021[56]).

The data at the level of the target occupation can then be matched with other datasets for the target country (e.g. labour force surveys) to estimate the average of the chosen indicator among groups with different characteristics – for example, the frequency of green-driven occupations among women. This will be obtained as a weighted average of the indicators for the target occupation where group-specific employment by occupation will be used as weight – that is, in the same example as above, a weighted average of the proportion of green-driven jobs by occupation, with female employment by occupation being used as weight.

1. This method does not necessarily yield a final binary indicator in each target occupation of the target country even when the origin indicator is binary. For example, the proportion of green-driven occupations is either 0% or 100% in the origin occupations and country. Yet, in the target occupation and country, most target occupations will have a proportion of green-driven jobs comprised between these two values.
2. For example, while Heavy and Tractor-Trailer Truck Drivers is considered a green increased demand occupation in the United States, which do not have a large network of electrified railways, this is unlikely to be correct for countries like Switzerland or Belgium, where the network of electrified railways is extensive.

2.2. Green-driven jobs: How many, where, who?

This section analyses the distribution of green-driven jobs across the OECD in comparison with GHG-intensive occupations, exploring their incidence across countries, regions and sectors, the evolution over the last decade and the characteristics of the workers holding these jobs. This analysis provides a snapshot of the distribution of green-driven and GHG-intensive occupations between 2015-19 (to avoid the very strong labour market fluctuations generated by the COVID-19 pandemic and the recovery that followed), not a projection of how many of these jobs there will be in the future and what will be their characteristics. The goal of this analysis is rather to identify which countries, regions or groups of workers are over-represented in green-driven occupations and, therefore, likely better placed to seize the opportunities that will be created by the green transition, or, conversely, are over-represented in GHG-intensive occupations and, hence, more at risk in the net-zero transition.

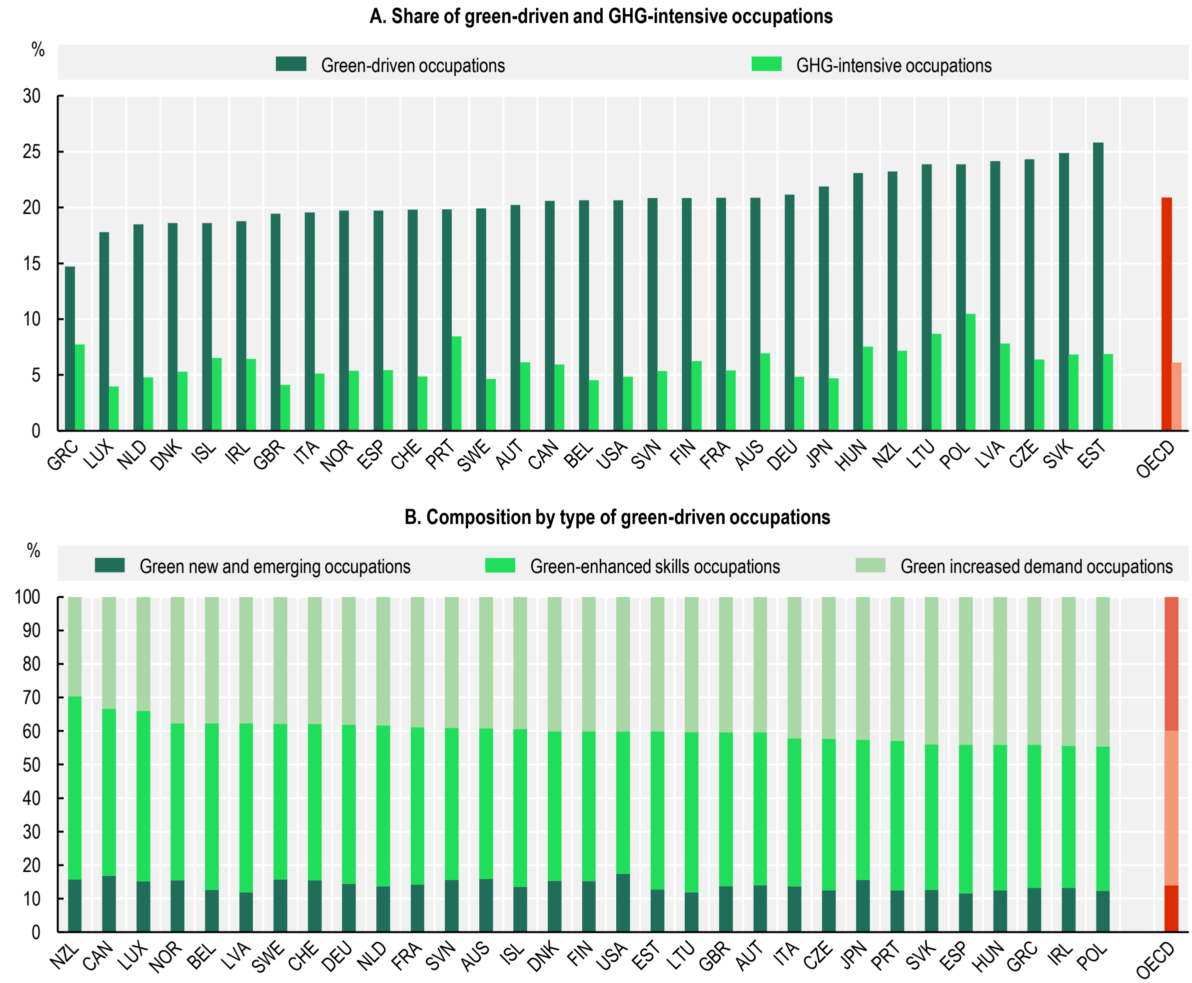
2.2.1. How many and where?

Across the OECD, between 2015 and 2019, around 20% of workers are employed in green-driven occupations (Figure 2.3, Panel A), ranging from about 15% in Greece to 25% in Estonia. On average, among these workers, about 46% are employed in green-enhanced skills occupations, i.e. existing occupations whose skill set is being altered because of the net-zero transition, and 40% in green increased demand occupations, i.e. existing occupations in increased demand due to the green transition but with no significant changes in tasks or worker requirements (Figure 2.3, Panel B). Only 14% are employed in green new and emerging occupations. The very large majority of workers employed in green-driven occupations are, therefore, employed in jobs that are not new. In fact, about two in five of these jobs are not even experiencing major changes in their work requirements.[19]

Occupations concentrated in high-emission industries employ around 6% of workers, ranging from almost 4% in Luxembourg to more than 10% in Poland (Figure 2.3, Panel A). The share of workers employed in GHG-intensive occupations is therefore significantly lower than the share of workers employed in green-driven occupations. However, it is higher than the share of workers employed in the new and emerging occupations (2.9%).[20]

Figure 2.3. One out of five workers is employed in green-driven occupations, but only few in new and emerging occupations

Percentages, average 2015-19



Note: Data refer to the average for 2015-19, except for Canada: 2017-19 and New Zealand: 2018. OECD: unweighted average of countries shown.

Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force Survey; Japanese Labour Force Survey; New Zealand: Household Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

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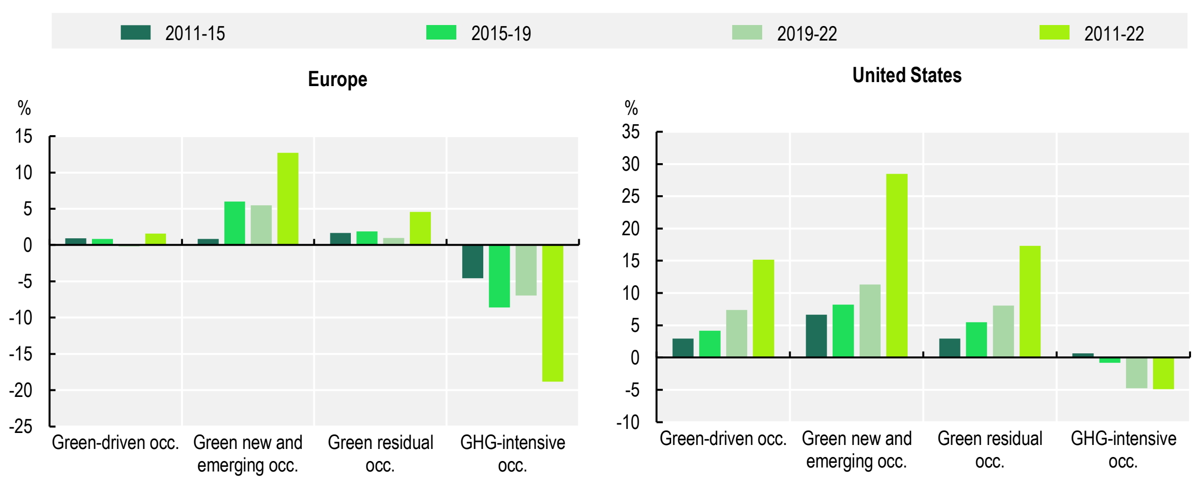
It is important to recall that green-driven and GHG-intensive occupations are not mutually exclusive – see Section 2.1.2 above. There are indeed 2.3% of workers, on average, who are employed in occupations that are both green-driven and GHG-intensive (Annex Figure 2.C.1). These "mixed" occupations can be found, especially,[21] in the group of green-enhanced skills occupations that are indeed occupations where skills and work requirements are changing because of the transition to net zero but may still be concentrated in high-emission sectors.

Between 2011 and 2022, the share of green-driven occupations in total employment has increased by 2% on average in European-OECD countries and the United States (Figure 2.4). This aggregate result masks diverging trends among green-driven occupations: in particular, Figure 2.4 shows that the incidence of green new and emerging occupations has increased by 12.9% over the same period[22] while green increased demand occupations and green-enhanced skills occupations also increased but at a significantly slower rate. However, if those occupations that are both green-driven and GHG-intensive are excluded, the growth of the remaining, green-driven occupations (labelled in the chart as “green residual”) is more than twice as large (5%). This is because occupations concentrated in high-emission sectors, including those occupations that are both green-driven and GHG-intensive,[23] experienced a -18% decline over the same period.[24]

Figure 2.4 suggests that the shares of green-driven and GHG-intensive occupations are positively correlated across countries,[25] which is, to some extent, linked to countries’ industrial composition. Not the entire economy is equally affected by the net-zero transition. While green-driven occupations can be found in all sectors, Figure 2.5 shows that, compared to the distribution of employment across sectors, green-driven occupations are more likely to be found in manufacturing, utilities and mining, construction and transports. GHG-intensive occupations, partly as a result of the definition itself (see Box 2.4 above), are even more concentrated in these macro-sectors and agriculture (where high emission industries are). Other services, which represent more than two-thirds of total employment, are composed mostly by occupations that are neither green-driven nor GHG-intensive.

Figure 2.4. Green new and emerging occupations are growing fast

Percentage change in the share of green-driven and GHG-intensive occupations in total employment



Note: Europe: unweighted average of Austria, Czechia, Estonia, Finland, France, Hungary, Lithuania, Luxembourg, the Netherlands, Norway, Poland, the Slovak Republic, Slovenia, Sweden and Switzerland. Green residual occupations are green-driven occupations excluding those occupations that can be both green-driven and GHG-intensive.
Source: Secretariat’s estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

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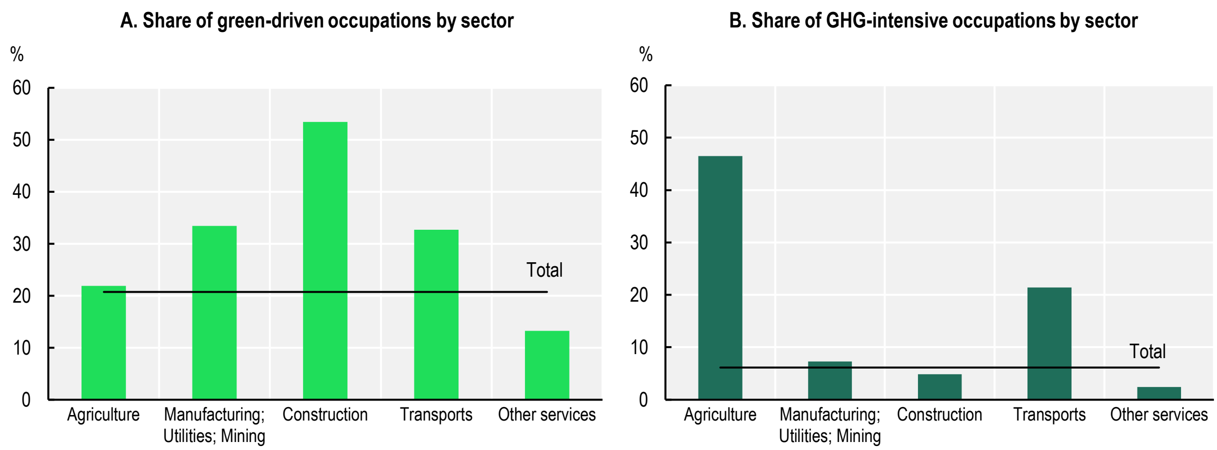
Figure 2.5. Green-driven occupations are more likely to be found in manufacturing, construction and transports

Percentages of employment by sector, average 2015-19



Note: Data refer to the unweighted average for 2015-19 of Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

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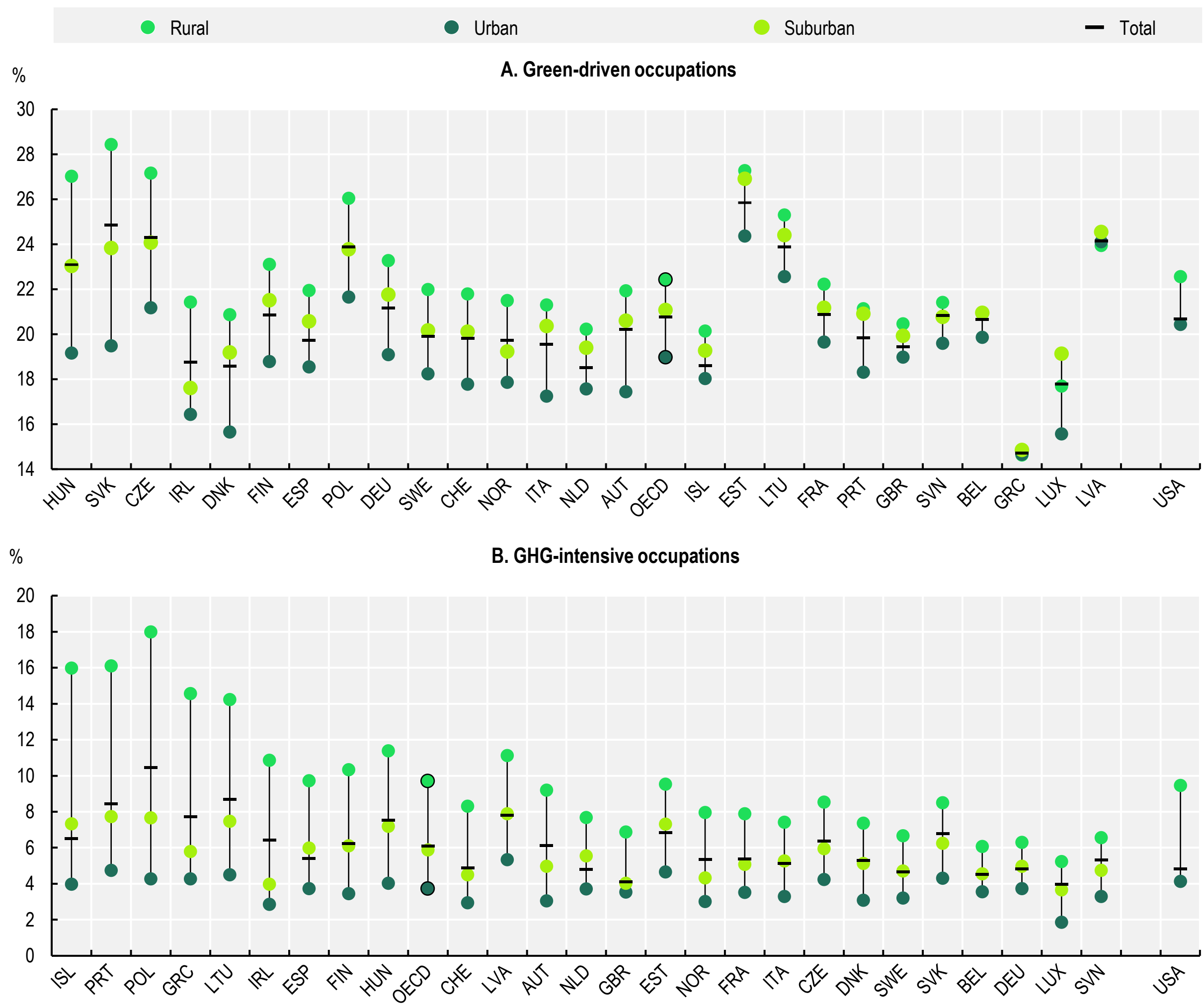
Given these strong sectoral patterns, it is not surprising, that in countries where the share of service sectors is high, e.g. Luxembourg, both the shares of green-driven and GHG-intensive occupations are lower than in countries where agriculture and manufacturing play a larger role, such as several central and eastern European countries. Nevertheless, Figure 2.3 shows that the gap between the shares of workers employed in green-driven and GHG-intensive occupations varies across countries, suggesting that, absent policy action, the transition to net-zero may be relatively more challenging for those countries where the gap is low such as Greece where there are less than two green-driven occupations for each GHG-intensive one than in those countries where the gap is large, as for instance in the United Kingdom, where there are almost five green-driven occupations for each GHG-intensive one.

The positive correlation between the shares of green-driven and GHG-intensive occupations that can be found across countries does not hold when descending at subnational level. Previous OECD work (2023[27]; 2023[70]) has already shown that there is substantial heterogeneity across regions in OECD countries with some having already benefitted from the net-zero transition while others having a high share of high-emission industries that are particularly at risk. Figure 2.6 shows that in all OECD countries occupations concentrated in high-emission sectors are more prevalent in rural areas[26] (or non-metropolitan areas in the United States), where agriculture, mining and manufacturing tend to be concentrated. However, the data also show that, with the exception of Greece and Luxembourg, green-driven occupations are also more prevalent in rural areas.[27] Yet, the areas where green-driven occupations are located tend not to be the same where occupations concentrated in high-emission sectors can be found, as already documented in Vona, Marin and Consoli (2018[42]) and Lim, Aklin and Frank (2023[71]) for the United States. In fact, the cross-region correlation between the shares of GHG-intensive and green-driven occupations is weak (0.21) and, when those occupations that are both green-driven and GHG-intensive are excluded, it becomes close to zero (Figure 2.7). OECD (2023[27]; 2023[70]) show that differences across regions are related to their degree of innovation, industrial composition, and the education of the workforce. Moreover, not all types of green-driven occupations are more prevalent in rural areas: new and emerging occupations which employ, on average, more high skilled and high educated workers, pay better wages and have higher job quality (see Sections 2.2.2 and 2.3) are, in fact, concentrated in urban areas. Without an effective policy strategy to mitigate the disadvantage of those regions most specialised in GHG-intensive activities and least specialised in green-driven occupations (see Box 2.6), there is a significant risk that the net-zero transition exacerbates regional disparities and endangers social cohesion.

Figure 2.6. Both green-driven and GHG-intensive occupations are more widespread in rural than in urban areas

Share of green-driven and GHG-intensive occupations by rural/urban area, average 2015-19



Note: Countries are ranked by decreasing gap of the share in rural areas compared to total. For European countries, the degree of urbanisation is defined on the share of local population living in urban clusters and in urban centres. It classifies areas into three types: thinly populated area (rural area); intermediate density area (towns and suburbs/small urban area), and densely populated area (cities/large urban area). In the United States, rural and urban areas are defined as non-metropolitan and metropolitan areas, respectively.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

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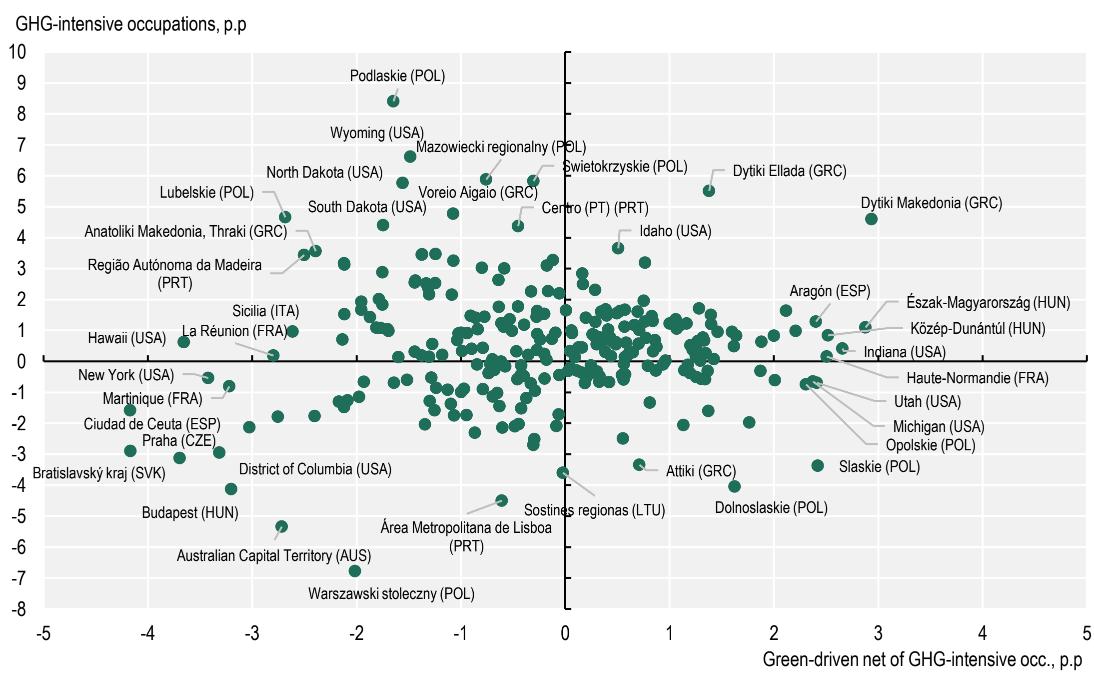
Figure 2.7 shows the share of green-driven occupations net of GHG-intensive occupations (the so-called "residual green") and GHG-intensive occupations at regional/state level in deviation in percentage points of the national average. This allows to identify in which regions jobs are relatively more at risk because of the net-zero transition, and which are relatively better placed to reap its benefits. In the top-left quadrant there are those regions/states where the deviation from the country average of GHG-intensity is significantly greater than that of green-driven intensity, i.e. regions/states that, as things stand, compared to the national average are more at risk of being left behind in the transition to net zero. In the bottom-right quadrant are those regions/states where the deviation from the country average of the share of GHG-intensive occupations is significantly lower than that of green-driven occupations, i.e. regions/states that, as things stand, are better placed to benefit from the transition to net zero compared to the national average. Figure 2.7 suggests that issues of geographic inequality may be particularly relevant in Poland which has regions both in the top-left and bottom-right quadrant, i.e. both regions well positioned to benefit from the net-zero transition as well as regions facing stronger challenges. To a more limited extent, similar geographical distribution issues emerge for Greece, Portugal and the United States.

Figure 2.7. Regions with higher incidence of GHG-intensive occupations are not necessarily the same as those with higher incidence of green-driven occupations

Share of green-driven occupations net of GHG-intensive occupations and GHG-intensive occupations at regional/state level in deviation of the national average, percentage points, average 2015-19



Reading: The Podlaskie Voivodeship in Poland or the state of Wyoming in the United States in the top-left quadrant have a share of GHG-intensive occupations compared to the national average significantly higher than that of green-driven occupations and, therefore, as things stand, are areas more at risk of being left behind in the transition to net zero compared to the national average. On the opposite, the Lower Silesian Voivodeship in Poland (*Dolnośląskie*) or Attica (*Attiki)* in Greece in the bottom-right quadrant have a share of GHG-intensive occupations significantly lower than that of green-driven occupations and, therefore, as things stand, are better placed to benefit from the transition to net zero compared to the national average.

Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

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Box 2.6. Place-based policies for a just transition

GHG-intensive industries and occupations are typically concentrated in specific regions. These are often different from the areas where green-driven occupations are more widespread and where the skills required by the net-zero transition are more common among the workforce – see Figure 2.7, Chapter 4 and OECD (2023[27]). Moreover, a successful transition to a net-zero emission economy requires new forms of production and, in some cases, new energy carriers and raw materials. These in turn require major transformations, with significant new climate-neutral investment and infrastructure, while abandoning investment in production assets that are inconsistent with reaching climate neutrality. Regions differ in their conditions to access such infrastructure, for example because of their remoteness and/or because of economies of scale and agglomeration. For example, hydrogen is best transported via pipelines (and so is unabated carbon dioxide, when channelled to storage sites). This implies that concentrated production sites, such as chemical clusters in Belgium and Germany, will likely be better served by (new or reconditioned) pipelines and will face lower costs than dispersed sites. Moreover, the locations of existing pipelines may be quite different from those needed by expanding low-emission production (OECD, 2023[70]). In addition, the regions hosting industries with the biggest challenges to reach climate neutrality are often socio-economically relatively weak.[1]

To be effective, policies to facilitate the needed transformations, and support workers, need to take into account the fact that these regions as well as their workers and firms in key industries need support to make these transformations happen. This will help avoid further widening of regional economic inequalities and prevent a "geography of discontent" (Rodríguez-Pose, Dijkstra and Poelman, 2023[72]), risking a major backlash to climate action. In addition, the spatial distribution of these activities may change based on new patterns of comparative advantage of different regions. This is why many countries are focussing on placed-based policies to ensure a just transition. As Neumark and Simpson (2015, p. 1198[73]) put it, place-based policies can be defined as interventions of a government "to enhance the economic performance of an area within its jurisdiction, typically in the form of more job opportunities" – see also OECD (2018[74]). Place-based policies are particularly suitable for interventions in the context of a just transition to reach climate neutrality, as they can harness local stakeholders around the joint use of new climate neutral infrastructure. Two complementary approaches can roughly be distinguished in the context of climate-change mitigation:

- Targeting green subsidies and spending to enhance the transition towards green production to areas that are most vulnerable to the effects of the transformations to reach climate neutrality, for example because they are specialised in GHG-intensive industries.
- Targeting compensatory interventions to the most negatively affected regions and people, but without orienting them specifically towards green activities, while keeping climate-change mitigation policies mostly space-blind.2 In this case place-based policy interventions will aim at exploiting the relative comparative advantage of people and regions and will be geared to the most feasible transitions towards high-growing activities, which may be promising independently from climate-change mitigation policies.

The first approach is at the heart of the US Inflation Reduction Act (IRA) of 2022.[3] The IRA includes a combination of grants, loans, tax provisions and other incentives to accelerate the deployment of clean energy, vehicles, buildings, and manufacturing. In total, around USD 370 billion will be disbursed for measures dedicated to improving energy security and accelerating clean energy transitions, with much of this amount being targeted to communities that have been identified as negatively affected by the phasing out of emission-intensive technologies and productions.[4] In practice this implies stimulating a transition of the most affected regions from being specialised in GHG-intensive activities to being specialised in green activities.

The European Union's strategy, articulated around the European Green Deal[5] and a number of cohesion-fostering instruments,[6] can be seen as a mix of the two approaches. On the one hand, about one-third of the European Regional Development Fund and the EU Cohesion Fund are specifically devoted to actions aiming to achieve climate neutrality by 2050. On the other hand, the Just Transition Mechanism provides targeted support to help mobilise around EUR 55 billion over the period 2021-27 to alleviate the socio-economic impact of the transition in the most affected regions, but includes, in its scope, all types of projects that do no significant harm to the environmental objectives.[7]

Whatever the approach taken, labour market policy interventions to accompany and support workers and communities along the net-zero transition need to incorporate the local dimension to be effective, for example by steering transitions towards industries and occupations where local labour shortages already exist or that are expected to emerge because of place-based investment and infrastructure programmes. Locally-based skill anticipation exercises may play a key role in this respect – see e.g. OECD (2023[27]).

In some cases, however, the economy of regions, which are mostly affected by the downsizing of GHG-intensive industries, may have a limited capacity of supplying enough good quality jobs in the short term. In those cases, complementary geographical mobility policies might be needed. This would require an integrated approach overcoming all barriers to mobility (including information provision, job-search assistance, housing assistance, childcare support, etc…), since it has been shown that financial incentives to mobility alone may be insufficient and result in bad-quality and unstable jobs in the destination location – see e.g. Caliendo, Künn and Mahlstedt (2023[75]). For example, in Sweden, the EU-financed "Relocate and React EU Relocate" project, concluded in 2023, organised a network of public employment services in cities and regions with high unemployment, which informed, recruited, and supported unemployed adults who were interested in moving to the area of the Northern city of Skellefteå, which was facing significant labour shortage due to significant development of green activities – see Chapter 4. However, in most countries, policies for geographical mobility remain unrelated to their green strategy. According to the answers to the OECD policy questionnaire on labour and social policies for the net-zero transition[8], only seven out of the 35 countries which have provided a response, have programmes to support relocating workers' housing needs, and they are not specifically linked to the transition to net zero.

1. For example, in the EU their GDP per capita and wages are more than 30% lower than national averages. Their firms in GHG-intensive industries may be less able to invest in needed new technologies, while workers are often unskilled. In some of these regions, many young workers are on temporary contracts, making access to needed training more difficult.
2. Space-blind policies can be defined as policies that are not targeted to the specifics of any particular place (World Bank, 2008[76]).
3. See www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook.
4. See also www.iea.org/policies/16156-inflation-reduction-act-of-2022.
5. See https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en.
6. See https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal_en#actions.
7. See https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021R1056.
8. A policy questionnaire on the labour and social policies that OECD member countries have in place or are developing to accompany the net-zero transition was distributed at the end of 2023. Some of the responses are reported in this Employment Outlook, while the full overview will be made available in a forthcoming policy brief.

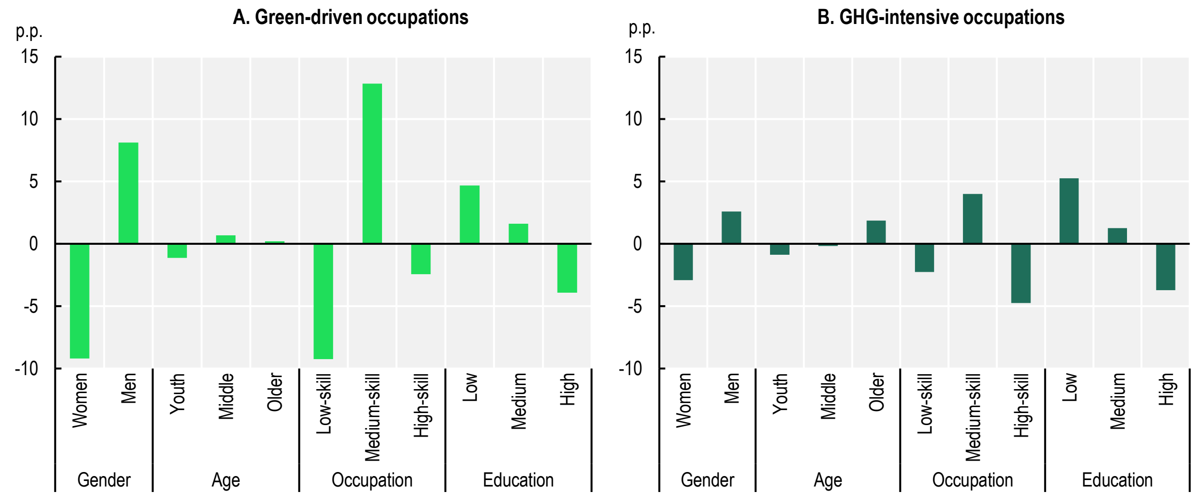
2.2.2. Who?

How do workers employed in green-driven occupations compare to those employed in occupations concentrated in high-emission sectors? Who are the workers likely better placed to seize the opportunities of the net-zero transition? And, conversely, who are those more at risk because employed in occupations concentrated in high-emission sectors? Figure 2.8 summarises the main characteristics while Annex 2.C provides country-specific results. The findings that emerge are the following:

- On average, men are more likely to hold green-driven occupations. At the same time, men are also more likely to be employed in occupations concentrated in high-emission sectors. This is in line with past analyses and reflects the fact that most green-driven and GHG-intensive occupations can be found in agriculture, manufacturing, mining and utilities and transports while women are predominantly employed in other service sectors. Remarkably, all OECD countries display such stark gender gap (Annex Figure 2.C.2).[28] This suggests that men stand to be both those more exposed to the risk of job loss in high-emission industries (see Chapter 3) but also better placed to reap the benefits of the net-zero transition. On the opposite, the concentration of women in services puts them less at risk of transition-induced job losses[29] but also raises concerns about their ability to benefit from the job opportunities that will open. In particular, the current underrepresentation of females in science, technology, engineering and mathematics (STEM) educational fields and enduring gender stereotypes raise concerns about women's capacity to benefit from the growing employment opportunities in the best paying expanding sectors (OECD, 2021[2]).
- Differences across age groups are very small (Figure 2.8), but, on average, young workers (between 15 and 34 years old) tend to be slightly less likely to be employed in both green-driven and GHG-intensive occupations. This pattern holds in the large majority of OECD countries (Annex Figure 2.C.3) and across types of green-driven jobs with the only exception of green increased demand occupations where young workers are slightly more likely to be employed than prime-age and older workers (Annex Figure 2.C.4). In contrast, prime-age workers (between 35 and 54 years old) are slightly more likely to be employed in a green-driven occupation while older workers (older than 54) are more likely to be employed in occupations concentrated in high-emission sectors. While on the one hand this suggests that the reallocation challenge may be more significant for workers who, on average, already experience practical and cultural difficulties in reskilling and finding a new occupation, these results also suggest that part of the reallocation process may be managed by natural attrition of older workers retiring at the normal age.
- In terms of occupational categories, Figure 2.8 shows that green-driven occupations are not more likely to be found among occupations in the top of the pay and skill distribution (high-skill occupations hereafter, including managers, professionals and technicians and associate professionals) but rather among occupations in the middle of the pay and skill distribution (medium-skill occupations hereafter, including clerical support workers, craft and related trades workers, plant and machine operators, and assemblers). On the opposite, the share of green-driven occupations among occupations at the bottom of the pay and skill distribution (low-skill occupations hereafter: service and sales workers and elementary occupations) is much lower than the average. These results also hold for occupations concentrated in high-emission sectors which are more prevalent among occupations in the middle of the pay and skill distribution than those at the top and the bottom. The patterns are very similar across countries (Annex Figure 2.C.5). These results differ from those of comparable analyses that had a narrow focus on a subset of green-driven jobs: in fact, the occupational pattern varies significantly across types of green-driven occupations. Annex Figure 2.C.6 shows that in all countries, new and emerging occupations are much more frequent among high-skill occupations, while it is the green-enhanced skills occupations and increased demand ones which are more frequent among medium-skill occupations.
- Finally, a different picture than for occupational categories emerges when looking at education: workers with low levels of education are more likely to be in both green-driven and GHG-intensive occupations relative to workers with middle and high levels of education (Figure 2.8) with remarkably similar patterns across countries (Annex Figure 2.C.7). This aggregate result is again driven by the groups of green-enhanced skills occupations and increased demand ones while new and emerging occupations, with the exception of the Slovak Republic, are more prevalent among high-educated workers – see Annex Figure 2.C.8.

Figure 2.8. Workers in green-driven and GHG-intensive occupations tend to have similar characteristics

Gap in percentage points between the share of green-driven (respectively GHG-intensive occupations) in each characteristic and the share in the whole economy



Note: The figure reports gaps in percentage points between the share of green-driven (Panel A) and GHG-intensive (Panel B) occupations by characteristics and the average share. Data refer to the average for 2015-19, except for Canada: 2017-19. In terms of age, youth are 15-34 years old, middle 35-54 years old, older 55+ year old. In terms of occupation, low-skill refers to Service and Sales Workers and Elementary Occupations (ISCO-08 5 and 9, medium-skill to Clerical Support Workers, Craft and Related Trades Workers and Plant and Machine Operators, and Assemblers (ISCO-08 4, 7 and 8), high-skill to Managers, Professionals and Technicians and Associate Professionals (ISCO-08 1, 2 and 3). Low education refers to less than upper secondary, medium education to upper secondary, high education to more than upper secondary. Unweighted average of Australia, Austria, Belgium, Canada, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States.
Reading: The share of women employed in green-driven occupations is 9 percentage points lower than the share of women employed on average.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey (gender, age); Canadian Labour Force Survey (gender, age, education); Japanese Labour Force Survey (gender, age); United States: Current Population Survey; All other countries: EU Labour Force Survey.

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In conclusion, the implementation of ambitious measures to combat climate change will result in decreased employment levels within GHG-intensive industries to the benefit of renewable energy generation as well as a larger number of industries that will be instrumental to make the transition happen, such as certain segments in construction and transport. This reallocation may also give rise to disparities across workers and regions. The analysis shown in this section suggests that, even if the reallocation process will go well beyond the two relatively small groups of GHG-intensive and green-driven occupations, these two groups have some similarities in common in terms of the characteristics of the workers who hold them that could help to make the transition manageable. And yet, the risk of widening inequalities across demographic groups and geographical areas is real – see Botta (2019[77]); OECD (2021[2]); and Chapters 3 and 4. In particular, the analysis has shown that green-driven occupations are a heterogenous group of jobs: fast-growing green new and emerging occupations are typically high-skill and employ highly educated workers in urban areas while the much larger but less dynamic groups of green-enhanced skills occupations and green increased demand ones are on average relatively more medium- and low-skill and employ many more low-educated workers.

Interestingly, the characteristics of the workers employed in declining GHG-intensive occupations are remarkably similar to those of the workers more exposed to high temperatures, as shown in Box 2.2. This suggests that while climate change mitigation policies may have costs for some groups of workers, there are also labour market costs of inaction for these same groups.

2.3. Green-driven jobs: Are they good?

How attractive are green-driven jobs? A successful transition towards a low-carbon economy not only will induce greater demand for green-driven occupations but also requires greater workers' willingness to search for, and pick up, job offers in these occupations. As recent evidence on labour shortages has demonstrated, the attractiveness of a job depends not only on its wage but also on other aspects of job quality (OECD, 2022[78]; OECD, 2023[79]). Workers indeed consider wages and working conditions together when evaluating jobs and job offers, and are ready to trade off part of their wage for terms and conditions of employment that they consider to be better – see e.g. Mas and Pallais (2017[80]); Taber and Vejlin (2020[81]); Albanese and Gallo (2020[82]); and Bassanini et al. (forthcoming[83]). Jobs in (shrinking) GHG-intensive industries are typically regarded as relatively good jobs, paying comparatively well (see also Chapter 3) and with a prevalence of permanent, full-time jobs. Overall, a key policy concern is that developing green-driven jobs may imply worsening job quality (Verdolini and Vona, 2022[31]).

This section, therefore, investigates the quality of green-driven occupations following the structure of the OECD job quality framework, which focuses on earnings, labour market security and the quality of the working environment (see Chapter 1).[30] Obviously, increasing demand in green-driven occupations will likely improve job quality in these occupations as companies will have to compete for workers. Nevertheless, *current* job quality is likely to be a good predictor of current job attractiveness and *future* job quality. However, to the extent that data on green-driven occupations for most countries are constructed using a complex crosswalk between the US SOC classification and the occupational classifications adopted in other countries (see Box 2.5), average differences in labour market performance variables (such as wages) between green-driven and other occupations are likely to suffer from a significant aggregation bias (see Box 2.7). To minimise bias issues, in this chapter job quality variables are transformed into discrete categories (for example high- and low-wage earners) and the share of green-driven occupations within these categories is estimated. Qualitative implications for job quality gaps between green-driven and other occupations can then be easily derived. For example, a relatively high share of green-driven occupations among high-wage workers (and a low share within low-wage workers) would be indicative of a positive average wage gap between green-driven and other occupations.

Box 2.7. Why are data on job quality presented in this chapter as frequencies of green-driven occupations among good- or bad-quality jobs?

All countries included in the analysis of this chapter, except the United States, do not use the US SOC occupational system. In these countries, therefore, the cross-walking procedure developed by Dingel and Neiman (2020[51]) is adapted and applied to obtain estimated shares of green-driven (resp. other) occupations within aggregate cells defined based on the occupational classification of each country – see Box 2.5, and Annex 2.A for details. For any given cell, these estimates could be seen as an estimate of the probability that each individual's job in that cell is a green-driven (resp. other) occupation. The data can then be matched with individual-level data reporting the cell each individual belongs to.

Once data are matched, it may seem natural to use the estimated shares of green-driven (resp. other) occupations in each cell as weights to estimate the average level of those variables that vary at the individual level but are not an invariant characteristic of the occupation. For example, the average wage of green-driven (resp. other) occupations could be obtained by aggregating cell-level average wages using, for each cell, the product of the employment share of the cell in total employment multiplied by the estimated proportion of green-driven (resp. other) jobs in that cell as weight. The average wage gap can then be obtained as the difference between the two average variables.

As shown in Annex 2.B, however, this procedure would underestimate the average wage gap between green-driven and other occupations, with the error being larger the larger the employment share of cells with the incidence of green-driven jobs close to 50%. The same applies to the gap in any variable which vary within occupations. For this reason, in this chapter, the analysis of differences across individual job quality indicators, such as wages, is performed by building a small number of discrete categories in the population (when these do not already exist in the data) and estimating differences in the incidence of green-driven and other occupations within these categories. For example, in the case of wages, three categories (low, middle and high wage) are identified, with the high-wage (resp. low-wage) category being defined as gross hourly wage larger than, or equal to, one-and-a-half times (resp. smaller than two-thirds of) the median wage in the country. Then, the proportion of green-driven and other occupations in each category are computed. A larger (resp. lower) incidence of green-driven jobs in the high-wage (resp. low-wage) category than in the whole economy would then be cautiously interpreted as evidence of a positive wage gap[1] – and the larger (resp. lower) the share of green-driven jobs in the high-wage (resp. low-wage) category, the larger the wage gap.[2] It can be shown that, mathematically, the risk of aggregation bias is limited, in this case, and empirical tests on US data suggests that such a bias is, at worst, small – see Annex 2.B.

1. A reading note is added in all charts to facilitate the interpretation of the results.
2. Rigorously speaking, a regularity condition (a weak monotonicity of the wage gap as a function of the wage categories used in the analysis) is necessary for this interpretation to hold.

2.3.1. Wages

Green-driven occupations tend to pay higher than average hourly wages. On average among the OECD countries for which data are available, the incidence of green-driven occupations is indeed larger among high-wage employees[31] (22%) than among low-wage employees (18.8%) – Figure 2.9, Panel A. In between these values, the incidence of green-driven occupations among middle-wage employees (20.6% on average) is close to the incidence in the overall economy. The gap between high-wage and low-wage workers remains robust to controlling for worker characteristics such as age, gender and education (Figure 2.9, Panel B).[32] On the opposite, GHG-intensive occupations are more frequent among low and middle-wage employees than among high-wage employees – see also Annex Figure 2.C.9. Nevertheless, the available evidence suggests that the negative wage gap between GHG-intensive and other occupations is relatively more important for men than for women, while there are no significant gender differences as regards wage gaps between green-driven and other occupations – see Annex Figure 2.C.10. This suggests that the transition to net-zero emissions may lead to a larger reduction of low-paid jobs for men than for women and, mechanically, a slowdown in the aggregate wage convergence across genders (even if the job-specific pace of convergence is unaffected).[33]

The aggregate figures concerning green-driven occupations, however, conceal significant cross-country heterogeneity. The incidence of these occupations is larger among high-wage employees than among low- or middle-wage employees in 16 out of the 26 OECD countries for which estimates are possible (Figure 2.9, Panel A). The largest difference between high-wage and low-wage employees, pointing to the largest wage gap between green-driven and other occupations, is found in Nordic and English-speaking countries – ranging between 7 percentage points in Finland and 16 percentage points in Norway, where over 30% of high-wage employees work in green-driven occupations.[34] In other six countries, the largest incidence of green-driven occupations is found among middle-wage employees. However, in Hungary, Italy, the Netherlands and Slovenia, green-driven occupations are more frequent among low-wage employees, suggesting a negative wage gap between green-driven and other occupations in these countries. By contrast, in all countries except Norway and Greece, the evidence presented in Annex Figure 2.C.9 suggests a negative wage premium for GHG-intensive occupations.[35]

Figure 2.9. Jobs in green-driven occupations are on average well paid

Percentage incidence by hourly wage category, 2018

Note: Panel A reports the percentage of green-driven occupations in wage and salary employment, by country and hourly wage category. Panel B reports the point estimate (and 95% confidence intervals) of the percentage difference in the incidence of each type of occupation between high and low-wage employees. High (resp. low) wage is defined as hourly wage above one-and-a-half times (resp. below two-thirds of) the median wage. “Total” refers to the share of green-driven occupations among all employees. Agriculture is excluded except in Australia, Canada and the United States in Panel A. Data for Belgium, Denmark, France, Greece, Iceland, Italy, Luxembourg, Portugal, Sweden and the United Kingdom do not include firms with less than 10 employees. Data for Canada and the United States refer to 2019. OECD: unweighted average of countries shown. Australia is not included in Panel B. GHG: greenhouse gases. In Panel A, countries are ranked by the difference in the incidence of green-driven occupations between high and low wage workers. Estimates of percentage effects in Panel B are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of occupation as dependent variable and including high and middle-wage dummies, educational attainment (3 classes), gender, age (3 classes), and country dummies as explanatory variables and standard errors clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the high wage dummy and are expressed in percentage of the untransformed dependent variable.

Reading: Panel A: In Norway, 30.6% (resp. 19.7% and 14.6%) of high-wage (resp. middle-wage and low-wage) employees have a job in a green-driven occupation. Panel B: Controlling for demographic characteristics, the percentage share of green-driven occupations is, on average, 58% higher among high-wage employees than among low-wage employees. A larger incidence of a given type of occupation among high-wage workers than among middle or low-wage workers is indicative of a positive wage gap between that occupation and the others.

Source: Secretariat’s estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australia: Table Builder of the Australian Bureau of Statistics (Labour Force: Characteristics of Employment); Canada: Canadian Labour Force Survey; United States: Current Population Survey; All other countries: EU Structure of Earnings Surveys.

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The negative wage premium for GHG-intensive occupations may seem surprising given that jobs in GHG-intensive industries[36] are typically regarded as relatively well-paid jobs, a stylised fact that is confirmed in the data (see Chapter 3). However, as shown in Chapter 3, the typical worker in GHG-intensive occupations has much lower education and hold a lower-skill job than the average worker in these industries. Moreover, by definition, workers in GHG-intensive occupations have fewer options outside downsizing GHG-intensive industries, which may put additional pressure on their bargaining power, while this argument does not apply to workers in these industries that have a job which is frequent also in other industries and can therefore more easily change sector of activity.

Given the composition of the three types of green-driven jobs discussed in the previous section, it is not surprising that, in all countries, green new and emerging occupations are much more frequent among high-wage employees: the incidence of these occupations is, on average, four times larger (or 3.9 percentage points larger) among high-wage than among low-wage employees (see Annex Figure 2.C.11). By contrast, the opposite holds for green increased demand occupations: in all countries, these occupations are more frequent among low- or middle-wage employees than among their higher paid counterparts – the incidence of these occupations among low-wage employees is 40% larger (or 2.8 percentage points larger) than among high-wage workers.[37] Green-enhanced skills occupations are somewhat in between these two opposites, as they are more frequent among high-wage employees than among other employees in 16 out of the 26 countries with available data.[38]

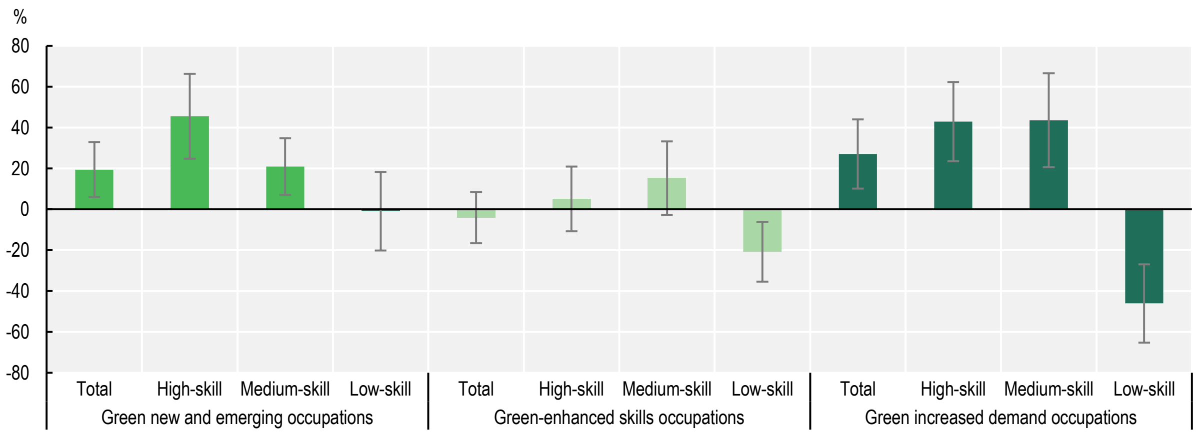
Part of the differences between high- and low-wage employees in the incidence of different types of green-driven occupations is due to workers sorting – for example, high-educated workers, which are usually better paid, are more frequent among new and emerging green occupations – see Section 2.2.2. In fact, controlling for demographic characteristics wipes out the negative effect concerning green increased demand jobs and reduces the positive effect for new and emerging occupations, which nonetheless remain very large (Figure 2.9, Panel B). Yet, the estimated average difference between high and low-wage employees is larger for green-enhanced skills occupations, suggesting worker sorting is far from fully explaining wage differentials.[39]

Another explanatory factor is that, in all countries, green new and emerging occupations are mainly high-skill occupations,[40] that is belong to a class of occupations that typically pay higher salaries, while the other two types of green-driven jobs are rather concentrated in middle- and low-skill occupations, which typically pay lower wages – see Section 2.2.2. Controlling also for main job characteristics (sectors and 1-digit ISCO occupations), the difference between low-wage and high-wage employees concerning the incidence of green-driven jobs, no matter their type, becomes smaller (Figure 2.10),[41] showing that the results of Figure 2.9 are mainly due to this composition effect.[42]

Further analysis, however, suggests that all types of high-skill, green-driven occupations, with the exception of green-enhanced skills occupations, are better paid than other high-skill occupations (Figure 2.10). Controlling for demographic and job characteristics, the shares of green new and emerging and green increased demand occupations are estimated to be, respectively, 46% and 43% higher among high-skill, high-wage workers than among high-skill, low-wage workers.[43] A similar pattern emerges for medium-skill occupations. These results likely reflect the specific scientific and technical competences that are still in scarce supply in the labour market but are required by these emerging occupations (see also Chapter 4). At the same time, all low-skill, green-driven occupations are less frequent among high-wage employees (and more frequent among low-wage employees) than other low-skill occupations – although results are statistically insignificant for new and emerging occupations – suggesting that low-skilled, green-driven occupations pay on average lower wages than other low-skill jobs.[44] The latter finding may result from the fact that the skill requirements of these jobs are not different from other jobs (and, in particular, in declining GHG-intensive occupations), so that labour supply may well exceed labour demand in these labour market segments. Lower wages in low-skill jobs may also result from lower workers' bargaining power, for example because green-driven occupations may have a lower level of unionisation (see Box 2.8 for evidence on the United States) and low-skill workers tend to have low bargaining power when not protected by collective representation – see e.g. Cahuc, Postel-Vinay and Robin (2006[84]) and Caldwell and Danieli (forthcoming[85]).

Figure 2.10. Green-driven occupations are often better paid than other high-skill occupations

Estimated percentage difference in the share of green-driven occupations between high and low-wage workers, by type of occupation and controlling for main demographic and job characteristics, 2015-19



Note: The chart reports the point estimate (and 95% confidence intervals) of the difference in the incidence of each type of green-driven occupation between high and low-wage employees. High (resp. low) wage is defined as hourly wage above one-and-a-half times (resp. below two-thirds of) the median wage. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of occupation within all, high, medium or low-skilled occupations as dependent variable and including high and middle-wage dummies, the share of 1-digit ISCO occupations, educational attainment (3 classes), gender, age (3 classes), sectors (5 categories), and country dummies as explanatory variables. Except for the case of all occupations, regressions are estimated separately for high, medium, and low-skill occupations. "Total" indicates the full sample with all occupations. Standard errors are clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the high wage dummy and are expressed in percentage of the untransformed dependent variable. The sample excludes Agriculture and includes Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, the United Kingdom, the United States. It does not include Agriculture and firms with less than 10 employees in Belgium, Denmark, France, Greece, Iceland, Italy, Luxembourg, Portugal, Sweden and the United Kingdom. Data for the United States refer to 2019.
Reading: Controlling for demographic and job characteristics and restricting the sample to high-skill occupations, the percentage share of high-skill, green new and emerging occupations is, on average, 46% higher among high-wage employees than among low-wage employees. A larger incidence of a given type of green-driven occupation among high-wage workers than among middle or low-wage workers is indicative of a positive wage gap between that occupation and the others included in the regression.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the Current Population Survey, for the United States and the EU Structure of Earnings Surveys, for all other countries.

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Overall, the good news is that, on average, green-driven jobs tend to be better paid (or at least, not less paid) than other jobs. Moreover, for many types of high-skill and medium-skill, green-driven occupations, including support jobs, there is a significant wage premium, which makes them not only attractive but likely reachable for similar level of competences (see Chapter 4). The bad news is that this does not hold for low-skill, green-driven occupations: jobs in these occupations are usually less paid than other low-skill jobs. These results point to the importance not only of upskilling policies (Chapter 4) but also of other labour market policies, including, potentially, certain forms of wage insurance (Chapter 3), to facilitate and accompany the transition.

Box 2.8. Are green jobs union jobs?

In some countries, trade unions are concerned that the reallocation of workers from emission-intensive activities to low emission ones may also imply a shift away from jobs that are more likely to be unionised to new jobs that are less likely to be unionised and therefore may offer worse working conditions. This was one of the issues at the centre of the long strike by the United Auto Workers (UAW) in the United States in the fall of 2023: UAW wanted guarantees that existing collective agreements will apply also in the new battery plants that will be built in the coming years to ensure that workers working in factories dedicated to internal combustion engines will be able to move to new plants while maintaining the same structure of wages and benefits.[1] But even in countries where trade union membership and collective bargaining coverage is high, the transition to net zero may lead to a shift away from the most organised sectors. In Sweden, for instance, the electric carmaker Tesla experienced its first strike around the world in November 2023 over its "no-union policy" and its refusal to negotiate a collective agreement for its repair and service shops across Sweden.[2]

In OECD countries where collective agreements are negotiated predominantly at sectoral level, the risk of a shift away from existing agreements is more limited since in some countries collective agreements are, under certain criteria, extended to all companies and/or employers' organisations also have an interest in having all companies applying the provisions set in collective agreements to ensure a level-playing field among them. In contrast, in countries where collective agreements are negotiated exclusively at the firm level, ensuring that the provisions set in the collective agreement continue to apply to new companies and plants may be more challenging. This is especially the case in the United States, where a hard-fought plant-by-plant vote is often required to establish a union and negotiate a collective agreement.

Figure 2.11 shows that, at least in the United States, these concerns are warranted: workers employed in occupations concentrated in high-emission sectors are more frequent among those covered by a collective agreement than among other workers (in other words, GHG-intensive occupations are more likely to be covered by a collective agreement) while workers in green-driven occupations, in particular those in new and emerging occupations and in green-enhanced skills ones, are less likely to be found among those with a collective agreement. While unionisation patterns for the United States may not be representative of OECD countries, a similar analysis for the European Union by Zwysen (2024[86]) shows that, despite very different institutional settings, the coverage rate by collective agreements is also substantially higher in GHG-intensive occupations than among other occupations; therefore, without an increase in bargaining coverage among the latter, it is set to decline as GHG-intensive industries shrink.

To address, at least in part, unions' concerns that the shift to net-zero emissions may imply a reduction in wages and benefits for the workers directly involved, the United States Inflation Reduction Act, a federal law aimed at promoting clean energy (among other objectives), includes specific provisions to favour companies that pay wages in line with those set in collective agreements.

Figure 2.11. In the United States, workers in green-driven occupations are less likely to be covered by a collective agreement

Marginal effect of being covered by a collective agreement on the share of green-driven occupations, controlling for main individual characteristics, 2015-19

Note: The chart reports the point estimate (and 95% confidence intervals) of the percentage difference in the incidence of each type of green-driven occupation between employees covered by a collective agreement and those not covered. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of green-driven occupation as dependent variable and including a collective agreement dummy, educational attainment (3 classes), gender, age (3 classes), time dummies as explanatory variables. Standard errors are clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the fixed-term contract dummy and are expressed in percentage of the untransformed dependent variable.
Reading: Controlling for demographic characteristics, the percentage share of green-driven occupations is 25.8% lower among workers covered by a collective agreement than among those not covered while the percentage share of GHG-intensive occupations is 59.6% higher among workers covered by a collective agreement than among those not covered.
Source: Secretariat's estimates based on the Current Population Survey, U.S Census Bureau.

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1. See www.nytimes.com/2023/09/16/business/electric-vehicles-uaw-gm-ford-stellantis.html.
2. See www.theguardian.com/commentisfree/2024/jan/10/elon-musk-sweden-unions-tesla-labour-car.

2.3.2. Labour market security

A second dimension of job quality is labour market security, which can be measured as the combination of the risk of job loss and the overall individual cost of the subsequent unemployment spell in terms of foregone wage (Nickell, Jones and Quintini, 2002[87]). The individual risk of unemployment could therefore be considered a synthetic measure of labour market insecurity (see Chapter 1).[45] For unemployed workers who had a previous work experience, European and US labour force surveys report information on the last occupation before unemployment. It is therefore possible to estimate the percentage of unemployed workers whose last job was in a green-driven occupation and compare it with the percentage of green-driven occupations among employed workers.[46] A higher figure for the unemployed would point to a greater risk of protracted unemployment spells, and lower labour market security, in the case of green-driven jobs. In fact, this is what emerges from the data: on average among the countries for which data are available, green-driven occupations represent 23% of the last-job occupations among the unemployed, while they represent only 21.1% among the employed – Figure 2.12, Panel A.

Green-driven jobs are on average more insecure than other jobs in most OECD countries: in only five of them (Denmark, Finland, Sweden, Switzerland and the United Kingdom), the evidence suggests that green-driven occupations are less frequent among the last jobs of the unemployed than among the employed. These results also appear remarkably stable to controlling for individual characteristics – Figure 2.12, Panel B. By contrast, GHG-intensive occupations are only marginally more frequent among the unemployed than among the employed (3% more frequent once observable demographic characteristics are controlled for), and this difference is statistically insignificant. This is consistent with the fact that these jobs are relatively stable jobs until the job is suppressed due to restructuring events (see Chapter 3). For this reason, once the transition accelerates, one could expect these jobs' labour market security will deteriorate.

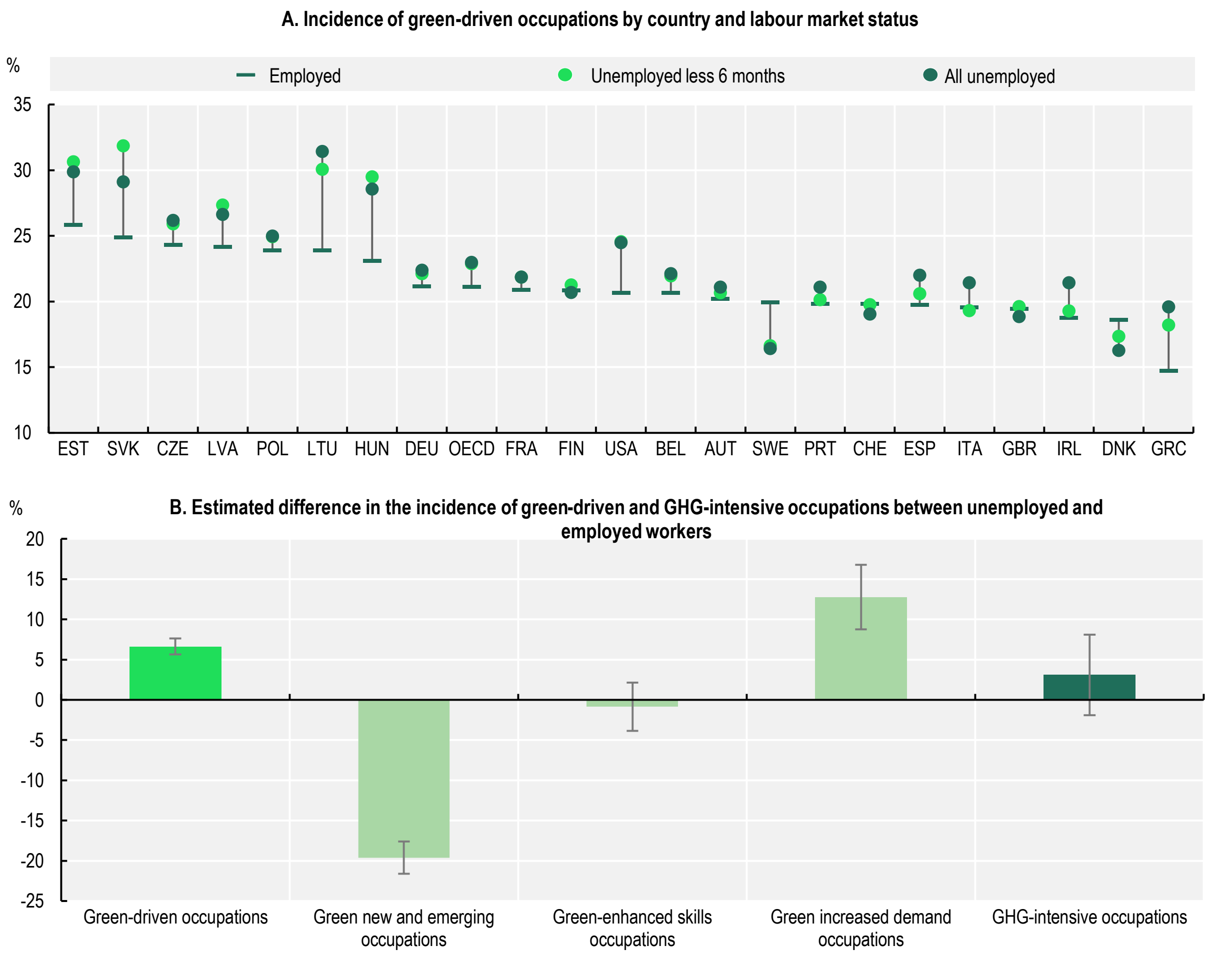
The labour market security gap between green-driven and other occupations is, nonetheless, entirely driven by the greater insecurity of green increased demand occupations: the share of these occupations is 13% higher among the unemployed workers' last jobs than among the employed – Figure 2.12, Panel B.[47] By contrast, the share of green new and emerging occupations and green-enhanced skills occupations is either insignificantly different between employed and unemployed workers or lower for the latter, pointing to equal or lower labour market insecurity for these two groups of occupations.

As in the case of wages, however, further analysis suggests that the differences among the three types of green-driven occupations are mainly due to the fact that new and emerging occupations are concentrated in high-skill occupations with greater labour market security, while the opposite is true for green-enhanced skills and, especially, increased demand occupations. Once both observable demographic and job characteristics are controlled for, all green-driven occupations appear slightly more insecure than other occupations. Controlling for sector and 1-digit ISCO occupations, new and emerging, green-enhanced skills, and green increased demand occupations are estimated to be, respectively, 2.7%, 0.2%, and 10% more frequent among the unemployed than among the employed (Figure 2.13).[48]

Except in the case of green-enhanced skills occupation, however, labour market insecurity levels are mainly due to low-skill occupations: for these green-driven jobs, labour market security appears indeed lower in low-skill, green increased demand occupations than in other low-skill occupations, while there are no significant differences within high-skill occupations – see Figure 2.13.[49] By contrast, the opposite occurs for green-enhanced skills occupations.[50]

Figure 2.12. Labour market security is lower in green-driven jobs in many OECD countries

Percentage incidence of green-driven occupations by labour market status, 2015-19



Note: Panel A reports the average percentage of green-driven occupations, by country and labour market status. Panel B reports the point estimate (and 95% confidence intervals) of the percentage difference in the average incidence of each type of occupation between unemployed and employed workers. Unemployed workers are classified according to their last occupation. Unemployed less 6 months refers to unemployed workers with an unemployment spell shorter than 6 months. Unemployed workers with an unemployment spell equal to or longer than 7 years are excluded in all countries except in the United States. Agriculture is not included. OECD: unweighted average of countries shown. In Panel A, countries are ranked by the difference in the incidence of green-driven occupations between unemployed and employed workers. Estimates in Panel B are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of occupation as dependent variable and including an unemployment dummy, educational attainment (3 classes), gender, age (3 classes), year and country dummies as explanatory variables and standard errors clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the unemployment dummy and are expressed in percentage of the untransformed dependent variable.

Reading: Panel A: In Estonia, 25.8% of the employed (resp. 29.9% of the unemployed and 30.6% of those unemployed by less than 6 months) have a job (resp. were employed before entering unemployment) in a green-driven occupation. Panel B: Controlling for demographic characteristics, the percentage share of green-driven occupations is, on average, 6.6% lower among the employed than among the unemployed (where data for the unemployed refer to the occupation in the last held job). A lower incidence of a given type of occupations among the employed than among the unemployed is indicative of greater labour market insecurity for that type of occupations.

Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Surveys.

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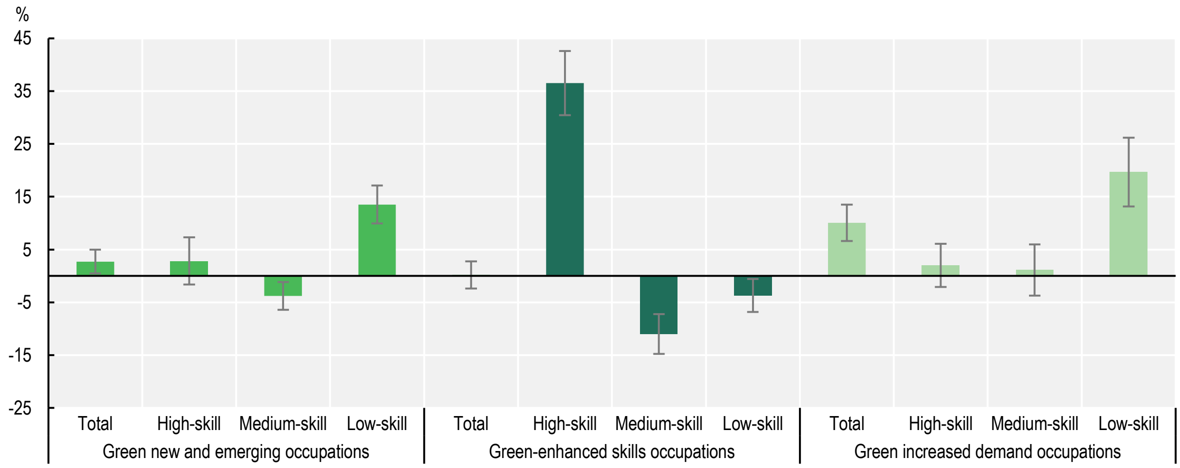
Figure 2.13. Many low-skilled, green-driven occupations have worse labour market security than other low-skill occupations

Marginal effect of labour market insecurity indicators on the share of green-driven occupations, by type of occupation and controlling for main individual and job (or last job) characteristics, 2015-19



Note: The chart reports the point estimate (and 95% confidence intervals) of the percentage difference in the incidence of each type of green-driven occupation between unemployed and employed workers. Unemployed workers are classified according to their last occupation. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of green-driven occupation within all, high, medium or low-skilled occupations as dependent variable and including an unemployment dummy, the share of 1-digit ISCO occupations, educational attainment (3 classes), gender, age (3 classes), sectors (5 categories), time and country dummies as explanatory variables. Except for the case of all occupations, regressions are estimated separately for high, medium, and low-skill occupations. "Total" indicates the full sample with all occupations. Standard errors are clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the unemployment dummy and are expressed in percentage of the untransformed dependent variable. The sample excludes Agriculture and includes Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom and the United States. Unemployed workers with an unemployment spell equal to or longer than 7 years are excluded in all countries except in the United States.
Reading: Controlling for demographic characteristics and job characteristics and restricting the sample to high-skill occupations, the percentage share of high-skill, green new and emerging occupations is, on average, 2.8% lower among the employed than among the unemployed (where data for the unemployed refer to the occupation in the last held job), although the difference is not statistically significant. A lower incidence of a given type of occupation among the employed than among the unemployed is indicative of lower labour market security for that type of occupation than for the other occupations included in the regression.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the Current Population Survey, for the United States and the EU Labour Force Surveys, for all other countries.

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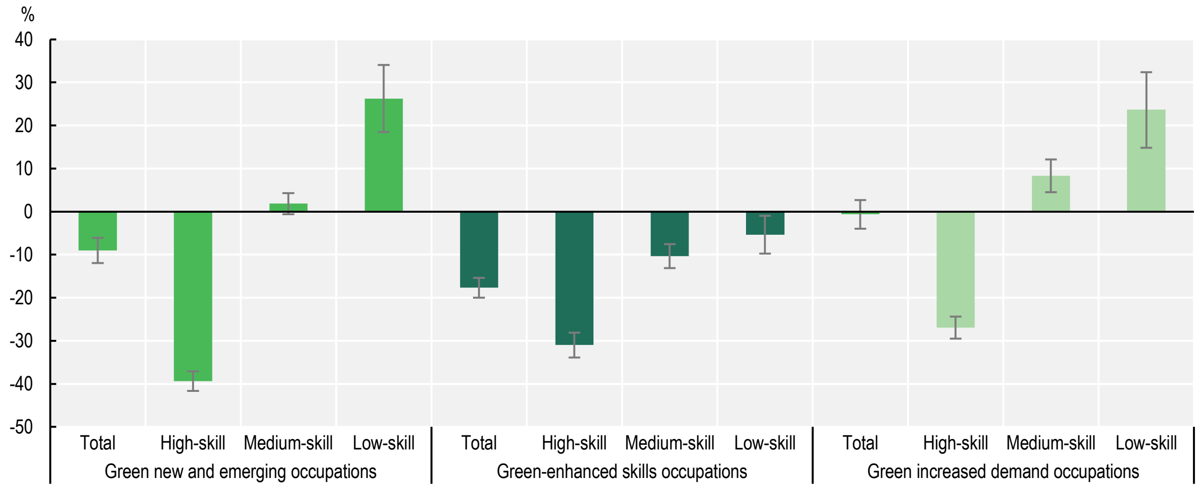
One factor that may explain the divergent patterns of labour market security among different types of green-driven occupations is the different incidence of fixed-term contracts. The evidence indeed suggests that, on average, fixed-term contracts are often associated with lower labour market security, and in particular a higher risk of job loss – see e.g. OECD (2014[15]).[51] Consistent with this hypothesis, the labour market insecurity pattern concerning low-skill occupations presented in Figure 2.13 is mirrored by similar results as regards the type of contract. Within low-skill occupations, fixed-term contracts are, on average, more frequent among green increased demand and new and emerging occupations (by 24% and 26%, respectively), while the opposite is true for green-enhanced skills occupations (see Figure 2.14). By contrast, the patterns depicted in Figure 2.13 and Figure 2.14 diverge as regards high-skill occupations. Whatever their type, high-skill, green-driven occupations are systematically less frequent among employees with fixed-term contracts but no less frequent among the unemployed than other high-skill occupations, suggesting that contract type is not the main driver of labour market security in these high-skill occupations. In other words, these results suggest that the typical worker in high-skill, green-driven occupations is more likely to hold an open-ended contract than workers in other high-skill occupations, and nevertheless has often no better labour market security.[52]

Figure 2.14. Among high-skill jobs, green-driven occupations have fewer fixed-term contracts

Marginal effect of the fixed-term contract indicator on the share of green-driven occupations, by type of occupation and controlling for main individual and job (or last job) characteristics, 2015-19



Note: The chart reports the point estimate (and 95% confidence intervals) of the percentage difference in the incidence of each type of green-driven occupation between employees on fixed-term and open-ended contracts. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of green-driven occupation within all, high, medium or low-skilled occupations as dependent variable and including a fixed-term contract dummy, the share of 1-digit ISCO occupations, educational attainment (3 classes), gender, age (3 classes), sectors (5 categories), time and country dummies as explanatory variables. Except for the case of all occupations, regressions are estimated separately for high, medium, and low-skill occupations. "Total" indicates the full sample with all occupations. Standard errors are clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the fixed-term contract dummy and are expressed in percentage of the untransformed dependent variable. The sample excludes Agriculture and includes Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.
Reading: Controlling for demographic characteristics and restricting the sample to high-skill occupations, the percentage share of high-skill, green new and emerging occupations is, on average, 39% higher among employees on open-ended than fixed-term contract. A higher incidence of a given type of occupation among employees on open-ended contract is indicative that the share of fixed-term contracts within that type of occupation is lower than in the other occupations included in the regression.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the Current Population Survey, for the United States and the EU Labour Force Surveys, for all other countries.

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One possible explanation of these results is that high-skill workers in green-driven occupations tend to have high-level positions in innovative startups or activities characterised by high average growth but also high failure rates and shakeouts, and therefore a relatively high risk of job destruction. Wage premia, however, likely compensate for the lack of labour market security. Moreover, high-skill, green-enhanced skills occupations are likely characterised by high rates of restructuring due to changing competences and work requirements – see Section 2.1.2. Workers unable to adapt to the new requirements may therefore find it difficult to maintain their employability.[53] At the same time, some other (not green-driven) high-skill occupations, such as health professionals or software developers, have a relatively high share of fixed-term contracts but still enjoy high labour market security (low unemployment rates) since they face strong labour demand. By contrast, the situation of workers in low-skill occupations is likely different: like their negative wage gap (see Section 2.3.1), their higher unemployment risk and incidence of fixed-term contracts probably reflect the weakness of their position in the labour market.

2.3.3. Quality of the working environment

The third dimension of job quality is the quality of the working environment which captures non-economic aspects of jobs including the nature and content of the work performed, working-time arrangements and workplace relationships. In the OECD Job Quality framework, the quality of the working environment is measured by the incidence of job strain, which results from insufficient resources in the workplace (e.g. work autonomy, social support at work or learning opportunities) to meet job demands (e.g. work intensity or physical health risk factors) – see Chapter 1 for a more in-depth discussion.

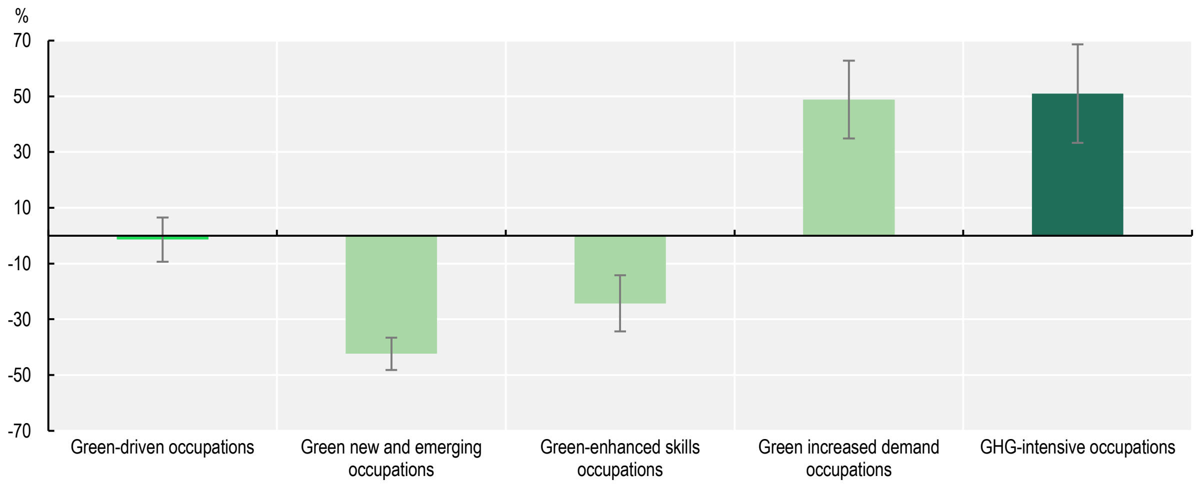
Measuring the quality of the working environment requires detailed information on working conditions that are typically available only in ad hoc surveys at international or national levels that are run at irregular intervals. Moreover, linking these surveys to the O*NET taxonomy of green occupational categories requires information on occupations at very detailed level, which is an additional stringent requirement that often does not hold in ad hoc surveys. As a result, only information for 2021 for European countries[54] and 2015 for the United States is available in this section.[55] Moreover, the sample size of these surveys is relatively small and, therefore, only aggregate results are displayed in the main text.

Keeping these limitations in mind, available data provide useful insights. Figure 2.15 shows that, on average, green-driven jobs are characterised by similar levels of job strain as other jobs (more precisely, the figure shows that the share of green-driven occupations is similar among strained and non-strained workers), i.e. the quality of the working environment is neither better nor worse than elsewhere. As for the other components of the OECD job quality framework (see Sections 2.3.1 and 2.3.2), averages hide significant cross-country heterogeneity (Annex Figure 2.C.12): in countries such as Czechia, Greece or Portugal, job strain is higher in green-driven occupations than in other jobs, while in Belgium, Italy and Sweden, job strain is lower among green-driven occupations than in other jobs.

Figure 2.15 shows that there is also a substantial heterogeneity across the three components of green-driven occupations, as already highlighted by Eurofound (2022[88]): new and emerging and green-enhanced skills occupations are significantly less strained while green increased demand occupations are significantly more strained. Differently from the two other dimensions of job quality, the differences among the three types of green-driven occupations are not due to the fact that new and emerging occupations are concentrated in high-skill occupations: even when controlling for the main job characteristics, the results for the three green-driven occupations remain qualitatively unchanged, suggesting that the differences in job strain are a more structural feature of these groups than the differences in wages and labour market security (Annex Figure 2.C.13).

Figure 2.15. The incidence of job strain is lower in new and emerging and green-enhanced skills green occupations

Marginal effect of the job strain indicator on the share of green-driven occupations, controlling for main individual characteristics, 2021



Note: The chart reports the point estimate (and 95% confidence intervals) of the percentage difference in the average incidence of each type of occupation between job strained and not-strained workers. Agriculture is not included. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of occupation as dependent variable and including a job strain dummy, educational attainment (3 classes), gender, age (3 classes) and country dummies as explanatory variables and standard errors clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the job strain dummy and are expressed in percentage of the untransformed dependent variable. Unweighted average of Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States.
Reading: Controlling for demographic characteristics, the percentage share of green new and emerging occupations is, on average, 42% lower among strained employees, i.e. employees whose number of job demands exceeds the number of job resources, than among non-strained employees.
Source: Secretariat’s estimates based on version 24.1 of the O*NET database and the European Working Conditions Telephone Survey 2021 and the American Working Conditions Survey 2015.

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Occupations concentrated in high-emission sectors, on the opposite, are characterised by higher levels of job strain than other jobs (again, more precisely, Figure 2.15 shows that the share of GHG-intensive occupations is higher among job strained than non-strained workers), i.e. the quality of the working environment is worse than elsewhere. Except for Slovenia, in all countries job strain is higher in GHG-intensive occupations than in other jobs (Annex Figure 2.C.12).

In conclusion, occupations concentrated in high-emission sectors have a lower quality of the working environment than other occupations. This may push some workers to look for better alternatives elsewhere. Therefore, as mentioned above when discussing the age profile of the workers employed in GHG-intensive sectors (see Section 2.2.2), part of the reallocation challenge may be dealt by some natural attrition. In contrast, the picture for green-driven occupations is more mixed: new and emerging occupations and green-enhanced skills occupations clearly display a better quality of the working environment while the group of green increased demand occupations appears less attractive in terms of working environment than other jobs, raising further questions on its ability to attract the workers that will be needed for the transition.

2.4. Concluding remarks

This edition of the *Employment Outlook* focuses on the effects of the transition to net-zero carbon emission on jobs and incomes. While there is broad agreement that the net effect of the transition on aggregate employment will be modest, the involved industry, occupational and regional reallocation of jobs will be significant. This chapter focuses on the jobs that are likely to benefit from the net-zero transition and examines their distribution and attractiveness. To do so, it introduces the concept of green-driven occupations, which extends beyond the more usual notion of "green jobs" and also includes other jobs that do not directly contribute to reducing emissions, but which will be in demand because of backward linkages.

The chapter shows that around 20% of the workforce is engaged in green-driven occupations across OECD countries, but less than one in six of these occupations are new and emerging ones. The rest are existing jobs in which skill requirements are changing because of the net-zero transition and jobs that will be in demand because they provide goods and services required by green activities. In contrast, about 6% of employment is in greenhouse gas (GHG)-intensive occupations. Both green-driven and GHG-intensive occupations tend to be concentrated in rural areas, but in different regions, indicating a concrete risk of widening geographical disparities during the transition to net-zero emissions.

This chapter has a specific focus on the quality of green-driven occupations, using the OECD Job Quality framework. The results show that green-driven jobs tend to pay higher wages and have fewer temporary contracts but enjoy less labour market security. Jobs that will likely be in demand because they provide support and intermediate goods and services to green activities (green increased demand occupations) also have worse quality of working conditions.

The sector of activity and skill-level of the occupation, however, are important determinants of these results: the difference between green-driven and other jobs is smaller when observable job characteristics are taken into account, except for the quality of the working environment (i.e. the non-economic aspects of jobs including the nature and content of the work performed, working-time arrangements and workplace relationships), which is unaffected. Moreover, the job quality advantage of green-driven occupations, including support jobs, tends to be concentrated in high-skill occupations, suggesting that workers endowed with the specific skills required by these jobs have a competitive edge in the labour market and are well positioned to reap the benefits of the transition. In contrast, low-skill, green-driven occupations tend to command significantly lower wages and labour market security, which suggests that green-driven occupations may appear less attractive than other jobs or unreachable for low-skilled workers without significant skill upgrading. The rising demand for green-driven occupations will most likely contribute to enhance job quality, because of increased competition among companies for workers with suitable competences. However, current job quality is an indicator of current job appeal and a good predictor of future job quality. Labour market policies will therefore be key in ensuring that the transition to net-zero emissions is a just transition, with equally shared benefits and costs. Measures to improve the job quality of green-driven jobs (e.g. conditionality of green subsidies on working conditions) as well as skill policies, active labour market policies, social dialogue and collective bargaining may have an important role to play in this process and will be discussed in detail in the next two chapters.

To monitor the labour market side of the transition to net-zero emissions, however, better quality data will be crucial. As the discussion in Section 2.1 shows, in most countries existing data are not sufficiently granular, which results inevitably in lack of precision and a high degree of uncertainty. To allow timely and effective monitoring and assessment of the effects of the transition on the labour market, most countries would need to re-consider the level of disaggregation of the labour market statistics they collect and make available for research, such as labour force surveys and register data. Existing international occupational and industry classifications such as ISCO and ISIC prove ill-suited to precisely identify workers in expanding green jobs. Therefore, it would be desirable to have labour force surveys and other labour market data at a more disaggregate level for specific occupations and sectors. For instance, occupations and sectors related to renewable energy use could be separated from those related to fossil fuels.[56] As the work of similar workers may be more or less green, depending on how tasks are performed and the overall activity of their plant, even this level of disaggregation may prove insufficient. Ad-hoc employer-employee surveys collecting workers' use of green technologies and practices – such as the 2012 US Green Technologies and Practices (GTP) survey (BLS, 2013[44]) – or country-specific inventories of green tasks by occupation – such as O*NET in the United States – are therefore likely to be needed as a complement. In addition, it would be important to envisage the possibility of ex-post matching of these surveys with comprehensive and regularly updated linked employer-employee data, which could then be used for monitoring and analysis.

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Annex 2.A. Crosswalking occupational classifications using Dingel and Neiman's method

Existing crosswalks between the different occupational classifications used in different OECD countries are typically many-to-many, meaning that each occupation in one classification corresponds to many occupations in another classification and vice versa. Therefore, correspondence between two occupations is often only partial. This chapter adapts and applies the methodology originally developed by Dingel and Neiman (2020[51]) for indicators of occupational characteristics that are shared by all jobs in the same occupation as defined in the standard occupational classification of one country (for example the proportion of workers in green-driven jobs, which takes the same value – 0 or 100% – within each 8-digit SOC occupation). The method allows to estimate reliably the average of such indicators for occupations defined in a different classification system used in another country. Dingel and Neiman (2020[51]) originally developed the method to translate any occupation-specific indicator available in the US SOC system into the ISCO system by constructing a weighted crosswalk, but the method can be applied more generally.

An example using occupations in the US SOC system as *origin occupations*, the United States as *origin country* and the ISCO system as *target occupations* would simplify the exposition of the method. For each *target country* using the ISCO system (e.g. one European country), the method is performed in four steps.

1. ISCO-SOC cells are determined based on a standard many-to-many crosswalk. These cells will be called *connection cells* hereafter.
2. For each target country, the US employment share S_{ic} of each ISCO-SOC connection cell *ic* is determined by using the following formula:

   $$S_{ic} = S_c \frac{s_i}{\sum_{k \in c} s_k}$$

   where *i* (resp. *c)* indexes ISCO (resp. US SOC) categories, S_c indicates the share of the US SOC occupation *c* in US employment, s_i indicates the employment share of ISCO occupation *i* in the target country and $k \in c$ indicates all ISCO occupations (indexed by *k)* that match with the SOC occupation *c*. In other words, the US employment share is "distributed" across occupations proportionally to their employment shares in the target country.
3. The same value of the indicator defined at SOC level (e.g. indicator of being green-driven or not) is assigned to all ISCO-SOC connection cells that correspond to the same SOC category.
4. For each indicator of interest (e.g. the proportion of green-driven jobs), its value for each ISCO occupation is obtained as a weighted average of the indicator in each ISCO-SOC connection cell, where S_{ic} are used as weight, that is:

   $$X_i = \frac{1}{\sum_{j \in i} S_{ij}} \sum_{c \in i} X_c S_{ic}$$

   where X stands for the chosen indicator and $j \in i$ and $c \in i$ indicates all SOC occupations (indexed by *j* or *c)* that match with ISCO occupation *i.* In other words, $d_{ic} = S_{ic} / \sum_{k \in i} S_{ik}$ can be seen as a (country-specific) crosswalk weight.

This method delivers a country-specific weighted crosswalk. The country-specific national average of the indicator X will be estimated by aggregating over ISCO occupations:

$$X = \sum_i X_i s_i = \sum_i \left(s_i \sum_{c \in i} X_c d_{ic} \right)$$

where X stands for the chosen indicator.

It is important to note that, because the employment-weighted average of group averages is the global average, in the special case in which $s_i = \sum_{k \in i} S_{ik}$ in the equation above and the indicator is constant within all jobs of each SOC occupation category (e.g. the proportion of employees in green-driven jobs), the economy-wide average of the indicator is the same no matter if computed on original or converted data.[57] In other words, when US data are converted from SOC into ISCO, since $s_i^{US} = \sum_{k \in i} S_{ik}$, it follows that:

$$X^{US} = \sum_c X_c S_c = \sum_i X_i s_i^{US}$$

This implies that the share of employment in one type of jobs (e.g. green-driven jobs) computed in the SOC system for the United States is comparable to the share of employment of that type of job in other countries, when computed with the method described here.[58]

This method does not necessarily yield a final binary indicator in each target occupation of the target country even when the origin indicator is binary. For example, the proportion of green-driven occupations is either 0% or 100% in the origin occupations and country by construction. Yet, in the target country, most target occupations will have an estimated proportion of green-driven jobs comprised between these two values.

The data at the level of the target occupations can then be matched with other datasets for the target country (e.g. labour force surveys) to estimate the average of the chosen indicator among groups with different characteristics – for example, the estimated frequency of green-driven occupations among women. This will be obtained as a weighted average of the indicators for the target occupations where group-specific employment by occupation will be used as weight – that is, in the same example as above, a weighted average of the proportion of green-driven jobs by occupation, with female employment by occupation being used as weight.

The original method was applied by Dingel and Neiman to 6-digit SOC categories and 2-digit ISCO categories.[59] However, nothing prevents to better exploit the available information in labour force surveys and construct weighted crosswalks that are specific for countries and other dimensions that are likely to be key determinants of the distribution of occupations (such as gender and industry). In this chapter, to compute the share of green-driven and GHG-intensive occupations, the method is alternatively applied to 8-digit SOC and 4 or 3-digit ISCO occupations, usually coupled with other dimensions, such as gender and 1-digit ISIC industries. To do so, a new many-to-many crosswalk developed by the European Commission (The ESCO Secretariat) and the US Department of Labor (The O*NET Network, under the auspices of the Employment and Training Administration) is employed.[60]

Nothing prevents the application of this method to other crosswalks. In this chapter it is used to match the US SOC system with occupational classifications used in other countries (e.g. CAN SOC and ANZSCO). It is also used to match 2-digit ISIC industries and 6-digit NAICS industries.

Annex 2.B. Downward aggregation bias for gaps in job quality variables

Wage gap (or gaps of individual variables): Large attenuation bias

A natural way to compute gaps in individual variables between green-driven and other occupations where individual data are aggregated by cells (including both green-driven and other occupations in each cell) would be to compute them as percentage differences of computed averages of each occupation, where the latter are weighted average of cell-level averages, and the weights are the estimated number of individuals of each group. However, if individual data vary within cells, this leads to an attenuation bias.

Let us consider the case of individual wages as a practical example and assume that the true wage gap is positive and, for simplicity, constant across occupations. The wage gap Δ can then be written as:

$$\Delta = \frac{w^g - w^n}{w^n} = \left(\frac{1}{G}\sum E_c s_c w_c^g \,/\, \frac{1}{N}\sum E_c (1 - s_c) w_c^n\right) - 1$$

where *w* stands for average wages (overall average wages when no superscript is indicated), *c* for the SOC occupation, *g* stands for green-driven jobs (with *G* being total employment in green-driven jobs), *n* for not-green-driven jobs (with *N* being total employment in these other jobs), *s* is the share of green-driven job (in the cell *c* where the subscript *c* is indicated) and E_c is employment in the SOC cell. Note that in the SOC system s_c is either 0 or 1, so that $w_c = w_c^g$ when $s_c = 1$ and $w_c = w_c^n$ when $s_c = 0$, which implies $w_c^g = \frac{1}{G}\sum E_c s_c w_c$ and $w_c^n = \frac{1}{N}\sum E_c (1 - s_c) w_c$.

Let us use ISCO as target occupational classification to make things concrete – see Annex 2.A. Applying the same formulas in ISCO generates a downward bias in Δ every time the estimated share of green-driven jobs in one ISCO occupation is different from 0 or 1. This is because (with *i* denoting the ISCO occupation):

$$w^g = \frac{1}{G}\sum E_i s_i w_i^g > \frac{1}{G}\sum E_i s_i \left(w_i^g - (1 - s_i) w^n \Delta\right) = \frac{1}{G}\sum E_i s_i w_i$$

The term on the right-hand side of the rightmost equality represents the natural way to guess-estimate the average wage of green-driven occupations from the ISCO-aggregated data (since w_i^g is unobservable). The last equality comes from the fact that:

$$\frac{1}{G}\sum E_i s_i w_i = \frac{1}{G}\sum E_i s_i \left(s_i w_i^g + (1 - s_i) w_i^n\right) = \frac{1}{G}\sum E_i s_i \left(w_i^g - (1 - s_i) w^n \Delta\right)$$

In the same way it can be shown that:

$$w^n < \frac{1}{N}\sum E_i (1 - s_i) w_i = \frac{1}{N}\sum E_i (1 - s_i)\left(w_i^n + s_i w^n \Delta\right)$$

This implies that the estimated numerator of the wage gap from ISCO-aggregated data is biased towards zero. Note that the bias is larger, the larger the amount of employment in cells such that $s_i(1 - s_i)$ is close to its maximum, that is close to $s_i = 1/2$. This occurs no matter the relationship between wages and the precision of ISCO-aggregated shares s_i in each cell. In other words, for this method to yield an accurate estimate of the wage gap, most ISCO-aggregated shares s_i should be close to 0 or 1.

In principle, the same issue emerges with discrete variables, if data needs to be aggregated into shares by cells but original data vary across individuals within the same cell. In that case the bias is larger, the larger the share in employment of cells where the proportion of green-driven jobs is close to one half.

Proportion of green-driven jobs by category: No systematic bias

When one computes the proportion of green-driven jobs within a wage interval or a specific category (e.g. educational attainment), the aggregation problem discussed above is less important. Consider the proportion *P* of green-driven jobs by a given category *S*:

$$P_S = \frac{1}{\sum_{k \in S} e_k} \sum_{i \in S} e_j s_j$$

where *j* indexes the individuals in category *S*, s_j is the true share of green-driven jobs corresponding to the SOC occupation of the individual (s_j is therefore equal to 0 or 1), while e_j represents the employment weight of the individual *j*. Suppose now that *P* is approximated by:

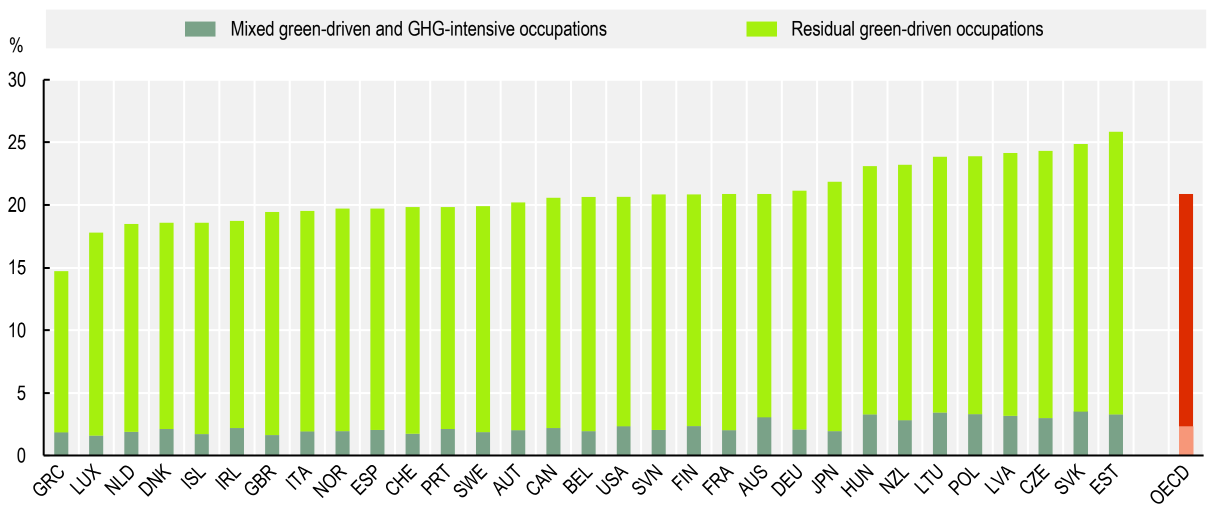
$$\widehat{P_S} = \frac{1}{\sum_S E_{kS}} \sum_S E_{iS} s_i$$

where $E_{iS} = \sum_{i,S} e_j$ denotes the sum of individual weights for each ISCO category *i* and category *S*, while s_i indicates the share of green-driven jobs in category *i.* For each individual *j* in category *S*, the measurement error would be either s_i or $s_i - 1$. As a consequence, for each ISCO category the average error would be $s_i(1 - s_{iS}) + (s_i - 1)s_{iS} = s_i - s_{iS}$, where s_{iS} stands for the true proportion of green-driven jobs within the category *S* in ISCO cell *i.* For this to generate large, systematic bias, s_{iS} should be much larger or smaller than s_i on average over all ISCO categories. In other words, the average precision of ISCO-aggregated shares s_i in each cell should be very weak. This is a much stronger (and less likely) condition than the one holding for gaps. An analysis performed by the Secretariat using CPS data by high/medium/low-wage categories and ISCO occupations instead of SOC occupations, indeed yields measurement errors of 15% or lower,[61] while the error on the wage gap, directly computed as a weighted average of cell-level average wages, is of the order of 70%.

Annex 2.C. Additional figures

Annex Figure 2.C.1. One in eight green-driven occupations is concentrated in GHG-intensive industries

Percentage of total employment, average 2015-19



Note: Data refer to the average for 2015-19, except for Canada: 2017-19 and New Zealand: 2018. OECD: Unweighted average of countries shown. GHG: greenhouse gases.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force Survey; Japanese Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

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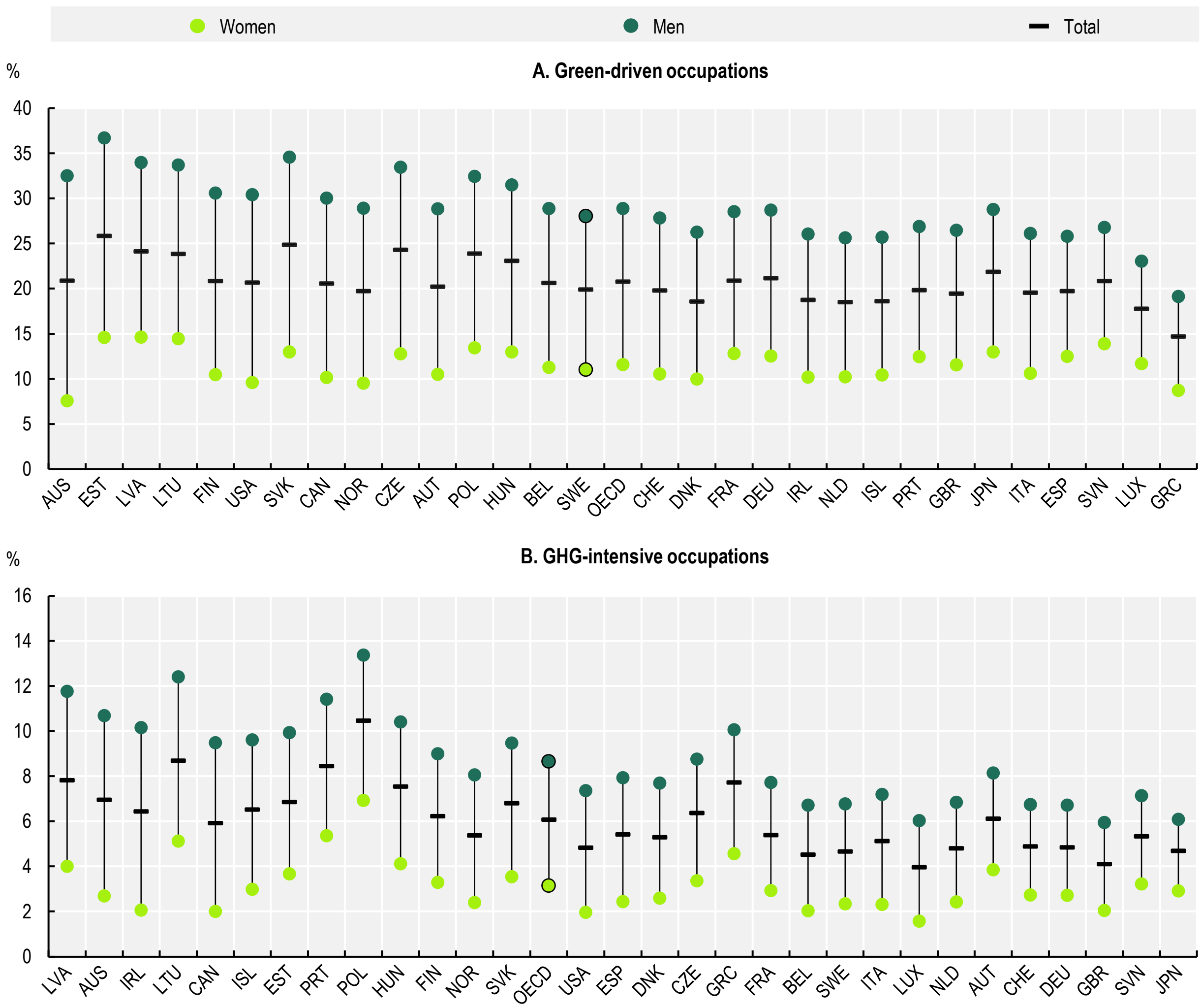
Annex Figure 2.C.2. Men are more likely to be employed in green-driven and GHG-intensive occupations

Percentage of total employment, average 2015-19



Note: Data refer to the average for 2015-19, except for Canada: 2017-19 and New Zealand: 2018. Countries are ranked by decreasing gap of the share for men compared to the total. OECD: Unweighted average of countries shown. GHG: greenhouse gases.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force Survey; Japanese Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

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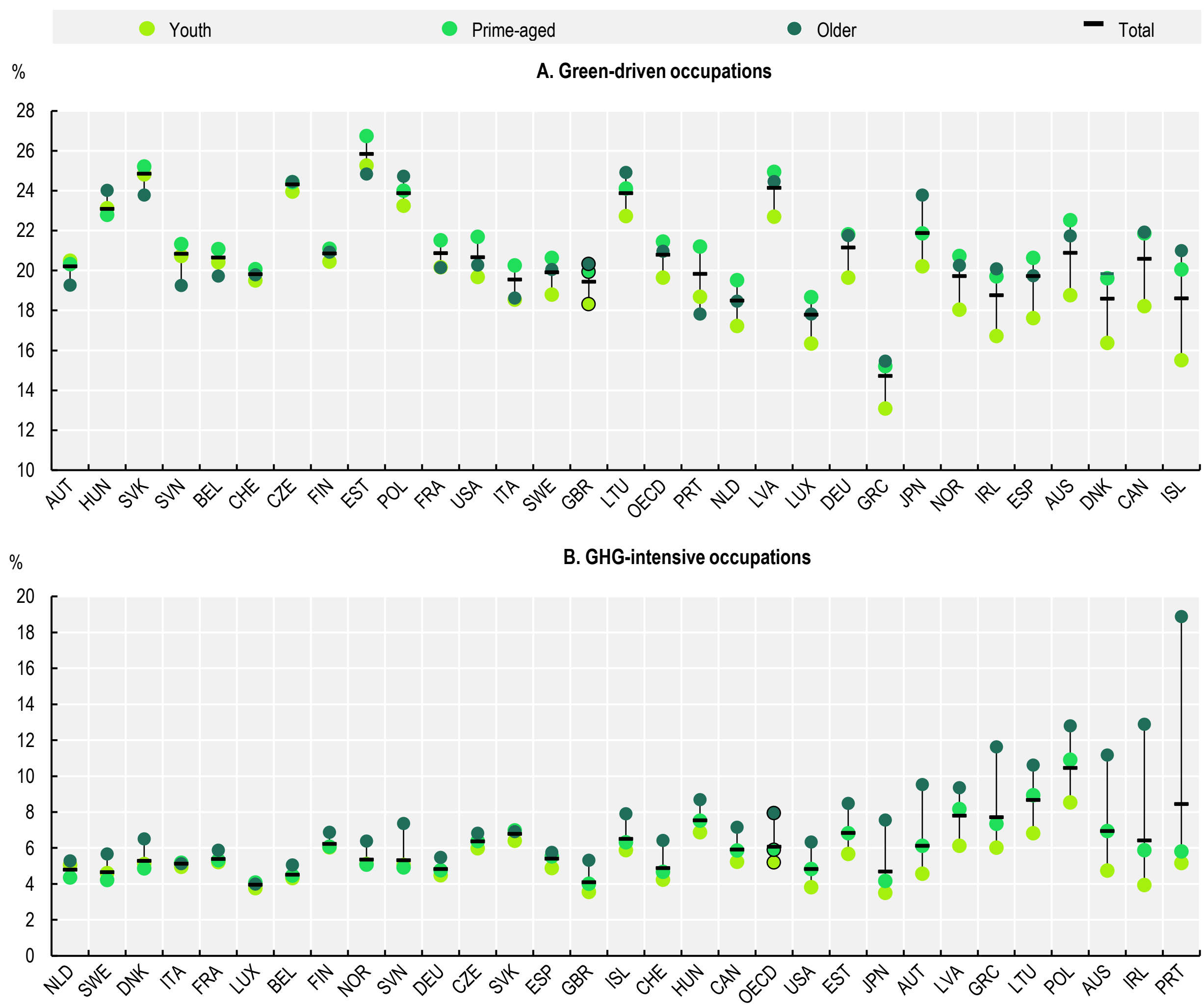
Annex Figure 2.C.3. Older workers are more likely to be found in GHG-intensive occupations

Percentage of total employment, average 2015-19



Note: Youth refer to those aged 15 to 34, prime-aged to those aged 35 to 54, older to those aged 55 and more. Countries are ranked by decreasing gap of the share for youth compared to the total. Data refer to the average for 2015-19, except for Canada: 2017-19 and New Zealand: 2018. OECD: Unweighted average of countries shown. GHG: greenhouse gases.

Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force survey; Japanese Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

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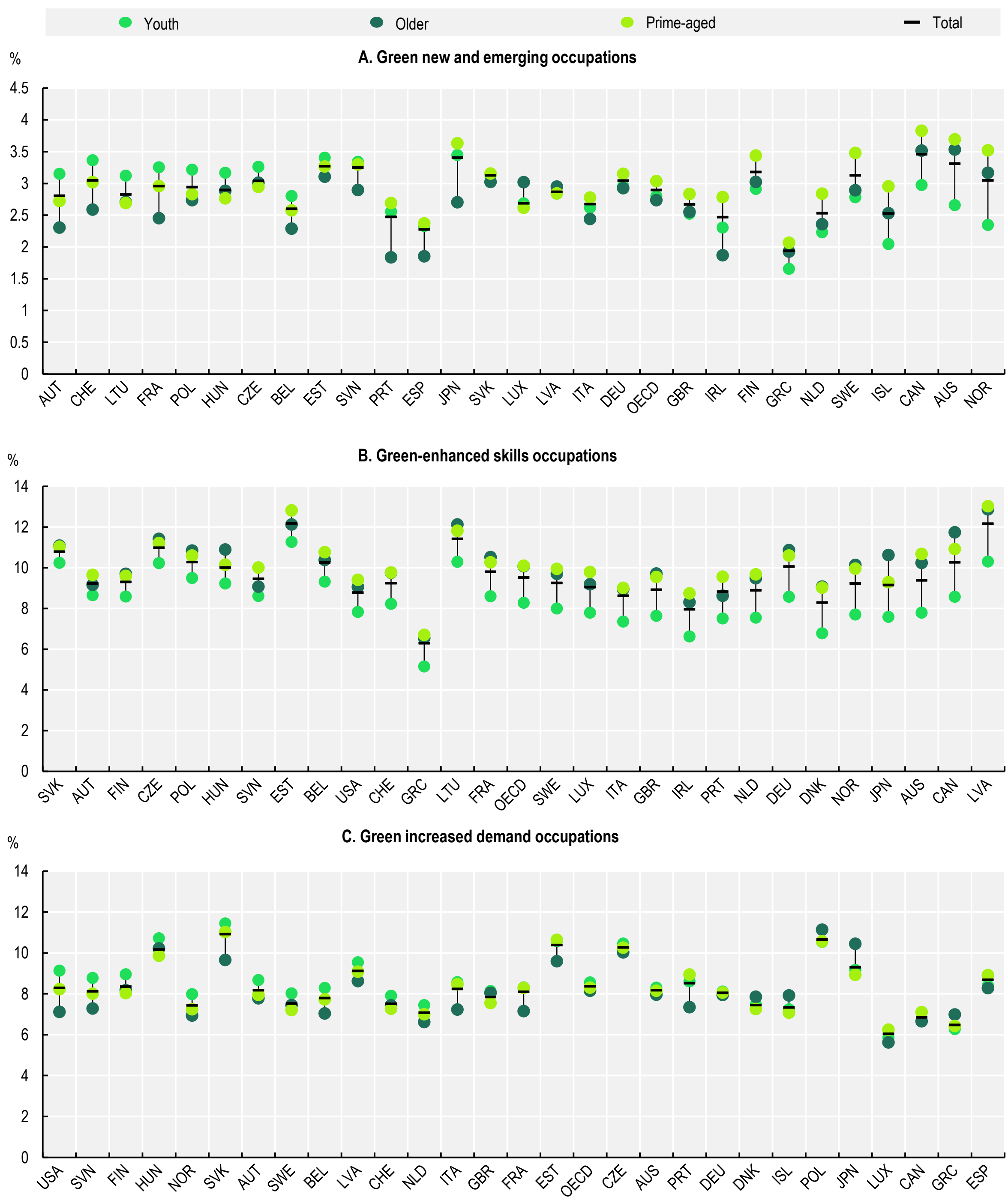
Annex Figure 2.C.4. There is limited variation in the age composition of different types of green-driven jobs

Percentage of total employment, average 2015-19



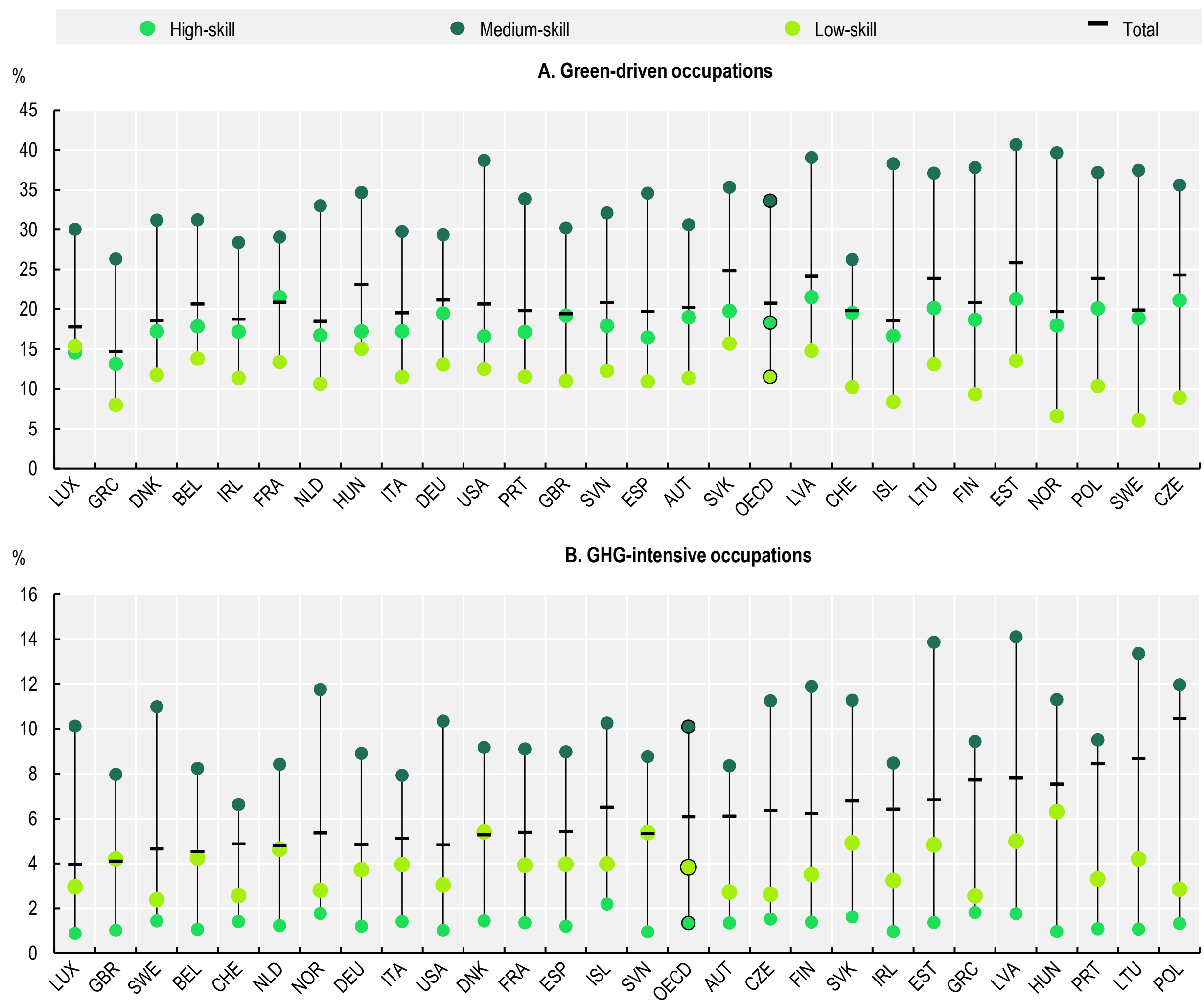
Note: Countries are ranked by decreasing gap of the share for youth compared to the. Data refer to the average for 2015-19. OECD: Unweighted average of countries shown.

Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force Survey; Japanese Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

StatLink https://stat.link/wj09bv

Annex Figure 2.C.5. Green-driven and GHG-intensive occupations are typically medium-skill ones

Percentage of total employment, average 2015-19



Note: Countries are ranked by decreasing gap of the share for low-skilled compared to the total in Panel A, and by decreasing gap of the share for high-skilled compared to the total in Panel B. Low-skill refer to Service and Sales Workers and Elementary Occupations (ISCO-08 5 and 9, medium skill to Clerical Support Workers, Craft and Related Trades Workers and Plant and Machine Operators, and Assemblers (ISCO-08 4, 7 and 8), high-skill to Managers, Professionals and Technicians and Associate Professionals (ISCO-08 1, 2 and 3). Data refer to the average for 2015-19. OECD: Unweighted average of countries shown. GHG: greenhouse gases.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

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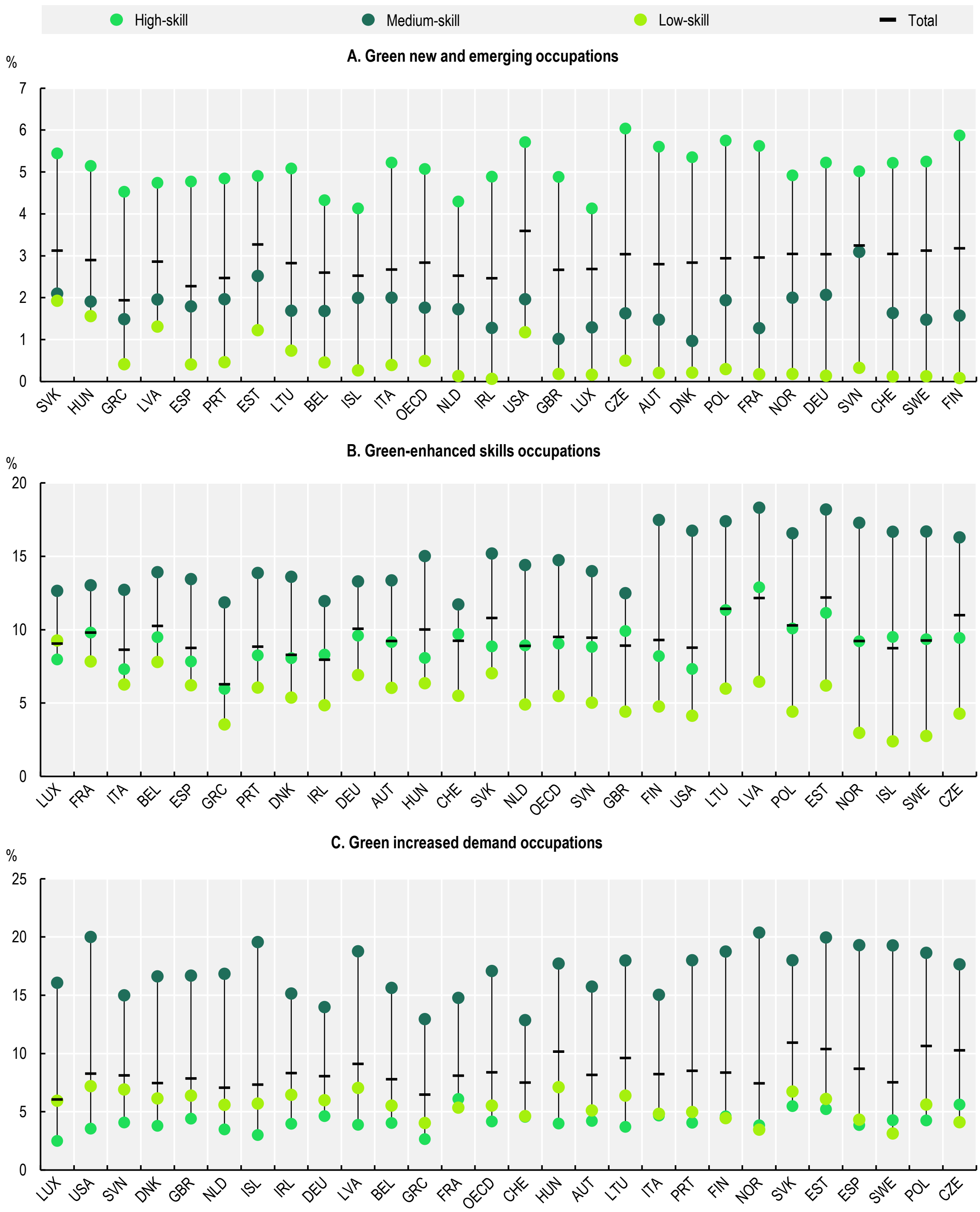
Annex Figure 2.C.6. The occupational composition of different types of green-driven jobs differs significantly

Percentages, average 2015-19



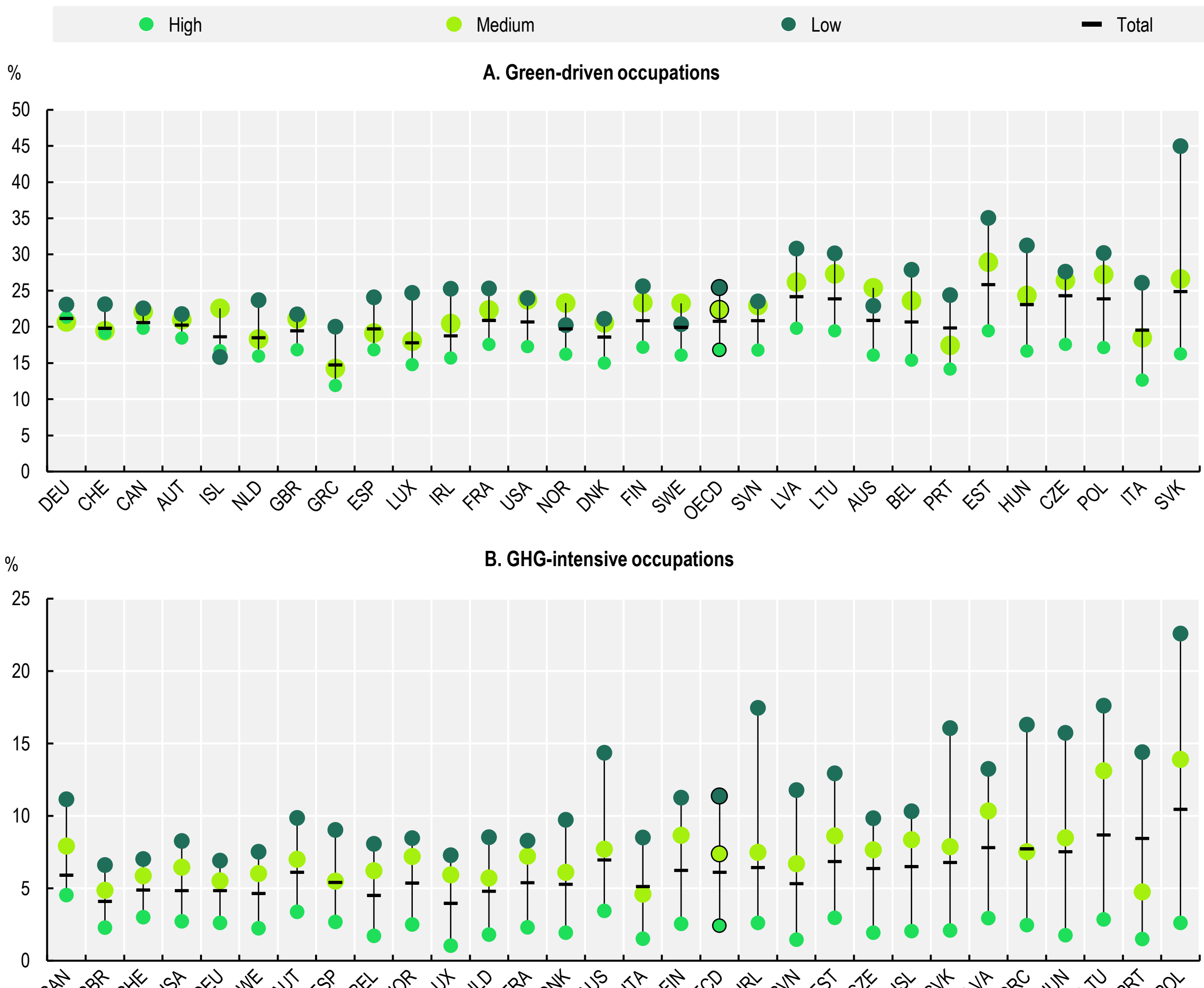
Note: Data refer to the average for 2015-19. Low-skill refer to Service and Sales Workers and Elementary Occupations (ISCO-08 5 and 9, medium skill to Clerical Support Workers, Craft and Related Trades Workers and Plant and Machine Operators, and Assemblers (ISCO-08 4, 7 and 8), high-skill to Managers, Professionals and Technicians and Associate Professionals (ISCO-08 1, 2 and 3). OECD: Unweighted average of countries shown.

Source: Source Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

StatLink https://stat.link/ai0tc1

Annex Figure 2.C.7. GHG-intensive occupations are more likely low educated while green-driven occupations are more heterogeneous

Percentages, average 2015-19

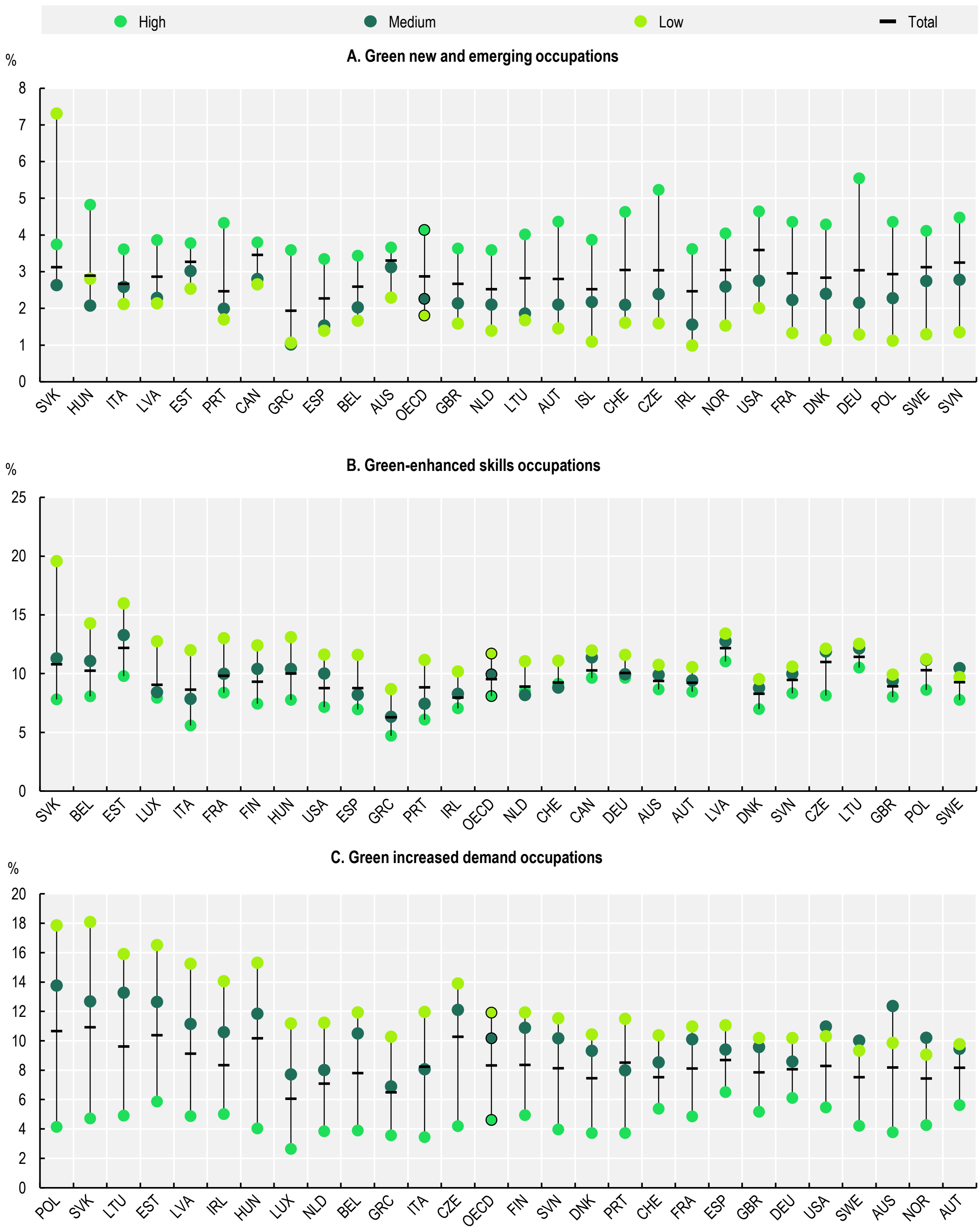


Note: Countries are ranked by decreasing gap of the share for high education compared to the total. Data refer to the average for 2015-19. Low education refers to less than upper secondary, medium education to upper secondary, high education to more than upper secondary. OECD: Unweighted average of countries shown. GHG: greenhouse gases.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

StatLink https://stat.link/6nria2

Annex Figure 2.C.8. The educational composition of different types of green-driven jobs differs significantly

Percentages, average 2015-19

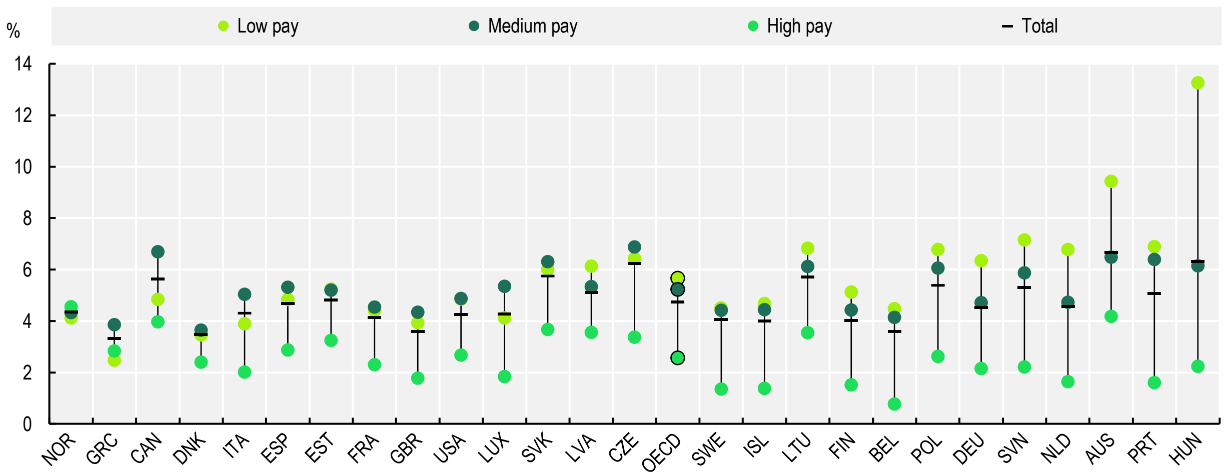


Note: Countries are ranked by decreasing gap of the share for high education compared to the total. Data refer to the average for 2015-19. Low education refers to less than upper secondary, medium education to upper secondary, high education to more than upper secondary. OECD: Unweighted average of countries shown.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: United States: Current Population Survey; All other countries: EU Labour Force Survey.

StatLink https://stat.link/k7u2yn

Annex Figure 2.C.9. Employees in GHG-intensive occupations typically earn low or middle wages

Percentage shares of GHG-intensive occupations, by wage category and country, 2018



Note: The figure reports the percentage of GHG-intensive occupations in wage and salary employment, by country and hourly wage category. High (resp. low) wage is defined as hourly wage above one-and-a-half times (resp. below two-thirds of) the median wage. Agriculture is excluded except in Australia, Canada and the United States. Data for Belgium, Denmark, France, Greece, Iceland, Italy, Luxembourg, Portugal, Sweden and the United Kingdom do not include firms with less than 10 employees. Data for Canada and the United States refer to 2019. OECD: Unweighted average of countries shown. GHG: greenhouse gases. Countries are ranked by the difference in the incidence of GHG-intensive occupations between high and low wage workers.

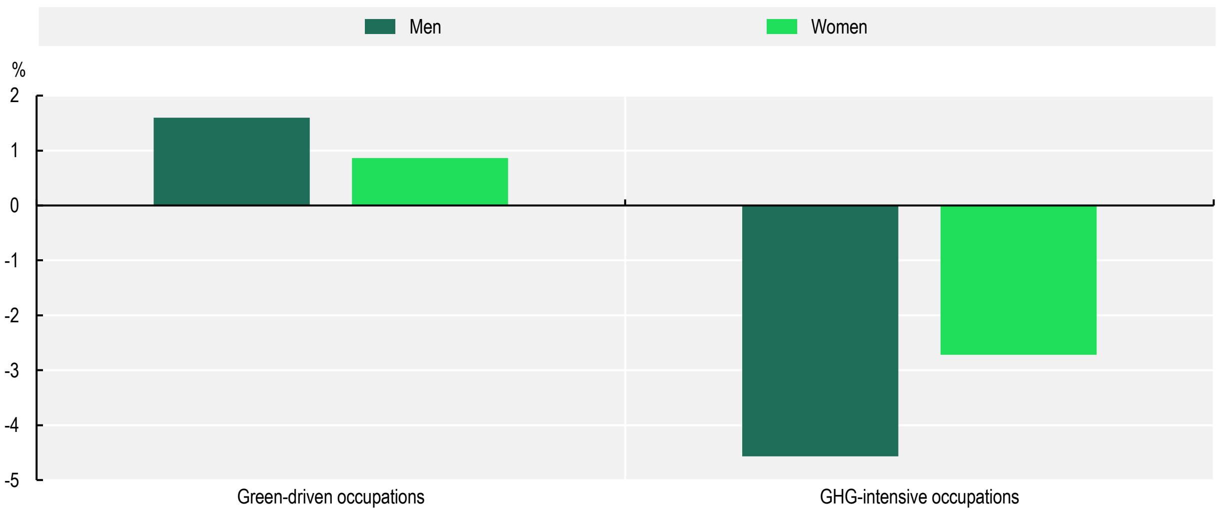
Reading: In Hungary, 13.3% (resp. 6.2% and 2.2%) of low-wage (resp. middle-wage and high-wage) employees have a job in a GHG-intensive occupation. A larger incidence of a given type of occupation among high-wage workers than among middle or low-wage workers is indicative of a positive wage gap between that occupation and the others.

Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australia: Table Builder of the Australian Bureau of Statistics (Labour Force: Characteristics of Employment); Canadian Labour Force Survey; United States: Current Population Survey; All other countries: EU Structure of Earnings Surveys.

StatLink https://stat.link/62q14c

Annex Figure 2.C.10. The wage gap in GHG-intensive occupations is less negative for women

Percentage difference between the share of green-driven and GHG-intensive occupations among high and low-wage workers, 2018



Note: The figure reports the cross-country unweighted average difference in the percentage of green-driven and GHG-intensive occupations in wage and salary employment between high and low wage workers, by gender. High (resp. low) wage is defined as hourly wage above one-and-a-half times (resp. below two-thirds of) the median wage. Included countries are Australia, Belgium, Canada, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, the United Kingdom, the United States. Agriculture is excluded except in Australia, Canada and the United States. Data for Belgium, Denmark, France, Greece, Iceland, Italy, Luxembourg, Portugal, Sweden and the United Kingdom do not include firms with less than 10 employees. Data for Canada and the United States refer to 2019. GHG: greenhouse gases. Countries are ranked by the difference in the incidence of GHG-intensive occupations between high and low wage workers.
Reading: On average, the share of green-driven occupation is 1.6% higher among high-wage men than among low-wage men. A larger incidence of a given type of occupation among high-wage workers than among middle or low-wage workers is indicative of a positive wage gap between that occupation and the others.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australia: Table Builder of the Australian Bureau of Statistics (Labour Force: Characteristics of Employment); Canadian Labour Force Survey; United States: Current Population Survey; All other countries: EU Structure of Earnings Surveys.

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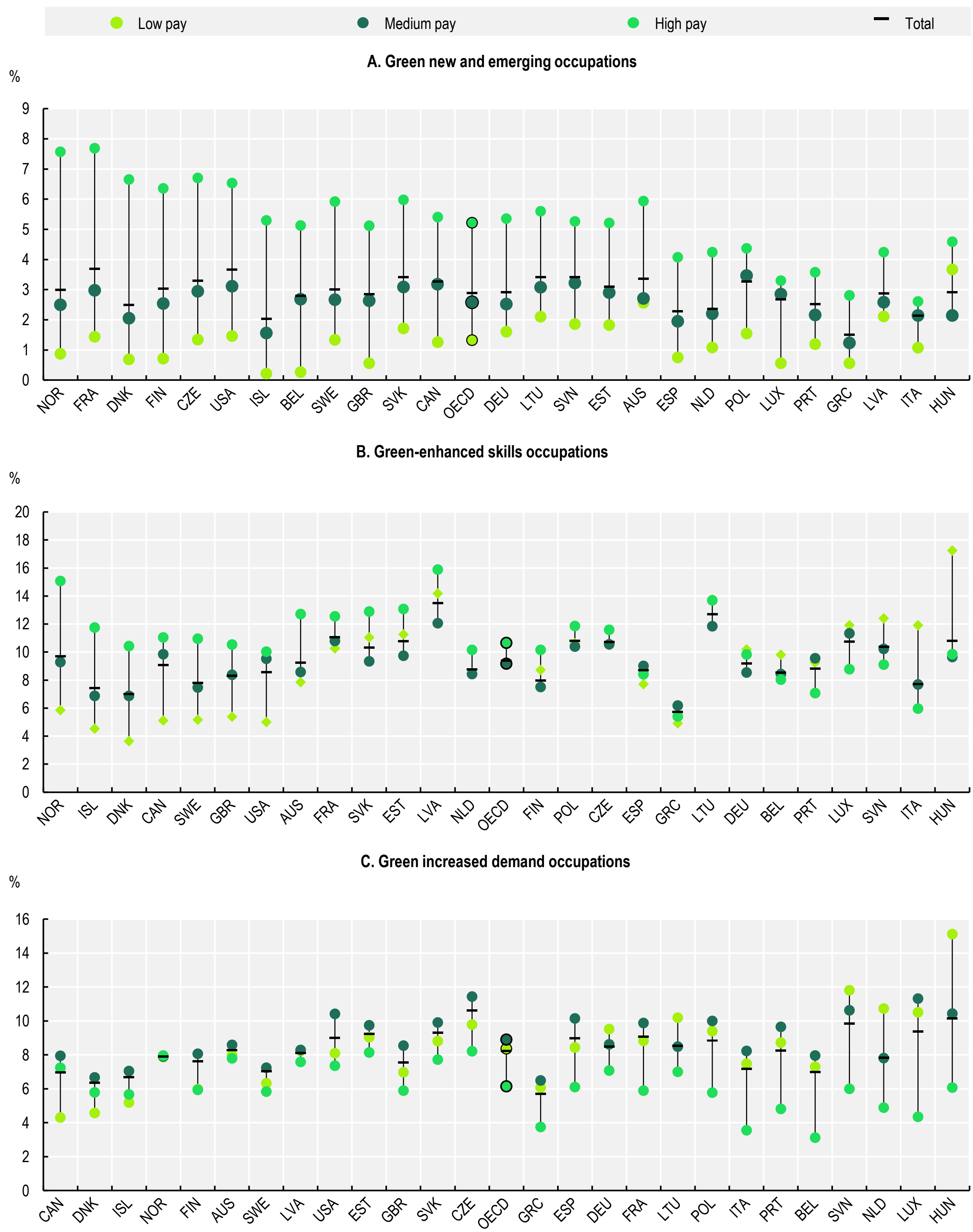
Annex Figure 2.C.11. Employees in green new and emerging occupations are mostly high wage workers

Percentage shares of green-driven occupations by country and wage category, 2018

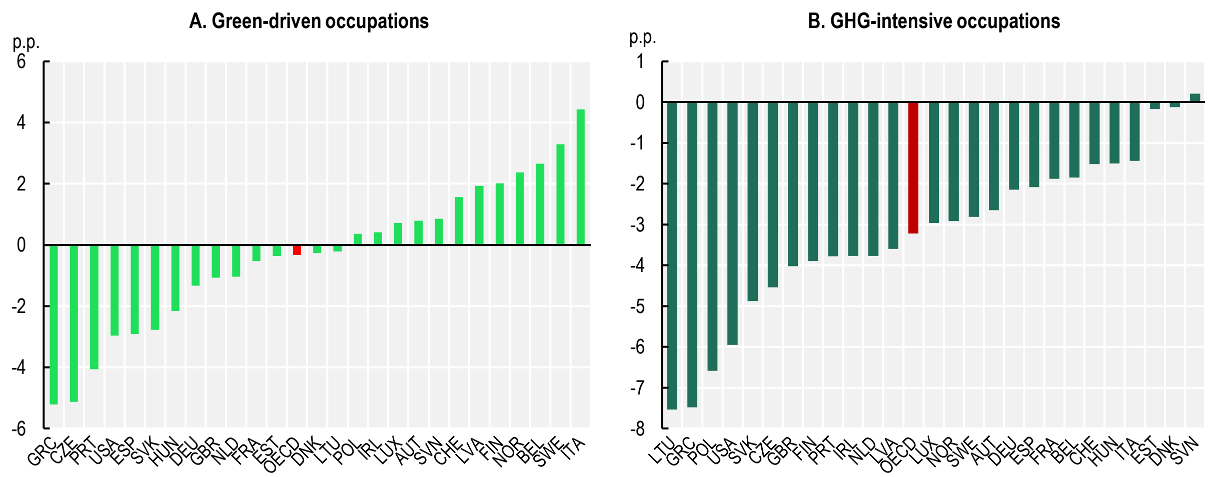


Note: The figure reports the percentage of each type of green-driven occupations in wage and salary employment, by country and hourly wage category. High (resp. low) wage is defined as hourly wage above one-and-a-half times (resp. below two-thirds of) the median wage. Agriculture is excluded except in Australia, Canada and the United States. Data for Belgium, Denmark, France, Greece, Iceland, Italy, Luxembourg, Portugal, Sweden and the United Kingdom do not include firms with less than 10 employees. Data for Canada and the United States refer to 2019. OECD: Unweighted average of countries shown. GHG: greenhouse gases. Countries are ranked by the difference in the incidence of each type of occupations between high and low wage workers.
Reading: In Norway, 7.6% (resp. 2.5% and 0.9%) of high-wage (resp. middle-wage and low-wage) employees have a job in a green new and emerging occupation. A larger incidence of a given type of occupation among high-wage workers than among middle or low-wage workers is indicative of a positive wage gap between that occupation and the others.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australia: Table Builder of the Australian Bureau of Statistics (Labour Force: Characteristics of Employment); Canadian Labour Force Survey; United States: Current Population Survey; All other countries: EU Structure of Earnings Surveys.

StatLink https://stat.link/dmu0tr

Annex Figure 2.C.12. Gap in the share of green-driven or GHG-intensive occupations in non-strained jobs compared with strained jobs

Percentage points, 2021 for EU-OECD countries and 2015 for the United States



Note: The chart reports the difference in percentage points between the share of green-driven occupations in non-strained jobs compared with the share of green-driven occupations in strained jobs (Panel A) and between the share of GHG-intensive occupations in non-strained jobs compared with the share of GHG-intensive occupations in strained jobs (Panel B). OECD: Unweighted average of countries shown. GHG: greenhouse gases.
Reading: In Panel A, in Greece, the share of green-driven occupations in non-strained jobs is 5.5 percentage points lower than in strained jobs, which means that workers in green-driven occupations are more strained than the others. In Italy, on the opposite, the share of green-driven occupations in non-strained jobs is 4.4 percentage points higher than in strained jobs, which means that workers in green-driven occupations are less strained than the others.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and Secretariat's estimates based on the European Working Conditions Telephone Survey 2021 and the American Working Conditions Survey 2015.

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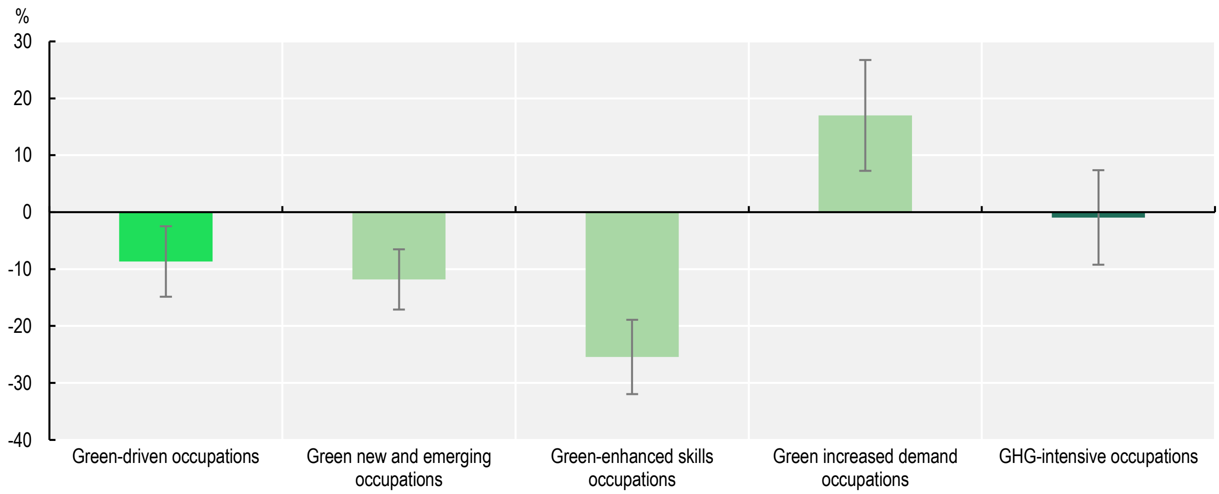
Annex Figure 2.C.13. The incidence of job strain is lower in new and emerging and green-enhanced skills green occupations even when controlling for the job characteristics

Marginal effect of the job strain indicator on the share of green-driven occupations, controlling for main individual and job characteristics, 2021 for EU-OECD countries and 2015 for the United States



Note: The chart reports the point estimate (and 95% confidence intervals) of the percentage difference in the incidence of each type of green-driven occupation between job strained and not strained workers. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of green-driven occupation within all, high, medium or low-skilled occupations as dependent variable and including a job strain dummy, the share of 1-digit ISCO occupations, educational attainment (3 classes), gender, age (3 classes), sectors (5 categories), and country dummies as explanatory variables. Standard errors are clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the job strain dummy and are expressed in percentage of the untransformed dependent variable. The sample excludes Agriculture.
Reading: Controlling for demographic and job characteristics, the percentage share of green new and emerging occupations is, on average, 12% lower among strained employees, i.e. employees whose number of job demands exceeds the number of job resources.
Source: Secretariat's estimates based on version 24.1 of the O*NET database and the European Working Conditions Telephone Survey 2021 and the American Working Conditions Survey 2015.

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Notes

[1] In addition, estimated costs would be even larger if a wider definition of well-being were considered: for example, Heutel, Miller and Molitor (2021[26]) estimate that, with inaction against climate change, elderly mortality in a country like the United States would increase by more than 2% by the end of this century.

[2] Individual trajectories out of high-emission jobs will be studied in Chapter 3.

[3] In 2012, the United Nations Statistical Commission (United Nations, 2012[32]) adopted the Central Framework of the System for Integrated Environmental Economic Accounting (SEEA). This framework allows for the estimation of employment in what is referred to as the environmental goods and services sector (EGSS). Building on the SEAA Central Framework, the ILO (ILO, 2013[93]) proposed a definition on green jobs which was adopted at the 19th Conference of Labour Statisticians Guidelines (ICLS), which differentiates between employment in the environmental sector (employment in environmental processes and employment in the production of environmental outputs) and green jobs, which includes these categories but must also fulfil the criteria for decent work. Conceptual and practical difficulties in its operationalisation have limited the adoption of this definition in the literature.

[4] This approach typically uses direct and indirect greenhouse gas emissions generated in producing a good or service, and takes activities with the lowest emissions as green. However, although this approach is attractive, data limitations makes it difficult to use it systematically, in particular to identify green jobs (Rodrigues et al., 2018[97]; Bontadini and Vona, 2023[30]).

[5] These are defined as: i) those activities whose primary purpose is the prevention, reduction and elimination of pollution and other forms of degradation of the environment; and ii) those activities whose primary purpose is the preservation and maintenance of the stock of natural resources and hence safeguarding against depletion – see e.g. Keese and Marcolin (2023[7]).

[6] See www.ons.gov.uk/economy/environmentalaccounts/methodologies/thechallengesofdefiningagreenjob.

[7] This implies that a security guard working for a renewable energy power generation plant would be considered green, while a wind turbine service technician working for a plant mainly active in fossil fuel electric power generation would not be considered green.

[8] Green tasks can be defined as typical activities associated with a particular occupation which have a direct positive impact on green objectives and are directly associated with green activities, such as: input reduction, efficiency, and use of renewables; waste reduction, reuse, and mitigation; pollution and greenhouse gas reduction, prevention, and mitigation; natural resource conservation and reclamation; and environmental advocacy and analysis (Peters, 2013[35]). A more extensive definition could consider any task that is executed using resource-efficient or environmentally friendly technologies (Biagi, Vona and Bitat, 2021[56]).

[9] Most, if not all, of the studies that look at the intensity of jobs in terms of green tasks start from the list of green tasks by occupation as published by O*NET.

[10] Renewable energy generation; green transportation (activities related to increasing efficiency and reducing pollution in transportation); energy efficiency; green construction (construction of new green building, retrofitting and installation of other green technologies in buildings); energy trading; energy storage; CCUS; energy-related research, design and consulting services; environment protection; natural

or high-efficiency agriculture and forestry; manufacturing of green technology and energy-efficient manufacturing processes; governmental and regulatory administrations associated with conservation and pollution prevention, regulation enforcement, and policy analysis and advocacy.

[11] For example, most type of construction workers – e.g. cement masons and concrete finishers – will likely be in demand because of the need of new infrastructure, even if their job is not directly involved in any green or low-carbon activity as described above – see e.g. Dierdorff et al. (2011[46]).

[12] ILO also adds climate adaptation activities in the list of green activities.

[13] A few studies for Europe tend to obtain much larger estimates of the order of 40% – e.g. Bowen and Hancké (2019[90]) and Eurofound (2022[88]). However, as shown by Valero et al. (2021[29]), these large estimates are essentially due to the complexity of translating information from one occupational classification (US SOC) to another (ISCO) and the questionable choice of assigning a "green" label to each ISCO occupation that matches at least one US SOC occupation. More generally, as argued by Vona (2021[56]), a much larger size of green employment in other countries than in the United States is a red flag for unsuccessful crosswalking across occupational classifications – see also Annex 2.A.

[14] It is important to underline here that this definition is purely operational, as it serves the purpose of characterising those jobs that are likely positively impacted by the net-zero transition, and should not be seen as a normative definition of desirable jobs.

[15] France Stratégie and Dares (2022[91]) made a growth forecast exercise by occupation with results published at a relatively disaggregate level (83 occupations). This exercise includes published forecasts for a low-carbon scenario, which has been used by France Stratégie (2023[92]) to identify occupations that are likely to be boosted by the net-zero transition. However, the classification used in these publications (FAP87) does not have an obvious crosswalk into ISCO (or other commonly used occupational classifications) and remains relatively aggregate with respect to the classifications more frequently used in this chapter. For these reasons, these data have not been exploited in this chapter.

[16] More precisely, it is likely that, in each occupation of this group, new jobs with altered, and greener, tasks (requiring different skills and credentials) will expand and old jobs with old types of tasks and skill requirements will downsize.

[17] The 2019 version of the O*NET database used here to define these occupations is the latest version updating jobs and tasks associated with green economy activities (O*NET database version 24.1 – www.onetcenter.org/dictionary/24.1/excel/).

[18] In contrast with previous OECD work, however, for countries using the ISCO classification, this chapter exploits a new crosswalk developed at a very disaggregate level as a joint effort by the European Commission and the US Department of Labor – European Commission, Directorate General for Employment, Social Affairs and Inclusion, through the ESCO Secretariat, and the US Department of Labor, Employment and Training Administration, through the O*NET Network. This crosswalk has been developed between 8-digit SOC occupations and 3 008 ESCO categories which represents a further disaggregation of ISCO occupations at the 4-digit level. The crosswalk is available at https://esco.ec.europa.eu/en/about-esco/data-science-and-esco/crosswalk-between-esco-and-onet and www.onetcenter.org/crosswalks/esco/ESCO_to_ONET-SOC.xlsx. Moreover, this chapter extends the country coverage by applying other crosswalks between the US SOC classification and the Canadian National Occupation Classification (NOC) and Australian and New Zealand Standard Classification of

Occupations (ANZSCO). See https://github.com/thedaisTMU/NOC_ONet_Crosswalk and https://labourmarketinsights.gov.au/media/pmukn3qt/ anzsco-2013-to-onet-soc-2019.xlsx.

19 The aggregate estimates of the workers employed in green-driven occupations shown in Figure 2.3 are higher than most of those that have been found in previous analyses on “green jobs” – see Section 2.1.1 above – including some of the OECD studies (Causa et al., 2024[69]; Causa, Nguyen and Soldani, 2024[64]), essentially because the concept used is more general as this analysis covers all those occupations that are likely to benefit from the transition to net zero. The estimates of GHG-intensive occupations, on the opposite, are broadly aligned with previous work and the small differences can be explained by the selection of high-emission industries and by the different crosswalks across different occupational classifications that have been used.

20 Green new and emerging occupations will be shown below to be the fastest growing group of green-driven occupations.

21 Two-thirds of the employment in these “mixed” occupations is on average in green-enhanced skills occupations, one-third in green increased demand occupations and less than 0.2% in new and emerging occupations.

22 Yet, as discussed above, new and emerging occupations weigh little in the aggregate stock of green-driven occupations.

23 For this latter group, the employment dynamics is likely to result from a, possibly temporary, composition effect, as the (larger) segment with old requirements in declining industries tends to downsize while jobs with new requirements in the (smaller) environment-friendlier sector tend to expand. Once the transition reaches an advanced stage, it is likely that employment growth in these occupations will start again.

24 If occupations concentrated in agriculture are excluded, the average rate of decline is halved but remains significant.

25 There is a correlation coefficient of 0.41, with zero being no correlation and 1 perfect positive correlation, between green-driven and GHG-intensive occupations, which decreases to 0.29 if those occupations that can be both green-driven and GHG-intensive are excluded.

26 Eurostat defines rural an area where more than 50% of its population lives in rural grid cells, i.e. not urban centres or urban clusters.

27 However, the rural-urban difference is larger in the case of GHG-intensive occupations than in the case of green-driven occupations, suggesting that GHG-intensive occupations are much more concentrated in rural areas than green-driven jobs.

28 In Australia, where the gap is the largest, the share of green-driven occupations among men is 11.6 percentage points higher than the national average while the share of green-driven occupations among women is 13 percentage points lower than the national average. In Greece, where the gap is the smallest, the share of green-driven occupations among men is 4.4 percentage points higher than the national average while the share of green-driven occupations among women is 6 percentage points lower than the national average.

29 As noted in OECD (2021[2]), women, even if not directly impacted, may still suffer from second-round effects of plant closures. In the United Kingdom, Aragon et al. (2018[89]) show that female employment was

hit a generation after the closure of the mines. The authors of the study attribute the time lag to the possibility that former miners may have rejected certain jobs perceived as "women's work", while the subsequent generation displayed greater willingness to pursue such opportunities.

[30] This section follows the three dimensions of the OECD Job Quality framework but the operationalisation differs slightly to make it applicable to the context and data availability. In particular, while the measure of earnings quality captures both average hourly wages and their distribution at national level, this chapter, which looks at individual workers, only considers average hourly wages.

[31] High-wage (resp. low-wage) employees are defined as those with gross hourly wage larger than, or equal to, one-and-a-half times (resp. smaller than two-thirds of) the median wage in the country. Middle-wage employees are the residual category including the median.

[32] As shown in Figure 2.9, Panel B, the unconditional average statistic presented in Figure 2.9, Panel A is within the 95% confidence interval of the cross-country estimate obtained through regression methods, controlling for individual characteristics. Regression estimates presented in the rest of this chapter are obtained by fitting linear regression models in which the dependent variables have been multiplied by 20 and transformed using an inverse hyperbolic sine transformation. The pre-multiplication by 20 is done to ensure that sample means are greater than 10 for all the dependent variables, as required for estimate reliability (Bellemare and Wichman, 2019[94]). Percentage effects are retrieved by applying the standard logarithmic approximation (Halvorsen and Palmquist, 1980[95])

[33] Given the employment size of GHG-intensive occupations, the effect on the aggregate gender wage gap would be minimal, however.

[34] The results for Norway are not due to offshore extractive activities. When the corresponding sector is excluded altogether from the sample, results remain unchanged.

[35] Interestingly, in 12 out of 26 countries, the highest share of GHG-intensive occupations is among middle-wage employees.

[36] See Box 2.4 for a detailed explanation of the difference between workers in GHG-intensive industries and workers in GHG-intensive occupations.

[37] See Section 2.1.2 for examples of jobs falling in each of these occupational categories.

[38] Despite these differences, cross-country correlations between wage premia (penalties) by type of green-driven occupations are high (always larger than 0.6), and country rankings are relatively stable – the lowest spearman rank correlation coefficient (0.6) is found between new and emerging green and green-enhanced skills occupations, but it remains largely significant at standard levels. In other words, in a country, in which one type of green-driven occupation commands higher salaries, salaries will also be higher in all other types of green-driven occupations.

[39] Results are qualitatively similar if occupations that are green-driven but are concentrated in GHG-intensive occupations are excluded from green-driven jobs of different types.

[40] See Annex Figure 2.C.6. Typical examples of new and emerging occupations with a significant employment share are for example Water/wastewater engineers and Solar sales representatives and assessors, all high-skill occupations.

[41] Except for green increased demand occupations, where the effect becomes slightly larger, while remaining contained.

[42] Results even change sign in certain cases: estimated differences are 19%, -4%, and 27% for, respectively, new and emerging, green-enhanced skills, and green increased demand occupations, respectively.

[43] These results are obtained by splitting samples into high, medium and low-skilled occupations, and fitting the regression models on the split samples.

[44] Somewhat similar results are found for GHG-intensive occupations that, within high-skill occupations, are more frequent among high-wage employees than among low-wage employees (with an estimated difference of 25%).

[45] In principle, this risk should be compounded with the effective replacement rate of unemployment benefits (see Chapter 1). However, an estimate of this rate is not available at the individual level in the microdata used for this chapter.

[46] The underlying assumption, which these estimates rely on, is that all unemployed who worked before lost their previous job. In appreciating these results, it is important to keep in mind that, in dynamic labour markets, workers may quit their job to search for better job opportunities while unemployed. To the extent that certain subsegments of the labour market of green-driven occupations are highly dynamic, the statistics presented in Figure 2.12 may therefore overestimate the level of job insecurity of these jobs. Nevertheless, the fact that green-driven occupations are no more frequent among short unemployment spells (less than 6 months) than among all others, suggest that the risk of overestimation is extremely limited.

[47] Controlling for demographic characteristics.

[48] Although insignificantly so in the case of green-enhanced skills occupation.

[49] More precisely, low-skill green new and emerging and green increased demand occupation are estimated to be, respectively, 12.7% and 18% more frequent among the unemployed than other low-skill jobs.

[50] These occupations are 31% more frequent among the unemployed, when high-skill, and 11% less frequent, when medium or low-skill.

[51] While this holds on average, there are nevertheless specific jobs and cases in which temporary contracts are associated to stable, good-quality jobs – see e.g. OECD (2014[15]) and below for a discussion.

[52] And even worse labour market security in the case of green-enhanced skills occupations.

[53] Unfortunately, available data do not allow testing these hypotheses.

[54] For European countries, the 2015 wave of the European Working Condition Survey could also have been used. However, the difference in survey mode (until 2015, workers were interviewed face to face while in 2021, due to COVID-19, the survey was undertaken via telephone) and the changes to the wording

and response options for some of the questions of interest advise against pooling together the 2015 and the 2021 waves.

55 The European Working Condition Survey and the American Working Conditions Survey are broadly comparable but the differences in the wording and response options suggest some caution in comparing the results between the two surveys.

56 In the case of ISCO occupations, this could be accomplished by using more detailed ESCO (European Skills, Competences and Occupations) categories for specific occupations, for example by collecting up to the 6-digit ESCO category for certain occupations such as "power production plant operator" (ISCO/ESCO 3131). Note that up to the 4th digit, ISCO and ESCO are the same classification. In the case of ISIC industries, CReMA categories could be used to further split detailed ISIC industries. The Classification of Resource Management Activities, abbreviated as CReMA, was developed by Eurostat and classifies activities, products, expenditure and other transactions that aim to preserve and enhance the stock of natural resources (Eurostat, 2020[96]). For example, "Production of energy from renewable resources" (CReMA 13A) could be separated from the rest of "Electric power generation, transmission and distribution" (ISIC 3510).

57 By contrast, this property does not hold if the whole occupation *i* that matches with both green occupation *c* and non-green occupations *c'* is considered green, as done in some of the previous works in the literature – see Section 2.1.

58 In other words, for any indicator that is a proportion with total employment at the denominator, the bias issue discussed in Annex 2.B does not emerge.

59 That work and most of previous OECD work – e.g. OECD (2023[27]) – has applied it starting from an old BLS many-to-many crosswalk between 6-digit SOC categories and 3-digit ISCO categories, – see www.bls.gov/soc/ISCO_SOC_Crosswalk.xls.

60 https://esco.ec.europa.eu/en/about-esco/data-science-and-esco/crosswalk-between-esco-and-onet and www.onetcenter.org/crosswalks/esco/ESCO_to_ONET-SOC.xlsx.

61 No bias is found for educational attainment categories.

3 Job displacement in high-emission industries: Implications for the net-zero transition

César Barreto, Jonas Fluchtmann, Alexander Hijzen and Agnès Puymoyen

The net-zero transition will create new job opportunities in low-emission activities but also increase the risk of job loss in high-emission activities. Concerns about job loss are understandable given the persistent earnings losses associated with displacement. In addition, these concerns risk undermining public support for climate change mitigation policies. Developing effective policies to support displaced workers is therefore not only crucial to alleviate the consequences of job displacement but also to ensure that concerns about job loss do not result in a backlash stalling progress towards net-zero emissions. To inform the development of such policies, this chapter provides an in-depth analysis of the consequences of job displacement in high greenhouse gas (GHG) emission industries using harmonised linked employer-employee data from 14 OECD countries and provides a detailed discussion of policies to support workers who lose their job as a result of the net-zero transition.

In Brief

Key findings

The net-zero transition will have significant implications for labour markets. While necessary to combat climate change, the net-zero transition is increasing the risk of job displacement in industries with high greenhouse gas (GHG) emissions. This could lead to large and persistent earnings losses among displaced workers. Concerns over job loss, in particular, risk undermining public support for climate change mitigation policies. To address these challenges and help governments in developing better policies to support displaced workers, this chapter provides an in-depth empirical analysis of the costs of job displacement in high-emission industries, using harmonised linked employer-employee data from 14 OECD countries (Australia, Austria, Canada, Denmark, Estonia, Finland, France, Germany, Hungary, the Netherlands, Norway, Portugal, Spain and Sweden).

The main findings of the chapter can be summarised as follows:

- ***GHG emissions are highly concentrated in specific sectors, representing a relatively small segment of overall employment.*** High-emission industries, which include energy production, heavy manufacturing, as well as transport services, accounted for about 80% of GHG emissions in the OECD in 2019, but represented only about 7% of overall employment. Between 2019 and 2030, employment in high-emission industries is expected to contract at an average annual rate of more than 2% as a result of ambitious emission reduction targets (e.g. the EU's Fit for 55 legislative package), well above the average annual employment decline of about 1% observed in those industries since 2000. This fast projected contraction of employment in high-emission industries signals a pronounced increase in the risk of job displacement.
- ***Employment in high-emission sectors differs substantially from employment in other sectors of the economy, potentially aggravating the consequences of job displacement for workers.*** Workers currently employed in high-emission industries are predominantly male, somewhat older and more likely to reside in rural areas than other workers. They also tend to be employed in relatively high-paying firms but have relatively low educational attainment compared with workers in low-emission industries. The combination of low levels of education, relatively high wages and living in rural areas may have considerable implications for the costs of job displacement and the ability of displaced workers to find a new job quickly.
- ***Job displacement carries significantly larger costs in high-emission sectors than in other sectors of the economy***. In many cases, job displacement represents a life-changing event, with far-reaching consequences for earnings, the main focus of this chapter, but also health, well-being or even mortality. Job displacement in high-emission sectors is costly and significantly more so than in low-emission industries. While displaced workers in low-emission industries face a decline in earnings of 29% on average during the six years after displacement, displaced workers in high-emission industries experience a decrease of 36%. This is 24% more than the earnings loss in low-emission industries. Displaced workers in high-emission industries are also more likely to change industry, occupation or region than displaced workers in other industries. These findings suggest that displaced workers in high-emission industries face additional challenges compared with those displaced in other sectors, including a decline of activity in their industries, occupations and regions. This may also explain why the net-zero transition spurs anxiety among workers in industries at risk.

- ***Steeper earnings losses in high-emission sectors mainly reflect differences in the composition of firms and workers.*** In part, earnings losses are larger in high-emission industries because workers tend to be older, have longer tenure, lower levels of education, fewer portable skills and are more likely to be employed in routine manual occupations. These factors increase the difficulty of finding another job after displacement but particularly that of finding a stable job that pays well. Differences in wages upon re-employment account for about 30% of the overall difference in earnings losses between high-emission and low-emission industries. The bulk of these wage losses is firm related (the transition to firms offering lower wages) rather than worker related (the loss of firm-specific human capital). All in all, earnings losses are larger for displaced workers in high-emission industries partly because firms in these industries pay relatively high wages given worker skills and partly because of the specific characteristics of these workers.
- ***Well-functioning labour markets tend to reduce the costs of job displacement, irrespective of the industry.*** Earnings losses over the first six years following job displacement in both high- and low-emission industries are largest in countries such as Hungary, Portugal and Spain, where they are around twice as large as those seen in other countries, such as Australia, Germany and Sweden. Differences between countries in the earnings losses of displaced workers mainly reflect structural differences in the difficulty of finding another job, as reflected by the unemployment rate, and the functioning of labour markets, rather than differences in the composition of firms and workers. These structural differences are in turn likely to be related to the presence of effective and coherent labour market policies and institutions and, in particular, policies that facilitate labour market transitions.
- ***Developing specific policies to support displaced workers is essential, not only to mitigate income losses and facilitate job transitions towards quality jobs, but also to show that concerns about job losses are being addressed***. Policy makers in OECD countries have various tools at their disposal that can help alleviate the earnings losses of displaced workers and support job transitions. Well-designed out-of-work income support schemes, such as unemployment insurance and social assistance, can play a key role in reducing the earnings losses of displaced workers during joblessness. These schemes also support effective job search, enabling the unemployed to take the necessary time to find a job that aligns well with their skills (or to upgrade their skills). Forward-looking and effective upskilling and reskilling policies are needed to support transitions to emerging and in-demand industries and occupations and the acquisition of new skills. Early intervention measures targeted at workers at risk of dismissal or who have been given notice of dismissal, as well as measures to deal with collective redundancies, may be particularly important and can limit the incidence and consequences of job displacement. Minimum wages and collectively negotiated wage floors can further play an important role in limiting re-employment wage losses by ensuring that the proceeds of productive labour are effectively shared with workers, especially those with weak bargaining position. Targeted approaches, such as wage insurance schemes, may also be a complementary tool to help speed up the transition to new jobs, particularly when workers are offered lower wages than before displacement.

Introduction

Across the globe, governments are steering their economies towards net-zero greenhouse gas (GHG) emissions to mitigate the impacts of climate change, promote sustainable growth and ensure long-term economic resilience. While the aggregate employment effects of the "net-zero transition" are expected to be modest (see Chapter 2), it will have a profound impact on labour markets by shifting activity in sectors with high GHG intensity ("high-emission") to resource-efficient sectors with low GHG intensity ("low-emission"). While some sectors and firms may be able to reduce their footprint by changing the way they operate, considerable employment losses in the most polluting sectors seem inevitable. Indeed, employment in high-emission sectors – such as coal mining and extraction of petroleum, but also certain parts of the manufacturing sector that use energy intensively – is expected to decline substantially faster in the near future, involving potentially significant job losses (Borgonovi et al., 2023[1]). Concerns about job loss are understandable since they can lead to significant long-term reductions in earnings (Jacobson, Lalonde and Sullivan, 1993[2]) and negatively affect health and even life expectancy (Schaller and Stevens, 2015[3]; Sullivan and Wachter, 2009[4]). Such concerns could also compromise public support for climate change mitigation policies and the ability of governments to deliver on their emission reduction targets (Dechezleprêtre et al., 2023[5]; Dabla-Norris et al., 2023[6]). A key challenge for policy makers is how to support the net-zero transition without compromising public support for climate change mitigation policies. Policies that effectively address concerns about the potential negative labour market effects of the net-zero transition and prepare workers at risk of job loss for transitions to emerging and in-demand industries and occupations are key in overcoming this important challenge.

The objective of this chapter is to shed further light on the labour market effects of the net-zero transition, with an emphasis on its costs in terms of job losses, to help governments develop more effective policies to support workers who lose their job as a result of the net-zero transition.[1] The starting point of the analysis is that job losses due to the planned reduction of GHG emissions are expected to be concentrated in a small number of specific industries that account for the bulk of emissions but only a small fraction of employment. Accordingly, an analysis of job displacement in high-emission industries using historical data is likely to be highly informative of the challenges that workers who lose their job in the future because of the net-zero transition might face, given the characteristics of firms and workers in those industries and the level of policy support available to displaced workers.[2] If anything, these challenges may become even more important given the accelerated pace of change and the subsequent rise in the risk of displacement and the decline in job opportunities in high-emission industries for displaced workers. The analysis addresses two key questions. First, it analyses the extent to which the costs of job displacement differ between workers in high- and low-emission industries within countries. Previous evidence suggests that displaced workers in high-emission industries face particular challenges in finding another job, and once they do, wages might be lower (Walker, 2013[7]; Barreto, Grundke and Krill, 2023[8]; OECD, 2023[9]). Second, it analyses the extent to which the costs of job displacement in high-emission industries differ between countries. Systematic differences between countries may suggest that the broader institutional context plays an important role in shaping the cost of job displacement (Bertheau et al., 2023[10]).

The chapter is organised as follows. It starts with a descriptive analysis of what distinguishes employment in high-emission industries from employment in the rest of the economy. It then proceeds with an in-depth empirical examination of the consequences of job displacement in high-emission sectors using comprehensive linked employer-employee data for 14 OECD countries. Based on the evidence, the chapter presents a discussion of the policy options, with the objective of identifying strategies that can most effectively support the workers who are displaced because of the net-zero transition. The chapter is accompanied by a technical background paper which systematically decomposes the results by sub-sector (energy supply, heavy manufacturing and transport) and provides additional information on the methodology and data used (Barreto et al., forthcoming[11]).

3.1. Characterising employment in high-emission industries

To reduce GHG emissions, OECD countries have embarked on a wide range of efforts – see e.g. Nachtigall et al. (2022[12]). These include, among others, regulations of emission intensity, increasingly stricter carbon pricing measures (see Chapter 5) and incentives for green investment. As a result of these measures as well as other structural developments (e.g. technological change, globalisation), total GHG emissions in OECD countries dropped by approximately 6% between 1990 and 2021 (OECD, 2024[13]).

However, to make good on emission targets and contain the increase in global warming, policy efforts have to step up. For instance, by 2030 Japan aims to reduce GHG emissions by 46% from 2013 levels, while the United States have pledged a 50-52% reduction in GHG emissions from 2005 levels by 2030 and the EU's Fit for 55 legislative package mandates a 55% reduction in GHG emissions by 2030 compared to 1990 levels.[3] Meeting these targets by 2030 requires drastically increasing the pace with which GHG emissions are reduced now. For example, compared to their efforts since 1990, EU countries under Fit for 55 will have to roughly double their required annual emission reduction until 2030. Likewise, Japan will have to increase its annual emission reduction by 50% over the efforts since 2013, while the United States will have to almost quadruple their annual efforts until 2030 compared to what they achieved since 2005. The coming years will therefore require a more rapid transition through extensive policy reforms and green investment, which may cause more disruption, particularly in high-emission sectors.

This chapter considers the GHG intensity of economic sectors as the main determinant of whether they will be negatively affected by the net-zero transition, consistent with the focus of major emissions-reduction initiatives, such as Fit for 55.[4] High-emission sectors are defined as industries that consistently feature among the top-polluting industries in OECD countries. A detailed description of this approach is laid out in Box 3.1. The final list of high-emission industries includes energy supply, heavy manufacturing (basic metals, chemicals, coke and petroleum, paper, other non-metallic mineral products), mining and quarrying, as well as transport services (air, water and land).

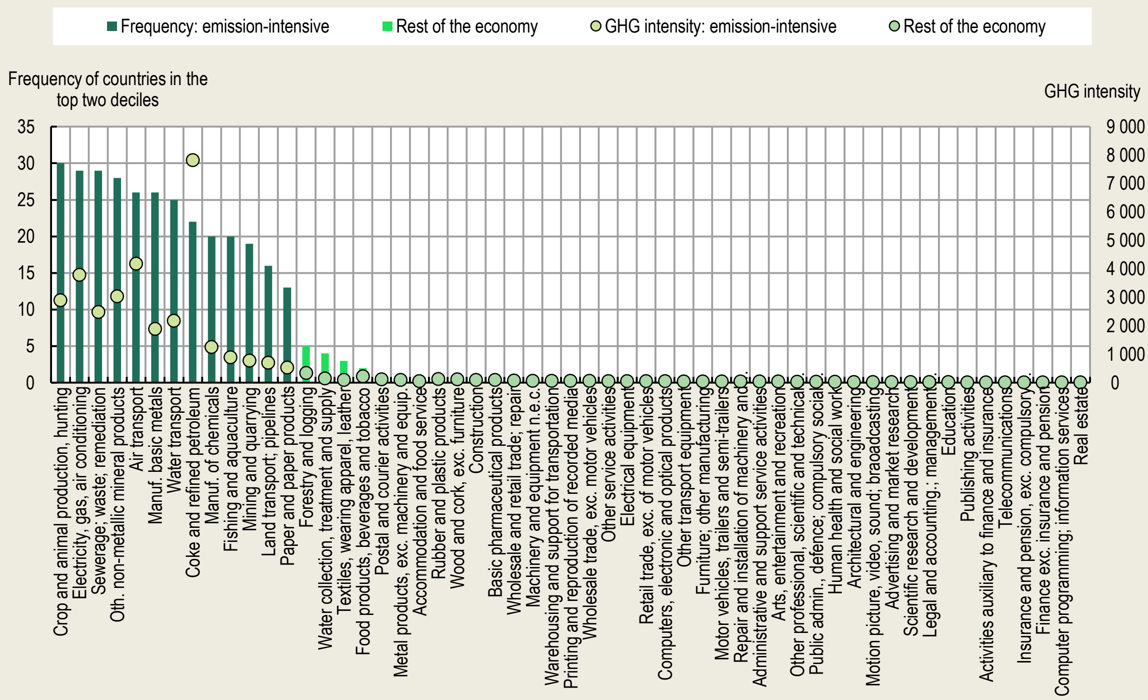
Box 3.1. Defining high-emission sectors

The classification of high-emission sectors in this chapter is based on Eurostat data for 27 EU countries as well as the United Kingdom, Norway, Iceland and Switzerland for 2-digit ISIC rev.4 sectors over the period 2009-20. The level of GHG emission intensity in a sector is measured by GHG emissions in CO_2-equivalent units per unit of value added (in tonnes per million EUR), excluding any supply chain linkage, and considers a broad set of gases contributing to global warming. Contributions of gases other than CO_2 are weighted in terms of how many times more damaging they are in trapping heat than carbon dioxide over a 100-year horizon. For example, methane is weighted as 28-30 CO_2-equivalent units as it is 28-30 times more effective in trapping heat.

This chapter categorises a sector as high emission if it ranks in the upper two deciles of the average GHG intensity distribution in at least 10 out of 32 countries (Figure 3.1). This threshold, as evident in Figure 3.1, effectively distinguishes high-emission sectors – averaging just below 2 500 CO_2-equivalent tonnes per million EUR of gross value added (in constant 2015 prices of the national currency) – from their counterparts. Notably, at the threshold, the frequency distribution shows a sharp decline of more than 50% in the frequency and 20% in GHG intensity.

Figure 3.1. Classification of high- and low-emission industries

GHG intensity within 2-digit NACE rev.2 sectors and frequency in top 2 deciles across 31 OECD countries, 2009-20 average



Note: GHG intensity is expressed as CO_2- equivalent emissions in tonnes per million EUR of gross value added.
Source: Eurostat – Air emissions accounts by NACE Rev. 2 activity.

StatLink https://stat.link/3xgc2z

The list of sectors included in the definition encompass energy supply, as well as transport services (water, air and land), mining and manufacturing of energy-intensive products (basic metals, non-metallic mineral products, refined petroleum products, chemical- and paper products). The sewerage and waste-collection sector is omitted from the final list of high-emission industries as it is not expected to decline and indeed is a much needed industry for the net-zero transition (see Borgonovi et al. (2023[1])). The agricultural sector is entirely omitted from the list of industries studied in this chapter for two reasons. First, mass layoffs in agriculture are more likely to capture seasonal rather than structural adjustments in employment. Second, employment projections for many OECD countries do not suggest a decline in employment growth in the agricultural sector, in contrast to most other emission-intensive sectors, as current policy packages tend to shelter agricultural production from the climate mitigation effort (Borgonovi et al., 2023[1]).

The classification of "high-emission industries" shows not only significant consistency across the countries considered, but also across different measures of emission intensity, such as carbon intensity or fossil fuel energy intensity (see Barreto et al. (forthcoming[11]) for details). A key limitation of the present approach is the classification of industries based 2-digit ISIC rev. 4 sectors. This does not allow disentangling subsectors which may be expected to expand because of the net-zero transition such as renewable energy power generation or electrified land transport from sectors that are expected to contract. However, cross-country emission data, whether in the form of GHG emissions, carbon intensity or energy use, are not available at a more disaggregate level.

3.1.1. Emissions are highly concentrated in specific sectors accounting for just 7% of employment

High-emission industries, as defined in this chapter, account for about 80% of total GHG emissions across the OECD. There is some moderate variation across countries due to differences in the national energy mix, the size of high-emission industries and emission regulations. For instance, while high-emission industries in France and the Slovak Republic emit slightly less than 70% of national GHG emissions, the same sectors emit slightly more than 90% in the Czech Republic, Denmark, Greece, Finland, Iceland and Norway (Figure 3.2). Despite their significant contribution to emissions, high-emission industries employ only about 7% of the total workforce on average among OECD countries, suggesting that emissions are highly concentrated (Figure 3.2). Importantly, this fact implies that any future reductions in emissions will be concentrated in a comparatively small segment of the labour market. This is particularly true in Ireland, the Netherlands and the United Kingdom, where the share of the workforce in high-emission sectors is just below 5%, but even in Poland, the country with the highest share, where 79% of emissions is concentrated in industries representing 12% of the workforce.

Figure 3.2. High-emission industries are responsible for most emissions but employ only a fraction of the workforce

Share of GHG emissions and employment in high-emission industries by country, 2019*

Note: * Data refer to 2016 and to CO_2 emissions for Mexico and the United States. Average across 26 OECD countries shown. Agriculture is excluded.
Source: OECD National Accounts and Eurostat Air Emissions Accounts.

StatLink https://stat.link/ejxuol

3.1.2. Employment in high-emission industries has been declining and the decline is expected to accelerate in the years to come

Reducing GHG emissions can be achieved by reducing economic activity in high-emission sectors as well as by changing the production technology within these sectors – see also OECD (2023[14]). Both processes require restructuring that may involve job losses and arising opportunities. Alongside previous declines in GHG emissions, employment in high-emission industries has indeed been shrinking substantially in EU countries during the period 2000-19, while employment in other sectors has continued to expand (see Figure 3.4) – in some cases also through green investment coupled with the explicit aim of creating quality jobs (see Box 3.2). This has shifted the composition of employment away from emission-intensive industries towards other sectors with low emissions (Borgonovi et al., 2023[1]). This trend is not solely attributable to the net-zero transition but also other structural factors, including the pivotal change from manufacturing-based to less carbon-intensive, service-oriented economies (Autor and Dorn, 2013[15]; Goldschmidt and Schmieder, 2017[16]; OECD, 2019[17]). The need and commitment for an accelerated reduction in GHG emissions also means that OECD labour markets will have to adjust further to additional declines in emissions in high-emission industries. While some of this may be achieved by within-industry and within-firm emission reduction efforts, the transition is still expected to lead to the reallocation of jobs towards greener and other less polluting activities. This increases the risk of job displacement, and may also aggravate its consequences by limiting opportunities for finding another job in affected sectors.

Box 3.2. Green subsidies and job creation

Green subsidies are used increasingly widely but little is known about their employment effects

The scale of green investments has increased notably in recent years, especially after the 2008 financial crisis, with initiatives like the *American Recovery and Reinvestment Act* allocating USD 90 billion towards clean energy in the United States, resulting in job creation, although primarily in skill-rich regions (Popp et al., 2020[18]). This trend accelerated following COVID-19 and the ensuing cost of living crisis, leading to substantial investments such as the USD 370 billion *Inflation Reduction Act* in the United States, focused on green energy infrastructure and job quality, and the European Union's *Green Deal Industrial Plan* aimed at supporting the net-zero transition by enhancing manufacturing capacities for green products and technologies while also focusing on upgrading the workforce's skills for the green economy (U. S. White House, 2023[19]; European Commission, 2023[20]). These efforts highlight a strategic shift towards sustainable recovery, energy transition, and the creation of high-quality jobs.

The use of green subsidies may not only promote the replacement of high-emission intensive technologies by greener ones, but they are also expected to create new opportunities for workers green-driven occupations (cf. Chapter 2), including those that have been displaced as a result of the transition. However, the available evidence on the labour market effects of green subsidies is limited and rather mixed. While some studies point to significant employment effects (e.g. Markandya et al. (2016[21])), other suggest they are modest (Pestel, 2019[22]) or that the public costs per job created is rather high (Álvarez et al., 2021[23]). There are also important questions about the quality of the jobs that are created. While most studies find that many green-driven occupations tend to be relatively well paid (Curtis and Marinescu, 2023[24]), Chapter 2 of this publication highlights important challenges in this regard.

New evidence on the effects of green subsidies on job creation from France

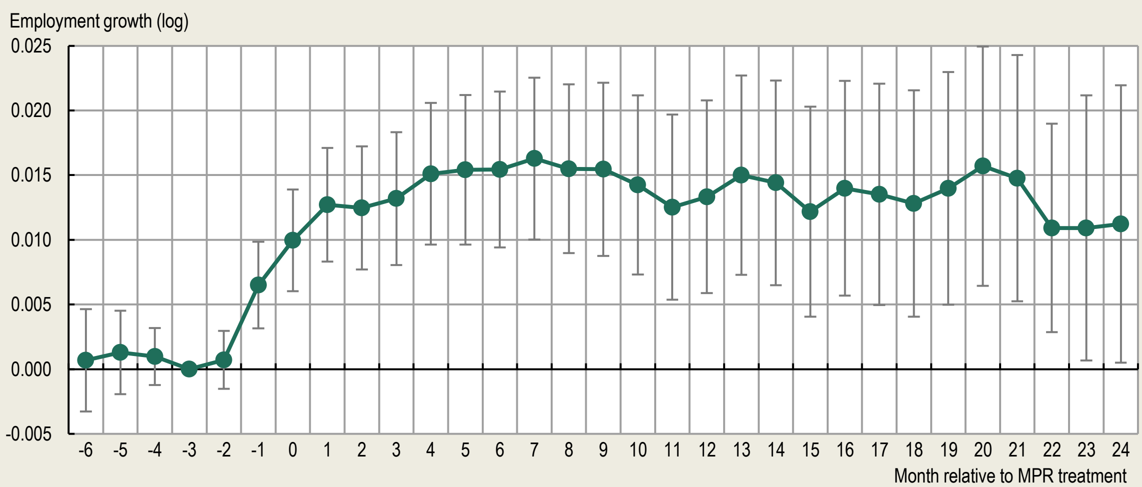
To provide evidence on the effect of green subsidies on job creation, this Box provides a preliminary evaluation of the French *MaPrimeRénov'* (MPR) programme. *MPR* was launched 1 January 2020 and provides subsidies for enhancing energy efficiency in housing up to a limit of EUR 20 000 for a single subsidy.[1] To receive the MPR subsidy the work must be conducted by a firm certified as a guarantor of the environment (*Reconnu Garant de l'Environnement*, RGE). In 2020 alone, there were more than 170 000 applicants.[2]

The effects of MPR are analysed empirically by comparing the monthly evolution of employment in firms who received subsidies with firms that never received a subsidy but have otherwise similar characteristics during the period 2020-22. To control for selection into the programme, recipient firms are matched to non-recipient firms in the same 2-digit industry, department, year and month (exact matching) and with similar characteristics in terms of recent employment developments, average firm wages, average municipality wages and average age in the firm (propensity score matching). The effects of MPR are analysed using an event-study design, which involves regressing log employment on a dummy for initial subsidy receipt interacted with months-since-treatment, controls for any subsequent subsidy received after first treatment as well as firm and year*month fixed effects. The results are presented in Figure 3.3. The results indicate that MPR led to an increase in employment of about 1.5% five months after the first subsidy. The effect slightly declines in subsequent months but some of the effect remains present during the period considered.

To provide an indication of the cost-effectiveness of the scheme in terms of euros per job created, it is possible to do a back-of-the-envelope calculation. This makes use of the estimated the percentage increase in employment due to the subsidy (1.5%), the average amount of the first subsidy (EUR 13 481) and the average pre-treatment level of firm employment (4.7 employees). This suggest that the cost job created was EUR 191 219. This is higher than the cost per job from Popp et al. (2020[18]) in the context of the *American Recovery and Reinvestment Act* for the United States, which pointed to a cost per job created of USD 66 700.

Figure 3.3. The impact of *MaPrimeRénov'* on employment growth

Event study estimates of the effect of *MaPrimeRénov'* on log employment by month, log points



Note: Estimates based on an event-study design which involves regressing log employment on a dummy for initial subsidy receipt interacted with months-since-treatment, controls for any subsequent subsidy received after first treatment as well as firm and year*month fixed effects. The dots represent point estimates which reflect the percentage increase in monthly employment due the initial receipt of a *MaPrimeRénov'* subsidy at the establishment level over the period 2021-23. The vertical markers reflect 95% confidence intervals based on standard errors clustered at the establishment level. The reference month for employment changes is -3 to avoid understating the magnitude of the treatment effect following Ashenfelter (1978[25]).
Source: OECD calculations based on administrative *MaPrimeRénov'* subsidy data linked to MMO data.

StatLink https://stat.link/arpiv5

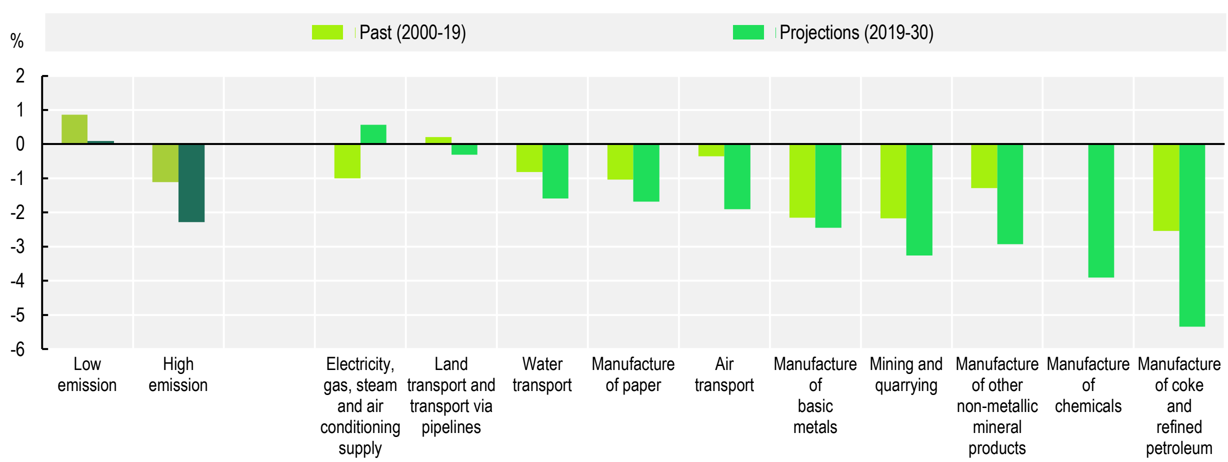
Note: This was box was prepared with contributions from Ian Whiton.
1. www.economie.gouv.fr/plan-de-relance/mesures/maprimerenov.
2. www.anah.fr/presse/detail/actualite/lancee-en-2020-maprimerenov-atteint-son-rythme-de-croisiere-avant-detre-ouverte-a-tous-en-janvier-2021/.

Projections based on the OECD ENV-Linkages Model show that most high-emission industries are expected to see noticeable declines in employment between 2019 and 2030 because of the implementation of climate-mitigation measures – e.g. the EU emission reduction targets (Fit-for-55) and similar packages implemented in the rest of the world (Borgonovi et al., 2023[1]).[5] Importantly, these declines are expected to markedly accelerate with respect to the past. In the EU, for example, the projected declines in the number of employed, which are expected to average 2.3% per year, are more than twice as large as the historical employment decline, which averaged 1.1% between 2000 and 2019 (Figure 3.4).

The projected pace of decline under EU Fit-for-55 also differs across high-emission industries. For example, employment in the manufacturing of chemicals as well as coke and refined petroleum is expected to decrease by 3.9% and 5.4% on average per year, respectively, while employment in manufacturing of basic metals and other non-metallic minerals as well as in mining and quarrying is expected to decrease by 2.5% and 3.3% on average per year. The manufacturing of paper as well as air and water transport see somewhat smaller average annual declines of just under 2% of employment, while land transport is projected to decline by on average 0.3% per year. Notably, the projections point to an increase in employment in electricity, gas, steam and air conditioning supply, which is a result of a strong increase in the use of greener sources of electricity generation in the energy mix of EU countries (which are bundled together with more GHG-intensive energy production in this industry) as evident from the more finely grained projections by Borgonovi et al. (2023[1]) or IEA (2023[26]). For example, employment in fossil-fuel powered electricity generation is projected to decline by about 80%, while employment in renewable and nuclear electricity generation is expected to substitute for it with an increase by 80%.

Figure 3.4. The speed of employment declines in high-emission sectors is projected to increase significantly

Past average annual employment changes between 2000 and 2019 and projected average annual employment changes between 2019 and 2030 under a 55% emission reduction for EU countries relative to 1990 levels (Fit for 55), average across countries, percentage



Note: The figure shows historical changes in employment between 2000 and 2019 as well as projected employment changes between 2019 and 2030, accounting for the Fit for 55 targets to reduce CO_2 – equivalent emissions by 55% in 2030 compared to 1990 levels. Agriculture is excluded. More information can be found in Borgonovi et al. (2023[1]).
Source: ENV-Linkages model.

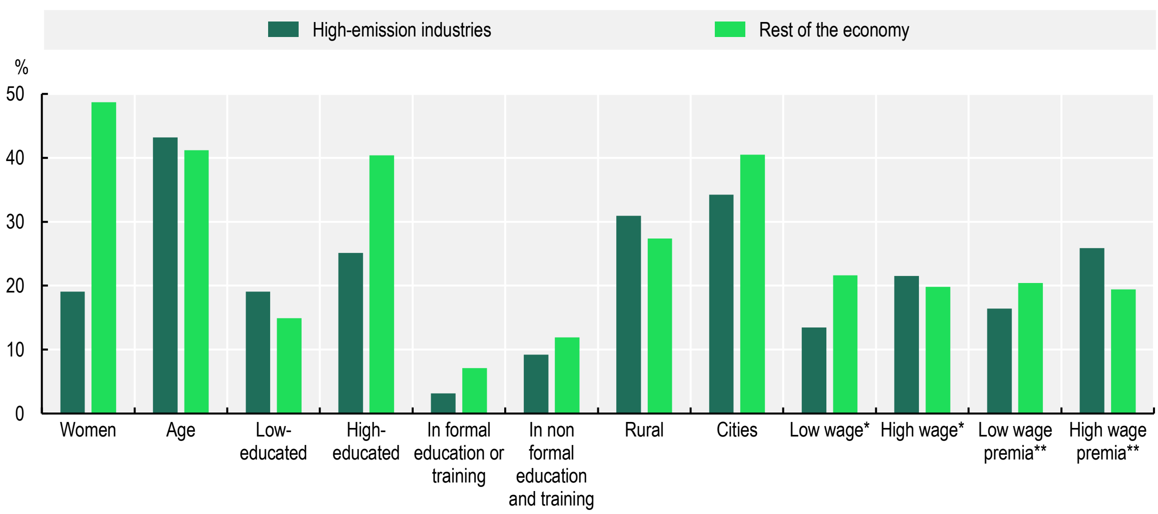
StatLink https://stat.link/iadv1g

3.1.3. Workers in high-emissions sectors are well paid despite comparatively low education, more likely to be male and live in rural areas

The characteristics of workers in high-emission industries differ notably from those of workers in low-emission industries (Figure 3.5, Panel A). For example, workers in high-emission industries are more likely to have low educational attainment (20% versus 15%) and less likely to have high educational attainment (25% versus 40%) than workers in low-emission industries. Furthermore, workers in high-emission industries also participate less frequently in formal and non-formal education and training programmes (Figure 3.5, Panel A). However, despite their relatively low educational attainment, they are less likely to earn low wages (i.e. a wage in the bottom two deciles of the wage distribution) and slightly more likely to earn high wages (i.e. a wage in the upper two deciles) than workers in other sectors. Indeed, higher wages in high-emission industries reflect higher firm wage premia, i.e. employers paying higher wages irrespective of workforce composition, rather than differences in skills among workers.[6] Workers in high-emission industries are further much more likely to be male, somewhat older and more likely to live in rural areas (Figure 3.5, Panel A). The combination of low skills, relatively high wages and living in rural areas, in particular, could have potentially important implications for the costs of job displacement.

Figure 3.5. Workers in high-emission industries differ markedly from other workers

Characteristics of workers in high-emission and low-emission sectors, EU-28 countries, 2018/19, percentage of each category



Note: Data refer to the share of each category, expressed in percentages, except for age (average number of years). Low education refers to less than upper secondary, high education to more than upper secondary, tertiary. Participation in formal and non-formal education and training refers to participation over the 4 weeks prior to survey response in the EU-LFS. Cities refer to densely populated areas, rural areas refer to thinly populated areas. Towns and suburbs (intermediate density areas) are not shown. * High (low) wages refer to the top (bottom) two deciles of the hourly pay from the main job. ** High (low) wage premia refer to the top (bottom) two deciles of the firm-related wage premia distribution obtained from a regression of hourly pay onto categorical firm identifiers, age groups, gender, and education levels, and exclude Finland, Iceland, Luxembourg and Slovenia. Agriculture is excluded.
Source: Eurostat, EU-LFS, 2019; Eurostat, Structure of Earnings Survey, 2018 (deciles).

StatLink https://stat.link/a710ng

3.2. Analysing the consequences of job loss in high-emission industries

This section provides an in-depth examination of the costs of job displacement in high-emission sectors based on harmonised linked employer-employee data from 14 OECD countries and a consistent econometric framework – see Barreto et al. (forthcoming[11]) for more details.

3.2.1. Methodology and data for analysing job displacement in high-emission industries

Determining the cost of job displacement for a given worker poses some methodological challenges. Ideally, one would like to compare the outcomes of the same worker in two states of the world, one in which the worker loses employment and another in which the worker continues to be employed. As this is evidently infeasible, the analysis in the chapter follows the literature by: i) focusing on mass layoffs to ensure focusing exclusively on workers who leave their jobs involuntarily; and ii) comparing the outcomes of displaced workers with those of observationally identical non-displaced workers from three years prior to displacement to six years after. The analysis is conducted separately for workers in high-emission industries and the rest of the private sector, as in Barreto, Grundke and Krill (2023[8]). As outcomes, it considers annual earnings, as well as its main components, including the probability of being employed, the number of days worked, daily wages and employer-specific wage policies as well as various mobility measures related to the probability of changing occupation, sector or region. For further details on the methodology, see Box 3.3 and Barreto et al. (forthcoming[11]).

In order to analyse the consequences of mass-layoffs for displaced workers, this chapter utilises linked employer-employee data for 14 OECD countries: Australia, Austria, Canada, Denmark, Estonia, Finland, France, Germany, Hungary, Portugal, the Netherlands, Norway, Spain and Sweden (see more information in Annex Table 3.B.1). The resulting dataset generally covers the years 2000 to 2019, and thus avoids potential confounding effects of the COVID-19 pandemic on labour markets. For some of the countries, the observation period begins later than 2000 or ends before 2019 – see Annex Table 3.B.1. The data are drawn from administrative records designed for tax or social security purposes or, in a few cases, mandatory employer surveys. As a result, these data are very comprehensive, often covering the universe of workers and firms in a country over several decades, and of high quality, given the financial implications of reporting errors for tax and social security systems.

Since tax and social security systems differ in their administrative requirements across countries, with potentially important implications for their comparability across countries, considerable effort has been made to harmonise the data (see Section 3 in Barreto et al. (forthcoming[11])). Individuals who are out of employment are recorded with zero earnings for such intervals, as is standard practice in the job displacement literature. The analysis is restricted to workers aged 18-50 in the private sector (but robustness checks are conducted to test the sensitivity of the results to focusing on workers aged 18-60).

Box 3.3. Estimating and decomposing the cost of job loss

This analysis follows the standard practice in the literature to estimate the cost of job loss separately for high-emission sectors and the rest of the economy (Barreto, Grundke and Krill, 2023[8]). It considers workers displaced from mass-layoff events, which are defined as events in which a firm reduces employment by at least 30%[1] To ensure that actual mass-layoffs are captured instead of mergers, acquisitions and outsourcing events of the firm, no more than 30% of displaced workers are allowed to be re-employed together in the same firm following the mass-layoff event.[2] The analysis is restricted to workers 18 to 50 years old to limit the influence of early retirement programmes (workers 18-60 are used in a robustness test). The analysis is further restricted to workers with at least two years of tenure in the year before displacement and in firms with at least 30 employees. Real yearly earnings are compiled from all sources, including income from multiple employers, overtime, bonuses, and severance payments, where available. Daily wages are calculated from the main employer for each respective year. Employers are identified at the establishment level or at the firm level if the former is not available.

The outcomes of workers who are displaced by a mass layoff (treated) are compared with those of non-displaced workers (control). As displaced and non-displaced workers may differ in their observable characteristics, each displaced worker is matched to an observationally similar non-displaced worker through a matching procedure (“statistical twinning”). First, treated units are matched with controls of the same gender in the same 1-digit industry and energy-related sector in the year prior to displacement. In addition, within the previously established cells, one-to-one nearest neighbour propensity score matching is applied. Propensity scores are estimated using a probit model that includes age, job tenure and firm size, as well as past wages. Using the estimated propensity scores, each displaced worker is assigned to its nearest non-displaced neighbour based on its propensity score. The matching procedure effectively balances the characteristics of displaced and non-displaced workers (Table 3 in Barreto et al. (forthcoming[11])). The underlying assumption for identification of causal effects is that, conditional on the observed covariates, displacement from a mass-layoff can be considered a random. This assumption would be violated if there is selection on unobservable characteristics (e.g. unobserved worker ability) that drives the probability of being treated by a mass layoff.

Based on the matched sample of treated and control workers, the outcomes of displaced and non-displaced workers are compared using the following event-study regression separately for workers in high-emission sectors and the rest of the private-sector:

$$y_{itc} = \alpha_i + \lambda_t + \sum_{k=-3}^{6} \gamma_k 1\{t = c + 1 + k\} + \sum_{k=-3}^{6} \theta_k 1\{t = c + 1 + k\} \times Displaced_i + X'_{it}\beta \ + r_{itc} \qquad (1)$$

where y_{itc} is the outcome of displaced worker *i* belonging to displacement cohort *c* or its matched non-displaced worker at time *t*. The coefficients of interest θ_k capture the change in outcome of displaced workers relative to that of non-displaced workers in the same sector, where *k* indexes event time such that *k=1* is the first post-displacement year and *k=0* the last year prior to displacement. The coefficients are normalised to *k*= *-2*, such that the effects are measured relative to that time period. The worker fixed effect α_i controls for time-invariant unobserved worker heterogeneity, λ_t is a calendar year fixed effect, γ_k a time since event fixed effect and X'_{it} contains a cubic of age. Finally, r_{itc} is the idiosyncratic error term. Standard errors are clustered at the worker level.

The outcomes considered are annual earnings relative to the pre-displacement average, the probability of being employed, the number of days worked, the log daily wage, the firm wage premium, and various mobility outcomes, such as the likelihood of changing the pre-displacement sector, occupation and region. Annual earnings are defined as the sum of labour payments (potentially, from different employers) in a given year divided by average pre-displacement annual earnings. The probability of being employed is a dummy equal to one if a worker has at least one day of dependent employment in a given year. In the event a worker is not observed in dependent employment in a given year, zero earnings are imputed, in line with the job displacement literature. This may overstate the actual costs of job loss to the extent that some displaced workers move to the public sector or become self-employed.[3] Days worked are defined as the total number of days in dependent employment in a given year conditional being employed at least one day irrespective of hours worked. Log daily wages are constructed as the natural logarithm of annual earnings divided by days worked at the main employer. Firm wage premia measure the average wage premia paid to all employees in a firm net of worker characteristics and is estimated using an AKM two-way fixed effects model (Abowd, Kramarz and Margolis, 1999[27]). Finally, the probability of changing sector, occupation or region is measured using a dummy which is equal to one if the observed value after displacement differs from its pre-displacement value and zero otherwise.

To provide an indication of the relative importance of the different components behind annual earnings losses, annual earnings y are decomposed into the components that can be attributed to the probability of being employed in the year p, the number of days worked in the year n, and the daily wage upon re-employment w (Schmieder, von Wachter and Heining, 2023[28]). Taking expectations over the samples of displaced and non-displaced workers, one can express the annual earnings of a displaced worker (D) relative to a non-displaced worker (ND) in each year relative to displacement as:

$$E[\Delta y] = E[p^{ND} n^{ND} w^{ND}] - \ E[p^D n^D w^D]$$

Rearranging terms gives:

$$E[\Delta y] = E[w^{ND}]E[n^{D}]\Delta E[p] + E[p^{ND}]E[w^{ND}]\Delta E[n] + E[p^{D}]E[n^{D}]\Delta E[w] + \mu$$

Where the first term gives the contribution of changes in the employment probability to changes in annual earnings relative to non-displaced workers, and the second and third term that of days worked and daily wages respectively. The contribution of the probability of being employed captures periods out of dependent employment lasting a full calendar year, in which annual earnings are imputed to be zero. The contribution of days worked captures periods of non-employment shorter than a full calendar year, which reflects a combination of non-employment and job instability. The contribution of daily wages captures changes in daily wages following displacement. To understand the sources of wage losses, the contribution of daily wages can be further decomposed into a worker- and a firm-related component (Lachowska, Mas and Woodbury, 2020[29]), by decomposing the treatment effect on wages $\Delta E[w]$ in the sum of changes in firm wage-premia $\Delta E[\Psi]$ plus changes in worker-related components $\Delta E[\rho]$ which capture the loss of human capital as well as match quality. The term μ is a residual which captures the change in the covariances between employment, days worked and daily wages that arises due to selection into employment. In practice, this component is very small and omitted for presentational purposes.

Note: A more detailed description of the methodology is available in Barreto et al. (forthcoming[11]).

1. A robustness check based on complete plant closures increases earnings losses across industries slightly but has no substantial impact on the differential effect between high- and low-emission industries.

2. Using a 20% threshold changes the patterns across countries and industries very little. It improves the identification of actual mass-layoffs. This increases estimated earnings losses, but with little impact on the differences between sectors and countries. However, a stricter threshold exacerbates small-sample issues with the number of displaced workers in the high-emission sector.

3. Nevertheless, using the British Household Panel Survey and studying the costs of job loss in the United Kingdom, Upward and Wright (2017[30]) find that reassigning earnings during periods of self-employment as zero makes very little difference to the estimated earnings losses. Bertheau et al. (2023[10]) also find that a similar exercise using Swedish data results in only minor differences.

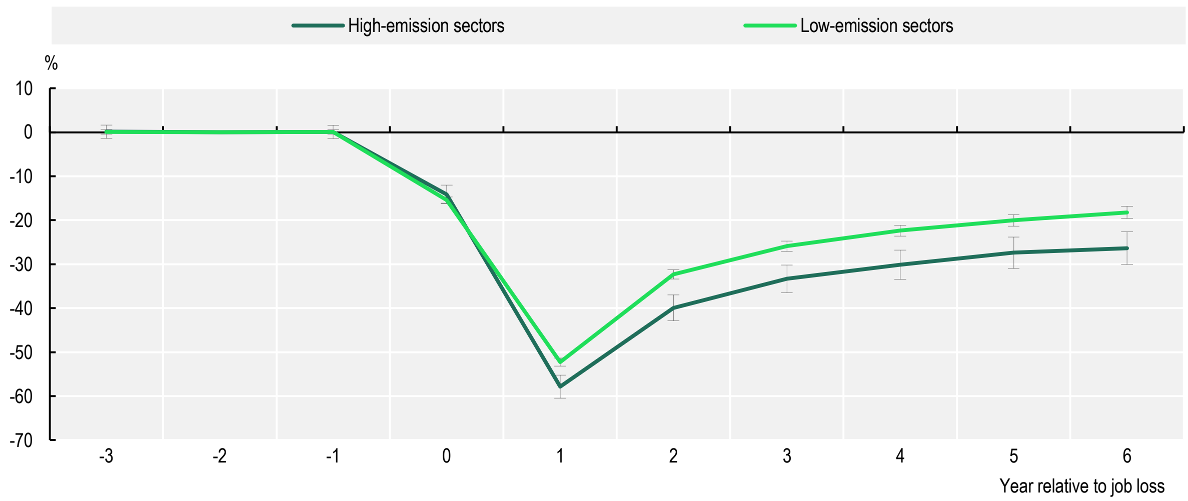
3.2.2. The consequences of job displacement in high- and low-emission industries on average across countries

Displaced workers in high-emission industries face larger and more persistent earnings losses than other displaced workers

Job displacement carries large costs for affected workers in all sectors, but workers displaced from high-emission industries face additional earnings losses exceeding those in low-emission industries. For instance, in the first year following a mass-layoff, workers displaced in low-emission industries see their earnings drop by 52% compared to non-displaced workers on average across countries. However, workers displaced from high-emission industries face a 6 percentage points additional drop to 58% compared to workers in low-emission industries (Figure 3.6). Even though the earnings of both groups of displaced workers gradually recover, the difference in earnings losses between them persists. After six years, the difference is 8 percentage points, with displaced workers in high-emission industries and low-emission industries workers having respectively 27% and 19% lower earnings relative to their non-displaced counterparts. On average during the six years since the year of displacement, the difference amounts to 7 percentage points, with earnings losses of 36% for workers displaced in high-emission industries and 29% for those in low-emission industries. Results echo previous findings by Haywood, Janser, & Koch (2023[31]), Andrews, Dwyer and Vass (2023[32]) and Rudd et al. (2022[33]) for displaced coal workers in respectively Germany, Australia and the United Kingdom, as well as Barreto, Grundke, & Krill (2023[8]) for displaced workers in carbon-intensive industries in Germany. However, for Canada, Chen and Morissette (2020[34]) find that, for a fraction of workers in the coal, gas and oil sector, displacement is not costly in the medium run.

Figure 3.6. Workers in high-emission industries face large and persistent job displacement costs

Difference in annual earnings between displaced workers and their matched counterparts relative to the time of displacement, average across countries, percentage



Note: The figure plots the average coefficients and the corresponding 90% confidence intervals across countries based on Equation (1). The coefficients capture the earnings losses of displaced workers relative to observationally comparable non-displaced workers. The point estimates show the impact of job loss on earnings in event time, where workers are displaced between time 0 and time 1, such that time 1 is the first post-displacement year. Related to this, earnings losses present a drop by construction at time 0, as earnings capture the sum of labour payments over the entire year and consequently already capture part of the displacement effect at time 0. The reference period for earnings losses is k=-2. Point estimates and confidence intervals from country-level regressions are averaged with equal weights. The countries included are Australia, Austria, Canada, Denmark, Estonia, Finland, Germany, Hungary, the Netherlands, Norway, Portugal, Spain, France, Sweden.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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The impact of job displacement in high-emission industries differs notably by sector as well, as laid out in detail in Barreto et al. (forthcoming[11]). For example, across countries, job displacement costs are most pronounced in industrial sectors that are intensive in energy demand, with earnings losses reaching 63% in the year of displacement relative to non-displaced workers. In transport sectors, earnings losses are comparable to or only moderately higher than in low-emission industries, while earnings losses for workers in energy supply industries vary considerably across countries.

Additional results that include older workers aged 50-60 at the time of displacement (Annex Figure 3.A.1) suggest that this slightly increases earnings losses in high-emission industries as older workers face somewhat larger earnings losses following displacement (see e.g. Athey et al. (2023[35])). On average over the 6 years following the year displacement, earnings losses in high-emission sectors increase by 1 percentage point to 37%, but the average difference with respect to low-emission sectors remains unchanged. This indicates that the estimated earnings losses presented in the baseline do not change much when including older workers. The baseline estimates moreover provide a better indication of the challenges that displaced workers face in transitioning to other jobs as they are less likely to be affected by early retirement.

Higher earnings losses in high-emission industries reflect a combination of fewer days worked, lower wages upon re-employment and longer spells out of work

Decomposing the earnings losses after job displacement into their contributions – namely (i) being out of work for an entire year, (ii) fewer days worked conditional on being employed at some point during the year and (iii) lower daily wages upon re-employment – can shed light on the underlying drivers that cause differences in job displacement costs for workers in high- and low-emission industries (see Box 3.3 for details on the methodology of decomposing earnings losses).[7] Differences in days worked in the first year after displacement are mainly related to the return to employment later in the year (i.e. after 1 January), whereas differences in subsequent years mainly reflect lower job stability upon re-employment.

On average over the six years following the year of job displacement, the lower likelihood of being in employment is the main factor behind earnings losses in both high- and low-emission industries (Figure 3.7 Panel A and Panel B). However, the 6-year average masks considerable variation in the importance of the earnings components over time. Initially, in the first year following displacement, differences in employment overwhelmingly drive earnings losses as reflected by differences in the probability of being employed and the number of days worked upon re-employment later in the year. By contrast, differences in re-employment wages play a marginal role. Over time, however, wages become more important for explaining earnings losses after displacement in high- and low-emission industries (both in relative and absolute terms). This increasing importance of wages may be explained by the earlier re-employment of workers with the highest skills and earnings potential as well as the gradual adjustment of job search toward lower paying jobs over prolonged unemployment duration – see e.g. Maibom et al. (2023[36]) and Hijzen, Upward and Wright (2010[37]). The days worked component falls strongly after the first year following job loss. From then on, differences in days worked mainly reflect differences in job instability upon re-employment while differences in the timing of job finding following displacement are negligible. Displaced workers may face higher job instability upon re-employment as they are more likely to be employed on temporary contracts and have lower job tenure.

Figure 3.7. Differences in earnings losses reflect larger wage losses, fewer days worked as well as longer spells out of work

Contribution of daily wages, days worked and employment to overall earnings losses after job loss in high- and low-emission industries in percentage (Panel A and B) and the difference in earnings losses between high- and low-emission industries in percentage points (Panel C), average across countries

Note: Average across countries of the contribution of daily wages, the probability of being employed, and days worked to the total earnings loss of displaced workers relative to observationally comparable non-displaced workers (see Box 3.3). The bars show the contribution of each margin to the overall earnings six years after job loss and on average over the six years following the year of job loss. The contributions of daily wages and days worked are conditional on being employed in a given year. The contribution of the probability of being employed captures the role of years in which no earnings from dependent employment are recorded in which case zero earnings are imputed. Point estimates from country-level regressions are averaged assigning each country an equal weight. The countries included are: Austria, Denmark, Finland, France, Germany, Hungary, the Netherlands, Portugal, Spain and Sweden. Due to missing daily wage and days worked information, Australia, Canada, Estonia and Norway are excluded.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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While employment is the main driver of earnings losses for displaced workers in high- and low-emission industries, its contribution stands out less strongly for explaining differences in earnings losses between high- and low-emission industries, particularly after the first year following job loss (Figure 3.7, Panel C). In the first year following displacement, differences in earnings losses between high- and low-emission industries mainly reflect a combination of a lower probability of employment and fewer days worked upon re-employment in the course of the year (see discussion above). In subsequent years, however, differences in earnings losses mainly reflect lower wages and days worked upon re-employment. In other words, after the first year following displacement, larger earnings losses in high-emission industries largely reflect lower job quality upon re-employment due to transitions to less well-paid and less stable jobs. Six years after displacement, the employment margin explains only about 31% of the difference in earnings losses, while differences in days worked (reflecting both the return to work during the year and job stability upon re-employment) account for 31% and differences in wages for 38%.

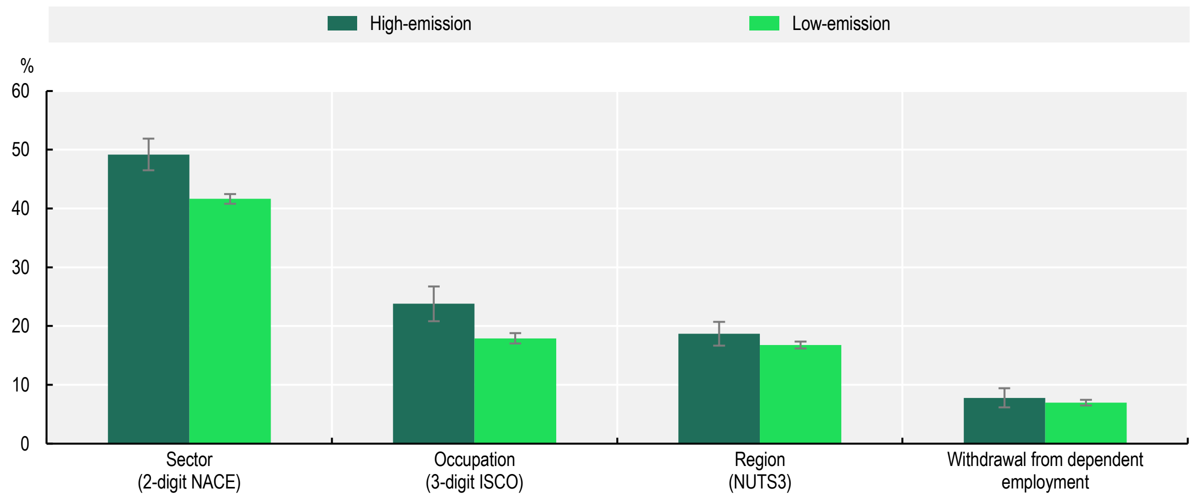
Displaced workers from high-emission industries are more likely to change industry and occupation

Workers displaced from high-emission industries are more likely to move to different sectors and occupations than displaced workers in other sectors (Figure 3.8). Six years after displacement, the probability of changing sector is around 49% for workers displaced from high-emission industries, about 8 percentage points higher than that for workers displaced from low-emission industries. Similarly, the probability of occupational switching after 6 years is 24% for displaced workers in high-emission industries, about 6 percentage points higher than in low-emission industries. Sectoral and occupational changes are likely to be costly due to the loss of industry- or occupation-specific human capital, contributing to the earnings losses of displaced workers (Huckfeldt, 2022[38]; Barreto, Grundke and Krill, 2023[8]; Kambourov and Manovskii, 2009[39]; Neal, 1995[40]; Gathmann and Schönberg, 2010[41]). Consequently, such changes reflect the difficulties that displaced workers in high-emission industries face in finding a job in the same industry and occupation.

Displaced workers in high-emission industries are slightly more likely to move to a different region, but this difference is not statistically significant (Figure 3.8). The probability of switching regions is 19% for workers displaced from high-emission industries, about 2 percentage points higher than in low-emission sectors. Albeit small, these differences could reflect the need for high-emission workers to find re-employment in local labour markets with better availability of jobs. Indeed, the high regional concentration of high-emission activities suggests that job displacement in these industries will necessitate additional geographic mobility as these sectors decline – see e.g. Lim, Aklin and Frank (2023[42]), OECD (2023[43]) and Chapter 2. Importantly for high-emission industries, the positive effect of regional mobility on earnings is most pronounced for workers who move from rural regions to urban ones (Huttunen, Møen and Salvanes, 2018[44]).

Figure 3.8. Workers displaced from high-emission industries change sector and occupation more often

Transition probability six years after job displacement, average across countries, percentage



Note: Bars show the probability of working in a different occupation, region, or sector than that recorded in the year before displacement (relative to matched non-displaced workers) and the vertical markers reflect the corresponding 90% confidence intervals. For withdrawals from dependent employment, the bar corresponds to the probability of permanent exits, i.e. a worker that is employed at time t but non-employed in all subsequent periods. As we exclude self-employment in all countries, it is possible that this partly captures transitions into self-employment. All differences between sectors are statistically significant at the 10% level. For sectoral changes and withdrawals from dependent employment, all 14 countries are considered. For occupational changes, the figure includes Germany, Denmark, Finland, Hungary, Norway and Sweden. For regional changes, the figure includes Australia, Austria, Germany, Denmark, Finland, Hungary, the Netherlands, Norway, and Sweden.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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Workers in high-emission industries are slightly more likely to withdraw from dependent employment following displacement, but again these differences are not statistically significant. Such exits from dependent employment may reflect transitions into self-employment or exits from the labour force, including early retirement (Figure 3.8). After six years, their likelihood of withdrawing from dependent employment is 8%, compared to 7% for low-emission industries. As the sample of displaced workers focuses on prime-aged workers (until the age of 50), this effect may reflect a higher likelihood of entering self-employment–- a status generally not covered in the administrative records–- or disability (Schaller and Stevens, 2015[3]) rather than early retirement. For displaced workers above the age of 50, the probability of withdrawing from dependent employment is larger for workers displaced in high- and low-emission industries, while the difference between the two also marginally increases (results not shown here). Withdrawal from the labour market for older workers is more likely to reflect early retirement (Chan and Huff Stevens, 2001[45]).

3.2.3. Cross-country differences in the consequences of job displacement in high-emission industries

With a focus on the average across countries included in the analysis, this chapter has so far shown that the costs of job displacement in high-emission industries are substantial and noticeably higher than those for workers displaced in low-emission industries. However, there may be important variation across countries in the level of job displacement costs for workers displaced in high-emission industries as well as in the difference in job displacement cost for workers in low-emission industries. The following sub-section therefore leverages the cross-country nature of the data to explore variation in job displacement costs within and between countries.

Workers displaced from high-emission sectors face particularly large earnings losses in all countries

Qualitatively, the within-country differences in job displacement costs between displaced workers in high- and low-emission industries are similar: in all countries considered in the analysis, displaced workers in high-emission industries face larger earnings losses on average over the first six years since displacement than displaced workers in other industries (Figure 3.9). This suggests that elevated displacement costs in high-emission industries are likely to be a common factor in OECD labour markets, and likely extend beyond the countries included in this analysis. However, there is wide variation in the quantitative differences in earnings losses between high- and low-emission industries across countries. The difference in average earnings losses between workers displaced in high- and low-emission industries is lowest in Australia, Canada, Germany, the Netherlands, Portugal and Sweden (below 5 percentage points), and highest France and Spain where it is more than 12 percentage points Differences in earnings losses to some extent reflect differences in the sectoral composition of high-emission industries. In countries, such as Australia and the Netherlands, displacement is concentrated in transport where earnings losses tend to be similar to those in low-emission industries, whereas in countries such as Hungary, displacement is concentrated in heavy manufacturing where earnings losses tend to be largest (see Barreto et al. (forthcoming[11])). However, even within detailed industries, there may be important differences in the challenges that displaced workers face across countries. In France, large differences in earnings losses are mainly driven by differences in days worked and re-employment wages, while in Austria and Spain differences in all three components are sizeable. The Netherlands stand out as differences in employment probabilities substantially reduce the difference in earnings losses between displaced workers in high- and low-emission industries.

Figure 3.9. The costs of job displacement in high-emission industries are consistently larger than those in low-emission industries

Decomposition of the average difference in earnings losses over six years since displacement between high- and low-emission industries into the contributions associated with wages, employment and days workers by country, percentage

Note: The bars show the average difference in the job loss effect on earnings between high- and low-emission industries over a period of six years after displacement. Countries are sorted based on the difference in earnings losses between high- and low-emission sectors. Due to missing information on daily wages and days worked, the bars for Australia, Canada, Estonia and Norway are not decomposed into the different components.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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Differences in wage losses tend to be firm-related rather than worker-related

Wage losses upon re-employment may be either worker-related or firm-related. Worker-related wage losses stem from the loss of firm-specific skills and a decline in the quality of the match, whereas firm-related wage losses reflect a decline in the generosity of a firm's wage policies (Lachowska, Mas and Woodbury, 2020[29]). Decomposing the contribution of wage losses to earnings losses into a worker- and a firm-related component suggests that firm-related wage losses account for most of the difference in wage losses between high- and low-emission industries, echoing the results of Barreto, Grundke and Krill (2023[8]). On average across countries, differences in average wage losses between high- and low-emission industries are entirely firm-related (Figure 3.10). Indeed, in several countries worker-related losses to be smaller in high-emission industries. This is the case in France, Hungary, the Netherlands and Sweden. One possible explanation for this may be that workers in high-emission industries have lower skills and hence are less at risk of losing (firm-specific) human capital following job loss. Overall, these results suggest that displaced workers from high-emission industries undergo larger earnings losses in part because they were displaced from higher paying firms. This may mean that these workers move to less productive firms, firms where workers capture lower rents, or lose compensating wage differentials for physically demanding working conditions (Card et al., 2018[46]; Sorkin, 2018[47]; Hirsch and Mueller, 2020[48]). Evidence for Portugal (not shown) suggests that displaced workers in high-emission industries move to less productive firms, while evidence from France by Brandily, Hémet and Malgouyres (2022[49]) shows that displaced workers may re-allocate to higher productivity firms that pay lower wages because of a loss in bargaining power.[8] This loss in bargaining power is in line with the finding in Chapter 2 that workers employed in occupations concentrated in high-emission sectors are more likely to be covered by a collective bargaining agreement than other workers.

Figure 3.10. Higher wage losses in high-emission sectors tend to be firm-related rather than worker-related

Contribution of wage losses to the difference in overall earnings losses between displaced workers from high- and low-emission sectors, decomposed into differences in firm- and worker-related losses, average over six years following displacement, percentage points

Note: Bars represent the contribution of wage losses to the overall difference in earnings losses between displaced workers from high-emission and low-emission industries on average over the six years after displacement (see Box 3.3). The bars are decomposed into the contribution of a firm-related component (e.g. firm wage policies) and a worker-related component (i.e. human capital, match quality) following Lachowska et al. (2020[29]). Countries are sorted based on the difference in wage losses between high- and low-emission sectors. The figure excludes Australia, Canada, Estonia and Norway due to missing information on daily wages.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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After focusing on the within-country variation in job displacement costs, the remainder of this sub-section considers how differences in the costs of job displacement for workers in high-emission industries vary between countries in levels.

There are large differences in the cost of job displacement in high-emission industries between countries

There are large differences in the cost of job displacement between countries (Bertheau et al., 2023[10]). With less than 30%, average annual earnings losses of displaced workers in high-emission industries are particularly low in Australia, Canada, Germany, the Netherlands, Norway and Sweden, but are especially high in Portugal, where they exceed 60% (Figure 3.11). These differences reflect to an important extent differences in the opportunities of displaced workers to find another job as well as the number of days worked once a job is found. In Portugal, the country with the highest earnings losses, more than 43 percentage points of the earnings losses following displacement in high-emission sectors can be explained by being out of employment for an entire year, with a further 24 percentage points attributable to fewer days worked and about 5 percentage points to lower re-employment wages. In contrast, in Sweden, the country with the third lowest earnings losses, employment and days worked respectively explain 14 percentage points and 9 percentage points. By contrast, the contribution of wage losses upon re-employment varies much less between countries, typically between 6 percentage points and 11 percentage point at most. The main exceptions are Sweden and the Netherlands where wage losses upon re-employment are much less important than in the other countries considered. Note that the differences between countries in the cost of job displacement and the importance of joblessness are similar in both high- and low-emission sectors, which suggests that factors related to the incidence of joblessness affect both sectors in a similar way.[9]

Figure 3.11. Country-differences in the costs of job displacement in high-emission industries mainly reflect differences in the incidence of joblessness

Decomposition of the average earnings losses over six years since displacement in high-emission industries into the contributions associated with wages, employment and days workers by country, percentage

Note: Bars refer to the average effect of job loss on earnings over six years following displacement for workers in high-emission sectors. Countries are sorted based on the level of earnings losses for high-emission sectors. Due to missing information on daily wages and days worked, the bars for Australia, Canada, Estonia and Norway are not decomposed into components.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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3.2.4. A tentative exploration of the mechanisms behind cross-country patterns in the consequences of job displacement

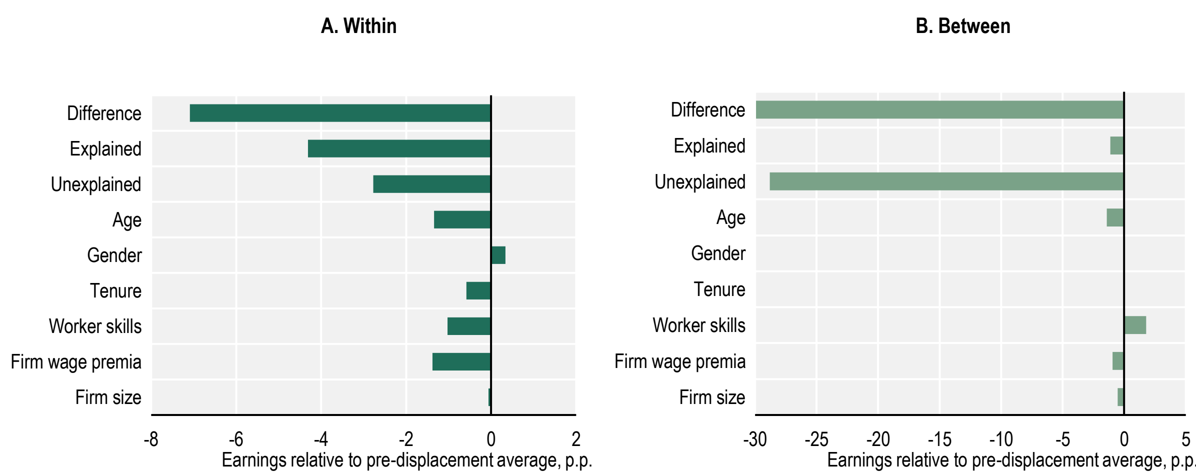
This sub-section provides a tentative exploration of the different mechanisms that may drive the country patterns described above by focusing on the composition of the workforce, the economic structure of countries and the nature of policies and institutions.

The composition of workers and firms explains most of the differences in the costs of job displacement between high- and low-emission industries, but hardly any of the differences across countries

While job displacement effects are estimated by comparing observationally similar displaced and non-displaced workers before and after mass-layoff events, displaced workers from high-emission sectors and the rest of the private sector can still differ in important ways (see e.g. Figure 3.5). This raises the question to what extent differences in the composition of firms and workers between displaced workers in high- and low-emission industries can account for differences in the costs of job displacement between high- and low-emission industries. By the same token, one may also ask to what extent differences in the composition of firms and workers explain differences in the costs of job displacement in high-emission industries between countries. To evaluate how much such composition effects contribute to within- and between-country differences in job displacement costs, Figure 3.12 presents an Oaxaca-Blinder decomposition accounting for individual and firm characteristics (see Box 3.4 for details).

Figure 3.12. Composition is important for within-country differences, but explains little between-country differences in job displacement costs

Oaxaca-Blinder decompositions of earnings gap after six years, between high- and low-emission industries within countries (left panel) and between high-emission industries between countries (right panel)



Note: The left panel refers to within-country differences in job displacement costs between workers in high- and low-emission industries and decomposes the difference in mean earnings losses within a country between sectors net of year effects. The reference group is displaced workers in low-emission industries. The right panel refers to between-country differences in job displacement costs for workers in high-emission industries and decomposes the difference in mean earnings losses for workers in high-emission sectors between countries. For the right panel, the reference country is Norway as it is the country with the lowest earnings losses. Worker skills are measured by the worker-related wage component, whereas firm wage premia are measured by the firm-related wage component. Both are estimated using two-way fixed effects wage models (Abowd, Kramarz and Margolis, 1999[27]). The decomposition excludes Australia and Spain as it is not possible to estimate two-way fixed effects for firms and workers due to data limitations.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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The composition of workers and firms is a key determinant for the differences in the costs of job displacement between high- and low-emission industries. About two-thirds of the differences in earnings losses between workers in high- and low-emission industries can be attributed to differences in the composition of workers and firms (Figure 3.12, Panel A). Displaced workers in high-emission industries tend to be older, have longer tenure and lower levels of portable skills (as measured by the worker-related component of wages). These are all factors that are associated with larger earnings losses.[10] Moreover, workers in high-emission industries tend to be disproportionately displaced from firms with high wage premia, i.e. firms that pay relatively high wages after taking account of worker skills, which are lost at re-employment (see above). Finally, displaced workers in high-emission industries are more likely to be employed in routine-manual occupations which further increases earnings losses (see Box 3.4).

By contrast, differences in the composition of firms and workers explain barely any of the between-country differences in the costs of job displacement in high-emission industries (Figure 3.12, Panel B). Instead, between-country differences in the cost of displacement in high-emission industries are likely to reflect structural differences related to the functioning of the labour market more broadly, as reflected in differences in the incidence of joblessness (Bertheau et al., 2023[10]).[11]

Box 3.4. The role of composition in the cost of job displacement in high-emission industries

While the analysis of job displacement is based on comparing the outcomes of displaced workers with those who are not displaced but have similar characteristics in the same sector (i.e. high-emission, low-emission), the characteristics of displaced workers in high-emission sectors may still differ from those in low-emission sectors or from those of displaced workers in high-emission sectors in other countries. Consequently, differences in the cost of job displacement between industries or countries may reflect differences in the composition of displaced workers or differences in the cost of job displacement for similar displaced workers. Oaxaca-Blinder decompositions can be used to shed light on the role of composition in explaining differences in the cost of job displacement between industries and countries. The remainder of this box first discusses the methodology and presents some additional results on the role of occupations.

Methodology

Start by denoting the *individual-level* difference-in-differences estimate (Δy_i) as:

$$\Delta y_i = \left(\bar{y}^{D}_{i,\,after} - \bar{y}^{D}_{i,\,before}\right) - \left(\bar{y}^{ND}_{i,\,after} - \bar{y}^{ND}_{i,before}\right) \quad (2)$$

where $\bar{y}^{h}_{i,\,after}$ indicates the average outcome for $h \,\epsilon\, \{Displaced, Non-displaced\}$ after job displacement (1 to 6 years) and $\bar{y}^{h}_{i,\,before}$ the corresponding average outcome before job displacement (-3 to -1 years). The individual-level difference-indifferences estimate Δy_i in turn can be written as a linear model of the observable characteristics of displaced (and non-displaced) workers in high- and low-emission industries:

$$\Delta y^{s}_{i} = X^{s}_{i}\beta^{s} + \vartheta^{s}_{i} \quad (3)$$

where $X^{s}_{i}, s\,\epsilon\,\{High, Low\}$ is a vector of worker and firm characteristics measured before displacement (i.e. in the baseline period at t=0 and ϑ^{s}_{i} is an error term.

Using equations (1) and (2), the Oaxaca-Blinder decomposition of the difference in the difference-in-differences estimate between high- and low-emission industries can be written as:

$$\Delta\bar{y}^{High}_{i} - \Delta\bar{y}^{Low}_{i} = \left(\bar{X}^{High}_{i} - \bar{X}^{Low}_{i}\right)\beta^{Low} + \bar{X}^{High}_{i}\left(\beta^{High} - \beta^{Low}\right) \quad (4)$$

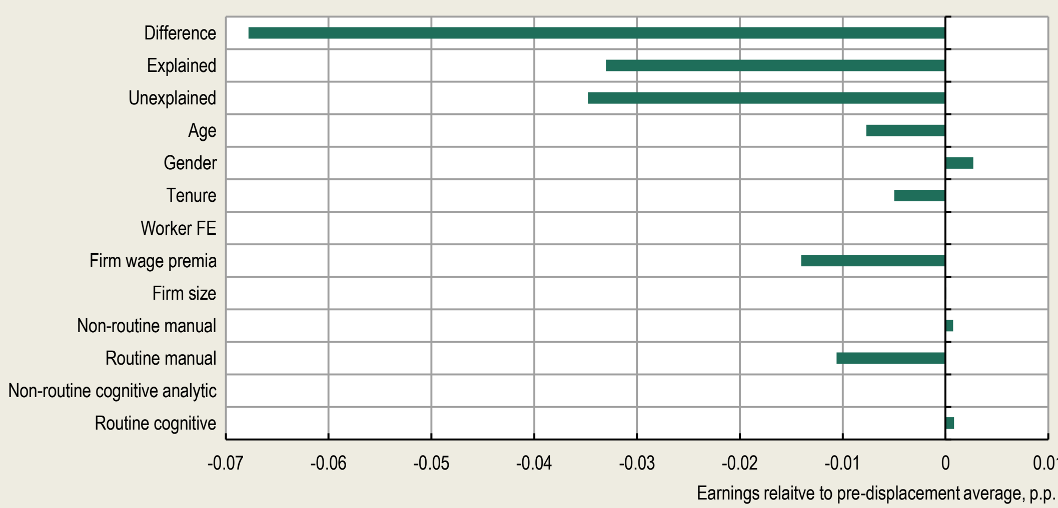
where the first component on the right-hand side captures the role of composition effect, i.e. the part that is explained by differences in observable characteristics between displaced workers in high- and low-emission industries, and the second component captures the structural effect, i.e. unexplained differences in the cost of job displacement between high- and low-emission industries holding composition constant. A similar decomposition can be used to shed light on the drivers of differences in the cost of job displacement in high-emission industries between countries. The results of the decomposition between industries within countries and within industries between countries are presented in Figure 3.12.

The role of occupational composition

While the baseline analysis for all countries focuses on the role of firm and worker composition in explaining differences in the cost of job displacement between industries and countries, for a subset of countries with information 3-digit occupations (ISCO), it is possible to go further by analysing the role of differences in the composition of occupations. Occupations are categorised into five groups based on their task content following Autor, Levy and Murnane (2003[50]): non-routine manual, routine-manual, non-routine cognitive analytic, routine-cognitive and non-routine interactive. The analysis reveals that occupational composition plays an important role in explaining differences in the earnings losses of displacement between high- and low-emission industries, on average across countries analysed (Figure 3.13). More specifically, the concentration of routine-manual occupations accounts for 32% of the difference in earnings losses between high- and low-emission industries. This suggests that displaced workers in emission-intensive occupations may have difficulty finding another job because opportunities in the same occupation are limited and they lack the skills to move to other occupations with higher skill requirements.

Figure 3.13. The concentration of manual routine occupations in high-emission industries contributes to higher earnings losses from job displacement

Oaxaca-Blinder Decomposition, difference in earnings losses between high- and low-emission sectors including occupational measures



Note: Average across Germany, Finland, Portugal, Hungary and Sweden. Each bar represents the contribution of a given occupational measure to the overall difference in earnings losses between high- and low-emission sectors based on an Oaxaca-Blinder decomposition. The reference category is non-routine interactive.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

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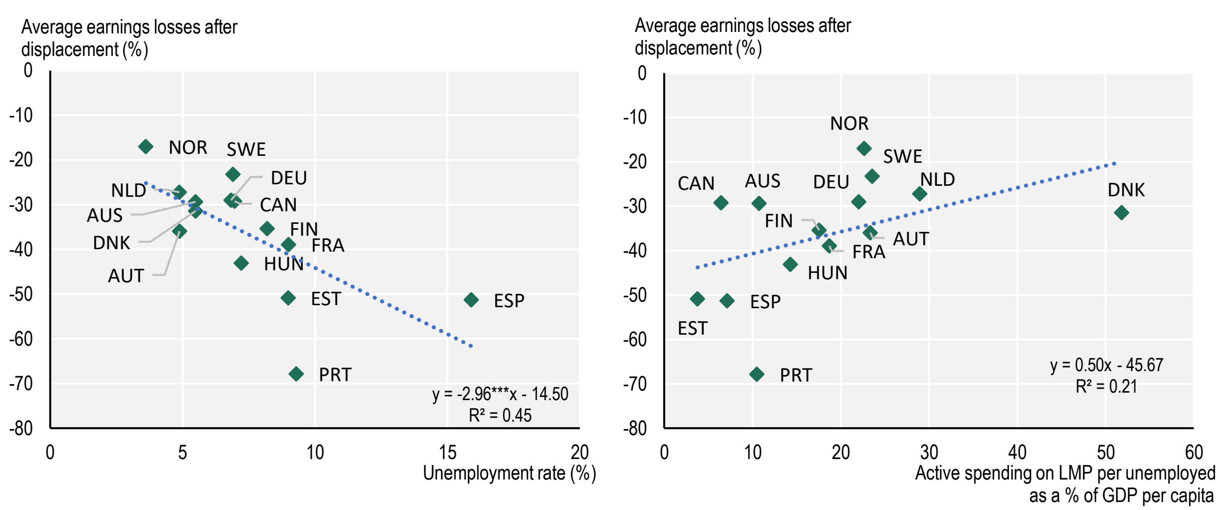
Policies and institutions play a key role in explaining differences in the cost of job displacement across countries

Differences in how well labour markets are functioning and the degree to which job transitions are facilitated may partially explain why the incidence of joblessness is an important correlate of differences in the costs of job displacement across countries. A well-functioning labour market is a labour market that provides opportunities for work to all (OECD, 2018[51]). A useful simple measure of this is the average unemployment rate. Indeed, countries with lower average unemployment rates have noticeably lower average job displacement costs for workers in high-emission industries (Figure 3.14, Panel A). For example, Australia, Canada, Denmark, Germany, the Netherlands, Norway and Sweden, are all countries where unemployment rates were relatively low over the period considered and have the lowest costs of job displacement among all countries considered. Similarly, Portugal and Spain, countries where unemployment tended to be relatively high, exhibit the highest costs of job displacement. At the same time, labour market policies may also be an important determinant of the costs of job displacement. For instance, countries with high expenditure on active labour market policies (ALMPs), such as spending on job search assistance and training initiatives, are also those with comparatively low job displacement costs (Figure 3.14, Panel B). For example, Denmark, Germany the Netherlands, Norway and Sweden spend an equivalent of around 20% or more of their annual GDP per capita per unemployed person, while displaced workers incur earnings losses of around 30% or less. In other countries, such as Estonia, which spends only slightly more than 5% of their annual GDP per capita per unemployed person, earnings losses are more than 50%.[12] However, in contrast to the unemployment rate, these patterns across countries are only suggestive as they are not statistically significant.[13]

Figure 3.14. Well-functioning labour markets and ALMPs may reduce job displacement costs

Average unemployment rate, public spending on ALMPs and average earnings losses after displacement in high-emission industries



Note: The figure displays the correlation of the unemployment rate and ALMP spending with earnings losses after job displacement in high-emission industries, which does not necessarily mean that there is a causal link.***, **, * indicate significance at the 1%, 5% and 10% level respectively. ALMP: Active labour market programmes; LMP: Labour market programmes.
Source: OECD Employment Database; OECD Social Expenditure Database; National linked employer employee data, see Annex Table 3.B.1 for details.

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3.3. Supporting displaced workers in high-emission industries

Building on the results of the previous sections as well as on findings from the broader literature and the OECD policy questionnaire on labour and social policies for the net-zero transition, this section discusses how labour market policies can best support displaced workers during the net-zero transition. While long-term planning and preparation for labour market adjustments in the net-zero transition may reduce the risk of job displacement in high-emission industries, some degree of job loss may be inevitable. The findings in this chapter suggest that the costs of job displacement are typically lower in countries with well-functioning labour markets where policies and institutions support effective job transitions. As such, the development and implementation of adequate labour market policies are essential, not only to support displaced workers in general, but also to maintain public support for the net-zero transition – see e.g. Dechezleprêtre et al. (2023[5]) and Dabla-Norris et al. (2023[6]). Beyond specific labour market policies, regional and place-based policies may be an important factor as well – see Box 3.5 as well as OECD (2023[14]; 2023[43]) and Causa et al. (2024[52]).

Box 3.5. Regional transition initiatives for declining industries

Transitions and diversification in the Australian automotive industry

Since the early 2000s, the Australian automotive industry suffered substantial challenges, mainly resulting from high production costs and challenges to compete on the global market. Even though the Australian Government established the *Automotive Transformation Scheme* in 2011, providing AUD 1 billion to encourage competitive investment and innovation in the sector, between 2013 and 2014 all remaining Australian car manufacturers declared to cease operations by 2017. Initial projections expected a loss of 27 500 jobs, many of which would be lost in the industry's supply chain. These developments posed challenges for regions in which the automotive industry was strongly embedded, such as in Northern Adelaide (South Australia) and greater Melbourne and Geelong (Victoria).

To create new jobs and stimulate economic growth in these regions, the Australian Government established the *Growth Fund* in 2014, including various sub-programmes designed to support high-value manufacturing, encourage investment in new business opportunities, and assist supply chain companies to diversify, therefore providing strong incentives to transition production and employment to new sectors. Workers received funding of up to AUD 1 300 for training and job search assistance. The state governments of Victoria and South Australia, as well as the car manufacturers themselves, provided additional transition and diversification supports for workers.

Following these initiatives, the actual number of redundancies was significantly lower than that initially projected, with approximately 14 000 workers being made redundant. Much of this was achieved through a diversification of supply chain companies. These developments are partially attributable to the *Growth Fund* and the substantial lead time to the closure of the Australian car manufacturing industry (Department of Employment and Workplace Relations, 2019[53]). Despite these initiatives, regional unemployment rates rose well beyond the national average, for example in Northern Adelaide. This may suggest that even comprehensive place-based policy initiatives may not be able to fully avert the economic scarring of a decline of strongly embedded regional industries (Beer, 2018[54]).

Structural transformation and the end of the German coal industry

Due to high production costs and limited economic feasibility, Germany began a phasing-out of subsidies for hard coal mining in 2007, marking the end of the sector by 2018. To accommodate this process, the *German Hard Coal Mining Act* offered financial aid to facilitate structural change in the affected states of North-Rhine-Westphalia (particularly the Ruhr area and Ibbenbüren) and Saarland, including re-training of workers and adjustment benefits in the transition to early retirement. In parallel, Germany also focuses on the phase-out of lignite coal mining by 2038, which is predominately concentrated in Eastern Germany (Lusatia) as well as North-Rhine-Westphalia (the Rhineland).[1]

Under broad public consensus, the *Commission on Growth, Structural Change and Employment*, established in 2018, developed a comprehensive strategy to ensure economic sustainability and opportunities for regions affected by the lignite exit. Expecting significant employment losses, various programmes were put in place to facilitate the transition of lignite workers to other industries, alongside research funding as well as wider support for economic restructuring and environmental rehabilitation in the affected regions. Younger workers and those with transferable skills were offered re-training and job placement services, while older workers were offered adjustment benefits in the transition to early retirement. The cost of these programmes was about EUR 40 billion, while an additional maximum of EUR 5 billion was allocated for early retirement (OECD, 2020[55]; Südekum, 2022[56]).

1. The current German Government is considering an earlier phase-out of lignite mining by 2030.

3.3.1. Unemployment compensation

Job displacement results in unemployment and the temporary loss of labour earnings until new employment is found (at which point partial earnings losses typically persist). In most OECD countries workers are predominantly insured against income shocks through public or contributory income support schemes, such as unemployment insurance and social assistance. However, severance pay and early retirement schemes also play an important role in some countries, particularly for older workers (Figure 3.15). For example, over the first year of unemployment, 40-year-old displaced workers previously earning two-thirds of the national average wage at job tenure of 4 years receive about 6.4 months of previous gross earnings as unemployment compensation including severance pay, on average across the OECD, whereas workers aged 60 with 20 years of tenure receive as much as 9.5 months of previous pay.

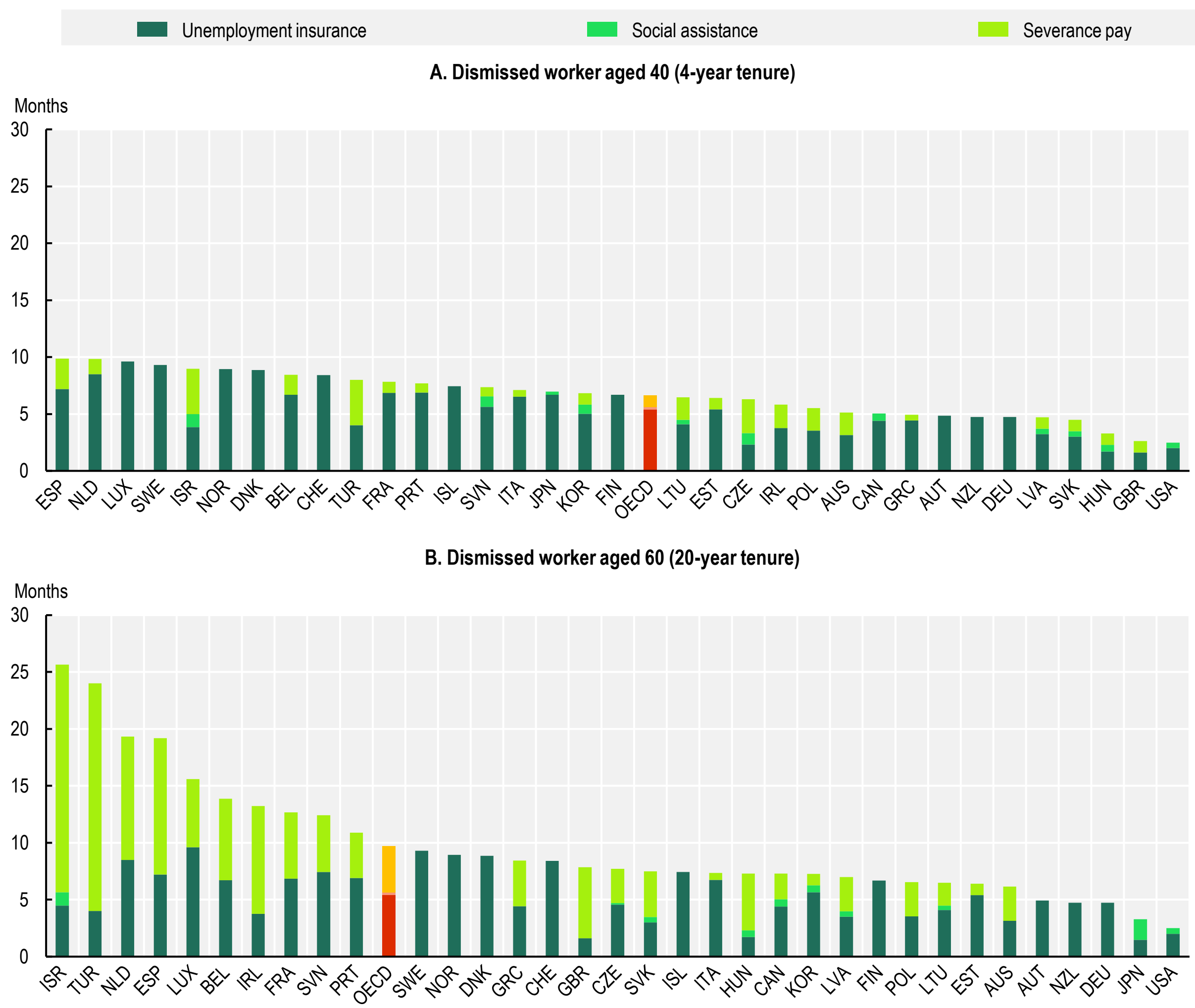
Unemployment insurance and social assistance

Arguably the most important tool to support displaced workers' incomes is unemployment insurance (UI). By providing crucial income support during periods out of work, conditional on active job search, UI facilitates good job transitions by allowing recipients to take the necessary time to find a job that aligns well with their skills and aspirations, rather than hastily accepting a poor job match. This does not only limit wage losses upon re-employment, but also supports the structural transformation by helping to secure a more stable match between workers' skills and job requirements (Nekoei and Weber, 2017[57]; OECD, 2023[58]). However, the UI benefit system needs to be carefully designed to avoid weakening incentives to job search and prolong unemployment spells – which in turn increases the risk of skill depreciation and reduced re-employment wages (Schmieder, von Wachter and Bender, 2016[59]) – while providing the necessary income security (OECD, 2023[58]; Marinescu and Skandalis, 2020[60]).

Across the OECD, the value of income support through UI varies strongly, driven by differences in income replacement levels and the duration of entitlements. For example, when considering only the first year of unemployment – a period after which many displaced workers have already found re-employment – income support through UI averages about 5.4 months' worth of previous gross annual earnings, with some countries providing somewhat different support by age (e.g. Czechia, Japan and Slovenia) (Figure 3.15) (OECD, 2023[58]). Moreover, in many OECD countries, UI provides additional support beyond one year. Unemployment insurance is typically part of a wider social safety net that can support displaced workers, though these make up a much smaller part of income support following job displacement (Figure 3.15). For example, after the expiry of UI entitlement, or at low levels of previous earnings, social assistance can provide additional support – averaging about 0.2 months' worth of gross pay. This is particularly important in countries where the maximum duration of UI is relatively short.

Figure 3.15. Income support over the first year of unemployment differs widely across countries

Value of gross income-supports in number of months of previous gross earnings over the1st year of unemployment,* 2022



Note: *The data only concern income support paid over the first year of unemployment and therefore do not consider potential support provided beyond the one-year mark. Data refer to 2022 and a single and childless worker earnings 67% of the national average wage with full eligibility to unemployment insurance. Age (for the 40-year-old worker) and earnings level are roughly matched to the cross-sample average of the countries included the displacement analysis of this chapter. Previous earnings, out-of-work benefits and severance pay are all expressed in gross terms. Severance pay refers to legislation in place as of 2019 and assumes dismissal for economic reasons/redundancy and, whenever regulations differ, a blue-collar worker. More information on severance pay regulation can be found in the methodology document to the OECD Indicators of Employment Protection (see www.oecd.org/els/emp/OECD2019-EPL.pdf). More information on the coverage of unemployment insurance and social assistance schemes, including the different treatment of unemployment insurance and unemployment assistance systems, can be found in the OECD Tax-Benefit Model methodology and the detailed country-specific policy rules (see www.oecd.org/social/benefits-and-wages).

Source: OECD Tax-Benefit Models and OECD Indicators of Employment Protection.

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Severance pay

In many OECD countries, severance pay is a key component in dismissal proceedings, providing compensation that aims to partially offset the sudden loss of income (OECD, 2018[51]). The level of severance pay differs significantly among OECD countries, but typically increases with tenure (Figure 3.15). With an average of one months' worth of gross pay across the OECD, it makes up a small part of income support in the year following job loss at shorter tenures. However, at longer tenures, it replaces on average slightly more than 4 months' worth of pay, with disbursements worth more than a year of pay for workers in Türkiye and Spain. As such, it can provide extra income security for workers that may find it harder to find re-employment at older ages. At the same time, it can provide a basis for social partners to bargain over transition measures (more below), while also providing incentives for workers to pursue internal flexibility through training and internal reorientation of the existing workforce. Some countries also mandate additional compensation in the case of collective dismissals (e.g. in Mexico). In some countries, additional severance payments can be mandated through collective agreements (e.g. in New Zealand and Türkiye) (OECD, 2020[61]).

Despite the role of severance pay as an income support, it may not be an efficient tool to reduce job displacement costs and facilitate labour market adjustment. This may result in providing too much support for displaced workers who find a suitable job quickly while it may leave too little support for those who have more difficulty doing so this. However, it is typically disbursed as a one-off payment that is less distortive in terms of job search incentives than unemployment insurance as it does not depend on being unemployed.[14] Moreover, as severance pay depends on previous earnings and, in contrast to UI benefits, is not capped, it can be a particularly important source of unemployment compensation for displaced workers previously earning relatively high wages. At the same time, high levels of severance pay entitlements may reduce job mobility among workers at risk of displacement (Garcia-Louzao, 2022[62]). Instead, it may be more beneficial to operate longer notice periods rather than higher severance pay as it can facilitate pre-displacement interventions by the public employment services (OECD, 2020[61]).

Early retirement schemes

Early retirement schemes facilitate an earlier transition into the pension system and have historically been available for many workers under different conditions, for example to facilitate economic restructuring and reduce excess labour supply – see e.g. Mirkin (1987[63]). In recent decades, however, they were often reserved for workers in physically demanding and hazardous occupations. These occupations partially overlap with those in high-emission industries, so that early retirement options have found application in the net-zero transition, but also for jobs that may not be physically demanding. For instance, in some countries, older displaced workers in declining industries are entitled to schemes that facilitate a labour market exit instead of extensive reskilling and training for the transition to new industries and occupations. For example, while the German coal exit plan offers displaced coal miners the possibility to retire from the age of 50 (underground miners) or 57 (surface lignite miners), other workers in the coal industry – such as technical, logistical, and administrative staff in coal and lignite mines and power plants – can claim an adjustment benefit from age 58, securing parts of lost employment income until the option to transition to early retirement at age 63 (Furnaro et al., 2021[64]).

However, early retirement schemes are hard to unwind once in place and can have significant negative and long-lasting effects on overall labour supply, economic growth and the sustainability of public finances (OECD, 2018[51]; 2009[65]). In light of rapid population ageing and labour shortages, early retirement can be seen as an expensive and unsustainable scheme to accommodate job loss. In addition, if the prospect of early retirement is not conditional on job displacement, it can dampen the incentives for early adjustment and occupational re-orientation. For example, in Poland, underground miners with an employment history of at least 25 years can retire at the age of 50. This scheme therefore creates strong incentives to stay employed in the coal mining industry and may limit sectoral and occupational mobility (Baran et al., 2018[66]). Early retirement schemes are therefore a strategically imprudent and economically counterproductive approach to react to the labour market challenges of the net-zero transition and their use should be strictly limited to exceptional cases, such as for physically demanding and hazardous occupations in which workers may also have a lower life expectancy – see also OECD (2023[67]).

3.3.2. Adequate wages and in-work income supports

Workers displaced in high-emission industries typically face pronounced wage losses upon re-employment and may be reluctant to accept jobs in new industries and/or occupations if wages are well below their previous earnings.[15] This can potentially prolong joblessness in the hope of finding higher-wage employment, with the additional risk that waiting for a better job may involve skill depreciation, potentially undermining re-employment wages and increasing public expenditures on income support. By improving remuneration for workers facing particularly low re-employment wages, wage setting institutions can ensure that all workers are paid fair wages (Criscuolo et al., 2022[68]; OECD, 2019[69]). In-work benefits can be complementary in this regard, providing additional financial support and work incentives.

Wage-setting institutions

Wage-setting institutions, in the form of minimum wages and collective bargaining, have an important role to play in ensuring that productivity gains are broadly shared with workers (OECD, 2018[51]), including in low-emission industries where firms tend to offer lower levels of wages for a given level of skills. In many countries, workers in low-emission industries such as hotels and restaurants are more likely to benefit from a minimum wage, while workers in high-emission industries are more likely to be unionised and covered by a collective agreement, which may be one of the reasons why such workers tend to be paid higher wages everything else equal (OECD, 2019[69]).[16]Job displacement from high-emission industries may lead to lower collective bargaining coverage – when such workers move to firms or industries that are less likely to be covered by a collective agreement (see Chapter 2 and Zwysen (2024[70])). Recent evidence from France shows that firm-related wage losses following job displacement tend to reflect transitions to more productive firms that pay lower wages conditional on skills and are less likely to conclude collective agreements (Brandily, Hémet and Malgouyres, 2022[49]). Minimum wages and broad-based collective bargaining systems can help avoid that job displacement reduces the sharing of productivity gains with vulnerable workers.

Wage insurance

Wage insurance (partially) covers the differences between pre-displacement and re-employment wages, typically on a temporary basis (Cahuc, 2018[71]). As such, it can increase job search incentives and reduce reservation wages and may be particularly effective in speeding up re-employment (Hyman, Kovak and Leive, 2024[72]). While in principle it can be provided on a permanent basis, limiting the duration of wage insurance eligibility and/or progressively reducing payments over time can reduce the risk of benefit dependency. The need for wage insurance may also decline over time as workers gain experience and develop job-specific human capital, which is reflected in wage increases. Furthermore, wage insurance could avert permanent labour market exit through early retirement schemes of older workers for whom the scope of reskilling may be limited (ILO/OECD, 2022[73]). To support displaced older workers, some countries have implemented such schemes in the past (Box 3.6). In the United States, it was targeted to trade-displaced workers and led to higher cumulative earnings over the four years following displacement by significantly speeding up re-employment. As a result, it paid essentially for itself through reduced expenditure on UI and increased tax receipts (Hyman, Kovak and Leive, 2024[72]). Schemes in other countries, such as Germany, were generally not targeted to specific groups of displaced workers beyond their age (Box 3.6).

Box 3.6. Wage insurance schemes in the United States, Germany and elsewhere

United States: Reemployment Trade Adjustment Assistance

To help workers who lost their job due to increased international trade and to foster public support for globalisation, the United States introduced *Trade Adjustment Assistance* (TAA) in 1962, running until 2022. While primarily covering costs of retraining programmes and offering extended UI benefits, a wage insurance programme entitled *Reemployment Trade Adjustment Assistance* (RTAA) was introduced in 2009. It aimed at mitigating the financial implications of job displacement while also encouraging and expediting reemployment (Hyman, Kovak and Leive, 2024[72]).[1]

Under the RTAA, TAA-certified workers aged 50 or older with pre-tax re-employment earnings up to USD 50 000 were eligible to receive a supplement to 50% of the wage difference with their previous job. These benefits were capped at USD 10 000 and paid for a maximum of two years from the date of re-employment or the end of state-funded UI entitlements (26 weeks, in most states). Participation rates were relatively low, with about 30 000 workers receiving wage insurance benefits between 2009 and 2021 (Hyman, Kovak and Leive, 2024[72]).

Recent evidence shows that RTAA- eligibility increased the speed of re-employment, while resulting in higher cumulative long-run earnings, particularly through faster re-employment. At the same time, there is no evidence that the quality of re-employment job is worse for RTAA-eligible workers. Because the estimated fiscal externalities of the programme in terms of reduced UI-expenditure and increased tax receipts exceeded wage insurance payments, the net costs of the programme were found to be positive, i.e. the programme yielded a net benefit to the government (Hyman et al., 2021[74]; Hyman, Kovak and Leive, 2024[72]).Three years following displacement, employment probabilities and earnings are similar for workers who were and were not eligible for wage insurance (and were instead eligible for extensive training). This suggests that the RTAA primarily worked as an inexpensive income-smoothing scheme after displacement for workers who find it hard to secure quality employment at ages close to retirement.

Germany: *Entgeltsicherung* (Wage Security)

Aiming to ease the transition of displaced workers back into employment, the German *Entgeltsicherung* (Wage Security) programme was in place between 2003 and 2011, targeting unemployed workers aged 50 or above with a minimum remaining UI benefit entitlement of 120 days. Beneficiaries received 50% of the net wage differential to their prior earnings in the first year of re-employment and 30% in the second year.[2] Moreover, pension insurance contributions were topped up to 90% of the contribution paid on the prior salary (Dietz et al., 2011[75]).

The uptake of the scheme was relatively low, in part owing to limited efforts by the public employment services to promote its use. For example, between 2003 and 2006, fewer than 10 000 workers received wage insurance payments, most of which were prior high-income earners. Likely due to the low initial take-up, the main evaluation of the programme in 2005 found no significant effects on re-employment (Brussig et al., 2006[76]; ZEW/IAB/IAT, 2006[77]). However, before the programme expired, take-up substantially increased, peaking at 20 000 participants in 2011 (Stephan, van den Berg and Homrighausen, 2016[78]). As such, a potential evaluation of the *Entgeltsicherung* based on later periods of the programme could be promising and may further enrich the understanding of wage insurance programmes for employment outcomes.

France and Japan: Other schemes

A few other countries have also implemented schemes or trials comparable to wage insurance. For example, since 2011, France's *contrat de sécurisation professionnelle* (job security contract) is accessible to workers laid off for economic reasons in companies with up to 1 000 employees (or those in reorganisation or liquidation proceedings), and offers a maximum of 12 months of full compensation of lost wages, capped at 50% of their remaining entitlements to UI benefits (Cahuc, 2018[71]). It has been shown to lead to somewhat faster re-employment and more stable employment relations (DARES, 2021[79]).

Japan's *Continuous employment benefits for the elderly* (高年齢雇用継続給付) supports workers between 60 and 65 years old, who are often laid-off and immediately re-hired as non-regular workers at lowered wages after firm-specific mandatory retirement age (OECD, 2018[80]). This scheme is compensating up to 15% of wages that fall below 75% of the average wage over the 6 months before reaching the age of 60. From 2025, the benefits will be reduced to a maximum of 10% of the wage level (MHLW, 2024[81]).

1. Between 2002 and 2009, the United States piloted the *Alternative Trade Adjustment Assistance* (ATAA), which, compared to the RTAA, had tighter eligibility criteria and lower take-up rates (Hyman et al., 2021[74]).
2. The wage difference had to be at least EUR 50 and re-employment wages were required to be at least at tariff wage level (local customary wages if the company is not subject to a collective agreement) while the employment relationship must have been subject to social insurance contributions (Dietz et al., 2011[75]).

Wage insurance schemes can be a useful complementary tool for compensating wage losses of displaced workers in the net-zero transition, while increasing the incentives for job search and the take-up of job offers. For example, Haywood, Janser and Koch (2023[31]) propose a wage insurance scheme to reduce job displacement costs resulting from the decline of the German coal industry, arguing that it reduces the welfare costs of the coal exit by over two-thirds – substantially more than it is estimated to cost. However, wage insurance schemes for workers displaced in high-emission industries could raise equity concerns, as these workers previously worked in well-protected sectors that extracted high rents with correspondingly high firm wage premia. In addition, subsidizing wage differentials could also pose the risk of lock-in effects in low-productivity and/or low-quality jobs and therefore undermine the productivity-enhancing nature of job reallocation (Cahuc, 2018[71]; Parsons, 2023[82]). These concerns need to be balanced against the potential efficacy of wage insurance and the possibility that it frees up resources to support other priority projects, as illustrated by the example of the United States. More generally, wage insurance could be one of the tools to support displaced workers in the net-zero transition, especially where other income and employment support policies are less developed. Indeed, public interest in wage insurance schemes to support displaced workers during the structural transformation has been growing recently.[17]

Make-work-pay policies

In-work benefits supplement labour income, often on a permanent basis, and can make work more attractive relative to income support during joblessness. As such, in-work benefits may alleviate in-work poverty and can be particularly valuable to workers with a low earnings potential and weak work incentives (see e.g. Immervoll and Pearson (2009[83])). In-work benefits can therefore be particularly useful to support displaced workers whose skills have become obsolete due to the loss of firm-specific human capital and whose earnings potential has been seriously compromised. Examples of in-work benefit schemes in the OECD include cash benefits, such as the French *prime d'activité* for low-wage earners, as well as tax credits, such as the *Earned Income Tax Credit* (EITC) in the United States. However, in-work benefits can partially be captured by employers by offering lower wages, particulary in the absence of moderate minimum wage floors. For example, it has been estimated that employers capture about 36% of every USD spent on EITC (Nichols and Rothstein, 2016[84]).

3.3.3. Activation policies and lifelong learning

Active labour market policies (ALMPs) and lifelong learning are important in supporting displaced workers in high-emission industries, given the difficulty that such workers have in finding equally well-paying jobs. By supporting job search and equipping workers with the necessary skills, such policies can facilitate transitions towards expanding sectors and occupations, including those associated with less polluting activities, as well as sectors and occupations with persistent labour shortages. Importantly, in countries with higher public expenditure on ALMPs, displaced workers tend to have lower average earnings losses (Figure 3.14). This evidence cautiously suggests that ALMPs with well-funded public employment services (PES) may help to mitigate the costs of job displacement. As shown in Figure 3.5, workers in high-emission industries rarely engage in formal and non-formal education and training in employment, and less often than workers in other sectors of the economy. This might suggest that workers in high-emission industries are less adaptable to growing skills demands and therefore may be less prepared to transition to new industries.

Public employment services

Public employment services (PES) can play a pivotal role in helping displaced workers in the job search process and steering them towards opportunities in expanding segments of the economy. Where barriers may persist, PES can further help in identifying relevant training and reskilling opportunities based on the skill-demands on the labour market, alongside financial support for such activities. Indeed, job search assistance has been shown to be more effective than other ALMPs in increasing re-employment probabilities (Card, Kluve and Weber, 2017[85]). Job search assistance is often used to steer vulnerable job seekers to green and in-demand jobs (e.g. in Colombia, the Slovak Republic and Spain, among others). For example, as part of the Recovery and Resilience Mechanism, Spain supports vulnerable unemployed that are affected by the net-zero transition, including women, younger and older workers, people with disabilities, the long-term unemployed, with dedicated job search assistance, alongside training programmes, that specifically aim for employment in green jobs (European Commission, 2023[86]). To efficiently support displaced workers during the net-zero transition, PES must not only be adequately staffed, but the staff must also be well aware of the transitions labour market effects, including a detailed sense of declining and emerging industries. PES must therefore be supported through continuous upskilling through best practice sharing, online modules, and extensive training, which can equip PES staff to adequately guide job seekers during the net-zero transition and to recommend the most relevant training and reskilling opportunities that maximise the chances of job seekers to find good quality jobs. Systematic skills assessment and anticipation (SAA) approaches can be a further tool in this process – see Chapter 4 and OECD (2023[43]). This will also require a detailed understanding of which transitions from high-emission industries and occupations are feasible, for example through a detailed analysis of skill-distances between different occupations and whether these can efficiently be closed through training offers (Sanchez-Reaza, Ambasz and Djukic, 2023[87]). In addition to PES, private employment services can also play a role in contributing to the effective reallocation of displaced workers (Langenbucher and Vodopivec, 2022[88]).

Skill-related training

In general, job transitions of workers in high-emission occupations are heavily self-contained with little mobility to other occupations (see Box 3.7). While this can suggest that employment in other occupations is not attractive enough, other barriers related to skills or location can also impede successful transitions (Lim, Aklin and Frank, 2023[42]). At the same time, workers in high-emission industries are more likely to be older and less educated than workers in other sectors, groups which often face technological gaps and might differ in their learning styles and preferences (OECD, 2019[89]). As such, high quality job training and reskilling initiatives that are tailored to the specific needs of workers in high-emission industries may be crucial to equip workers with the right skills for transitions to occupations with other skill demands – see Chapter 4. Estonia, for example, specifically supports the up- and reskilling of displaced workers in the shale oil industry to allow for transitions into new sectors and occupations (European Commission, 2023[86]). Similar to job search assistance, skill-related training and occupational re-orientation programmes can be effective in increasing re-employment probabilities, particularly in the medium and long run (Card, Kluve and Weber, 2017[85]). They have also been shown to increase re-employment wages after displacement in the Austrian steel industry (Winter-Ebmer, 2006[90]).[18]

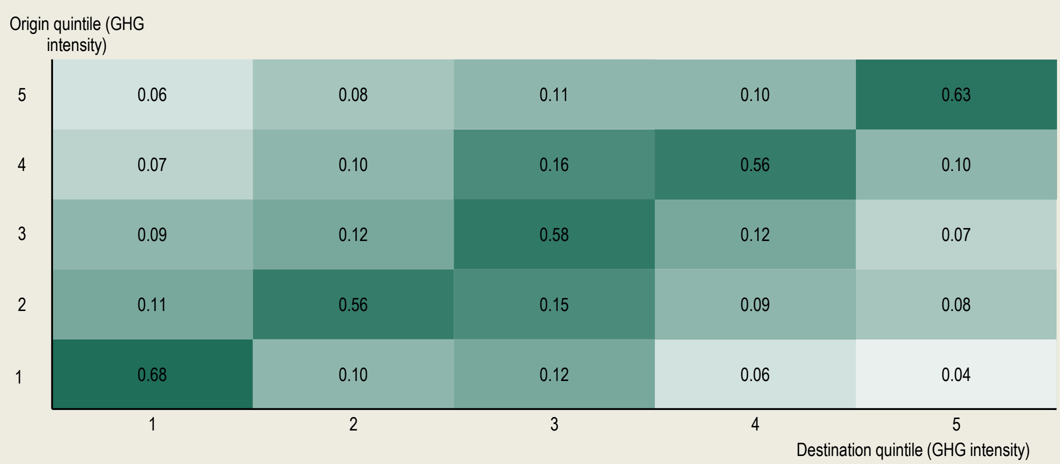
Box 3.7. Where do workers in occupations concentrated in high-emission industries go when they change job?

As employment in high-emission industries adjusts, understanding occupational mobility and labour market re-allocation becomes critical. To this end, this box documents occupational transitions at a disaggregate level (3-digit ISCO)[1] according to the degree of emission intensity. Occupations are grouped into quintiles, based on their concentration in high-emission industries[2] (e.g. quintile 5 represents occupations that are most concentrated in high-emission industries). Transitions across quintiles weighted by employment to account for the differences in employment levels which influence transition levels into and out of the quintiles. The probability of moving from one quintile to another is defined as the within-country sum of transitions between the two, divided by the total outflow from the origin quintile, and then averaged across countries (Finland, Germany, Hungary and Portugal). In contrast to the main analysis of this chapter, this box considers all transitions and not just those originating from mass layoffs.

Workers in the most emission-intensive occupations predominantly transition to similarly emission-intensive occupations (Figure 3.16). Nearly two-thirds of these transitions remain within the 5th quintile of the emission intensity distribution. It is less common for these workers to move to occupations of lower emission intensity, especially those at the very bottom of the distribution. While there is also a significant number of within-quintile transitions everywhere, the highest and lowest emission intensity quintiles are the most self-contained. This hints at potential mobility barriers, related to for example skills or geography, posing challenges for workers seeking less emission-intense roles during the net-zero transition. This concentration highlights a pressing need for targeted policies to ensure a balanced and sustainable occupational transition.

Figure 3.16. Workers from emission-intensive occupations tend to move to other emission-intensive occupations

Transition probabilities across emp. weighted quantiles of the within occupation emission intensity concentration



Note: Data refers to transitions between quintiles of the within-occupation emission intensity concentration over the period 2000-19. Transition probabilities are calculated based on employment weighted quintile-to-quintile job flows over the total amount of job outflows from the origin quintile within each country and are then averaged across Germany, Hungary, Finland and Portugal.
Source: National linked employer employee data, see Barreto et al. (forthcoming[11]) (Table 1) for details.

StatLink https://stat.link/0r4vbz

1. The differences in the share of occupational changes between Figure 3.16 and Figure 3.8 arise from differences in the aggregation levels of the analyses and the focus of Figure 3.8 on job changes due to displacement, while Figure 3.16 includes all job changes.
2. For example, metal-processing-plant operators have a particularly high concentration in high-emission industries, whereas senior managers are more equally distributed across sectors and therefore have a much lower concentration in high-emission industries.

3.3.4. Managing and reducing the cost of job displacement

Mass layoff regulation and early intervention

Most OECD countries have specific regulations for mass layoffs (or "collective dismissals") that go beyond those for individual dismissals. These encompass requirements and guidelines that aim to reduce the effects of job displacement on workers, while offering firms the flexibility to adjust their workforce subject to these conditions. Examples are extended notice periods, mandatory consultation with employees or their representatives, additional severance pay provisions and measures to facilitate the transition to re-employment (OECD, 2020[61]). Extended notice requirements, in particular, can play an important role in facilitating early interventions by public employment services as discussed in more detail below.

Early interventions during the notice period by the public employment services, before (individual or collective) dismissal takes place, can be particularly effective at reducing the cost of job displacement, for example by reducing stigma effects of unemployment, or even preventing it entirely by facilitating direct job-to-job transitions prior to displacement (OECD, 2018[91]). Training and adaptation towards new roles within the same firm can also help to avoid displacement (e.g. financed through the *Qualifizierungsgeld* in Germany). Despite their effectiveness, these early intervention strategies are not as widely implemented as they could be. One good example is the region of Silesia in Poland, where workers at risk of displacement in coal and coal-related firms receive comprehensive outplacement services before dismissal takes place. A wider application of these strategies could reduce the incidence of job loss through early transitions to new employment and better accommodate its consequences by providing early assistance (OECD, 2020[61]; 2018[51]).

Social plans and transition initiatives

Social plans and transition initiatives can also play an important role in mitigating the costs associated with job displacement and preparing displaced workers for re-employment. These measures typically operate through co-ordinated efforts between employers and worker representatives (and sometimes PES) to reduce the number of dismissals and, particularly, mitigate their negative consequences for workers. Some of these efforts also aim to create structured pathways for displaced workers that can significantly increase their re-employment chances. A number of countries operate short-time work schemes to support company restructuring (e.g. Germany, Spain). While this may appear counter-intuitive, the rationale of these schemes is to either prepare workers for a different role in their firm (e.g. using a greener technology) or help them move onto a different firm (e.g. with lower emissions).

For example, in Germany, transfer companies (*Transfergesellschaften)* can be established as part of a social plan during mass layoffs. Workers can voluntarily enter transfer companies for up to a year, where they receive job search assistance and skill training, while public funds and employer top-ups compensate them for wage losses. These measures reduce earnings losses by about a third in the first year after displacement and enhance employment outcomes, particularly for those at higher risk of prolonged unemployment who are also more likely to select into transfer companies (Fackler, Stegmaier and Upward, 2023[92]). Another example are Sweden's job security councils (*Trygghetsrådet*). These are established through collective agreements and financed by employers, offer supplementary financial supports and job search assistance on top of what is provided by the PES and UI (OECD, 2015[93]). While the support of job security councils does not appear to have a significant effect on unemployment duration or re-employment wages, at least for blue-collar workers, it does appear to lead to more stable jobs (Andersson, 2018[94]).

3.4. Concluding remarks

The net-zero transition is essential for a sustainable future, yet it presents significant challenges. While the aggregate employment effects are likely to be modest, the net-zero transition is expected to have a significant impact on workers in high-emission firms and industries, which will have to change the way they operate and, in some cases, reduce or even close certain activities. Forward-looking climate change mitigation policies that provide future guidance to firms on the planned reduction of GHG emissions and the availability of reconversion and green subsidy schemes can help firms anticipate future change and prevent some involuntary job losses. However, some job losses are inevitable, and policies that support displaced workers, by providing income support during joblessness and facilitating the transition into new jobs, are therefore of vital importance. Proactive skills and labour market policies are particularly important. Early interventions by public employment services, as early as during the notice period before workers lose their job, can be particularly effective in reorienting displaced workers towards new jobs, potentially in emerging and in-demand industries and occupations, and in reducing the costs of job loss. Forward-looking upskilling and reskilling policies are key to ensuring that workers in declining high-emission activities can develop the skills that are needed to make successful transitions to expanding activities. This not only would reduce the cost of job displacement by shortening the time spent out of work and increasing re-employment wages, but also may enable workers to seize emerging opportunities, including in low-emission activities, before displacement takes place.

When considering policies to support displaced workers, an important question is whether workers who lose their job as a result of the net-zero transition should receive targeted support or whether it is best to rely on universal policies that provide effective support to all displaced workers irrespective of the reason (OECD, 2005[95]). The answer to this question may vary from country to country, but there may be a political economy argument for introducing specific policies for workers displaced because of the net-zero transition. Such policies can be seen as a way of compensating workers for the costs of policy-induced structural change but also as a means of maintaining public support for climate change mitigation policies. However, such targeted policies also raise important implementation issues related to the difficulty of justifying differences in regulatory treatment between different groups of displaced workers and the fact that the reason for job displacement is not always easy to establish in practice. Universal systems may be preferable from this perspective, but also require a political consensus for strong income support and re-employment policies that is not always present.

This chapter raises several important avenues for future work. First, the consequences of job displacement in high-emission activities and the corresponding policy responses are likely to depend to an important degree on the regional context. Future work could analyse the extent to which the costs of job displacement depend on the regional concentration of high-emission activities, how far mass layoffs and firm closures affect local labour market outcomes, and the role of place-based policies that take account of local conditions as well as policies that facilitate geographical mobility. Second, there is a need for a better understanding of the specific barriers that prevent workers in high-emission industries from making successful job transitions. The chapter already shows that transitions between high- and low-emission occupations are rare. Future work could explore the extent to which low occupational mobility reflects barriers related to skills, geography or lack of demand. This work would not only help to increase understanding of how to better accompany displaced workers in declining activities but also why firms with persistent labour shortages have difficulty in finding suitable workers.

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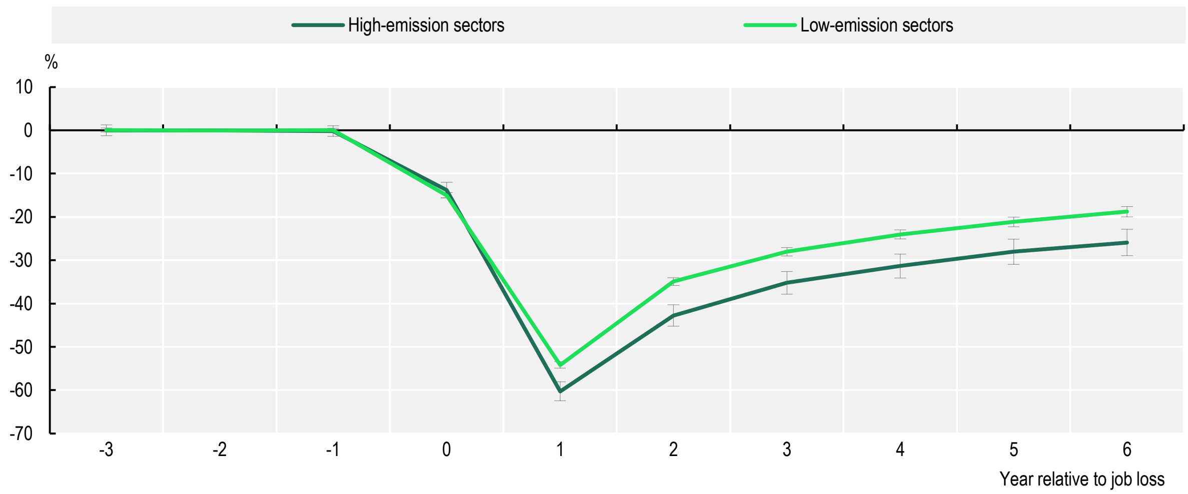
Annex 3.A. Additional figures

Annex Figure 3.A.1. Displacement costs are slightly larger when including older workers

Difference in annual earnings between displaced workers and their matched counterparts relative to the time of displacement, average across countries, workers aged 18 to 60, percentage



Note: The figure plots the average coefficients and the corresponding 90% confidence intervals across countries based on Equation (1) for workers aged 16 to 60. The coefficients capture the earnings losses of displaced workers relative to observationally comparable non-displaced workers. The point estimates show the impact of job loss on earnings in event time, where workers are displaced between time 0 and time 1, such that time 1 is the first post-displacement year. Related to this, earnings losses present a drop by construction at time 0, as earnings capture the sum of labour payments over the entire year and consequently already capture part of the displacement effect at time 0. The reference period for earnings losses is k=-2. Point estimates and confidence intervals from country-level regressions are averaged assigning each country an equal weight. The countries included are: Australia, Austria, Canada, Denmark, Estonia, Finland, Germany, Hungary, the Netherlands, Norway, Portugal, Spain, France, Sweden.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

StatLink https://stat.link/yf4gt1

Annex Figure 3.A.2. Country-rankings in the level of earnings losses following displacement in low-emission industries roughly mirror those for high-emission industries

Decomposition of the average earnings losses over six years since displacement in low-emission industries into the contributions associated with wages, employment and days workers by country, percentage

Note: Bars refer to the average effect of job loss on earnings over six years following displacement for workers in low-emission sectors. Countries are sorted based on the level of earnings losses for low-emission sectors. Due to missing information on daily wages and days worked, the bars for Australia, Canada, Estonia and Norway are not decomposed into components.
Source: National linked employer employee data, see Annex Table 3.B.1 for details.

StatLink https://stat.link/zip64g

Annex 3.B. Additional tables

Annex Table 3.B.1. Data sources

Country	Name	Source	Sample	Period
Australia	Person Level Integrated Data Asset (PLIDA)	Tax administration	10% random sample of workers	2002-19
Austria	AMS-BMASK Arbeitsmarktdatenbank	Social security administration	Universe	2000-19
Canada	Canadian Employer-Employee Dynamics Database	Tax administration	Universe	2001-19
Denmark	Integrerede Database for Arbejdsmarkedsforskning (IDA) and other data from Statistics Denmark	Tax administration	Universe	2000-19
Estonia	Data from the Tax and Customs Board Register	Tax administration	Universe	2003-19
Finland	FOLK employment data from Statistics Finland, Employer Payroll Report from Tax Admin.	Tax administration	Universe	2000-19
France	Panel DADS	Social security administration	8.5% random sample of workers	2002-19
Germany	Integrierte Erwerbsbiographien (IEB)	Social security administration	10% random sample of workers	2000-19
Hungary	ADMIN – I – Panel of administrative data (OEP, ONYF, NAV, NMH, OH)	Social security administration	50% random sample of workers	2003-17
Netherlands	CBS Microdata from Statistics Netherlands	Tax administration	Universe	2006-19
Norway	Arbeidsgiver- og arbeidstakerregister (Aa-registeret), Lønns- og trekkoppgaveregisteret (LTO)	Tax administration	Universe	2000-19
Portugal	Quadros de Pessoal	Mandatory employer survey	Universe	2002-19
Spain	Muestra Continua de Vidas Laborales con Datos Fiscales (MCVL-CDF)	Social security and tax administration	4% random sample of workers	2006-19
Sweden	Longitudinell integrationsdatabas för sjukförsäkrings- och arbetsmarknadsstudier (LISA), Företagens ekonomi (FEK), Jobbregistret (JOBB)	Social security administration	Universe	2002-18

Notes

[1] The analysis of job displacement in this chapter is based on contributions by Stefano Lombardi (VATT, IFAU, IZA and UCLS), Patrick Bennett (University of Liverpool and IZA), Antoine Bertheau (NHH and IZA), Winnie Chan (StatCan), Andrei Gorshkov (Uppsala University), Jonathan Hambur (Reserve Bank of Australia), Benjamin Lochner (FAU, IAB and IZA), Jordy Meekes (Leiden University and IZA), Tahsin Mehdi (StatCan), Balázs Muraközy (University of Liverpool), Gulnara Nolan (Reserve Bank of Australia), Oskar Nordström Skans (Uppsala University, UCLS, IZA and IFAU), Kjell Salvanes (NHH and IZA), and Rune Vejlin (Aarhus University and IZA). This chapter is part of a broader OECD project that mobilises linked employer-employee data for cross-country research and policy analysis (LinkEED 2.0). For more details, please visit: www.oecd.org/employment/emp/linkeedv2.htm.

[2] Considerable shocks or long-term declines that impact activity and employment in high-emission industries are not unprecedented. For example, the unexpected collapse of the international oil price between 2014 and 2016 had a profound impact on the Norwegian economy, with workers in the oil industry experiencing high rates of job loss and unemployment compared with other workers (Juelsrud and Wold, 2019[96]; Salvanes, 2022[97]). Likewise, the decline of the coal industry in several OECD countries and the associated loss of jobs have led to substantial long-term losses in earnings and reduced labour market prospects among affected workers (Andrews, Dwyer and Vass, 2023[32]; Haywood, Janser and Koch, 2023[31]; Rud et al., 2022[33]; Chen and Morissette, 2020[34]).

[3] Fit for 55 stipulates a 55% overall reduction in emissions, with varying targets across different sectors. For example, a 61% reduction from 2005 levels for sectors under the EU Emission Trading System (ETS), while the sectors governed by the Effort Sharing Regulation (ESR) are tasked with achieving a 40% reduction.

[4] For an overview and the development of approaches measuring high-emission jobs, rather than industries, see Chapter 2 and Causa, Nguyen and Soldani (2024[101]).

[5] The OECD ENV-Linkages model is a computable general equilibrium model linking economic activity and greenhouse gas emission across various macroeconomic sectors and regions. See more in Château, Dellink and Lanzi (2014[100]).

[6] This can reflect different factors, including that workers in high-emission industries may be employed in more productive firms, firms in high-emission industries capture higher rents, workers in high-emission industries have a strong bargaining power thanks to higher trade union density and collective bargaining coverage or firms in high-emission industries compensation for physically demanding working conditions by paying higher wages (Card et al., 2018[46]; Sorkin, 2018[47]; Hirsch and Mueller, 2020[48]; Brandily, Hémet and Malgouyres, 2022[49]).

[7] Lower wages upon re-employment, measured as daily wages, reflect a combination of hourly wages and working time. Daily instead of hourly wages are used to enhance the cross-country comparability of the results – see Barreto et al. (forthcoming[11]). Fewer days worked conditional on being employed at least one day during the year may reflect a combination of the return to work during the year (as the first job after displacement starts after 1 January), the instability of employment following displacement (for example if workers are more likely to be re-employed on temporary contracts) or permanent exits during the year from employment (for example workers moving to inactivity or self-employment after 1 January).

[8] The authors find that displaced workers tend to move to firms that are less likely to conclude a firm-level collective agreement and tend to have a less organised workforces.

[9] The country ranking of earnings losses following job displacement in high emission industries is broadly similar to that in low-emission industries, which are more representative of the overall experience of job loss in the economy (Annex Figure 3.A.2). One notable exception is France, which moves from having slightly above-average earnings losses to below-average earnings losses. The importance of joblessness for explaining between-country differences remains unaltered.

[10] Older workers with high tenure in their pre-displacement jobs are particularly vulnerable to the prospect of job loss, while male workers on average tend to have lower losses compared to females (Illing, Schmieder and Trenke, 2022[98]; Athey et al., 2023[35]). When including all workers up to the age of 60 in the analysis, the age component in the Oaxaca-Blinder decomposition contributes slightly more to the differences in the costs of job displacement between high- and low-emission industries (results not shown).

[11] Between-country differences are analysed relative to the country with the smallest earnings losses (Norway).

[12] The association between spending on ALMPs and the earnings losses due to job displacement varies considerably across categories of spending and is strongest with spending case workers, job-search-assistance and counselling.

[13] For earnings losses in low-emission industries, the slope coefficients with respect to the average unemployment rate and the average spending on ALMP per unemployed as a percentage of GDP per capita are -2.08 and 0.40 respectively. This indicates that the association between these variables is qualitatively similar to that in high-emission industries.

[14] Severance pay can also affect job search through an income effect which may increase the overall duration of unemployment (Chetty, 2008[99]).

[15] In some countries, e.g. Germany, unemployed job seekers can decline job offers without repercussions if the offered wage is significantly lower than the wage on which the unemployment benefit is calculated.

[16] For example, in Germany, the presence of strong trade union confederations in high-emission industries plays a crucial role for job quality as compared to other sectors (Jäger, Noy and Schoefer, 2022[102]). Overall, German firms bound by collective agreements and those with works councils tend to offer higher wage premia (Hirsch and Mueller, 2020[48]).

[17] See, for example, articles in Le Monde (2024), "*Comment mieux accompagner la transition environnementale sur le marché du travail?*", https://www.lemonde.fr/idees/article/2024/05/17/comment-mieux-accompagner-la-transition-environnementale-sur-le-marche-du-travail_6233817_3232.html and in the Financial Times (2024), "*What if the government insured you against a pay cut*?", www.ft.com/content/651c615e-4237-4b21-9158-016cb577d0f0.

[18] The meta-analysis of Card, Kluve and Weber (2017[85]) suggests that the employment effects of job search assistance and retraining efforts have different time profiles. While assistance programmes focusing on immediate job placement show consistent short- and long-term effects, training reskilling initiatives have greater employment effects over medium to long durations.

4 Skills for the green transition

Dzana Topalovic and Michele Tuccio

Analysing skills in the context of the net-zero transition is crucial as it helps identify mismatches between existing workforce competences and those demanded by emerging green activities. Addressing these gaps through training and education ensures a smoother transition, but policies need to be carefully designed. To this end, this chapter explores the skill requirements of occupations playing a key role in the net-zero transition and compares them with those of emission-intensive jobs. Skill distances between different types of occupations are also examined to identify feasible job transitions and relevant retraining needs. Finally, good practices in designing and implementing targeted policies to foster skills for the green transition are examined.

In Brief

Key findings

Transitioning to a net-zero economy offers great opportunities for job creation and economic development. However, without attention to skills, some workers, such as those in declining industries or with limited access to education and training, may be left behind. Putting skills at the centre of the debate is essential to inform policies to address labour shortages, support workforce development, drive innovation and progress, and promote social equity in the emerging green economy. Ensuring that the workforce has the right skills is also crucial to avoid the slowing down of the net-zero transition, as novel technologies require new and enhanced competences. Investing in comprehensive and inclusive skill development programmes will help empower workers for success in the evolving labour market and contribute to ensuring that the transition to a net-zero economy is equitable and sustainable for all.

This chapter sheds new light on the skill needs of the green transition. Identifying the skills that are in high demand in a more sustainable economy is essential to enable individuals to develop the right set of skills and adapt to changing work practices. Skills are also key to promote effective labour market mobility and facilitate the transition from sectors with high greenhouse gas (GHG) emissions to greener activities, while ensuring that businesses have the workforce skills they need to adopt greener technologies. Policy makers will have to take steps to promote the development of the skills needed for the green transition. This chapter reviews the policy tools and good practices governments and stakeholders can use to facilitate skill development and job transitions, with a particular focus on disadvantaged groups, notably those with low skills and limited labour market mobility.

The key takeaways of the chapter are as follows:

- Skills themselves are not inherently "green"; what matters is how they are used. The concept of "skills for the green transition" emphasises the role of human capabilities in driving environmentally sustainable practices. This underscores the need to apply existing skills to jobs and tasks that align with environmental goals, and to foster workforce development and acquisition of these skills. The focus is on enabling and empowering the labour force to contribute to a more sustainable future.
- The skills that workers in green-driven occupations need to master are those linked to the knowledge economy. Process skills – such as critical thinking, monitoring and active learning – and cross-functional skills – like complex problem solving and decision making – are both crucial in enabling workers to quickly adapt to the innovation-driven nature of the green transition. By contrast, the level at which technical skills – such as equipment maintenance and installation – are required by green-driven occupations is substantially lower, suggesting that there will be a shift towards high-skilled analytical jobs in the green economy. Furthermore, newer jobs emerging as a result of the green transition demand even higher proficiency across all skills compared with green-driven occupations already well established in the labour market, pointing to a rising demand for skilled workers in the labour market.
- When comparing the skill requirements of green-driven occupations with those of GHG-intensive and environmentally neutral occupations, the analysis shows that new green-driven occupations with low education and experience requirements generally demand higher skill proficiency than jobs with similar education and experience requirements in GHG-intensive and neutral occupations. Conversely, the skill requirements of green-driven and GHG-intensive occupations

with high education and experience requirements are very similar. This suggests that, purely based on skill profiles, transitioning from GHG-intensive to innovative, green-driven occupations may be significantly more challenging for low-skilled workers than for workers in high-skilled positions. Ensuring sufficient and appropriate training for low-skilled workers will be paramount to address both skill shortages in green industries and the learning needs of low-skilled workers.

- These findings are confirmed when looking at skill distances between occupation pairs. Indeed, the majority of GHG-intensive occupations share similar skill requirements with at least one non-GHG-intensive occupation, suggesting that transitions out of polluting sectors are feasible with well-targeted reskilling.
- Looking at the feasible career transitions out of each single GHG-intensive occupation based on skill distances can provide additional information on the type and extent of retraining needed to successfully promote the required labour market transition. The case of petroleum engineers is illustrative of this. In fact, this GHG-intensive occupation shares very similar skill requirements with a number of green-driven occupations, including environmental engineers and climate change policy analysts. Retraining to be able to access either of these jobs would be feasible by focusing on specific skills: petroleum engineers would have to improve their knowledge of biology and chemistry to become environmental engineers, while more communication and advocacy skills would be necessary to take up a climate change analyst role.
- Training is crucial for individuals to adapt to the changing landscape of work in the green transition. Workers in green-driven and GHG-intensive occupations train less than those in other jobs, and skill shortages in key green sectors pose challenges for the net-zero transition. Flexible, short learning programmes, along with training leaves and financial support, are crucial to address some of the barriers adults face in participating in training. Training can also be made more accessible if it takes the form of an on-site and work-based learning that provides practical hands-on experience and is financially compensated. Initiatives in Australia and Canada offer targeted training enabling adults to enter in-demand green sectors, such as renewables and sustainable construction. Adults might require additional support to undergo training for the green transition, and countries like the United States and Sweden have programmes that provide holistic support and services, such as work-based training, financial support and career guidance for adults transitioning to in-demand green employment.
- Skill disparities among different groups of workers raise concerns about potential inequalities in the net-zero transition. Gender imbalances in employment and skills, with women being under-represented in the green economy, are of particular concern. Initiatives in countries such as Spain, Austria and Sweden aim to make the green transition just and inclusive and address disparities through targeted training programmes and financial support.
- The involvement of trade unions, employer associations and professional associations throughout the skill policy cycle is crucial to ensure inclusive and diverse perspectives in policy design and implementation. Collective bargaining also plays an important role in facilitating greater access to training opportunities. However, there are only a few policies promoting private-public collaboration in the green transition.

Introduction

Policies fostering green growth are triggering changes in the labour market, with job creation in climate-friendly sectors (Chapter 2) and job losses in emission-intensive sectors (Chapter 3). These changes are profoundly affecting the demand for skills as emerging and growing occupations tend to require different skill sets to those needed in contracting industries. Moreover, even jobs in sectors not directly affected by the transition to net-zero emissions will have to incorporate relevant transversal skills such as environmental awareness and sustainability. Policy makers need to foster the move towards a cleaner economy and limit the personal cost for workers who have to transition into different jobs or acquire new skills to remain in their positions. This chapter examines how the green transition impacts skill needs for green-driven occupations and those intensive in greenhouse-gas (GHG) emissions,[1] how workers can move between these job categories, and what training and activation policies are necessary to ensure the success of these transitions.

A large segment of the analytical work on the labour market effects of the net-zero transition measures numbers of jobs created and destroyed rather than skill needs (OECD, 2023[1]). Yet, lack of relevant skills emerges as a major barrier to making the green transition happen (Söderholm, 2020[2]). In addition, to reduce the cost of the transition for workers, policy makers who want to facilitate a swift transition out of contracting industries and into environment-related occupations need to understand their respective skill requirements and use this information to strengthen job transition mechanisms. Failing to do so could lead to severe skill imbalances causing unemployment for those currently employed in GHG-intensive industries – as documented in Chapter 3 – and skill shortages and mismatches for employers in expanding sectors.

As discussed in Chapter 2, the green transition is affecting occupations beyond the core set of "green jobs" in the energy sector (such as solar technicians, insulation installers and wind turbine technicians). In order to grasp the full effect of this global shift towards a net-zero economy, it is necessary to move beyond discussions only centred around technical skills for the green transition and look at the wider skill sets required in emerging and in-demand jobs. This allows for a better understanding of the fundamental differences in job requirements between GHG-intensive and green-driven occupations, and helps to map out the training and job transitions needed for countries to succeed in the net-zero transition.

This chapter looks at the skill requirements of different types of jobs in the context of the green transition. It applies an innovative approach to estimate the skill distances between thousands of occupational pairs to identify which workers could move out of GHG-intensive occupations with relatively limited upskilling and reskilling efforts, and which workers might require more support to make this career move.[2] The chapter is structured as follows: Section 4.1 outlines concepts and definitions that underpin the analysis. Section 4.2 examines the skill profile of green-driven, GHG-intensive and neutral occupations, and the distances in skill requirements between these occupations. Section 4.3 then discusses how training and other policy tools should be used to bridge skill gaps and ensure the success of the net-zero transition. Section 4.4 concludes.

4.1. Skills are not green per se, but they can contribute to greening the economy

Defining what is a green skill is not an easy task. Despite the key role skills play in the labour market, there is little agreement in the literature as to what "skills" are and how they should be defined. Cognitive abilities, knowledge types, education and years of schooling have been commonly used in the literature to proxy for the skill level of workers – see OECD (2017[3]) for further discussion. When analysing a large economic and societal shift such as the net-zero transition, it is important not to use these terms interchangeably and to choose the unit of measurement carefully, as different units have different implications for policy making. For example, measuring skills as years of schooling can help policy makers determine the number of available places in education and training, but it does not allow an analysis of what competences and knowledge should be taught within those programmes.

For the purpose of this chapter, a skill is the ability and capacity to carry out processes and use knowledge in a responsible way to carry out a task (OECD, 2018[4]). There are a finite number of skills that can be combined in numerous ways to carry out an infinite number of tasks. The concept of skills is related to tasks, knowledge and abilities, yet it remains distinct and independent (Box 4.1). This chapter will use the terms skills, knowledge and abilities as separate concepts unless specified otherwise.

Box 4.1. Skills, abilities and knowledge are related but distinct concepts

- A task is a specific activity or assignment that needs to be completed. It is an action or set of actions aimed at achieving a particular goal or objective. For example, an environmental economist would have to carry out the task of collecting and analysing data to compare the environmental implications of economic policy.
- Abilities are innate or acquired qualities that enable an individual to perform specific mental or physical tasks. For example, to carry out the task of collecting and analysing data to compare the environmental implications of economic policy an environmental economist will need to possess the ability of deductive reasoning, that is to apply general rules to specific problems to produce answers.
- Knowledge is the understanding, information, and awareness acquired through learning, study, or experience. It involves the theoretical or factual understanding of concepts, principles, or ideas. As they are working with economic policy, environmental economists will need to have a high proficiency in mathematics.
- Skills refer to the practical application of knowledge and abilities to perform a particular task or activity effectively. They are developed through practice, experience, and training. Skills are what enable us to use our abilities and knowledge to perform a task. In order to analyse data to compare the environmental implications of economic policy, environmental economists need to master the skills of writing and critical thinking.

Source: OECD (2017[3]), *Getting Skills Right: Skills for Jobs Indicators*, https://doi.org/10.1787/9789264277878-en.

Skills are the competences that individuals possess (such as critical thinking, persuasion and repairing skills) that are used to carry out tasks.[3] As economies are becoming greener, we are seeing the emergence of new green tasks – that is, tasks that contribute positively to lowering the negative impact of humans on the environment. A number of recent studies have exploited information on these new green tasks to estimate skill needs for the green transition – a method often called “task-based approach”. More specifically, the task-based approach measures green jobs as those occupations involving a large share of green tasks. In turn, the skills that are used more and at a higher level in green jobs are identified as key skills in the greening labour market (Biagi, Vona and Bitat, 2021[5]). Building on the seminal work by Consoli et al. (2016[6]), several other studies attempt to further understand the connection between tasks, skills and the green transition (Bowen, Kuralbayeva and Tipoe, 2018[7]) and apply it to country-level analysis (Rutzer, Niggli and Weder, 2020[8]; Lobsiger and Rutzer, 2021[9]).

While the skills that are linked to green jobs and measured through task-based approaches have frequently been denoted as “green skills” (Vona et al., 2018[10]; Tyros, Andrews and de Serres, 2023[11]), the skill sets required for green jobs are the same as those used in emission-intensive jobs, even if they are required at different levels and intensities. This chapter will label skills that are important in green-driven occupations as “skills for the green transition”. Indeed, in the transition to net-zero emissions, the types of skills remain the same; however, they have to be used in innovative ways to carry out new, green tasks.[4] For example, “install photovoltaic systems” is a green task. To achieve this task efficiently, a worker needs to have a series of skills, such as “judgement and decision making” and “troubleshooting”, as well as abilities like “finger dexterity” and “attentiveness”. Similarly, a cook in a restaurant might choose to implement a no-waste rule and use food scraps in preparing meals (a new task) and must therefore collaborate more with the other cooks to utilise all the ingredients (using co-ordination skills at a higher level). In this perspective, it is more precise to talk about “skills for the green transition” rather than “green skills”. This allows for a broader understanding of how the green transition is affecting the demand for skills as it is not limited to focusing only on technical skills in, for example, clean-energy engineering jobs.

For policy makers, the skill dimension of the net-zero transition is crucial to link jobs to workers. Skills can be acquired through formal, informal and non-formal learning, and are often a better proxy for job matching than age, experience or formal qualifications (though these concepts are positively correlated).[5] Examining the change in skill needs allows to fill in the blank and connect the dots between jobs (tasks) and talent (skills).

4.2. Skill requirements of green-driven occupations are different than those of the rest of the labour market, especially for low-skill jobs

4.2.1. How to measure skills for the green transition

To examine the skill profile of jobs linked to the green transition, it is necessary to have detailed data on skill requirements by occupation. In particular, information about the skill levels required in each occupation can be exploited to understand the differences in skill sets between jobs. Yet, taxonomies of job requirements are relatively rare, given the difficulties in gathering detailed information on the use of skills for hundreds of occupations. The most frequently used datasets on skill requirements by occupation are O*NET – the Occupational Information Network Programme – and ESCO – the European Skills, Competences, Qualifications and Occupations classification. O*NET is an online database and resource sponsored by the Department of Labor of the United States providing detailed information that can shed light on the rapidly changing nature of work. It contains numerous job-specific descriptors (including occupational requirements for 120 skills, abilities and knowledge areas) on almost 1 000 occupations covering the American economy. In a similar vein, ESCO is a project financed by the European Commission that offers a common language on occupations and skills to support more integrated labour markets across Europe. It provides descriptions of over 3 000 occupations and almost 13 900 skills.

While both datasets have their own advantages and limitations, for the scope of this analysis O*NET is preferred for several reasons: (1) it is already used throughout most of the literature on environmental-related jobs as well as in other OECD studies, making it easier to compare results and track developments in skill requirements; (2) every occupation in O*NET has numerical information on the skill level required to successfully perform tasks, which is a key feature needed to compute differences in skill requirements between jobs (by contrast, for each occupation, ESCO only labels a subset of skills as either “essential” or “optional”). More details on the O*NET skill taxonomy are presented in Box 4.2.

Box 4.2. The O*NET skill taxonomy

The O*NET database contains detailed information on worker requirements in terms of 52 abilities, 33 knowledge areas, and 35 skills. Abilities, which are enduring attributes of the individual that influence performance, can be cognitive (e.g. memorisation), physical (e.g. stamina), psychomotor (e.g. finger dexterity) or sensory (e.g. far vision). Knowledge, instead, consists of organised sets of principles and facts applying in general domains, and can be disaggregated in 10 categories: arts and humanities, business and management, communications, education and training, engineering and technology, health services, law and public safety, manufacturing and production, mathematics and science, and transportation.

The 35 skills included in O*NET are grouped into two separate categories: basic skills (i.e. developed capacities that facilitate learning or more rapid acquisition of knowledge) and cross-functional skills (i.e. developed capacities that facilitate performance of activities that occur across occupations). Under these two broad headings, skills are further distinguished into more detailed categories. The complete skill taxonomy is presented in Table 4.1.

Table 4.1. The skills included in the O*NET database

	Basic skills
Content skills Background structures needed to work with and acquire more specific skills in a variety of different domains	**Reading Comprehension**: Understanding written sentences and paragraphs in work-related documents. **Active Listening**: Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times. **Writing**: Communicating effectively in writing as appropriate for the needs of the audience. **Speaking**: Talking to others to convey information effectively. **Mathematics**: Using mathematics to solve problems. **Science**: Using scientific rules and methods to solve problems.
Process skills Procedures that contribute to the more rapid acquisition of knowledge and skill across a variety of domains	**Critical Thinking**: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems. **Active Learning**: Understanding the implications of new information for both current and future problem-solving and decision-making. **Learning Strategies**: Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things. **Monitoring**: Monitoring/assessing performance of yourself, other individuals, or organisations to make improvements or take corrective action.
	Cross-functional skills
Social skills Developed capacities used to work with people to achieve goals	**Social Perceptiveness**: Being aware of others' reactions and understanding why they react as they do. **Co-ordination**: Adjusting actions in relation to others' actions. **Persuasion**: Persuading others to change their minds or behaviour. **Negotiation**: Bringing others together and trying to reconcile differences. **Instructing**: Teaching others how to do something. **Service Orientation**: Actively looking for ways to help people.
Complex problem solving skills Developed capacities used to solve novel, ill-defined problems in complex, real-world settings	**Complex Problem Solving**: Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
Technical skills Developed capacities used to design, set-up, operate, and correct malfunctions involving application of machines or technological systems	**Operations Analysis**: Analysing needs and product requirements to create a design. **Technology Design**: Generating or adapting equipment and technology to serve user needs. **Equipment Selection**: Determining the kind of tools and equipment needed to do a job. **Installation**: Installing equipment, machines, wiring, or programmes to meet specifications. **Programming**: Writing computer programmes for various purposes. **Operations Monitoring**: Watching gauges, dials, or other indicators to make sure a machine is working properly. **Operation and Control**: Controlling operations of equipment or systems. **Equipment Maintenance**: Performing routine maintenance on equipment and determining when and what kind of maintenance is needed. **Troubleshooting**: Determining causes of operating errors and deciding what to do about it. **Repairing**: Repairing machines or systems using the needed tools. **Quality Control Analysis**: Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
System skills Developed capacities used to understand, monitor, and improve socio-technical systems	**Judgment and Decision Making**: Considering the relative costs and benefits of potential actions to choose the most appropriate one. **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.

Resource management skills Developed capacities used to allocate resources efficiently	**Time Management**: Managing one's own time and the time of others. **Management of Financial Resources**: Determining how money will be spent to get the work done, and accounting for these expenditures. **Management of Material Resources**: Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work. **Management of Personnel Resources**: Motivating, developing, and directing people as they work, identifying the best people for the job.

Source: O*NET Database.

In O*NET, the level of the 35 available skills (i.e. the degree, or point along a continuum, to which a skill is required or needed to perform an occupation) is provided on a 1-7 scale. However, to compare skills across occupations and make this chapter's results more intuitive, average levels have been standardised to a scale ranging from 0 to 100, using the following equation:

$$level_{standard} = \left(\frac{level_{original} - level_{minimum}}{level_{maximum} - level_{minimum}}\right) * 100$$

where $level_{standard}$ is the standardised rating of a skill level, $level_{original}$ is the original skill rating on the 1-7 scale, $level_{minimum}$ is the lowest possible rating for that skill, and $level_{maximum}$ is the highest possible rating (see Adserà and Bhowmick (2022[12]) for a similar strategy).

In 2009, the O*NET programme launched the project "Greening of the World of Work: Implications for O*NET-SOC and New and Emerging Occupations", whose goal is to explore the impact of green economy activities and technologies on occupational requirements. With the help of occupational analysts and experts, the O*NET programme has identified three categories of occupations linked to the green transition (Dierdorff et al., 2009[13]):[6]

- Green Increased Demand Occupations: occupations already included in the O*NET database that see an increase in employment demand due to the green transition but without there being significant changes in tasks and skills requirements. In other words, these are occupations whose work context may change, but their tasks themselves do not.
- Green Enhanced Skills Occupations: occupations already included in the O*NET database that see a significant change in tasks due to green economy activities. While their essential purpose remains the same, tasks, skills and knowledge tend to be altered because of the green transition.
- New and Emerging Green Occupations: occupations that did not exist in the O*NET database and have been recently created through green economy activities.

The category of "New and Emerging Green Occupations" is clearly defined, as it represents only those occupational titles that emerged because of the green transition but did not exist in the O*NET taxonomy before 2009. This category mostly includes environment-related jobs, such as wind energy engineer or industrial ecologist. By contrast, definitions for "Green Increased Demand Occupations" and "Green Enhanced Skills Occupations" are less clear-cut. Both represent occupations that already existed in the O*NET database, and the difference between them is linked to the change (or absence thereof) in tasks. Both categories include environment-related occupations (such as environmental engineer for enhanced skills jobs and hydrologists for increased demand jobs), as well as occupations that are not inherently linked to green outputs or processes (e.g. machinists, chemists, carpenters, …). For this reason, this chapter combines them in one single group, thereby ending up with two definitions of green-driven occupations: new occupations and established occupations.[7]

These two categories of jobs are exploited to provide a snapshot of the skills and knowledge required by the green transition. They are also used to explore the differences between the skill requirements of green-driven occupations, GHG-intensive occupations,[8] and environmentally neutral occupations, where the latter refers to occupations that are simultaneously neither green-driven nor GHG-intensive, and, therefore, are not directly linked to the green transition.

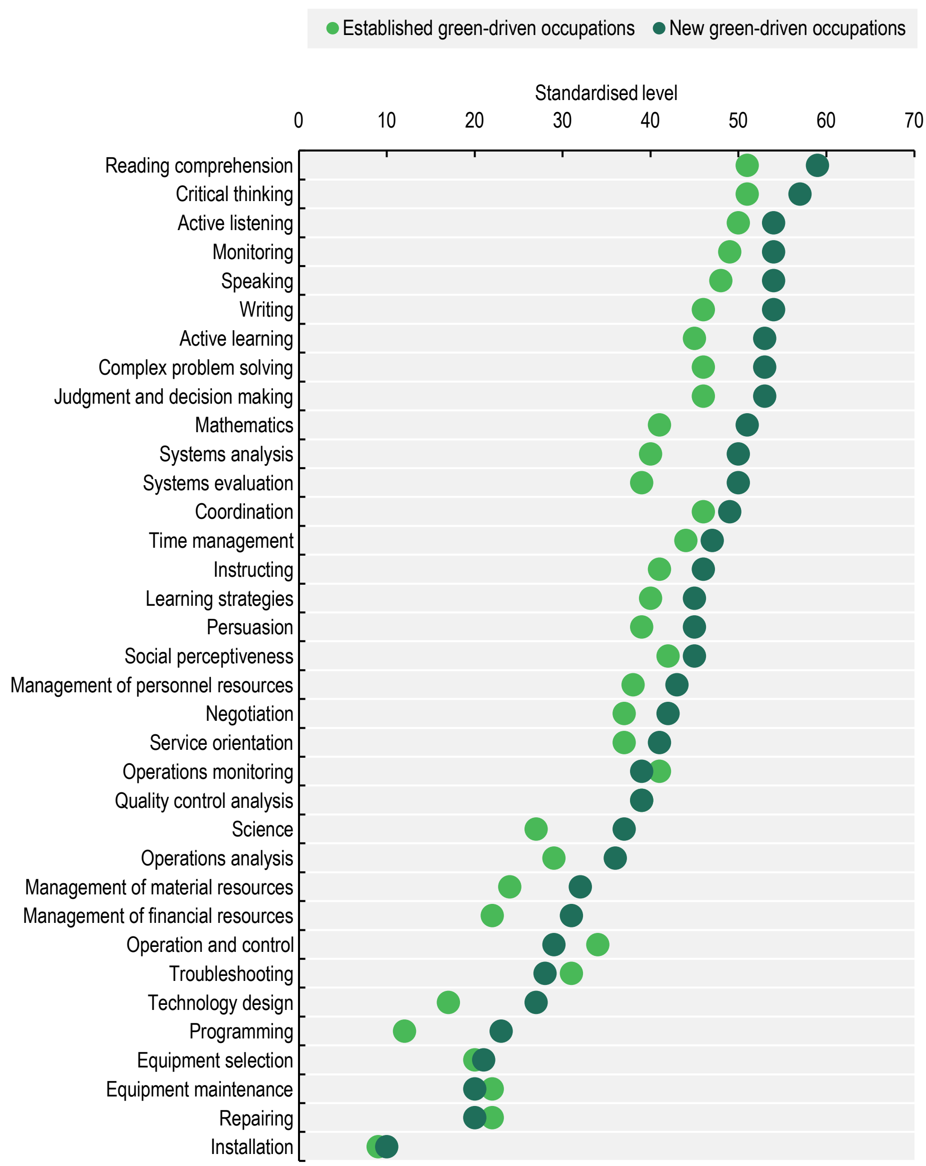
4.2.2. Green-driven occupations require great proficiency of information processing skills

Similar to the pattern observed generally across most occupations in OECD countries (Handel, 2012[14]), the skills required at the highest proficiency by both established green-driven occupations and new green-driven occupations are process skills, i.e. those procedures that contribute to the more rapid acquisition of knowledge across a variety of domains (Figure 4.1).[9] These include critical thinking, monitoring and active learning. Process skills are essential for acquiring new knowledge, and their importance in green-driven occupations illustrates that workers are expected to be constantly able to learn new techniques and adapt to new lines of work. This is not surprising given the rapid technological advancements in the field and businesses adapting to new green demands. Green-driven occupations also require good proficiency in a number of cross-functional skills which are typically linked to the knowledge economies (economies where the generation, distribution, and application of knowledge and information plays a significant role), such as complex problem solving and judgement and decision making. This shows the key relevance of workers' adaptability and proactivity in rapidly changing work contexts.[10]

By contrast, in line with general labour-market developments, technical skills – i.e. those developed capacities used to design, set-up, operate, and correct malfunctions involving application of machines or technological systems – are on average required at a low level in green-driven occupations. This is the case, for example, of equipment selection and maintenance, repairing, and installation, as well as certain resource management skills, like management of material or financial resources. This reflects two important trends. On the one hand, green-driven occupations tend to be analytical jobs with fewer physical tasks, and hence manual skills (like installation) are less required. On the other hand, averages mask important differences across jobs. In fact, while not extensively used by most workers, technical skills remain essential for specific positions, including some green-driven occupations. For example, repairing and equipment maintenance are the most required skills for wind turbine service technicians. Similarly, resource management skills are fundamental for green-driven occupations like geothermal production managers or biomass power plant managers.

Figure 4.1 points at another central finding. Even if trends across skill categories remain similar for the two groups, new occupations emerging from the shift towards a cleaner economy require on average a higher proficiency in almost all skills compared to established green-driven occupations. In other words, the degree of proficiency to which a particular skill is required for an occupation is typically higher for emerging, fast-growing jobs,[11] suggesting that the new lines of work require even more skilled workers.[12] This is critical since it implies that as new occupations emerge, the green transition is gradually raising the demand for all skills in the labour market, with clear consequences for the future world of work and skill policies.

Figure 4.1. Skill requirements of green-driven occupations



Note: The figure shows the level at which a particular skill is required or needed to perform tasks in the occupation. For an easier interpretation, means have been standardised to a scale ranging from 0 to 100, where greater values implies that a given skill is required at higher levels.
Source: OECD elaboration based on O*NET data.

4.2.3. Skill requirements are similar across different types of high-skill jobs, while they are much higher for low-skill green-driven occupations

Figure 4.2 compares, at a lower level of granularity, the average skill requirements of green-driven occupations to those of GHG-intensive occupations, as well as to neutral occupations. A potential bias might arise in this analysis if the occupations linked to the green transitions were extremely different from those in the rest of the economy, especially in terms of skill requirements. To control for it, this chapter compares jobs that fall in the same "job zone", which is defined by O*NET as a group of occupations with similar requirements for education, experience, and on-the-job training. For example, the O*NET job zone 1 ("occupations that need little or no preparation") includes occupations such as dishwashers, cement masons and dry-cleaning workers. By contrast, the most demanding job zone, O*NET job zone 5 ("occupations that need extensive preparation"), includes anaesthesiologists, biologists and hydrologists.

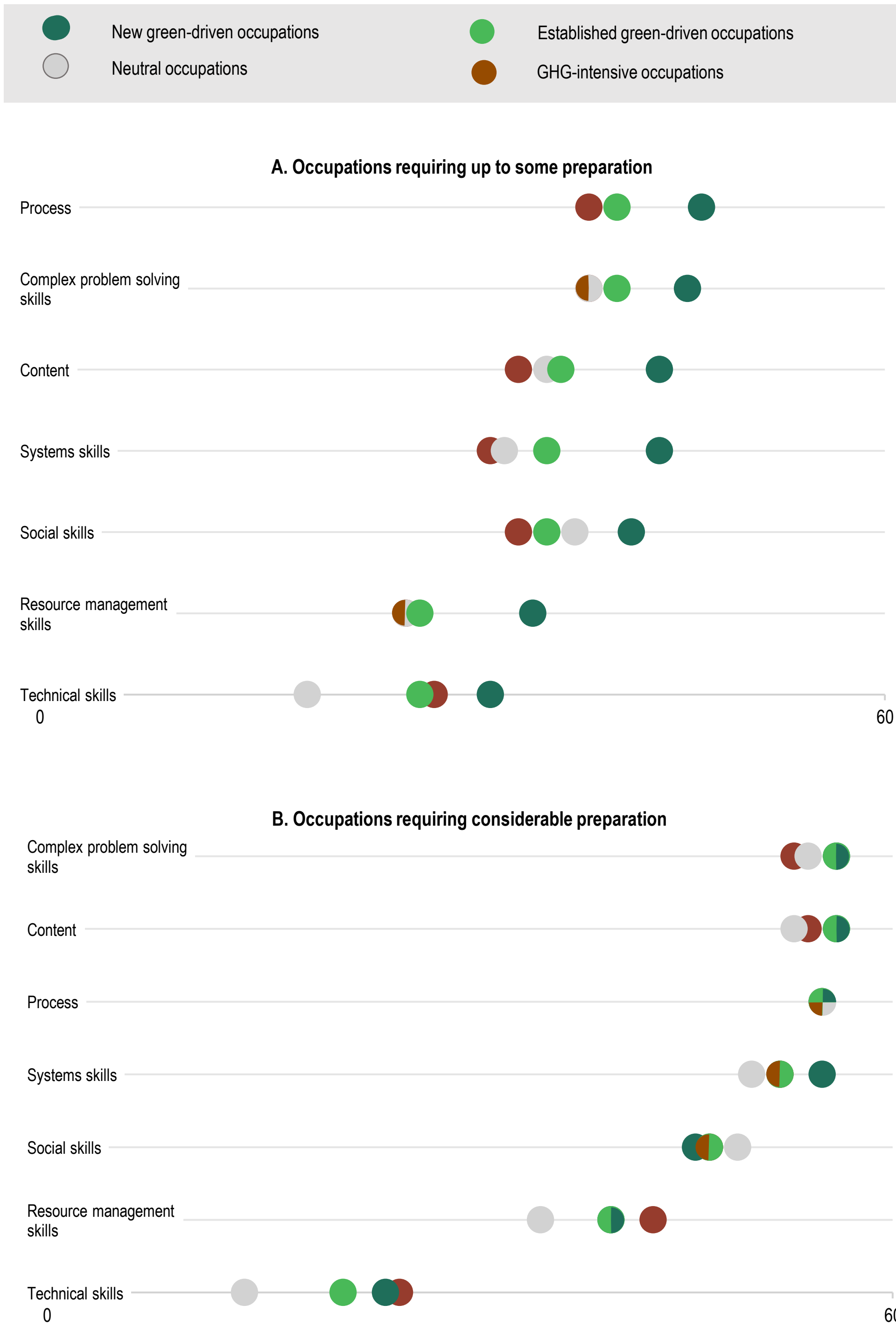
To make the results easier to interpret and ensure sufficiently large sample sizes, the five original job zones developed by O*NET have been aggregated into two categories: occupations requiring "up to moderate preparation" and occupations requiring "at least considerable preparation".[13] In particular, occupations included in the second category typically require at least a bachelor's degree, two to four years of work-related experience and relevant on-the-job or vocational training. This is the case, for example, for accountants, chemists and engineers.

Within low-skill jobs (needing little to moderate preparation only), new green-driven occupations – such as solar photovoltaic installers or geothermal technicians – require much higher levels of all skills than the other job categories (Panel A of Figure 4.2). This confirms the greater complexity of the emerging occupations, even within the category of lower-skilled jobs. Established green-driven occupations – e.g. forest and conservation workers – also have greater skill requirements than GHG-intensive and neutral occupations, but levels are significantly closer to those of other occupations. On average, GHG-intensive occupations – such as extraction workers or wellhead pumpers – require the least proficiency in all skill categories, except for technical skills, suggesting that this type of jobs rely more on manual work and mechanics.

On the other hand, estimates for high-skill occupations (needing at least considerable preparation), show a more striking pattern: differences in skill requirements across job categories are much smaller (Panel B of Figure 4.2). In the extreme case of process skills (e.g. critical thinking, active learning), there is no gap at all. GHG-intensive and green-driven occupations, both established and new, are particularly similar in their requirements of all basic skills (both process and content), and in some other cases GHG-intensive occupations – such as mining and geological engineers – require even greater skill proficiency – namely, for social skills, resource management skills and technical skills.

Overall, these results suggest that transitions out of GHG-intensive occupations and into the most innovative green-driven occupations can be easier to achieve for those working in high-skilled positions than for low-skilled workers, who would need extensive re- and up-skilling before making the move.[14] For this latter group of workers, transitions from GHG-intensive to neutral occupations may be more feasible, as skill requirements of these two job categories are much more similar. Yet, workers in low-skill jobs will have to undertake training for more skills than their higher-skilled counterparts to enter greener employment. If training is not made accessible to all individuals, including the most disadvantaged, it may be very challenging to fill the vacancies of those lower-skill green-driven jobs. Moreover, low-skilled workers displaced from GHG-intensive industries might find it more difficult to move into fast-growing labour market segments – see also Chapter 3 – and risk being left behind in the green transition.

Figure 4.2. Skill requirements by type of occupation



Note: The figure shows the level at which a group of skills is needed to perform the occupation. For an easier interpretation, means have been standardised to a scale ranging from 0 to 100, where greater values implies that a given skill category is required at higher levels.
Source: OECD elaboration based on O*NET data.

To efficiently undertake a task, workers do not only need to be proficient in a number of skills, but also must have good knowledge of certain domains.[15] In particular, new and emerging green-driven occupations require higher levels of scientific knowledge. The main knowledge areas that are needed to work in these occupations (both those requiring up to moderate preparation, such as wind turbine service technicians, and those requiring at least considerable preparation, such as wind energy engineers) are engineering and technology, mathematics, and computers and electronics (Figure 4.3). Knowledge of mechanics – i.e. the knowledge of machines and tools, including their design, use, repair, and maintenance – and English language – this being a proxy for mastering the language of the country of residence, which is the United States for O*NET data – is also required in up to moderate preparation (Panel A) and at least considerable preparation (Panel B) occupations. It is worth noting that the same knowledge can be applied to different tasks (which are more occupation-specific) and the knowledge of mechanics can be applied to many different types of machines and tools.

High-skilled GHG-intensive occupations require many of the same knowledge areas as green-driven occupations – namely, mathematics, engineering and technology, and English language. However, low-skill GHG-intensive occupations have considerably different knowledge requirements than green-driven jobs: their most required knowledge areas are education and training, production and processing, and public safety and security (in addition to mechanical, which they share with green-driven occupations). Once again, these results confirm that for jobs requiring up to moderate preparation there is a discrepancy between the knowledge that workers acquire in GHG-intensive occupations and what is needed in green-driven occupations. This is less the case for high-skilled jobs, for which knowledge areas are similar regardless of their link to the green transition.

Figure 4.3. Most required knowledge areas by type of occupation

A. Occupations requiring up to moderate preparation in terms of education, experience, and on-the-job training

GHG-intensive occ.	New green-driven occ.
Mechanical	Mechanical
Education and training	Engineering and technology
Production and processing	Mathematics
Public safety and security	Computers and electronics

B. Occupations requiring at least considerable preparation in terms of education, experience and on-the-job training

GHG-intensive occ.	New green-driven occ.
Mathematics	Mathematics
English language	English language
Engineering and technology	Engineering and technology
Administration and management	Computers and electronics

Note: For each group of occupations, the figure shows the top 4 knowledge areas that workers need to perform the occupation (areas are not presented according to their actual ranking).
Source: OECD elaboration based on O*NET data.

4.2.4. Reskilling will be needed to facilitate job transitions out of GHG-intensive occupations, particularly for workers in certain sectors

To shed additional light on feasible job transitions for workers out of GHG-intensive occupations, skill distances between occupation pairs are computed (see Box 4.3 for a description of the methodology to measure skill distances). Understanding how close jobs are in terms of skill requirements can provide useful information on career opportunities for workers in declining industries. In Table 4.2, every row represents the top 5 occupations – either green-driven (coloured in green) or neutral (coloured in grey) – that are closest to a given GHG-intensive occupation in terms of skill requirements. This ranking is based on skill distances between occupation pairs, and it is restricted to occupations within the same job zone to ensure that potential transitions take into account occupational requirements in terms of education, experience and training. Results are presented by sector, but the computation of skill distances considers all occupations, including those in other industries.

Box 4.3. Measuring skill distances between occupations

The methodology adopted to calculate skill distances between occupation pairs builds on previous OECD work, such as OECD (2019[15]), OECD (2022[16]) and Tuccio et al. (2023[17]). First, for each item n – which is one of the 35 skills, 52 abilities or 33 knowledge areas that are included in the O*NET database – we compute the difference between the level of that skill, ability and knowledge area for a given occupation, i, and for another occupation, j, both belonging to the same O*NET job zone. Then, these individual distances are squared and added up. The Euclidean distance is the square root of the resulting value:[1]

$$dist_{i,j} = \sqrt{\sum_{n=1}^{120} (value_i^n - value_j^n)^2}$$

Once the Euclidean distances are computed for all US Standardized Occupational Classification (SOC) occupations at the most detailed level (8-digit), the values are normalised between 0 and 100 using a min-max approach similar to the one described in Box 4.2, where the minimum value is 0 (i.e. in case occupation i and occupation j coincides) and the maximum value is the largest distance observed across all occupation pairs in the dataset. Occupation pairs are then sorted by distance. A small distance between two occupations corresponds to a high degree of similarity in skill requirements, and it therefore suggests the need of less retraining efforts should the worker choose to move from occupation i to occupation j. Larger distances imply very different skill profiles between occupation pairs, and hence modest potential for transitions without major reskilling.

1. Given the focus of this chapter on skill profile similarities between occupations, this analysis does not set negative terms for $(value_i^n - value_j^n)$ to zero. While this has been used in the past to introduce an asymmetry in retraining (such as in OECD (2022[16])), the analysis of this chapter seeks to capture the absolute distance between two occupations rather than a directional transition from one occupation to another. Moreover, introducing zero values for negative skill distances generates the risk of relying on limited sets of skills to measure overall distances between occupations. Similarly, this chapter does not use O*NET importance ratings as a weight in the distance calculation to give more value to those skills particularly important for occupation *j*. If weights were used, results would be affected by an overreliance on a smaller skill set. Given the pertinence of transitioning workers out of GHG-intensive occupations, assigning equal importance to all skills, abilities, and knowledge areas gives a more holistic overview of skill profiles.

The main finding stemming from Table 4.2 is that, across the board, the majority of GHG-intensive occupations share similar skill requirements with at least one neutral or green-driven occupation. In other words, the standardised skill distance between most emission-intensive jobs and their closest non-polluting occupation is within 25% of the maximum distance, i.e. it is less than 25 in a 0-100 scale. For example, the skill requirements of pourers and casters in manufacturing (a GHG-intensive occupation) are similar to those of polishing workers (a neutral occupation) (skill distance = 13). In a similar vein, extraction workers in mining have a comparable skill profile to the established green-driven profession of rail-track laying operators (skill distance = 15). No GHG-intensive occupations have the exact same skill requirements as a neutral or green-driven job, suggesting that even when occupations are similar in skills some retraining effort will be needed to enable the transition.

Notable exceptions are GHG-intensive occupations related to air transportation. These appear to require a very specific mix of skills compared to other jobs, with the extreme case of airline pilots, having such a unique skill profile that the skill distance to their closest occupation is as large as 48. If the airline transportation sector were to decline as a consequence of the transition to net-zero emissions, its workers would have major reskilling needs to facilitate transitions to different industries. However, if the air transportation sector were to produce fewer GHG emissions through new green technologies, these workers would only need upskilling to accommodate new green tasks.

Interestingly, results in Table 4.2 also suggest that, not only transitions out of GHG-intensive occupations are feasible for most workers, but many individuals in these roles can even move to green-driven occupations if accompanied by tailored reskilling. In particular, the skill profile of GHG-intensive occupations in mining and oil and gas is markedly similar to that of at least one green-driven occupation (see one example in Figure 4.4 below). By contrast, most GHG-intensive occupations in manufacturing and several GHG-intensive occupations in agriculture and transport may struggle to transition directly to a green-driven occupation without important retraining efforts, as skill requirements are relatively different. For workers in such roles, therefore, moving towards a neutral occupation could be a more feasible career option. For example, purely based on their skill profile, furnace operators might find it easier to reconvert to the neutral occupation of machine feeders (skill distance = 16) than to become biomass plant technicians, which is their closest new green-driven occupation (skill distance = 29).

Clearly, this analysis of theoretical career transitions based on skill profile similarity does not take into consideration other important factors such as wage differences or available vacancies, which ultimately depend on local labour markets and vary from country to country or even from locality to locality. As argued by Borgonovi et al. (2023[18]), if declining industries were concentrated in certain regions while growing industries were located in others, skills policies would need to be complemented by mobility initiatives to effectively enable workers to transition between these sectors – see also Chapter 2. Moreover, the transitions suggested by Table 4.2 do not consider the fact that workers in emission-intensive sectors may face substantial competition from workers with specific experience in climate-friendly sectors or more relevant qualifications.

Table 4.2. Skill similarity between GHG-intensive occupations and other occupations

	Distance to closest occ.	#1	#2	#3	#4	#5
Agriculture-related GHG-intensive occupations						
Farm Labor Contractors	27					
Graders and Sorters, Agricultural Products	22					
Animal Breeders	25				■	
Agricultural Equipment Operators	20	■				■
Fallers	24	■				■
Farmworkers, Farm, Ranch, and Aquacultural Animals	19		■		■	
Logging Equipment Operators	19		■	■		
First-Line Supervisors of Farming, Fishing, and Forestry Workers	20		■	■		■
Farmworkers and Laborers, Crop, Nursery, and Greenhouse	24	■	■	■		
Fishing and Hunting Workers	19		■		■	■
Farmers, Ranchers, and Other Agricultural Managers	22	■	■	■		
Oil and gas-related GHG-intensive occupations						
Wellhead Pumpers	21					■
Derrick Operators, Oil and Gas	19	■		■		
Rotary Drill Operators, Oil and Gas	21	■	■	■		
Petroleum Engineers	23		■	■	■	
Gas Compressor and Gas Pumping Station Operators	19		■	■	■	
Gas Plant Operators	13	■	■			■
Roustabouts, Oil and Gas	17	■		■	■	■
Petroleum Pump System Operators, Refinery Operators, and Gaugers	17	■	■	■		■
Pump Operators, Except Wellhead Pumpers	15	■	■		■	■
Mining-related GHG-intensive occupations						
Roof Bolters, Mining	17	■				■
Rock Splitters, Quarry	19	■		■		
Helpers – Extraction Workers	15	■			■	
Loading and Moving Machine Operators, Underground Mining	20	■	■		■	
Excavating and Loading Machine and Dragline Operators, Surface Mining	17	■		■	■	
Mining and Geological Engineers, Including Mining Safety Engineers	21	■		■	■	■
Manufacturing-related GHG-intensive occupations						
Extruding, Pressing, and Compacting Machine Setters, Operators and Tenders	13					
Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders	16					
Shoe Machine Operators and Tenders	18					
Extruding and Forming Machine Setters, Operators and Tenders, Synthetic-Glass	13					
Refractory Materials Repairers, Except Brickmasons	16	■				
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	15	■				
Pourers and Casters, Metal	13		■			
Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	17			■		
Metal-Refining Furnace Operators and Tenders	16			■		
Glass Blowers, Molders, Benders, and Finishers	14			■		
Cutting and Slicing Machine Setters, Operators, and Tenders	12			■		
Foundry Mold and Coremakers	14					■
Paper Goods Machine Setters, Operators, and Tenders	14					■
Patternmakers, Metal and Plastic	17			■	■	
Control and Valve Installers and Repairers, Except Mechanical Door	17			■	■	■
Transportation-related GHG-intensive occupations						
Airfield Operations Specialists	23					
Flight Attendants	23					
Reservation and Transportation Ticket Agents and Travel Clerks	24					

	Distance to closest occ.	#1	#2	#3	#4	#5
Electrical and Electronics Installers and Repairers, Transportation Equipment	21	Grey	Grey	Grey	Grey	Grey
Dredge Operators	19	Green	Grey	Grey	Green	Grey
Railroad Brake, Signal, and Switch Operators and Locomotive Firers	18	Green	Grey	Green	Grey	Grey
Airline Pilots, Copilots, and Flight Engineers	48	Grey	Green	Grey	Green	Grey
Captains, Mates, and Pilots of Water Vessels	24	Grey	Green	Green	Grey	Grey
Aircraft Mechanics and Service Technicians	19	Grey	Grey	Green	Green	Green
Aircraft Cargo Handling Supervisors	24	Grey	Grey	Green	Green	Grey
Rail Yard Engineers, Dinkey Operators, and Hostlers	17	Green	Green	Grey	Grey	Grey
Commercial Pilots	30	Green	Green	Grey	Grey	Green
Sailors and Marine Oilers	20	Grey	Grey	Green	Green	Green
Rail Car Repairers	18	Grey	Green	Green	Green	Green
Signal and Track Switch Repairers	22	Green	Green	Grey	Green	Green
Ship Engineers	21	Green	Green	Green	Grey	Green

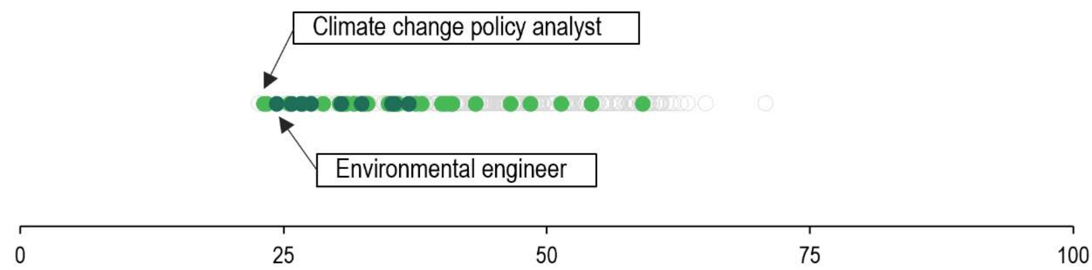
Note: The table presents the standardised distance (in a 0-100 scale) between each GHG-intensive occupation and its closest green-driven or neutral occupation (column "Distance to closest occ."). The table also shows the top 5 most similar occupations based on skill distances (columns "#1" to "#5"), where green squares represent green-driven occupations and grey squares represent neutral occupations. The square furthest left (i.e. "#1") denotes the most similar occupation to the GHG-intensive occupation, while the square on the right (i.e. "#5") denotes the fifth most similar occupation.
Reading: For the GHG-intensive occupation of roof bolters in mining the most similar occupation in terms of skills requirement is a green-driven occupation, the second, third and fourth most similar occupations are neutral, while the fifth most similar occupation is also green-driven. Roof bolters and their most similar occupation have a skill distance of 17 (out of 100).
Source: OECD elaboration based on O*NET data.

4.2.5. Two case studies: Petroleum engineers and rolling machine setters, operators and tenders

Average skill distances hide significant variation. As a result, deriving meaningful insights on job transitions based on skill distances necessitates a disaggregated approach to acknowledge the intricate interplay of a myriad of possible career pathways. For the purpose of this chapter, career mobility options out of two GHG-intensive occupations – one requiring at least considerable preparation and one requiring up to moderate preparation – are explored.

The case of petroleum engineers – a GHG-intensive occupation requiring high education, training and experience – illustrates well the potential of reskilling to transition out of polluting industries. In fact, when the distance of this job vis-à-vis all other occupations requiring at least considerable preparation is computed based on their respective skill requirements, many green-driven occupations appear to have a similar skill profile (Figure 4.4). In particular, both environmental engineers (an established green-driven occupation) and climate change policy analysts (a new green-driven occupation) are among the five most similar occupations to petroleum engineers on the basis of their skill requirements.

Figure 4.4. Skill distance of occupations from petroleum engineers

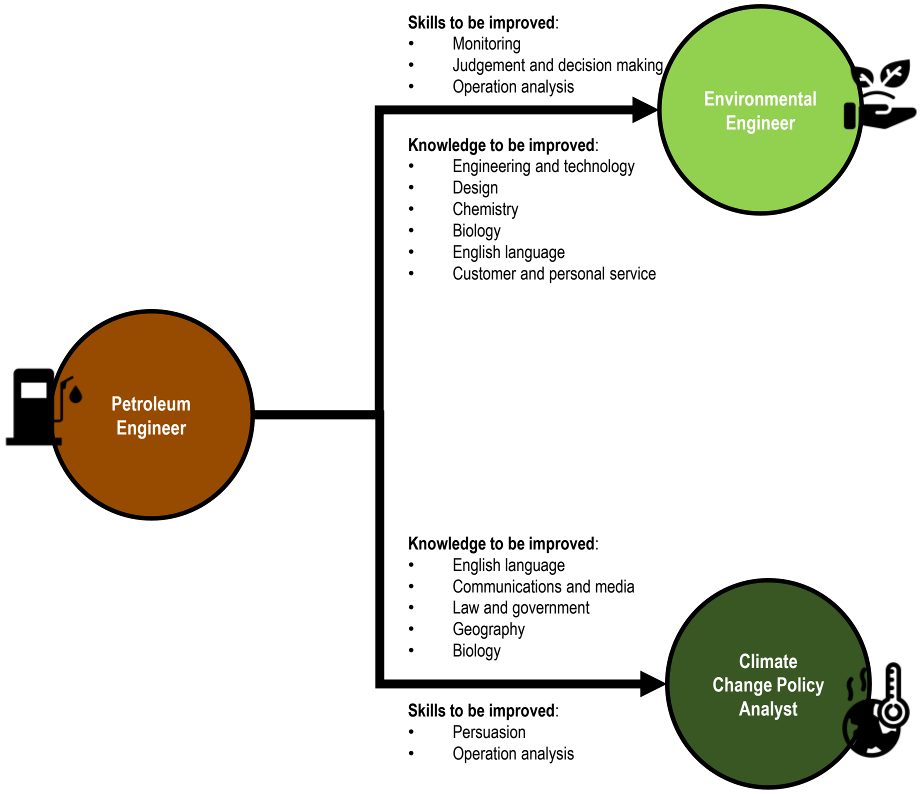


Note: Each dot in the figure represents an occupation (grey and white dots are neutral occupations, light green dots are established green-driven occupations, dark green dots are new green-driven occupations). Dots are ranked based on their skill distance with petroleum engineers – dots on the left (right) represent occupations that are very similar (different) to petroleum engineers.
Source: OECD elaboration based on O*NET data.

Ultimately, petroleum engineers would need to (re)train only on few skills to enter either one of these roles (Figure 4.5). For example, to become environmental engineers, petroleum engineers would need to enhance their proficiency in monitoring and operation analysis – that is the ability to analyse needs and product requirements to create design – and have better knowledge of chemistry and biology. Similarly, petroleum engineers already meet most of the requirements to become climate change policy analysts, except skills linked to communication and advocacy. This shows that, should the oil industry phase out, petroleum engineers could transition to a job that actively contribute to a net-zero economy by retraining on a limited number of skills (although some of these – especially knowledge areas such as chemistry – might require a longer training duration).

As discussed in the previous section, skill similarity alone cannot explain transitions between occupations: a lack of substantial wage losses and availability of jobs are also key determinants of job mobility. In the case of the United States, for example, the 2023 median pay for a petroleum engineer was USD 135 690 per year and there were about 20 400 individuals employed in this occupation. While on average environmental engineers earn less (USD 100 090 per year), there are more job opportunities in this field in the United States – in 2023, 39 900 workers were employed as environmental engineers and the projected percentage change in employment from 2022 to 2032 is 6%, compared to an average growth rate for all occupations of 3% (U.S. Bureau of Labor Statistics, 2024[19]). Nevertheless, Box 4.4 suggests that these theoretical career moves are already occurring, presenting evidence from the oil industry in the United States.

Figure 4.5. Examples of job transition pathways for petroleum engineers



Note: Skills and knowledge areas are considered as "to be improved" if the standardised level of the item for destination occupations is over 5 points higher (in a scale 1-100) than for petroleum engineer.
Source: OECD elaboration based on O*NET data.

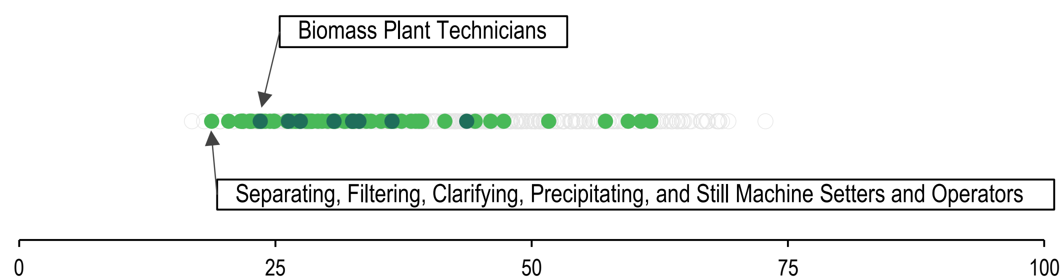
Box 4.4. How petroleum engineers are driving the renewable revolution in Texas

Following the oil price collapse during the COVID-19 pandemic, oil and gas companies in the United States laid off almost 160 000 workers in 2020. By contrast, many renewable businesses have been expanding rapidly since the initial shock of the pandemic, mostly thanks to the availability of skilled labour among former oil and gas workers. In energy hubs in Houston and Dallas, Texas, workers have been steadily transitioning from fossil fuel to renewable energy jobs. A recent study finds that 125 000 oil exploration, production and pipeline jobs were lost in the Houston area from 2014 to 2020, a 26% reduction, with an estimate that many more traditional energy jobs could be lost over the next three decades (Greater Houston Partnership, 2021[20]). By comparison employment in wind energy grew nearly 20% from 2016 to 2021, to more than 113 000 workers in the industry. Companies in the renewable energy sector report recruiting a large part of their workforce from the oil and gas sector, due to the easy transfer of knowledge and skills between the two industries. Workers also find transitioning from oil and gas to renewable energy relatively easy, arguing that "the basics are the same" in terms of tasks and skills. Further, workers in Texas find that emerging industries offer more job stability and future career opportunities thanks to their rapid expansion. This example supports economic theory that workers' relocation costs depend on the skill similarity between occupations and that workers move to occupations with similar task requirements (Gathmann and Schönberg, 2010[21]).

Source: Krauss, C (2023) *As Oil Companies Stay Lean, Workers Move to Renewable Energy* in The New York Times: www.nytimes.com/2023/02/27/business/energy-environment/oil-gas-renewable-energy-jobs.html.

Another illustrative example is the one of rolling machine setters, operators and tenders – workers who set up, operate, or tend machines to roll steel or plastic forming bends, beads, knurls, rolls, or plate, or to flatten, temper, or reduce gauge of material. This is a GHG-intensive occupation requiring up to moderate preparation, employing about 24 750 individuals in the United States in 2023, with a median pay of USD 47 040 per year (U.S. Bureau of Labor Statistics, 2024[19]). Among the top 10 occupations with relatively similar skills requirements to those of rolling machine setters, operators and tenders, there are only two established green-driven occupations – namely, separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders (in 3rd position) and engine and other machine assemblers (in 6th position). By contrast, there is virtually no new green-driven occupation that is very similar in terms of skill profile, as the first of these emerging occupations (biomass plant technicians) comes in 33rd position (Figure 4.6).

Figure 4.6. Skill distance of occupations from rolling machine setters, operators and tenders

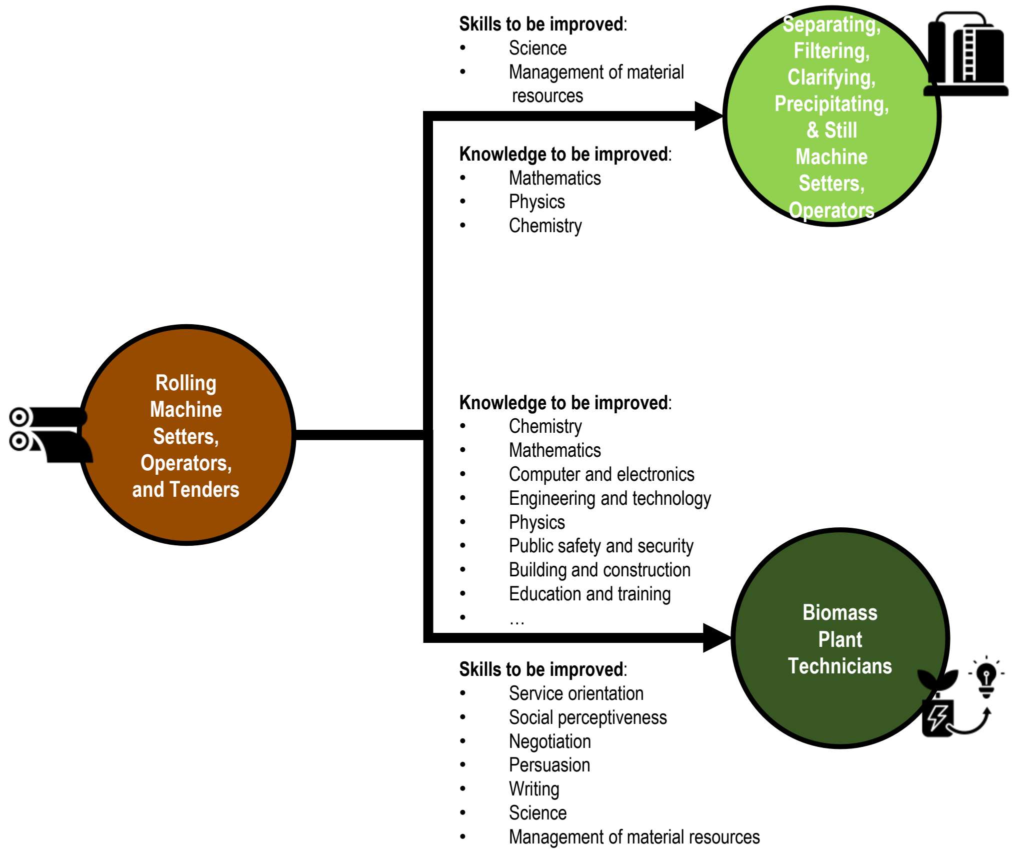


Note: Each dot in the figure represents an occupation (grey and white dots are neutral occupations, light green dots are established green-driven occupations, dark green dots are new green-driven occupations). Dots are ranked based on their skill distance with rolling machine setters, operators and tenders – dots on the left (right) represent occupations that are very similar (different) to rolling machine setters, operators and tenders.
Source: OECD elaboration based on O*NET data.

It should come as no surprise that the skill requirements of the GHG-intensive occupation of rolling machine setters, operators and tenders are very similar to those of still machine setters, operators and tenders working on the extraction, sorting, or separation of liquids, gases, or solids from other materials to recover a refined product (Figure 4.7). In fact, the main difference between the two jobs lies in the products they manufacture and the technology used. Notably, rolling machine operators who would like to shift towards this green-driven occupation would have to improve their knowledge of mathematics, physics and chemistry, which is needed to understand processes such as precipitating, fermenting or evaporating. Once again, this remains a theoretical career pathway and it does not account for actual vacancies or working conditions that might influence a worker's decision differently. In terms of pay, 2023 data from the United States shows that the median pay for separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders is close to that of the GHG-intensive occupation rolling machine setters, operators and tenders (U.S. Bureau of Labor Statistics, 2024[19]).

On the other hand, the most similar new green-driven occupation – biomass plant technician – has a very different skill profile. In addition to increasing their knowledge of mathematics, physics and chemistry, rolling machine operators would have to learn notions of computer and electronics, engineering and technology, as well as public safety and security, building and construction, and many other fields. Proficiency should also be expanded for many skills, including service orientation, social perceptiveness, negotiation and persuasion – underscoring the greater role that social interactions play for biomass plant technicians.

Figure 4.7. Examples of job transition pathways for rolling machine setters, operators and tenders



Note: Skills and knowledge areas are considered as "to be improved" if the standardised level of the item for destination occupations is over 5 points higher (in a scale 1-100) than for rolling machine setters, operators and tenders.
Source: OECD elaboration based on O*NET data.

4.3. Targeted policies are needed to foster skills for the green transition

To avoid that the burden of the green transition is shared unequally and to ensure that everybody can seize the opportunities that will be created in the green economy, targeted policies will have to be implemented to facilitate the transition of workers out of GHG-intensive occupations as well as the entry of workers into the growing green-driven occupations, all while trying to avoid large social costs for individuals and communities. The impact of the transition to a net-zero economy and climate mitigation policies is uneven across socio-economic groups, negatively impacting those with low education attainment and skill levels (see Chapters 2 and 3), who will also suffer the most as consumers (see Chapter 5). In the endeavour to carry out a just transition to net-zero, extra attention will have to be devoted to low-skilled workers who face larger skill gaps in job transitions and generally participate less in training.

Decision makers are faced with a variety of policy options to foster the development of skills for the green transition, and combinations of different policy tools are likely to be necessary. This section reviews policy interventions available to expand and improve training programmes, and to facilitate job transitions away from declining jobs in GHG-intensive sectors and/or into green-driven jobs. It also provides good-practice examples to contextualise the policy tools and their benefits. The OECD prepared two policy questionnaires to collect information on good practices across OECD countries in the area of green transition: the 2023 policy questionnaires "Adult Learning for the Green Transition" and "Labour and Social Policies for the Net-Zero Transition".

4.3.1. Skills assessment and anticipation support evidence-based policy design by identifying relevant gaps in skills for the green transition

Having quality training provision and support services that are aligned with occupational requirements is crucial, and decision makers need to ensure that policies effectively address labour market needs. Data on skill needs provide policy makers with key information to design a wide range of policies to tackle skill shortages. Skill gaps and shortages are already recognised as bottlenecks in green sectors, constraining innovation and technology adaption and slowing down the adoption of green methods and tasks (Keese and Marcolin, 2023[22]).

Skills assessment and anticipation exercises (SAAs) are studies that generate information about the current and future skill needs of the labour market (skill demand) and the available skill supply (OECD, 2016[23]). SAAs rely on a wide range of data sources and inputs to estimate skill gaps, such as data from centralised statistical agencies, ministries, public employment services, employers, employees, education and training providers, and increasingly exploit big data to measure skill needs. The results of SAAs can be used to influence a variety of policies, including formal education, adult learning, career guidance, industry policies and migration policies.

Economy-wide assessments of existing and emerging skill needs are common in OECD countries. More targeted exercises for workforce planning are also conducted focusing on areas facing significant shortages or specific changes in skill needs, such as the healthcare or technology sectors (OECD, 2016[23]; OECD/ILO, 2022[24]). However, SAAs are not yet widely used in policy planning for the green transition (OECD, 2023[1]). There are several challenges in using SAAs to predict needs for green talent, reflecting innate challenges in the green transition itself, such as issues of defining sustainability targets, green industries occupations, and identifying which skills are key in green jobs (OECD, 2023[1]). Nonetheless, building a knowledge base on skills for the green transition is crucial to design and carry out specific skill policies that are responsive to the needs of the net-zero transition.

Employment projections are vital for policy makers to know where jobs are being created and destroyed to direct attention to the sectors and industries most in need of support. However, without a skill dimension, these analyses are less useful when designing policies for transitioning workers and strengthening training systems. Carrying out SAAs and implementing the results in policy making would ensure a close link between employment and training policy.

In Greece, the Ministry of Labour and Social Security has developed the Mechanism of Labour Market Diagnosis, a tool which utilises big data to identify and analyse cutting-edge skills, including skills for the green transition.[16] The analysis uses the ESCO skill taxonomy, as well as data on employment and earnings, and validates findings through quantitative business surveys and qualitative foresight panels. Top green skills are identified for all main sectors, and results are used in policy making by the ministry.

Results from SAAs can be particularly useful to update occupation and qualification frameworks used to define the content of adult training programmes to ensure courses prepare participants for the labour market needs, helping address skills shortages. Many countries are recognising that their national qualification and occupational standards need to be updated to include skills and tasks required to work in a net-zero economy. Assessment and anticipation of skills for the green transition are particularly important to design and implement relevant and tailored courses and training programmes.

For example, the Clean Energy Generation study – a SAA carried out by Jobs and Skills Australia in 2023 – concluded that there is a need to update national occupational standards of jobs related to the green energy transition in order to accurately capture the new skill needs (Jobs and Skills Australia, 2023[25]). The study concluded that there were not sufficient feedback mechanisms to fully incorporate findings on new green jobs and skills in the Australian and New Zealand Standard Classification of Occupations (ANZSCO). The study highlighted examples of discrepancies in skill profiles between occupations in the study and ANZSCO, and the omission of certain key sustainable occupations from the national occupational standards. As such, new projects related to the green economy were made to feature training components with skills identified by the study, including the New Energy Skills Program which assists training organisations in developing up-to-date and industry-relevant training on the green energy transition. In addition, the results of the SAA can be used by Jobs and Skills Councils (JSCs) to draw on workforce analysis and projections to develop plans for their industry sectors and create more consistent approaches to addressing skill gaps. A national network of ten JSCs provides industry with a stronger voice to ensure Australia's VET sector delivers better outcomes for learners and employers. This includes a JSC responsible for energy, gas and renewables sectors, which will play a key role in helping drive the clean energy transition, collaborating with industry to build the required green energy workforce.

Carrying out an SAA for the green transition is an opportunity to change training culture through collaboration among different stakeholders. For example, the Norwegian Committee for Skills Needs published in 2023 an SAA which estimates the effect of the green transition on number of jobs and their skill requirements in Norway. The Committee, which consists of experts and social partners, including actors in the education and training sector, highlights the need to update education and training systems to respond to the changing skill needs (Kompetansebehovsutvalget, 2023[26]).

A major barrier in addressing skill shortages is that the green transition spans across several policy areas. To build a holistic and resilient skill system that can tackle the challenges brought about by the green transition, it is necessary to bring together a wide array of stakeholders relevant to training design and provision as well as to employment and activation policies. SAAs can be a good initial starting point to create connections and communication channels between different education and training providers, government bodies and employers in adapting and shaping the training culture in response to the needs of the green transition.

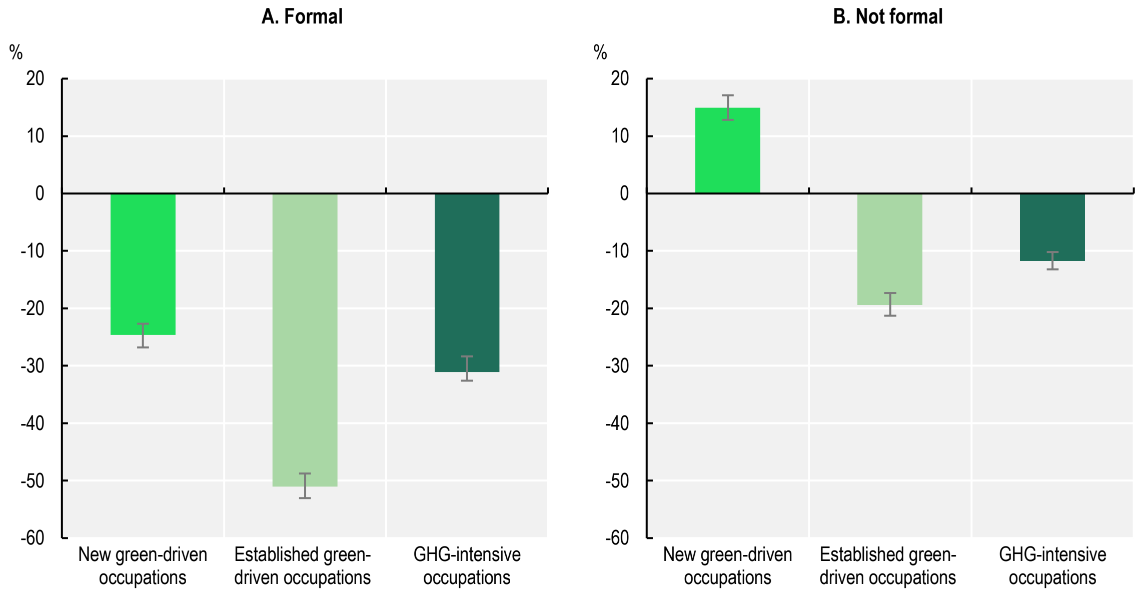
4.3.2. Adult learning needs to be aligned with the needs of the green transition

Training plays a central role in enabling individuals and businesses to benefit from the green transition. Failing to develop and maintain skills that are relevant to labour market needs translates into skill shortages and mismatches, leading to negative effects on individuals' employability and on businesses' productivity and competitiveness.

Yet, in many countries, adult learning systems lack focused policy attention and resources, affecting their readiness to address future skill challenges. Moreover, even when training is available, those who need it the most participate less than the average (OECD, 2019[27]). For instance, in OECD countries, workers in GHG-intensive and green-driven occupations participate less in formal training than the average. Controlling for demographic characteristics, the share of established green-driven occupations is 51% lower among those who participate in formal training than among those who do not and 25% lower for those in new green-driven occupations – see Figure 4.8.[17] Displaying a similar pattern, the share of workers in GHG-intensive occupations is 31% lower for formal training and 12% lower for non-formal training. Analysis by Causa et al. (2024[28]) shows a similar pattern with workers in high-polluting jobs training less across the board while workers in greener jobs participate less in non-formal training in several countries. Reasons why workers in green-driven occupations train less could be complex. One possibility is that workers in green-driven occupations might receive substantial initial education that covers most of the skills they require, thereby reducing the need for frequent, ongoing retraining. Green industries might also develop strong in-house expertise, emphasising informal or on-the-job training over formal learning programmes. However, cross-country differences indicate that policy might play an important role in training participation of workers in green-driven occupations. Indeed, awareness of training opportunities seems to be an issue for green-related topics, and countries should implement policies to increase the availability and awareness of training for the green transition, including for workers in green-driven occupations.

Figure 4.8. Workers in green-driven and GHG-intensive occupations train less than average

Point estimate of the percentage difference between workers that participate in training and those that do not participate, 2018



Note: Panel A and B report the point estimate (and 95% confidence intervals) of the percentage difference in the average incidence of each type of worker between those workers that undertake training and those that do not. Estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of occupation as a dependent variable and including a training dummy (formal training in Panel A and informal training in Panel B), educational attainment (3 classes), gender, age (3 classes) and country dummies as explanatory variables and standard errors clustered on the dimensions of variability of the dependent variable. The reported point estimates and confidence intervals refer to the estimated coefficient of the training dummy and are expressed in percentage of the untransformed dependent variable.
Reading: Controlling for demographic characteristics, the percentage share of green-driven occupations is, on average, 50% lower among employees who undertake formal training and 18% lower among employees who undertake informal training, than among those that do not. The share of workers in GHG-intensive occupations participating is 31% lower for formal training and 12% lower for non-formal training.
Source: OECD estimates based on version 24.1 of the O*NET database and the following country-specific sources: Australia: Table Builder of the Australian Bureau of Statistics (Labour Force: Characteristics of Employment); United States: Current Population Survey; All other countries: EU Structure of Earnings Surveys.

Training for the green transition is becoming a priority for many governments. In 2022 the European Council adopted recommendations to stimulate learning for sustainable development, which highlights the need to provide learning in formal, non-formal and informal settings (European Council, 2022[29]). The United Nations Environment Programme has recently produced a framework for education on green jobs – guidelines aimed at the higher education community on how to prepare students for the green economy (United Nations Environment Programme, 2021[30]). The importance of the challenge is not lost on OECD countries, with 13 out of 26 of them reporting they are funding new training and apprenticeship programmes for the green transition (OECD, 2023[31]).[18]

In Canada, the Energy to Digital Growth Education and Upskilling Project (EDGE UP) was developed by Calgary Economic Development in partnership with the Information and Communication Technology Council (ICTC) with the goal of reskilling displaced mid-career oil and gas professionals and supporting them in starting a career in the technology sector in Calgary. The EDGE UP programme created reskilling pathways based on a skills mapping research study that highlighted the transferrable skills of workers in high-emission occupations and their skills gaps when compared with the needs of the most in-demand digital occupations (Blueprint, 2021[32]). As a result, the programme offers short duration workplace readiness training, technical training (such as IT Project Management, Data Analytics and Software Development), micro credentialing, and employment support. A similar programme also in Canada, Workforce 2030 is a cross-sectoral coalition of employers, educators and practitioners launched to support low-carbon workforce development in the building industry in Ontario. The coalition covers several training initiatives, including the Rapid Upskilling for Green Building programme, which transitions COVID-19-impacted workers into high-demand jobs in the green construction industry. The project focuses specifically on workers from marginalised communities and those underrepresented in the building sector (especially women and youth from racial minorities) and uses employer and union channels to raise awareness on pathways to green employment (Future Skills Centre, 2023[33]).

Work-based learning, including apprenticeships and dual programmes, also has the potential to facilitate the green transition. With work-based learning, individuals can get the experience that employers seek and gain the specific skills and credentials they need to enter new occupations. Work-based learning also has the advantage of linking theoretical knowledge to the practices in the workplace. For the learner, this type of training is associated with a wage or an allowance, making the training more accessible by removing the opportunity cost of learning versus working. For employers, work-based learning gives access to potential job candidates with the specific skills and experiences needed to fill vacant roles and allows them to tailor the learning to their business needs. For example, the Australian New Energy Apprenticeships Program seeks to support 10 000 apprentices in the clean and renewable energy sector.[19] The programme offers financial assistance to learners through direct incentive payments up to AUD 10 000. The programme also supports employers who may be eligible for up to AUD 15 000 in wage subsidies. In Austria, the Foundation for the Environment programme (*Umweltstiftung*) provides adults over the age of 50, the long-term unemployed, and adults with low qualifications or qualifications not relevant for integration into the labour market the opportunity to undertake a work-related education and training course or apprenticeship programme with financial support from the public employment service.[20] Under the programme, companies provide both the theoretical and practical training for participants, and covers any additional costs not covered by the Foundation. Upon successful completion of a training programme and/or apprenticeship, the companies commit to hiring the participants. During the training, participants receive a monthly subsidy for the training costs (stipend) from the company in addition to public unemployment benefits. Examples of training courses currently offered via the Foundation for the Environment programme are building sealant (skilled worker), and electrical engineer/photovoltaic technician (apprenticeship certificate).

In addition to reskilling to transition into green jobs, many workers will have to upskill for the green transition as their own tasks are likely to change with the introduction of new green technology and green business practices. Greening within companies and sectors plays an important role in the transition to net-zero emissions, and many companies are adopting low-emission production processes and activities that are likely resulting in existing workers carrying out new tasks. The success of the green transition is dependent on a fast but realistic adoption of technologies (Way et al., 2022[34]) which will put pressure on employers to ensure their workers have the skills to keep up to date with the operational demands of new technology. These workers already have most of the skills and knowledge required to carry out work but will need a “top up” of training to adjust for new green work modes. Training for such workers, which likely makes up the largest share of training needs for the green transition, should come in the form of short training programmes that can be combined and stacked to address the individual needs of the learner. This type of flexible adult learning can help address many of the barriers that hinder workers from participating in training, such as lack of time (due to either work or care responsibilities), inconvenient place and mode of learning, and lack of interesting or relevant training (OECD, 2023[35]).

4.3.3. Financial mechanisms can foster green training

Financial incentives to train, if carefully designed, can raise participation in training and improve inclusiveness in adult learning by addressing barriers to participation and provision of training opportunities. Ensuring that no one is left behind in the green transition is crucial, both as a matter of fairness and because failure to address social concerns can lead to standstills and reversal in climate actions. Financial incentives – such as training vouchers for workers and employers and subsidies for providers – can improve training for the green transition for two reasons: 1) they reduce individual barriers to training, and 2) they support the provision of targeted training programmes that are needed to foster green business practices. As green-driven occupations tend to pay higher wages than other jobs (see Chapter 2), financial incentives should strike the right balance between, on the one hand, recognising private returns to education by making individuals and employers contribute to the cost of training, and, on the other, promoting inclusiveness by subsidising training for low-skilled individuals and businesses facing financial constraints.

In Germany, the Citizen's Benefit Act (*Bürgergeld-Gesetz*) has strengthened financial incentives for the upskilling of people receiving unemployment or citizen's benefit. For those eligible, new financial incentives (training bonuses for successful examinations, *Weiterbildungsprämie*) and monthly training benefit (*Weiterbildungsgeld*) apply for training that leads to vocational qualification in in-demand qualifications, including those related to the green transition. To tackle non-financial barriers, the Citizen's Benefit Act has also widened the possibilities to receive funding to improve reading-, maths- or IT-skills of adults, and to complete a vocational qualification even if a prolonged period to finish is necessary (Federal Ministry of Labour and Social Affairs, 2024[36]). In Japan, the Ministry of Health, Labour and Welfare offers educational training benefits for workers undertaking specialised practical education and training on green topics. The benefit system covers 50% of the course fee (up to JPY 400 000 per year) paid every 6 months during the training. If individuals obtain a qualification and employment in a relevant sector within a year of completing the training, they can receive an additional 20% of the course fee (Ministry of Health, Labour and Welfare, 2023[37]). Eligible courses are available on the Ministry's webpage. Similarly in Croatia, the public employment service (PES) recently implemented a system where all workers and jobseekers are eligible for training vouchers to cover the cost of a green training module. These modules are meant as short training programmes (up to a year) on green topics and are offered at a post-secondary education level. The training programmes are approved by the PES and advertised in a green training database.[21]

Financial incentives can also be directed at employers to provide training for their staff to adjust and adapt to the greening of their business operations. In the context of the green transition, many employers are adapting their business operations to become more environmentally friendly. As these changes are often individual to each employer, the employers themselves becomes best suited to determine which upskilling programmes are needed and how to best train their employees for the new tasks.

Eight out of twenty-six OECD countries report having programmes that include subsidies or tax deductions to employers that offer green training to employees (OECD, 2023[31]).[22] For example, the Public Service for Employment and Vocational training in Wallonia (Belgium), *Le Forem*, offers vouchers for employers to train their staff in green-related areas at approved training centres. The vouchers have a value of EUR 30 and correspond to 1 hour training per employer, and eligible companies are entitled to several vouchers per employee and an extra number of vouchers for training courses related to the green transition so that they can offer additional training on subject matters related to sustainability (Le Forem, 2023[38]). In the United Kingdom, the Skills Bootcamp programme enables employers to train their existing staff in a range of subjects, including skills for the green transition. The Department for Education covers 70% of the costs of training for employers with 250 or more employees, and 90% of the cost for employers with fewer than 250 employees. The content of courses on green skills is tailored to regional labour market needs, and their provision is flexible and lasts up to 16 weeks. Upon completion of an employer-supported Skills

Bootcamp training course, the participant is often offered a new role or responsibility within their firm (GOV.UK, 2022[39]).

Financial incentives are also available for training providers to promote the development of training courses for the green transition. Fourteen out of twenty-six OECD countries report offering funding for providers to create new training programmes or apprenticeships (or update curricula of existing ones to include skills and competences for green jobs) (OECD, 2023[31]).[23] For instance, in Greece the PES requires relevant training providers to offer courses focusing on skills for the green transition. These programmes are centred around the green economy and are available for both employed and unemployed adults. Similarly, a cross-country project in the Baltic states (Latvia, Lithuania and Estonia) aims to promote the integration of topical environmental issues in adult education by developing and piloting a non-formal learning programme and teaching materials for adult educators. The project, titled “Green Skills for a Greener Life”, is funded by the Nordic Council of Ministers through their education co-operation programme Nordplus. The project has developed extensive training materials for adult education institutions on how to implement green training programmes, including a 12-hour course for adult teachers and educators, and the material is available in four languages (Latvian, Lithuanian, Estonian and English) (Nordplus, 2023[40]).

4.3.4. Career guidance supports adults in understanding the impact of the green transition on their jobs and employability

Navigating labour market changes and multiple reskilling and upskilling opportunities is challenging for workers, especially those who are already under-represented in training. At the same time, companies report struggling to attract talent with the right skills (see also Chapter 1), although many of the skills necessary to carry out green-related jobs already exist in the labour market. According to LinkedIn data, in 81% of transitions into green jobs the worker already had some green skills or work experience in a green job (LinkedIn Economic Graph, 2023[41]), indicating that workers need to acquire the relevant skills before they transition to a green-driven job. As green-related occupations are expanding, policy makers will need to devote more attention to steering adults towards relevant training opportunities.

Career guidance – i.e. services that support individuals in successfully navigating a changing labour market through advice and information on learning and employment opportunities – is a fundamental policy tool to connect people with jobs and training opportunities in the green sector. Career advisors can help workers and jobseekers enrol in training necessary to transition into green-driven jobs by interpreting information about the labour market and tailoring the advice to the individual’s skill profile, needs and aspirations.

Career guidance can be delivered through a number of different providers and channels. Traditionally, the public employment service is the most used career guidance provider. However, education and training institutions, employers, private career guidance providers, and dedicated public guidance agencies can also play an important role. For instance, public-private collaborations are necessary to inform both the content of guidance and its use by adults. However, awareness and limited use of career guidance remains an issue, and groups already facing disadvantage in the labour market use career guidance services less than the reference population (OECD, 2021[42]). Strengthening career guidance by increasing quality and coverage, as well as raising awareness, is crucial to connect talent with training and career opportunities for the green transition.

Guidance on environmentally conscious career choices should be also accessible in early education. For young students, career counselling should emphasise the impact of their chosen education paths on sustainability, guiding them towards the new and evolving green-driven occupations. Across OECD countries, only 31% of 15-year-old students achieved foundational levels in environmental sustainability competence – a measure combining scientific literacy, awareness of climate change and global warming, caring for the environment, self-efficacy about explaining environmental phenomena, and behaviour to promote environmental sustainability (OECD, 2023[43]). As young people stay in education and training longer and as the labour market becomes more complex, career guidance becomes increasingly important to help young students build a foundation for a career in the context of the green transition.

Career guidance is also a good tool to enable skill matching between workers and jobs. Skill matching is a process by which the skills of an adult are thoroughly mapped and the person is matched with a job that fits their skill profile. Skill mismatches entail large costs for individuals, employers and society and can result in lower earnings and job satisfaction, higher risk of job loss, loss of competitiveness as well as lower economic growth. Persistent mismatches could slow down the transition to net zero. By identifying the skills already possessed by workers, better matches can be made to fill labour shortages as well as enable targeted further education.

Several OECD countries have implemented policies for guidance for the green transition. Nine out of twenty-six OECD countries report that they have career guidance initiatives in place to facilitate transition into green jobs (OECD, 2023[31]).[24] In some cases, the environmental angle has been added to existing, broader guidance programmes. In France, the Human Resources Consulting Service (*Prestation de Conseil en Ressources Humaines, PCRH*) provides support to small and medium-sized enterprises in human resource management, increasingly related to the green transition. The PCRH, a service of the Ministry of Labour co-operates with the skills operators (*opérateurs de compétences*) to provide upskilling and training opportunities to their employees faced with new tasks, including green tasks (Ministère du Travail de la Santé et des Solidarités, 2017[44]).

In other cases, career guidance is added as a component of a wider environmental training programme. For example, in the United States, guidance is used throughout the Environmental Protection Agency's Brownfields Job Training grant programme to ensure that students learn the skills needed to secure employment in the environmental field based on local labour market demands. The grant is awarded to non-profit organisations and other eligible entities that connect jobseekers with employers in green projects and provides guidance and training to enable the matching of workers and employers. The programme focuses particularly on unemployed individuals, low-income households, and minority residents of solid and hazardous waste-impacted communities (United States Environmental Protection Agency, 2023[45]; 2023[46]; 2015[47]).

Public employment services (PES) are some of the main providers of career guidance services across the OECD (OECD, 2021[42]) and several countries are undertaking actions to strengthen the provision and guidance relating to the green transition within the PES. In Croatia, guidance counsellors at the Croatian Employment Service receive instructions on how to guide candidates participating in the voucher scheme for digital and green training programmes. The German public employment service is undertaking work to increase the visibility of future skills as important competencies for the changing world of work, and are planning to add a new skill dimension, titled "Green skills – skills for ecological change" to the occupational system. This will enable individual users of the PES occupation information system to receive additional information on green skills and training via a visual marker.

Career guidance is both an individual and societal good: it helps individuals progress in their learning and work, but it also fosters the effective functioning of the labour market, contributing to a range of societal policy goals, including social mobility and equity. This justifies the public investment in career guidance activities. In the north of Sweden, the PES centre of Skellefteå maintains a network of career guidance advisors across the country through the EU-financed project Relocate and React EU Relocate. The project, concluded in 2023, sought to inform, recruit, and support unemployed adults in cities and regions with high unemployment, to gain employment in the north of Sweden, which is facing significant skills shortages due to massive green industrial developments. The network of PES guidance advisors identified potential candidates for the employment and relocation programme, and advisors in Skellefteå offered comprehensive career guidance to the candidates, including on training opportunities in line with the labour market needs of the greening industries (Skellefteå Relocate, 2023[48]).

4.3.5. Promoting an inclusive green transition is essential to ensure a sustainable future

Participation in training differs substantially between different groups of adults. Low-skilled adults, unemployed adults, self-employed, temporary employees and part-time workers, those who work in SMEs, and, in some countries, women, generally participate less than their counterparts (OECD, 2019[27]). As previously discussed, participation in training is also lower among workers in GHG-intensive occupations and green-driven occupations. There is therefore a risk that, without proper policy attention, the net-zero transition could exacerbate already existing labour market inequalities (Keese and Marcolin, 2023[22]).

The move towards a net-zero economy might also generate a double disadvantage for women, if not carefully supported by the right policies. Indeed, the green transition has a strong gender dimension in the labour market, where only 11.5% of women hold a green-driven job (against 28.9% of men) – see Chapter 2, as well as OECD (2023[49]) and Causa et al. (2024[28]). A review of seven EU Member countries finds that men might benefit relatively more from the growth in green jobs than women, since green growth is mainly driven by an increase in employment in blue collar or STEM jobs, where women have historically been underrepresented (European Commission, 2023[50]).[25] The gender employment gap is substantial, with for example 85% of green jobs in Spain being held by men in 2022.

Similar results are also found looking at skills directly. For instance, a LinkedIn study shows that the green gender skill gap (the share of men versus women qualifying as green talents) has grown by 25% over the past seven years globally (Linkedin Economic Graph, 2023[51]). Countries like Germany and France are showing even more concerning trends, with the green gender skill gap increasing by 44% and by 93% respectively between 2016 and 2023. At the same time, GHG-intensive industries are traditionally male-dominated, with 83% of these jobs held by men (OECD, 2023[49]) and therefore while men are benefiting more from the expansion of green-driven occupations than women, they will also be disproportionately affected by the contraction of emission-intensive industries – see Chapter 2. Addressing disparities is crucial to ensure the green transition is inclusive and does not create or intensify existing inequalities in employment, skills and training.

Several OECD countries see the green transition as an opportunity to reduce disparities in the labour market by targeting groups with poorer labour market outcomes. In the European Union, Recovery and Resilience Plans are expected to facilitate and accelerate the green transition, while increasing resilience, cohesion and sustainable growth. Countries such as Austria, have anchored their green skill strategies under a broader Just Transition strategy, which combines the success of the green transition to principles of participation, inclusiveness, and social justice (ILO, 2015[52]).

Sweden implemented a green jobs scheme in 2020 aimed at creating subsidised jobs suitable for people far from the labour market, particularly newly arrived migrants and the long-term unemployed. Participants receive training to help increase their employability in the labour market in jobs related to sustainability. The Swedish Government invested EUR 17 million per year in the scheme between 2021 and 2023 (European Commission, 2023[50]).

Increasing participation of underrepresented groups is an important part of Australia's strategy for the clean energy transition. Given the large skill shortages in the sector, several initiatives have a specific focus on increasing training participation and employment of women and vulnerable groups in in-demand occupations related to the green and clean energy transition. For example, the Fee-Free TAFE initiative will deliver 180 000 places in vocational education courses free of cost for priority groups, including First Nations people, jobseekers, people with disability and women in non-traditional fields of study. The fee free study programmes are available for in-demand occupations, including several occupations key in the energy transition and/or focusing on renewable and sustainable technologies (Department of Employment and Workplace Relations, 2023[53]). The New Energy Apprenticeship Program and the Women in Male-Dominated Trades initiative both feature services that are specially designed for women wanting to enter male-dominated trades (Department of Employment and Workplace Relations, 2023[54]). The programmes offer custom career counselling, advisors during the apprenticeship or traineeships specialised to help with the challenges faced by women in male-dominated trade jobs, and networking opportunities with other apprentices and trainees. Both programmes are an important step towards facilitating transitions of underrepresented groups into environment-related jobs.

4.3.6. Actively engaging stakeholders is essential for a successful transition

Stakeholder involvement is crucial for the successful development and implementation of upskilling and reskilling policies. Social dialogue is key for designing successful reform packages which include policies for different types of learning, addressing multiple barriers to participation and focusing on multiple target groups (OECD, 2020[55]), though not all OECD countries have a labour-market model which relies on social dialogue. Nonetheless, voices of diverse groups of stakeholders are encouraged to capture the complexity of the transition to net-zero emissions.

Within the context of the green transition, social dialogue is relevant at all stages of the skills policy cycle. Social partners can participate in the anticipation of skills needs, the development of skill strategies and policies, the implementation of upskilling and reskilling policies (including the provision and financing of training, and negotiating training rights), and the quality assurance of the training provided (Global Deal, 2023[56]; OECD, 2019[57]). Inclusivity in policy design and implementation ensures diverse perspectives, knowledge transfer, and fosters solutions that deal with the many different challenges faced by workers, employers and governments. Wide stakeholder participation fosters public acceptance and improves the awareness raising and legitimacy of policies and regulations. Collaborative decision-making processes can also produce policies that address diverse needs, ultimately improving their effectiveness.

Collective bargaining is a tool that can be used by trade unions to ensure workers' right to training leave, funding for training, and remuneration upon acquiring new qualifications. For workers in GHG-intensive sectors, trade unions can advocate for and support workers' transition programmes, including reskilling and upskilling to help workers adapt to new job requirements – see also Chapters 2 and 3. Yet, despite the importance of a green and just transition, only 23% of collective agreements address environmental aspects explicitly (ILO, 2022[58]). However, collective bargaining agreements have a significant impact in securing the right to training which can have positive effect on training for the net-zero transition, given that there is enough awareness regarding the needs and career opportunities created by the transition. In Sweden, the Education Support for Transition agreement concluded by Swedish social partners and the Government in 2022 entitles both adults who are employed and between jobs the right to financial support for up to 44 weeks of full-time training to expand and strengthen their skills in line with future labour-market needs (Government Offices of Sweden, 2022[59]). In Denmark, the 2017 national-level tripartite agreement on adult and continuing training included a "reconversion fund" of around EUR 53 million for workers to undertake further training on their own initiative, including advanced training in order to keep up with the rapid transformation of the labour market (Government of Denmark, 2017[60]).

Similarly, employers' associations, as well as professional and sectoral associations, play an important role in comprehensive policy design, particularly in addressing skill gaps as they act as intermediaries between businesses and the workforce. They are well positioned to identify skill needs within specific industries and provide valuable input to education and training institutions, ensuring that learning programmes align with labour market needs. Through social dialogue, employers' associations can also advocate for policies that support workforce development and address skill gaps, particularly for the green transition where employers are facing challenges in hiring workers with the right skills.

Though collaborative approaches are seen as best-practice in addressing labour-market issues related to the green transition, only 8 out of 26 OECD countries report having policies in place to promote private-public collaboration on skills for the green transition (OECD, 2023[31]).[26] Public-private sector collaborations include collaborations between employers and training providers for the development of training programmes, or involvement of employers in public skills anticipation and assessment exercises.

In addition to supporting employers and workers and fostering green talent in the workplace, employer associations and trade unions could advocate for strengthening skill systems for the green transition at a governmental level.

In the United Kingdom, Local Skill Improvement Plans (LSIPs) is a government-initiated, employer-lead programme aimed to bring together local stakeholders to identify and carry out initiatives that will address local skills needs in regard to net-zero targets, adaptation to climate change, and other environmental goals. LSIPs have been established in 38 areas of the country, and bring together employers, training providers, researchers and local communities to plan, design and implement changes in technical education and training to increase responsiveness of skill systems to labour market needs (Department for Education, 2023[61]). The GBP 165 million Local Skills Improvement Fund enables the development and provision of training programmes outlined by the LSIPs. Similarly, since 2023, Germany has set up working groups involving experts from trade unions, employer and business associations, and the public sector (i.e. Federal Ministry of Labour and Social Affairs, the Federal Ministry of Education and Research, the Federal Employment Agency, the Conferences of Ministers of the Länder), to analyse the changing skill needs due to the twin transition. Findings from the consultations are expected to be published in 2025, setting the course for public initiatives on upskilling and reskilling (Federal Ministry of Labour and Social and Federal Ministry of Education and Research, 2021[62]; Federal Ministry of Labour and Social Affairs and Federal Ministry of Education and Research, 2022[63]).

Beyond facilitating upskilling and reskilling initiatives, social partners play an important role in setting the agenda for the green transition and advocating for skills-based policies (OECD, 2023[1]). There is no commonly agreed definition of the green transition, and in many countries social partners and advocacy groups have taken a leading role in defining, implementing and measuring concepts related to green jobs and green skills. In Norway, there is a long-standing collaboration between the main employer association, NHO, and the largest confederation of trade unions, LO, on skill-related issues. Recognising the lack of information on skill needs for the green transition, the two organisations jointly commissioned a skills assessment and anticipation exercise to investigate and quantify the skill gap faced by employers and workers in eight key value chains for the green transition in Norway (such as offshore wind, hydrogen, and sustainable construction industry) (Oslo Economics, 2023[64]). Following the findings of the report, NHO and the Norwegian LO jointly issued statements and recommendations, particularly for the need for a tripartite high-level expert group to discuss strategic issues related to the green transition. In addition to this specific collaboration, eight employer and employee organisations are part of the government-led Norwegian Committee on Skill Needs, which aims at providing evidence-based assessments of Norway's future labour market, and also includes representatives from county councils and several researchers (Kompetansebehovsutvalget, 2023[26]).

Awareness building remains an important action that stakeholders can carry out to further the green transition. Despite being one of the most prominent global megatrends, many businesses do not perceive that the green transition will impact their business operation. More than 60% of businesses in Croatia do not perceive the green transition as an opportunity, and only 16% of businesses had their own strategy aimed at the green transition in 2021 (European Commission, 2023[50]). In Norway, climate scepticism is high among workers in sectors impacted by the green transition and could pose a challenge in implementing sustainable forms of work, particularly in construction, transportation and industrial sectors (Kompetansebehovsutvalget, 2023[26]).

In France, the National Observatory of Jobs and Occupations in the Green Economy (*Observatoire national des emplois et métiers de l'économie verte*) is a government-lead initiative that is set up to identify and better understand jobs and skills in the green economy. The Observatory produces knowledge on the impact of the ecological transition on jobs, skills, and training, and monitors the work done by partnering institutions on modelling the macroeconomic and sectoral impacts of the green economy (Ministère de la transition écologique et de la cohésion des territoires, 2023[65]). The Observatory brings together a range of stakeholders including governmental units across different ministries and cabinets, the national institute for statistics, the public employment service, research institutions, local authorities, educational bodies and think tanks. The Observatory is one of the leading advisors for policy making for the green transition in France and draws on a wealth of inputs to carry out high-quality assessments, as well as disseminate findings and recommendations to a wide array of stakeholders, resulting in diverse and inclusive policy making for the green transition.

4.4. Concluding remarks

Skills play a central role in the transition to a net-zero economy. Without the right skills, workers will not be able to carry out the tasks and functions needed to curb emissions and enable the green transition. Ensuring access to quality education and training that allow workers to acquire the right skills is a top priority both in achieving sustainability goals and guaranteeing a fair transition. However, precisely identifying the key skills needed in the new world of work is challenging. Competing definitions and measurement of skills, occupations and industries affected by the green transition have left many decision makers without a clear understanding of the policy priorities to enable the net-zero transition. This chapter focuses on the connection between green-driven and GHG-intensive occupations, increasing and decreasing skill demands, and how policies can help guide workers and connect people to opportunities.

The green transition is connected to technological and sustainable innovation, and this is reflected in the evolving skill requirements of occupations. Green-driven occupations, in particular, require higher levels of process skills (critical thinking, monitoring, active learning) and cross-functional skills (such as complex problem solving and decision making). Within green-driven occupations, those that have only recently emerged as a result of the green transition (new and emerging green-driven occupations) require the highest skill level across almost all skills.

This chapter shows that new green-driven occupations with lower education and experience requirements generally demand higher skill levels compared with jobs with similar education and experience requirements in GHG-intensive and neutral occupations. To transition into green-driven jobs, workers in low-skilled GHG-intensive jobs would require significant retraining. A transition to neutral occupations may therefore be more feasible for them, but policy makers should devote additional attention to these workers to ensure they are not excluded from opportunities in the green transition. On the other hand, transitions between high-skilled GHG-intensive occupations and green-driven occupations can be achieved at little cost. Retraining, if needed, would be centred around knowledge areas rather than skills, to enable workers to use their existing skills in new contexts.

Looking at skill distances between individual occupational pairs confirms these observations. Regardless of the actual skill distance, most GHG-intensive occupations have several closely related green-driven occupations that workers could transition into more easily than many other neutral jobs. For example, petroleum engineers would need only to improve their communication and advocacy skills to take up a climate change analyst role. However, workers in industries such as manufacturing, agriculture, and transport may find it hard to transition directly to green-driven occupations because of the wide gap in requirements. For workers in these jobs, transitioning to neutral occupations could be a more realistic option.

In the context of the green transition, effective training is imperative for individuals to navigate evolving work environments. Notably, workers in green-driven and GHG-intensive occupations exhibit lower training rates than their counterparts in neutral jobs, contributing to skill imbalances in critical green sectors. Recognising the dual demands of reskilling and upskilling, the implementation of flexible, short training programmes becomes essential, addressing obstacles such as time constraints and ensuring labour-market relevance. Additionally, work-based learning can provide practical experience and facilitate accessibility through the combination between paid work and study.

Financial incentives can facilitate the transition to a green economy by addressing barriers to training. Carefully designed incentives can boost participation, ensuring inclusiveness in adult learning. When designing financial instruments, the emphasis should be on making training accessible, recognising common barriers like lack of time and financial resources. Financial incentives can also be used to address supply-side issues, such as lack of relevant training courses, by either incentivising employers to offer training themselves or supporting training providers in designing and offering cutting-edge training in skills and knowledge for the green transition.

Policy makers in many countries are seeking to empower individuals to actively take a leading role in redirecting their career pathways. Yet, information on how the green transition is affecting the demand for skills is rarely communicated in an accessible and clear way. Without this information, workers may not be attracted to training for the green transition or be aware of the benefits of transitioning into greener employment. Career guidance plays a crucial part in bridging this gap, by assisting individuals of all ages in comprehending the personal challenges and rewards associated with the green transition.

Training and skill disparities among diverse worker groups raise concerns about potential inequalities in the green transition. Gender imbalances in both employment and skills, notably the underrepresentation of women in green-related jobs and skills, are particularly worrying. There is also a risk of further alienating individuals with low labour-market attachment. Ensuring the green transition is equitable for all requires a special focus on underrepresented groups in skills and training policies. In the pursuit of a just green transition, policy makers need to utilise the wealth of knowledge and influence of social partners to ensure inclusive and diverse perspectives in policy design and implementation.

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Notes

[1] See Chapter 2 for the definition of green-driven and GHG-intensive occupations.

[2] This chapter, therefore, focuses on potential transitions across occupations, but it does not examine the reskilling needs of workers within an occupation linked to green-driven changes in everyday tasks, as suitable data for this analysis are not available. Moreover, while it looks at the feasibility of cross-occupational transitions based on skill requirements, the chapter does not assess their affordability. In other words, the analysis identifies the occupations where workers could potentially move based on their skill profile, but it does not evaluate whether such positions exist in the individual's local labour market or whether wage differences could hinder such career moves. Two case studies will be discussed later in the chapter to partially address these issues.

[3] A thorough description of the skills used in the analysis of this chapter is presented in the following section.

[4] Unlike skills and abilities, knowledge areas could be considered green; however, their measurability will depend on how knowledge is classified in a taxonomy. For example, while the knowledge area of "engineering and technology" cannot be unambiguously defined as "green", "photovoltaic science" could be considered so. However, available datasets (like O*NET) typically group knowledge areas into broader categories, which do not lend themselves to explicit analysis on green knowledge.

[5] Formal learning is organised and structured with clear objectives, typically withing within initial education or by a formal training provider. Informal learning, often referred to as learning by experience, is not organised and does not have a defined set of objectives in terms of learning outcomes. Non-formal learning is organised and has learning objectives but occurs at the initiative of the individual or as a by-product of more organised activities (which may not have themselves have learning objectives) (Werquin, 2010[70]).

[6] The latest version of the O*NET database updating jobs and tasks associated with green economy activities was published in 2019 (O*NET database version 24.1 – www.onetcenter.org/dictionary/24.1/excel/).

[7] A challenge of this analysis is that O*NET provides information on the jobs associated with green economy activities using their O*NET-Standard Occupational Classification (SOC) 2009 taxonomy. Information on skill requirements is taken from one of the latest versions of the O*NET database (O*NET 27.2), which utilises the O*NET-SOC 2019 taxonomy. Merging the 2009 and 2019 occupational classifications results in a few instances where two or more occupations in the 2009 taxonomy conflate in one single occupation in the 2019 taxonomy. This poses a challenge as some occupations in the 2019 taxonomy are now a combination of one (or more) green-driven and one (or more) non-green-driven occupations. This creates some situations in which the new and established green-driven occupations variables for certain O*NET-SOC 2019 occupations are not binary but have a value between 0 and 1 (i.e. based on the proportion of green-related jobs from the 2009 taxonomy being aggregated into one single 2019 occupation). As dummies are more suitable for the analysis at the core of this chapter, these few instances of ambiguous observations have been modelled so that their green-driven variables become 1 if the share of green-driven occupations from 2009 is higher than 50%, and 0 if below or equal.

[8] This analysis uses the definition and measurement of GHG-intensive occupations of Chapter 2. However, 18 occupations belong simultaneously to both categories – see the discussion in Chapter 2. This is the case, for instance, of railroad conductors or geological technicians. For simplicity, this chapter considers them as green-driven only, as it prioritises the O*NET definition of green jobs over the industry-based

definition of GHG-intensive occupations. In fact, as most of these occupations are green-enhanced skills occupations, information on tasks, skills, and knowledge reflects the changes that are occurring to these jobs because of the green transition.

[9] Estimates are computed using simple average of 8-digit SOC occupations.

[10] Results from Figure 4.1 suggest that the skill requirements of green-driven occupations are largely similar to the skills that are becoming more prevalent because of artificial intelligence. Indeed, OECD (2023[68]) shows that, beyond expertise in specialised AI and data science skills, workers need also to have high levels of cognitive skills – such as critical thinking, problem solving, and judgement and decision making – to effectively develop and interact with AI systems. Hence, as a result of both the green and digital transitions, it will be increasingly important for workers in various occupations to possess this broad range of skills. This can pose important challenges for decision makers, as certain segments of society already lack proficiency in cognitive and analytical skills, thereby requiring targeted policy efforts to avoid leaving the low skilled behind. Several OECD countries are putting in place initiatives to support individuals facing the challenges emerging because of the twin transition. For example, the public employment service in Greece runs Apprenticeship Vocational Schools, whose focus for 2023-34 is on both digital and green topics.

[11] Chapter 2 shows that green new and emerging occupations are the fastest growing group among green-driven occupations.

[12] This is in line with more general results by Quintini and Lassebie (2022[69]), who find that innovations in technology and automation increase the need of workers to master a broader range of skills at a higher proficiency level to interact with the technology.

[13] In particular, this chapter's category of occupations requiring up to moderate preparation (also called "low-skilled jobs" in this chapter) groups together the original O*NET job zone one (little or no preparation needed), job zone two (some preparation needed) and job zone three (medium preparation needed), whereas this chapter's category of occupations requiring at least considerable preparation (also called "high-skilled jobs") aggregates O*NET's job zone four (considerable preparation needed) and job zone five (extensive preparation needed).

[14] This is in line with the results of Bechichi et al. (2019[71]), who found that, more generally across the economy, high-skilled occupations tend to have greater possibilities than low-skilled jobs to transit to other occupations with smaller training needs.

[15] In addition to skills and knowledge, workers also require the right abilities in order to perform tasks. However, as abilities are innate and enduring attributes, they cannot be easily improved through education and training. Given that this chapter aims at distilling job requirements for the purpose of policy making, a measurement of abilities is therefore not included.

[16] The Greek Mechanism of Labour Market Diagnosis tool can be found at: https://mdaae.gr/en/.

[17] As in Chapter 2, estimates are obtained from a linear regression with the inverse hyperbolic sine of the share of each type of occupation as a dependent variable and including a training dummy. The dependent variables have been multiplied by 20 and transformed using an inverse hyperbolic sine transformation. The pre-multiplication by 20 is done to ensure that sample means are greater than 10 for all the dependent

variables, as required for estimate reliability (Bellemare and Wichman, 2019[66]). Percentage effects are retrieved by applying the standard logarithmic approximation (Halvorsen and Palmquist, 1980[67]).

[18] Countries include Austria, Belgium, Canada, Costa Rica, Croatia, France, Greece, Hungary, Latvia, Norway, Poland, Spain and Sweden. For example, the Austrian public employment service in the municipality of Sigmundsherberg is establishing a centre for training in climate protection which will provide training for around 400 people per year for the green occupation sector.

[19] Further information can be found at: www.apprenticeshipsupport.com.au/New-Energy-Apprenticeships.

[20] Further information can be found at: www.aufleb.at/arbeitsstiftung/umweltstiftung/.

[21] The database on green training programmes developed by the Croatian Employment Service is available here: https://vauceri.hzz.hr/katalog-vjestina/.

[22] Countries include Belgium, Czechia France, Japan, Korea, the Netherlands, Poland and the United Kingdom.

[23] Countries include Belgium, Canada, Costa Rica, Croatia, Greece, Estonia, France, Hungary, Latvia, Lithuania, Norway, Poland, Spain, and Sweden.

[24] Countries include Australia, Croatia, France, Latvia, the Netherlands, the Slovak Republic, Spain, Sweden, and the United States.

[25] The countries analysed by European Commission (2023[50]) are Austria, Spain, France, Malta, the Netherlands, Portugal and Sweden.

[26] Countries include Australia, Belgium, France, Germany, Latvia, the Netherlands, the United Kingdom, and the United States.

5 Who pays for higher carbon prices? Mitigating climate change and adverse distributional effects

Assia Elgouacem, Herwig Immervoll, Anasuya Raj, Jules Linden, Cathal O'Donoghue and Denisa Sologon

Carbon pricing incentivises a reduction in emissions and is one of the key climate change mitigation policies. It may raise a number of concerns, however, not least in the context of recent inflation surges and the energy crisis brought about by Russia's war of aggression against Ukraine. A key concern is that carbon pricing measures may have adverse distributional consequences, which in turn can hinder support for necessary climate change mitigation action. This chapter estimates the carbon content of households' consumption baskets and examines how higher carbon prices alter household budgets and consumer prices – and therefore the real value of workers' wages. It examines whether carbon pricing measures are regressive and explores how burdens differ across groups, including disadvantaged ones. Based on the distributional impact and associated carbon price revenues, the chapter considers the scope for offsetting household burdens by channelling revenues back to households in the form of income transfers.

In Brief

Key findings

To address the causes of climate change, OECD countries have implemented different climate change mitigation policy packages that include carbon pricing measures to varying degrees. These measures, whether explicit such as carbon taxes or emissions trading systems or implicit such as fuel excise taxes, incentivise a reduction in emissions. Prices for carbon emissions built into current measures are generally far from the levels that are considered in line with national and international commitments, notably the targets agreed upon in the Paris Agreement. Numerous governments are therefore considering reforms to increase these prices, broaden the share of emissions covered by such instruments or introduce new carbon pricing measures.

By charging producers and consumers for emissions, carbon pricing may result in potentially sizable burdens for households, which can differ substantially between population groups. There are concerns that this may aggravate existing disparities and worsen economic challenges for specific groups, notably in a context of recent and on-going cost-of-living crises. The size and distribution of carbon price burdens can also weaken support for more ambitious climate change mitigation policies. There can be a case for shielding vulnerable groups from adverse impacts of higher carbon prices, not only for social equity reasons, but also as a means to build or maintain public support for the required transition to a net-zero emission economy.

This chapter examines the impact of carbon pricing policies on households. It discusses different channels for distributive effects and quantifies household burdens stemming from the effects of carbon prices on consumption expenditures. The chapter also explores possible compensation measures that governments can finance with carbon pricing revenues and the extent to which they can attenuate the burdens for different income groups. The empirical analysis calculates carbon footprints for households in five OECD countries that differ in terms of carbon prices, greenhouse gas emissions and GDP levels: France, Germany, Mexico, Poland and Türkiye. Estimates account for households' own use of fossil fuels and for emissions released in the production of all other goods and services that they consume. The resulting footprints are combined with granular data from the OECD's Effective Carbon Rates database to approximate household burdens from carbon pricing reforms introduced over the 2012-21 period. The analysis of distributional impacts from carbon pricing conducted in this chapter adopts the *status quo* as a counterfactual without factoring in the costs of policy inaction on household living standards, which are expected to be significant (see Chapter 2).

The main findings of the chapter include the following:

- Large parts of households' energy use are related to basic needs. Poorer households tend to spend large shares of their incomes on energy, giving rise to equity and affordability concerns when prices for fuel, electricity or other necessities go up. Results in this chapter mostly confirm regressive spending patterns for energy. For instance, in the years prior to the COVID-19 pandemic, low-income households (the bottom 10%) in Poland and Türkiye spent more than one-fifth of their incomes on energy – 3 to 10 times the shares spent by those on the highest incomes (the top 10%). But not all forms of energy are necessities. Spending shares for motor fuel increase with income in Mexico and Poland, and motor fuel spending shares in Germany vary little between income groups. In Mexico, high-income households in fact devote larger parts of their income to energy than poorer households, indicating that energy can be a luxury item in middle-income countries.

- The immediate impact of carbon pricing on households' budgets depends on their reliance on different fuels for heating and transportation (direct effect), and on emissions embodied in all other goods that give rise to carbon emissions (indirect effect). Across the five countries, non-fuel consumption in the years preceding the COVID-19 pandemic accounted for between 45% and 71% of all CO_2 emissions linked to household spending. This result highlights that assessments of distributional impacts need to go beyond examining households' own fuel and energy consumption, which has sometimes dominated policy debates.
- Carbon footprints are very unequal both across and within countries. Before the COVID-19 pandemic, average annual emissions related to household consumption ranged from around 1 tonne of CO_2 per household in Mexico and Türkiye, to 6 tonnes in Poland, and 8 to 9 tonnes in France and Germany. Carbon footprints differ markedly between income groups. On average across the five countries, the highest-income households (top 10%) accounted for 4.5 times the emissions of those in the bottom 10%. But emissions also vary within income groups, e.g. by employment status, age, family size and between urban and rural areas. These findings can help to anticipate patterns of public support for, or resistance to, carbon pricing policies. A granular picture of emissions by demographic group is also needed for targeting support to the most impacted groups, and for anticipating future emission trends and associated policy priorities, e.g. in the context of population ageing.
- Households' carbon footprints are a primary determinant of carbon pricing burdens, but they are not the only one. Carbon pricing measures do not apply uniformly across sectors and fuels and therefore not all emissions are priced equally. For instance, excise taxes, carbon taxes and emissions trading systems can, and often do, vary substantially between industries and fuel types, and each measure can therefore affect consumers and households differently.
- Increases in carbon prices and the resulting burdens on households were limited in five of the five countries over the 2012-21 period, altering the cost of an average households' consumption basket by 1% of income or less. This is small, relative to both recent annual inflation rates and cumulative inflation over the decade prior to the cost-of-living crisis. Average additional burdens were largest in Poland, at 2.3% of household income, but they were negligible in Türkiye.
- Additional carbon price burdens linked to these reforms were sizeable for some income groups, however, and effects were mostly regressive, reflecting the reliance of low-income households on high-emitting consumption items. In France, estimated additional burdens as a share of household incomes for the bottom 10% were three times those for the top 10%, and in Germany, they were approximately twice as big. A notable exception is Mexico, where relative additional burdens were bigger among high-income households, reflecting the top-heavy pattern of energy spending.
- Although lower-income households often saw the biggest burdens relative to their incomes, losses for many middle-class households were mostly of a similar order of magnitude. Therefore, while carbon pricing impacts the living standards of the poor, it also matters for middle-class workers.
- As part of broader policy packages, channelling some or all revenues from carbon pricing back to households allows governments considerable scope to cushion losses and shape distributional outcomes. Some past studies have suggested possible trade-offs between equity and environmental objectives, as redistribution can increase overall emissions when low-income groups spend larger shares of their incomes on carbon-intensive goods than better-off households. Results in this chapter indicate that such differences in carbon intensity between most income groups are, in fact, small overall and carbon footprints are larger for high-income groups, pointing to opportunities for compensating households without increasing emissions.

- Simple compensation measures, such as a uniform lump-sum transfer to all households, are sometimes favoured among researchers and in policy debates. But results illustrate that they may be insufficient to protect all disadvantaged households. They are also not cost effective, leaving little to no room for financing other priorities such as public investment, programmes to boost household investments in energy efficiency or to help workers transition between jobs as part of a green transition. This calls for efforts to reduce the fiscal costs of direct compensation measures, by linking transfer amounts to household burdens and support needs.
- As the urgency of action to mitigate the potential dramatic effects of climate change escalates, future carbon price increases may be much more sizeable and fast-paced in some countries than they have been during the past decade. The mostly regressive patterns of past reforms analysed in this chapter underscore the need to carefully consider distributional impacts of future policy changes, along with suitable compensation, both for equity reasons, and to ensure necessary public and political support.

Introduction

Climate change and climate-change mitigation both have potentially major welfare and distributional effects.[1] In the medium to long term, large sections of the global and national populations will be significantly better off with effective climate-change mitigation that averts rapid-onset disasters (floods, hurricanes, wildfires) and slow-onset events (desertification, heat waves, rising sea levels, etc.). In the short term, however, there can be notable trade-offs between the intended effects of mitigation policies, such as incentives from higher carbon prices, and unintended distributional effects (Baumol and Oates, 1988[1]; Baranzini, Goldemberg and Speck, 2000[2]).The specific patterns of short-term losses, in turn, have been found to be key drivers of public and political support for necessary policy action to fight climate change (Büchs, Bardsley and Duwe, 2011[3]; Tatham and Peters, 2022[4]).

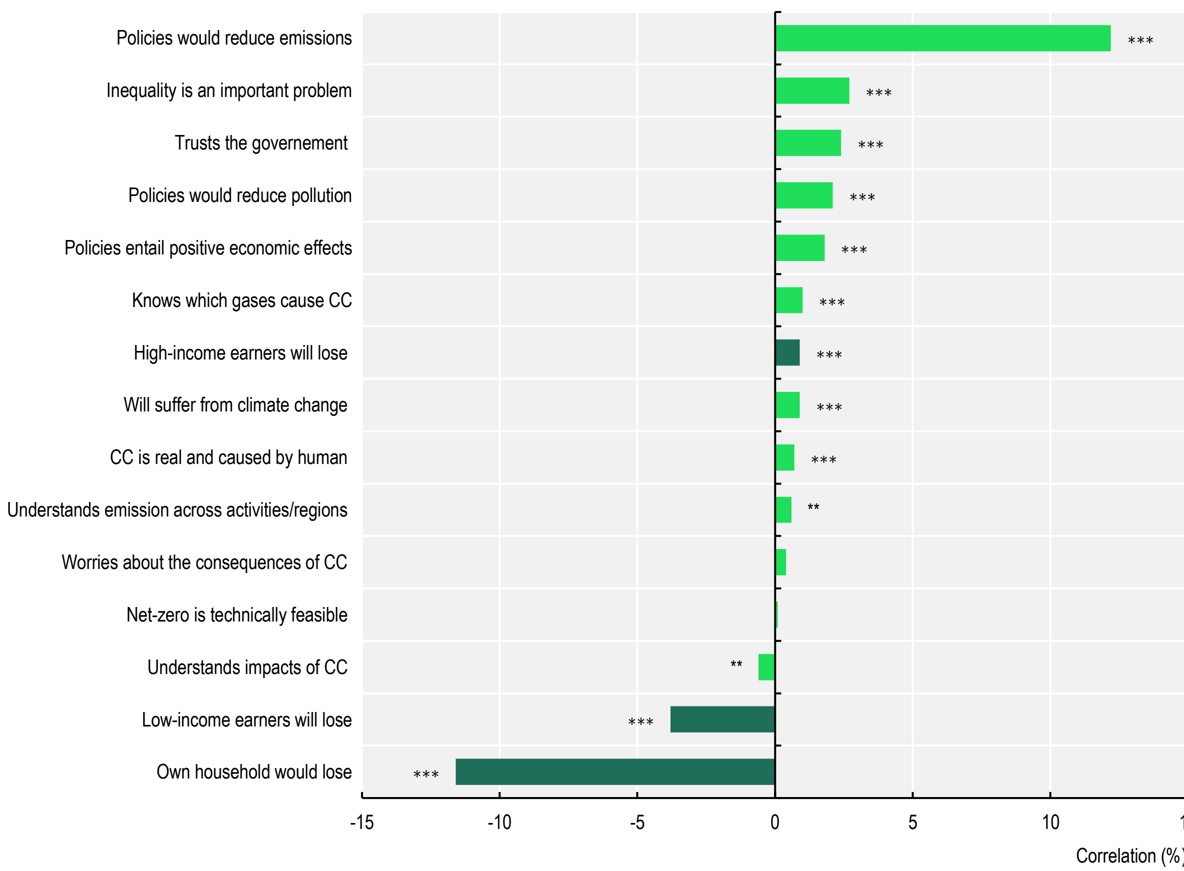
Carbon pricing is frequently seen as one of several policy tools for turning national and international net-zero commitments into reality. Like other mitigation measures, carbon pricing can be controversial, not least in the context of recent cost-of-living increases.[2] Unlike other abatement strategies, however, it generates revenues, which governments can employ to accelerate the net-zero transition, to make it more equitable, to adapt to consequences of climate change that can no longer be avoided (Boyce, 2018[5]), or also to lower other distortionary taxes or reduce public debt.[3]

The implementation of carbon pricing measures remains uneven globally and across the OECD. There are concerns among policy makers and the public about undue burdens on households, workers and firms (see also Chapters 2 and 3), with notable controversies and recent protests by specific groups in some countries. Surveys asking households directly about their concerns indicate that economic worries (such as unemployment, price growth or poverty) frequently rank more prominently than environmental ones (OECD, 2023[6]), suggesting that voters may tend to resist carbon pricing if they perceive that it will create significant costs for them. A recent large-scale survey of 40 000 people across 20 OECD countries and emerging economies (Dechezleprêtre et al., 2022[7]) shows that public support hinges not only on respondents' assessment of their own household's gains and losses, but also on broader distributional impacts, such as respondents' perception of burdens on lower-income households (Figure 5.1). There can therefore be a growing tension between the escalating need for decisive climate action and the political feasibility of agreeing and implementing it.

Current carbon prices remain well below levels that are considered in line with national and international commitments, notably the targets affirmed in the Paris Agreement (OECD, 2023[8]; OECD, 2022[9]). For instance, to reach net zero emissions by 2050, scenarios developed by a network of 127 central banks point to a globally weighted implicit price on all emissions of more than EUR 600 per tonne of CO_2 (Network for Greening the Finanical System, 2023[10]), when using carbon prices as a proxy for all climate policies. Some studies warn that even carbon prices of this order of magnitude will not suffice to meet net-zero emission targets, without accompanying policies to markedly raise the responsiveness of emissions to carbon pricing, such as regulations concerning certain uses of fossil fuels or support for clean technology (D'Arcangelo et al., 2022[11]). Yet, in 72 OECD and non-OECD countries that together account for 80% of global greenhouse gas (GHG) emissions, less than half of all emissions were covered by some form of carbon pricing measure[4] in 2021 (OECD, 2023[8]), and prevailing price levels are mostly much too low to incentivise deep emission cuts. In OECD countries, only a small share of emissions is priced at or above EUR 60 per tonne of CO_2. Globally, sizeable fossil-fuel subsidies reduce effective carbon prices, sometimes turning them negative in countries with little or no carbon pricing measures in place (OECD, 2022[12]).

Figure 5.1. Support for climate policies hinges on perceived gains and losses

Correlation between beliefs (as listed) and support for a carbon tax package with cash transfers



Note: Results of regressions of support on standardised variables measuring respondents' beliefs and perceptions. Dark green indicates variables measuring expected gains and losses. Country fixed effects, treatment indicators, and individual socio-economic characteristics are included but not displayed. The dependent variable is an indicator variable equal to 1 if the respondent (somewhat or strongly) supports each of the main climate policies. N=40 680, R2=0.378. CC: climate change.
Source: Adapted from Dechezleprêtre, A. et al. (2022[7]), "Fighting climate change: International attitudes toward climate policies", https://doi.org/10.1787/3406f29a-en.

StatLink https://stat.link/fknrvx

As the time available for bridging gaps between current and required climate change abatement efforts becomes shorter, a prospect of drastic and fast-paced policy changes carries growing risks of significant adjustment burdens for households, and of trade-offs between carbon pricing and household living standards.[5] These trade-offs are currently not well understood, however. In particular, there is a lack of evidence on the distributional effects of policies, and their drivers, especially in a comparative context. In practice, countries have implemented a range of different carbon pricing measures (such as cap and trade emissions certificates, explicit carbon taxes and implicit measures like excise taxes) – all with different rates and bases and with potentially quite different effects on households.

This chapter estimates the carbon content of households' consumption baskets and assesses how higher carbon prices alter household budgets and consumer prices – and therefore the real value of workers' wages. It considers carbon pricing in the broad sense of the term, to account for explicit carbon pricing policies (carbon taxes and emissions trading systems), but also implicit carbon pricing through fuel excise taxes. It examines whether carbon pricing measures are regressive and explores differences in carbon price burdens across groups, including those that may be of particular policy interest, such as low-income, older or rural populations, or by gender. In a final step, the chapter considers the scope for offsetting household burdens by channelling carbon price revenues, or certain portions of them, back to households in the form of income transfers ("revenue recycling"). The results enable assessing the patterns of gains and losses and, hence, the feasibility of ensuring that a majority are better off than in the absence of carbon pricing and revenue recycling. The chapter builds on two companion papers. An earlier country-specific OECD analysis developed and illustrated the methodology in the context of a hypothetical reform in one OECD country (Immervoll et al., 2023[13]). A longer technical paper undertakes the comparative assessment of recent real-world policy reforms, and presents the results discussed in this chapter (Elgouacem et al., forthcoming[14]).

The empirical part of the chapter draws on granular information on different types of carbon pricing that countries have introduced over the past decade, using Effective Carbon Rates data collected by the OECD Centre for Tax Policy and Administration (OECD, 2016[15]; OECD, 2023[8]). The analysis combines granular Effective Carbon Rates data with emission factors for different fuels, and with input-output information to approximate the carbon content across fuel types and product categories and, ultimately, the carbon footprint of household consumption baskets. This makes it possible to trace carbon prices through the value chain, and to quantify carbon price burdens at the household level using household budget surveys. Although climate change mitigation impacts current and future generations for years to come, the focus in this chapter is on short-term distributional effects following carbon-pricing reforms. This choice is partly made for methodological reasons, such as the difficulty of accounting for households' medium-term behavioural adjustments in a realistic manner. In addition, the political-economy implications of perceived gains and losses arising from climate mitigation policies suggest that evidence on short-term impacts can be critical for initiating or accelerating policy action.

As with all modelling approaches, the analysis is subject to a number of simplifying assumptions and limitations, which may be addressed in further empirical work. It draws on granular input-output and household budget data, assuming that production technologies and product demand remain as given. A choice was also made not to model consumers' subsequent behavioural responses to the calculated price changes across goods and services, due to data and methodological limitations. A novelty of the approach is that it combines sectoral and household-level data with detailed policy information on recent carbon price changes. However, the current version of the analysis focuses on domestic policy changes and does not account for differential changes in carbon pricing across countries and the resulting impact on consumer prices through trade linkages. Finally, the analysis leaves out the effects of carbon pricing on the labour market for tractability reasons (see Chapters 2 and 3 for a discussion of the green transition's effects on labour markets more generally). The text discusses the rationale and possible effects of simplifying assumptions in more detail and the concluding section suggests associated priorities for future work.

Section 5.1 briefly sets out the objectives of carbon pricing, discusses distributional effects of different climate change mitigation measures, and the channels through which they operate, and summarises carbon pricing policies and recent policy changes across countries. Section 5.2 describes existing evidence on the distribution of carbon price burdens, along with evidence gaps. Sections 5.3 and 5.4 present an empirical analysis of carbon price burdens across five OECD countries. Section 5.3 outlines patterns of energy spending, which are a key driver of household emissions. It then analyses carbon footprints associated with all types of household consumption, comparing them across income levels and other household characteristics. Section 5.4 calculates household burdens resulting from carbon pricing reforms between 2012 and 2021, quantifying effects on household budgets across income groups. The section also considers the effects of a simple compensation measure, simulating the extent to which full or partial revenue recycling could offset carbon pricing burdens, and discussing implications for redistribution strategies. A final section offers concluding remarks.

The distributional impacts of carbon prices matter for labour market policies on multiple fronts. These include the use of revenues raised from carbon pricing to reduce other distortionary taxes such as labour taxes, and the link between labour costs growth and carbon price growth, which affects the welfare impacts of carbon pricing and the real value of wages. The concept of a “double dividend” in the context of carbon taxes (Goulder, 1995[16]) describes the situation where carbon pricing could yield both environmental benefits (by reducing emissions) and economic benefits (through an efficient recycling of the generated revenue, such as reducing distortionary labour taxes) and has been extensively discussed in the literature. Labour costs growth rates can proxy income growth rates and compared against carbon price growth rates may better help evaluate the welfare impacts of carbon price reforms. Such a comparison also helps inform on the effect of carbon price reforms on the real value of wages. These aspects are touched upon in various parts of the chapter (in particular Sections 5.3 and 5.4). Finally, the distributional impacts of carbon pricing measures on households’ consumption may aggravate some of the labour market inequalities induced by the net-zero transition (see Chapters 2 and 3) and reinforce the need for investment in skills (see Chapter 4).

An overarching objective of the chapter is to explore key drivers of distributional outcomes, such as the type of carbon pricing measure, patterns of households’ fuel consumption and the carbon intensity of different goods and services. The presentation of results seeks to inform policy decisions about alternative carbon pricing reform paths, including strategies for providing compensation to households. As countries seek to narrow gaps between the private and social costs of GHG emissions over the coming decades, the empirical analysis may serve as one possible template for a regular monitoring of the distributional implications of carbon pricing initiatives, while also highlighting important future methodological extensions.

5.1. Carbon pricing: Objectives and policy evolution

Measures to contain carbon emissions are progressing, but so is the urgency of greater commitments and corresponding decisive and sustained action – see IEA (2022[17]). Since 2020, the Paris Agreement requires countries to outline and communicate their national climate action plans, known as nationally determined contributions (NDCs) and update them every five years. These NDCs aim to achieve deeper emission reductions, with many countries striving for net-zero targets: globally, net-zero targets have been pledged by 105 countries covering more than 80% of global GHG emissions (OECD, 2023[18]). Most of these targets are not legally binding, however, and global emissions continue to rise (IEA, 2024[19]; Climate Watch, 2024[20]). The anticipated mitigation effect of current international and national commitments is nowhere near sufficient and even full implementation of existing conditional and unconditional commitments made under the Paris Agreement for 2030 will put the world on a course of temperature increases of at least 2.5°C this century (United Nations Environment Programme, 2023[21]). By 2030, GHG emissions would need to fall by 14% and 42% relative to 2019 levels to correct course in line with the Agreement's 2°C and 1.5°C goals, respectively (Pouille et al., 2023[22]).

The relative advantages and challenges of different climate-change mitigation strategies remain subject to debate, including among climate scientists (Drews, Savin and van den Bergh, 2024[23]), and countries' mitigation commitments and approaches differ. A consensus view among climate scientists is that a series of transformative step changes, involving a combination of multiple policy levers, are needed to reach net zero at a pace that is consistent with avoiding catastrophic effects of climate change (Lenton et al., 2023[24]; Jaakkola, Van der Ploeg and Venables, 2023[25]). Such policy packages may encompass measures on both the demand and the supply side, including carbon pricing, as well as regulatory measures, subsidies targeted to specific sectors and direct investments to advance technological solutions (Blanchard, Gollier and Tirole, 2023[26]; OECD, 2023[27]). Each of these mitigation approaches has distributional consequences, impacting households through numerous channels (Box 5.1).

Box 5.1.Distributional effects of different mitigation strategies: Overview and key mechanisms

Climate mitigation policies have distributional effects that impact households economically (by altering their capacity to consume), and otherwise (through direct effects on people's well-being and health, and through co-benefits, e.g. better air quality, of reducing CO_2 emissions) (Zachmann, Frederikson and Clayes, 2018[28]; Rudolph, Beyeler and Patel, 2022[29]). Economic effects include price changes, the focus of this chapter. In addition, mitigation alters the incomes of workers and asset owners through changing returns to different production factors, including labour, natural resources, and equity in "green" or "brown" industries (Rausch, Metcalf and Reilly, 2011[30]). Several meta studies provide systematic reviews (Peñasco, Anadón and Verdolini, 2021[31]; Lamb et al., 2020[32]; Markkanen and Anger-Kraavi, 2019[33]) and Chapters 2 and 3 in this publication discuss employment effects of climate-change mitigation. This box illustrates relevant distributional mechanisms via other channels, focussing on non-price mitigation. The distributional impact of carbon pricing is discussed in greater detail in the main text.

Energy efficient and clean technologies play a central role in the climate change- mitigation agenda. Demand-side policies, including subsidies and related incentives (such as preferential feed-in tariffs for solar power) tend to accelerate technology adoption and diffusion and can be politically attractive (Giraudet, Guivarch and Quirion, 2011[34]; Douenne and Fabre, 2022[35]). Yet, assessments of past measures generally show that they are regressive, and generally more so than carbon pricing, as they primarily benefit higher-income households with the necessary capital to invest in low-emitting assets (Lihtmaa, Hess and Leetmaa, 2018[36]; Lekavičius et al., 2020[37]; Winter and Schlesewsky, 2019[38]; West, 2004[39]; Levinson, 2019[40]). Findings differ, however, across technologies, with more regressive impacts of subsidies for electric vehicles than for home insulation or solar panels, and little correlation between heat pump adoption and income (Borenstein and Davis, 2016[41]; Davis, 2023[42]). Design features of subsidies or tax credits, such as refundability, timing and targeting, all shape distributional impacts (Giraudet, Bourgeois and Quirion, 2021[43]; Borenstein and Davis, 2016[41]). Outright bans on the demand side are relatively common in Europe, placing restrictions on the use of cars or certain types of residential heating (Braungardt et al., 2023[44]). Bans also raise equity issues, e.g. by creating large and possibly unaffordable asset-replacement costs for the poorest, unless bans are combined with targeted exemptions or compensation (Torné and Trutnevyte, 2024[45]).

Supply-side measures shape production processes via regulation or through subsidies, such as those provided for in the US Inflation Reduction Act (Bistline et al., 2023[46]; Bistline, Mehrotra and Wolfram, 2023[47]) and the European Union's Net-Zero Industry Act. Comprehensive studies are not yet available but there is some initial evidence of progressive impacts of “supply-push” policies that form part of such packages (Brown et al., 2023[48]). Regulatory approaches can take the form of targeted measures, such as building energy codes, fuel economy standards and vehicle pollution-control, including outright bans of high-emission technologies, with some evidence of high burdens for lower-income households (Davis and Knittel, 2019[49]; Jacobsen, 2013[50]; West, 2009[51]; Bruegge, Deryugina and Myers, 2019[52]). Regulation can also take the form of encompassing packages involving multiple levers, such as the US Clean Air Act (Robinson, 1985[53]) and equivalent provisions in other countries. The scope of these packages varies, as do their distributional impacts, with some evidence of regressive effects (Levinson, 2019[40]).

As part of strategies to tackle the causes of climate change, different types of carbon pricing measures have been introduced to shift the marginal private cost of carbon towards its marginal social cost and to align with climate neutrality targets.[6,7] Carbon pricing incentivises a reduction in emissions, including through the reduced use of fossil fuels and the substitution from dirtier to cleaner fuels and technologies. It is usually recommended for its effectiveness in reducing GHG emissions, and because it can be administratively simple, requiring less information than other types of regulation. A key argument for pricing carbon is economic efficiency, in the sense of reducing emissions where it is least costly to do so, without being technologically prescriptive. Moreover, carbon pricing does not weigh on government budgets but instead generates revenue (High-Level Commission on Carbon Prices, 2017[54]; Pigou, 1920[55]; Nordhaus, 1991[56]; Pearce, 1991[57]; Blanchard, Gollier and Tirole, 2023[26]).

Political traction of carbon pricing has increased globally, and there are currently more than 70 explicit carbon pricing initiatives, at regional, national and subnational levels.[8] Available estimates suggest that significant emission reductions are possible as a result of carbon pricing, e.g. in the order of 3-7% for a price increase of EUR 10 per tonne of CO_2 applying to all emissions (Sen and Vollebergh, 2018[58]; D’Arcangelo et al., 2022[11]). For a USD 40/tCO_2 tax covering only 30% of emissions in the European Union, Metcalf and Stock (2023[59]) estimate a cumulative emissions reduction of 4-6%, with a low impact on employment and growth – see also Chapter 2. To put these values into perspective, a carbon price of USD 1/tCO_2 adds about 0.3 cents to the price of one litre of petrol, or about 1 cent per gallon.

But the speed of adoption varies greatly and recent data point to a growing divide between countries with high and low prices (OECD, 2022[12]). Numerous governments are therefore considering reforms to introduce new carbon pricing measures, to increase prices in existing measures, or to expand them to cover greater shares of emissions. Crucially, and as highlighted by the Intergovernmental Panel on Climate Change (IPCC), “coverage and prices have been insufficient to achieve deep reductions” (Calvin et al., 2023, p. 53[60]). In 72 countries accounting for 80% of worldwide GHG emissions, and including 45 OECD and G20 countries, less than half of GHG emissions (42%) were priced in some form in 2021, either directly through carbon pricing instruments or indirectly through fuel excise taxes or similar. In OECD countries, only 14.6% of GHG emissions were priced at EUR 60/tCO_2 or more in 2021 (and 18.5% of CO_2 emissions from energy use only). Prices were lower in G20 countries,[9] with only 6.6% of GHG emissions (and 8.7% of CO_2 emissions from energy use) priced at EUR 60 or more.

A price of EUR 60/tCO_2 corresponds to a low-end estimate of the social cost of carbon in 2030, and a mid-range estimate for 2020 (High-Level Commission on Carbon Prices, 2017[54]) and the US Government currently relies on a mean value of USD 51/tCO_2 (Interagency Working Group on Social Cost of Greenhouse Gases (IWG), 2021[61]). Recent and forward-looking studies typically support significantly higher values. A 2021 report by the European Commission (2021[62]) suggests a central value of EUR 100/tCO_2 already through to 2030, while a recent comprehensive review indicates a preferred mean estimate of USD 185/tCO_2, at 2020 prices (Rennert et al., 2022[63]). Estimates of prices that are compatible with longer-term net-zero commitments vary but are higher still.[10] Scenarios developed by a network of 127 central banks, and using carbon prices as a proxy for all climate policies, point to a Net Zero 2050 weighted global price of USD 600/tCO_2, at 2010 prices (Network for Greening the Finanical System, 2023[10]).

5.1.1. Evolution of carbon prices: Effective carbon rates

The OECD's Effective Carbon Rates (ECR) database traces the evolution of carbon price policies starting in 2012. The ECR database maps carbon prices to the emissions they cover for each country, by sector and by fuel type. It includes carbon taxes, permit prices from emissions trading systems (ETSs) as well as fuel excise taxes. Carbon taxes and emissions trading systems are explicit forms of carbon prices, as they directly price CO_2 (or GHG) emissions. Fuel excise taxes are economically similar to explicit carbon prices, since their base, fuel use, is directly proportional to associated CO_2 emissions. Fuel excise taxes, however, can vary across fuel types in ways that do not reflect emissions (e.g. through preferential tax treatment of diesel of heating fuel). Excise tax rates are often higher than explicit carbon prices and they exist in almost all countries. Box 5.2 describes the ECR database and measurement approach in further detail.

Box 5.2. Effective Carbon Rates: Concept, measurement, and interpretation

The OECD Effective Carbon Rates 2021 (ECRs) database covers 72 countries, collectively emitting approximately 80% of global greenhouse gas (GHG) emissions in 2021. It presents carbon prices arising from carbon taxes, emissions trading systems (ETSs) and fuel excise taxes. Effective carbon rates account for implicit fossil fuel support / subsidies when delivered through preferential excise or carbon tax rates, so total ECRs are always greater than or equal to zero. They do not account for government measures that lower pre-tax prices of fossil fuels, i.e. for *negative* carbon prices.[1] "Carbon taxes" include explicit taxes not only on CO_2 emissions, but also on emissions of GHGs other than CO_2, such as taxes on fluorinated gases (F-gases).

The pricing instruments included in the ECR dataset either set an explicit price per unit of GHG (e.g. per tonne of CO_2e, as in the case of ETSs or carbon taxes), or on a base which is proportional to the resulting GHG emissions (e.g. excise taxes per unit of fuel):

- **Carbon taxes** generally set a rate on fuel consumption based on its carbon content (e.g. on average, a EUR 30/tCO_2 tax on carbon emissions from diesel use would translate into a 7.99 eurocent per litre tax on diesel) or less frequently, apply directly to GHG emissions.
- **Fuel excise taxes** are typically set per physical unit (e.g. litre, kilogram, cubic metre) or per unit of energy (e.g. gigajoule), which can be translated into rates per tonne of CO_2.
- The **price of tradable emission permits** issued under ETSs, regardless of the permit allocation method, represent the opportunity cost of emitting an extra unit of CO_2e (the CO_2 equivalent of GHG including CO_2 as well as other GHG, see below).[2]

The considerable granularity of the ECR data is key for capturing differences in emission prices across sectors and, therefore, across the consumption categories that shape carbon price burdens for households. The database covers six sectors that together span all energy uses: road transport, electricity, industry, buildings, off-road transport, agriculture and fisheries. Fuels are grouped into nine categories: coal and other solid fossil fuels, fuel oil, diesel, kerosene, gasoline, liquified petroleum gas (LPG), natural gas, other fossil fuels and non-renewable waste, and biofuels.

CO_2 emissions in the ECR database are based on energy use data from the International Energy Agency's World Energy Statistics and Balances (IEA, 2020[64]). The ECR database covers CO_2 emissions from energy use from six sectors (mentioned above). Since its 2018 vintage, it also covers other GHG emissions – i.e. emissions from methane (CH_4), nitrous oxide (N_2O), F-gases[3] and process CO_2 emissions (excluding land use change and forestry, LUCF). These are sourced from the CAIT database (Climate Watch, 2024[20]).[4] Due to data limitations, and to facilitate comparisons with previous ECR vintages, other GHG emissions are not allocated to the six economic sectors but are considered separately (as a seventh sector).[5]

In the context of this chapter, the standard ECR indicator is used as the price that is passed on to consumers. This does not account for free emissions allocations to producers. Using it as a basis for assessing consumer prices, therefore effectively assumes full marginal-cost pass-through, regardless of the permit allocation method, with any free allocations being a rent for emitting firms. There is some empirical evidence of marginal-cost pass-through, and associated “windfall profits”, in the energy sector (Fabra and Reguant, 2014[65]; Nazifi, Trück and Zhu, 2021[66]). Nevertheless, full marginal-cost pass-through is a simplifying assumption and the actual incidence will vary across countries and sectors.

Annex 5.B provides additional details on the methodology and discusses a number of core issues related to the ECR indicator and its interpretation.

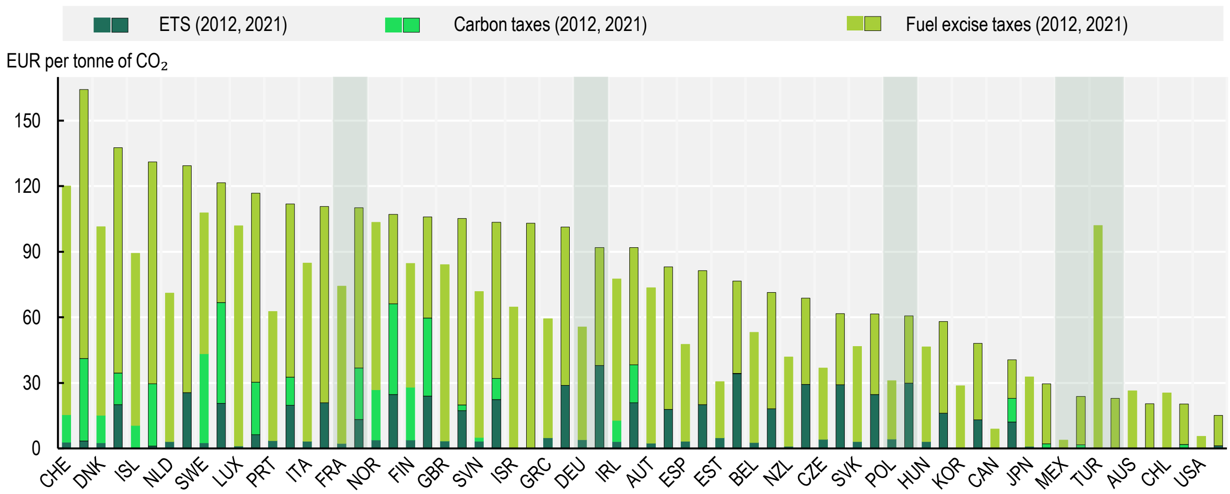
1. Net Effective Carbon Rates, available from year 2018, account for a broader range of fossil fuel subsidies, i.e. those that decrease pre-tax prices of fossil fuels, and hence include negative carbon prices (Garsous et al., 2023[67]).
2. Thus, effective carbon rates are sometimes also referred to as effective *marginal* carbon rates. Effective *average* carbon rates, which account for free allocations, are discussed in Annex 5.B.
3. HFCs, PFCs, and SF6.
4. Excluding Land-use Change and Forestry (LUCF).
5. See e.g. the International Energy Agency’s documentation on GHG emissions from energy use (IEA, 2021[68]).

Source: OECD (2023[8]), *Effective Carbon Rates 2023: Pricing Greenhouse Gas Emissions through Taxes and Emissions Trading*, https://doi.org/10.1787/b84d5b36-en; OECD (2022[12]), *Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action*, https://doi.org/10.1787/e9778969-en; OECD (2016[69]), *Effective Carbon Rates: Pricing CO2 through Taxes and Emissions Trading Systems*, https://doi.org/10.1787/9789264260115-en.

Effective carbon rates have been increasing in most OECD countries over the 2012 to 2021 period (Figure 5.2), both in nominal and in real terms. Where they decreased, this was in general due to inflation or exchange rate fluctuations. In most OECD countries, fuel excise taxes clearly make up the largest part of total ECR. EU countries as well as Iceland and Norway have been subject to the EU ETS since 2005 and permit prices substantially increased between 2018 and 2021. As part of its Fit for 55 package, the European Union plans to extend carbon pricing through emissions trading to transportation and buildings sectors. Explicit carbon taxes were first introduced in Finland in 1990 and in Norway in 1991, with numerous countries implementing or announcing them since then. In addition, countries variously commit to phasing out fossil fuel subsidies (G20 Leaders Statement, 2009[70]; OECD/IEA, 2021[71]).

Figure 5.2. Evolution of effective carbon rates in 34 OECD countries, 2012-21

In 2021 EUR per tonne of CO_2, levels for 2012 and 2021



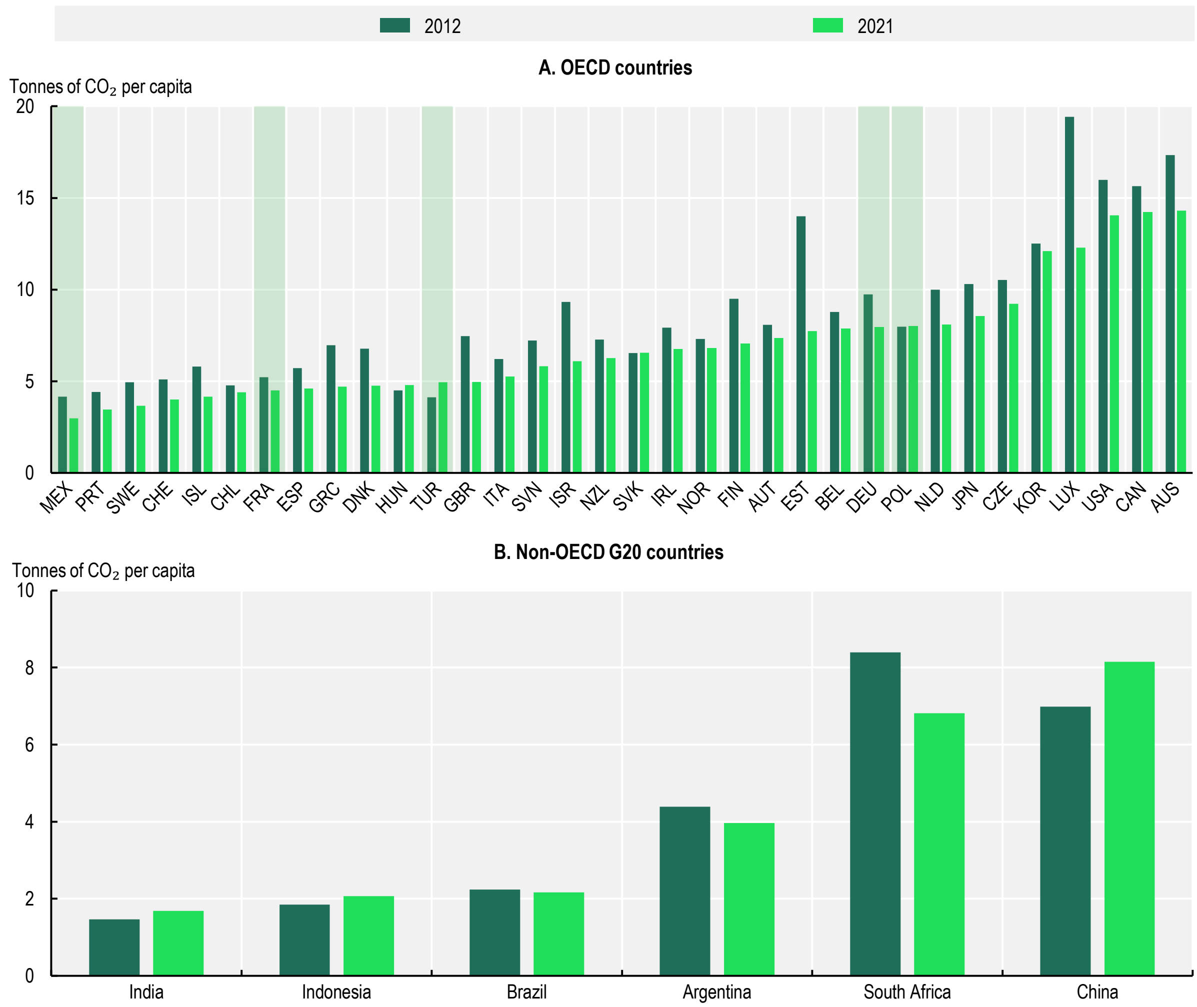
Note: For each country, the two bars refer to the two years (2012, 2021). Highlighted countries are those included in the empirical analysis of this chapter. The chart presents emissions-weighted average Effective Carbon Rates (ECR) over the whole economy, by pricing instrument, presented in 2021 constant EUR. Effective Carbon Rates are the sum of carbon taxes, permit prices from emissions trading systems (ETS) and fuel excise taxes. The emissions-weighted average effective carbon rates presented here are computed excluding emissions from the combustion of biomass.
Reading: In 2012, the average ECR in France was of EUR 74.5 per tonne of CO_2, with carbon pricing mostly resulting from fuel excise taxes (with an average of EUR 72 per tonne of CO_2 across the economy). In 2021, the average ECR in France was of EUR 110 per tonne of CO_2, with carbon taxes and ETS prices increasing the most since 2012: the French economy-wide average carbon price resulting from the EU ETS was of EUR 13/tCO_2 and from carbon taxes of EUR 23.6/tCO_2.
Source: OECD Effective Carbon Rates database.

StatLink https://stat.link/8veb70

In parallel, per-capita carbon emissions from energy use declined in most OECD countries (Figure 5.3). By contrast, in spite of lower average emissions than OECD countries in 2012, non-OECD G20 countries have not all followed the decreasing trend in the OECD area. In particular, China, India and Indonesia have seen a rise in per capita emissions. In India and Indonesia, they nevertheless remained lower than in most OECD countries in 2021. These differences arise due to many factors, including the different levels of developments between most OECD and non-OECD G20 countries. Less developed countries may rely more on energy-intensive resources to foster their development.

Figure 5.3. Carbon emissions from energy use

In tonnes of CO_2 per capita, 2012 and 2021



Note: Highlighted countries are those included in the empirical analysis of this chapter. Emissions are on a territorial basis generated in each country. This contrasts with average carbon footprints, as derived in the empirical part of this chapter, which are linked to domestic consumption, i.e. taking into account emissions along the value chain. The emissions presented here are carbon emissions from energy use and exclude emissions from the combustion of biomass.
Source: OECD Effective Carbon Rates database.

StatLink https://stat.link/x07w19

The main fuels responsible for CO_2 emissions from energy use in OECD countries are natural gas (33%), followed by coal (25%), diesel (16%) and gasoline (13%) (Annex Figure 5.B.1). In non-OECD G20 countries, coal holds a much more important share (65%).[11] Carbon prices levied on these fuels are very heterogeneous, in terms of both the rates and the type of policy measure.[12]

5.2. Previous results on the distribution of carbon price burdens

In part, concerns about the distributional impacts of carbon pricing stem from the fact that domestic fuels are, at the same time, necessities for many households, and a main source of their GHG emissions. When prices go up, the poorest households may be ill-equipped to draw on savings, to cut back on other expenditures, or to reduce their reliance on high-emission products (OECD, 2022[72]; Sologon et al., 2022[73]). As a result, low-income groups may bear a substantial burden from higher carbon prices. A regressive impact, in turn, risks worsening key aspects of inequality, material deprivation and social exclusion, such as energy poverty (including fuel poverty) or food insecurity. Aspects of poverty and deprivation may also worsen even if carbon pricing is not regressive. The current cost-of-living crisis has dramatically heightened concerns over the economic burdens on households from rising living costs, and higher energy prices in particular.

There are numerous drivers of distributional outcomes. Studies tend to focus on the gradient of carbon price burdens by income group and a common question is whether this overall pattern is “regressive”, in the sense that relative burdens decline with income. Other inequalities, such as difference between age groups, education levels, dwelling types or geography have received comparatively little attention in past studies, though a few have shown that such “horizontal” inequalities, even for a given income level, can be greater than “vertical” differences between income groups (Labrousse and Perdereau, 2024[74]; Missbach, Steckel and Vogt-Schilb, 2024[75]; Cronin, Fullerton and Sexton, 2019[76]). For instance, Causa et el. (2022[77]) find that energy price inflation between 2021 and 2022 had stronger impacts on rural households.

Results are available for several countries, but country coverage is far from comprehensive. The scope, objectives and approaches of studies vary greatly, making findings difficult to compare and interpret. Many studies focus on fuel expenditures but do not consider the effects of carbon prices on the affordability of everything else. Likewise, studies frequently do not account for compensation measures that can be financed from carbon-tax revenues (“revenue recycling”). A common focus is on specific hypothetical policy changes (such as the introduction of a comprehensive across-the-board carbon tax), without considering real-world price variations due to differentiation between sectors, exemptions or linkages between different types of carbon pricing that typically exist in parallel (such as carbon taxes, excise taxes on fuel and/or ETS). To date, there is no comparative[13] distributional assessment of real-world policies that governments have already implemented, including combinations of different carbon pricing measures, and associated lessons for the design of future reforms – single-country distributional analysis of specific components of carbon pricing may nonetheless be found (Gonzalez, 2012[78]; Sajeewani, Siriwardana and McNeill, 2015[79]; Callan et al., 2009[80]).

The net effects of carbon pricing on the cost of households’ entire consumption baskets vary strongly between countries and policy measures, depending not only on spending patterns, but also on population characteristics and existing inequalities (Ohlendorf et al., 2020[81]; Andersson and Atkinson, 2020[82]). Importantly, carbon prices affect not only the cost of transportation and heating but, subject to the carbon intensity of the production process, also the prices of other goods and services (Vogt-Schilb et al., 2019[83]; Immervoll et al., 2023[13]).

There is a common conjecture that carbon taxation and other forms of carbon pricing are regressive in high-income countries (Klenert and Mattauch, 2016[84]). However, home fuel and electricity taxation tends to be more regressive than fuel taxation in the transport sector (Büchs, Ivanova and Schnepf, 2021[85]; Köppl and Schratzenstaller, 2022[86]; Pizer and Sexton, 2019[87]), which can be progressive, especially in countries with moderate car ownership and well-developed public transport systems (Wang et al., 2016[88]; Missbach, Steckel and Vogt-Schilb, 2024[75]; Flues and Thomas, 2015[89]). Constrained energy consumption among low-income households can make carbon pricing somewhat less regressive, although even small increases in energy costs are a concern for households who already consume below their needs.

In countries with lower GDP levels, including in the OECD area, households at the bottom of the income distribution tend to face significant risks of energy affordability (Flues and van Dender, 2017[90]). Outside the OECD, progressive impacts are also more likely in poorer countries, where energy can be a luxury that is unaffordable for large parts of the population, home fuels can be less important due to patchy heating provisions or climatic conditions, and car ownership is highly concentrated at the top of the income distribution (Ohlendorf et al., 2020[81]; Dorband et al., 2019[91]; Mardones, Di Capua and Vogt-Schilb, 2023[92]; Steckel et al., 2021[93]; Missbach, Steckel and Vogt-Schilb, 2024[75]; Klenert and Mattauch, 2016[84]).

Most studies do not compare distributional impacts between different types of carbon pricing. Those that do suggest that pricing direct emission through taxes on fuel consumption (excise taxes) is more regressive than pricing all emissions, including also indirect ones from the consumption of everything else (e.g. through a carbon tax) (Ohlendorf et al., 2020[81]; Immervoll et al., 2023[13]). Yet, extending pricing to GHG other than CO_2 can make emissions pricing more regressive, primarily through the impacts on food prices. Exemptions of specific energy carriers or sectors also affects the distribution of carbon price burdens. For instance for a federal carbon tax in Mexico, which exempts natural gas, Renner (2018[94]) finds that burdens are relatively equal across income groups, but that it would be regressive if natural gas were included.

Behavioural responses, which are the primary purpose of carbon pricing, can also differ by population group and can therefore influence distributional outcomes. Households' consumption decisions respond to changes in relative prices (substitution effect) but also to average price levels (which then impact available income – income effect). The resulting distributional impact depends on preferences and the ability of low and high-income households to adjust their consumption of carbon intensive goods. There is no clear evidence on whether high or low-income households respond more strongly to carbon prices, with some studies suggesting greater responses among low-income households (West and Williams, 2004[95]) and others finding the opposite (Campagnolo and De Cian, 2022[96]). Overall, the impact of households' behavioural response on the distributional impact of carbon prices seems limited at current carbon price levels (Renner, Lay and Greve, 2018[97]; Immervoll et al., 2023[13]), though this may not hold for bigger and/or fast-paced increases in the future. The lack of any clearer income gradient of behavioural responses reflects multiple drivers of price reactions, but also significant methodological challenges and data limitations (Annex 5.B). Within a country, behavioural impacts may differ across income groups due to many factors, including their composition: for example, if higher income households tend to live in more densely populated areas, they may have more substitution options for lower-emitting transport; or if lower income households tend to commute more, they may have less possibilities to reduce their car usage (and related emissions).

The literature commonly considers revenue recycling as an appropriate tool to alleviate any undesirable distributional impact of carbon pricing (Klenert et al., 2018[98]; Immervoll et al., 2023[13]). Even simple revenue recycling schemes, such as per capita transfers, can lead to progressive impacts of carbon pricing (Feindt et al., 2021[99]; Budolfson et al., 2021[100]). Moreover, available results suggest that it may be feasible to ensure favourable distributional outcomes by redistributing less than the full amount of carbon pricing revenues, leaving some of it for other purposes (Landis, 2019[101]). As carbon price burdens are typically highly heterogeneous, however, redistributing the tax take through an across-the-board lump-sum transfer will create both gainers and losers (Sallee, 2019[102]; Cronin, Fullerton and Sexton, 2019[76]).

Beyond the consumption and revenue-recycling channels, carbon pricing has further distributional effects, similar to those of other climate-mitigation measures, notably by altering the demand or supply of production factors, including labour (see Box 5.1 above).[14]

5.3. Carbon footprints and distributional impact of carbon pricing reforms

This section combines a range of data sources to explore the impact of carbon pricing measures in five selected OECD economies: France, Germany, Mexico, Poland and Türkiye. These five countries were chosen based on data availability and quality, and they capture a reasonable spread of geographic region, GDP levels, emissions per capita and carbon price levels (see Figure 5.2 and Figure 5.3).

A particular focus of the empirical assessment is to link information on carbon prices and emissions (which is needed for tracing carbon price burdens through the value chain) with micro-data data on consumption patterns (needed for quantifying burdens at the household level, and for assessing government policies that aim to cushion or offset those burdens). Existing studies have tended to be country-specific, or to look at simplified hypothetical reforms or a specific type of carbon pricing, such as excise taxes (see literature overview in Section 5.2). By contrast, this section compares a broad range of carbon pricing reforms that countries have implemented between 2012 and 2021, drawing on the OECD's ECR database.

The assessment builds on a recent analysis on Lithuania (OECD, 2023[103]; Immervoll et al., 2023[13]). Annex 5.A describes the methodology. In a nutshell, it draws on granular input-output data, which capture emissions by sector and allow tracing them from source inputs to final consumer products and services. Emissions for different output categories are then matched with household spending information from available budget surveys to approximate the carbon footprint from household consumption across groups in a bottom-up manner, incorporating emissions from producing and combining relevant inputs. Apart from the comparative perspective using data sources for different countries, this approach is similar to that followed in some national studies (Pottier, 2022[104]).[15]

This chapter does not report households' subsequent reactions to price changes at this stage, because of data and methodological limitations. Households do respond to price changes, and the earlier study that this chapter partly builds on illustrates an approach for estimating a full set of budget and price elasticities (Immervoll et al., 2023[13]). That study estimates that behavioural reactions, mainly in the form of shifts to less polluting goods and services, reduces carbon price burdens by less than 10% for most income groups. However, estimated responses differ significantly across studies and across and within countries. More importantly for the present study, evidence on the overall distributional impact arguably remains inconclusive. Section 5.2 and Box 5.3 provide an overview of previous studies and of the estimation difficulties in the context of carbon pricing. The considerable range of available results on behavioural responses, and the lack of an empirical consensus on the direction of the distributional impact of consumer behaviour, suggests that the effects of methodological and data choices may currently dominate the variation in responses across population groups. Studying households' evolving responsiveness to carbon price changes is an important topic for future research (see Section 5.5).

Box 5.3. Consumer response to carbon prices: Estimates, driving factors and knowledge gaps

Behavioural responses to carbon pricing are central for effective mitigation, and households play a crucial role in lowering emissions. When emission prices go up, households adjust consumption patterns towards lower-emitting products and services in response to price increases (price elasticities). In addition, higher prices change consumption as a result of reduced overall budgets (in real terms, budget elasticities). Household responses shape the effectiveness of Pigouvian taxes in tackling negative externalities. They are potentially also relevant for estimating second-order distributional consequences of price changes.

Both own and cross-price responses are relevant when assessing behavioural reactions. But a key focus of existing studies is on the responsiveness of fuel demand to changing fuel prices. This is commonly captured in a single number, the own-price elasticity of fuel demand, with a large literature using a number of different estimation strategies and data sources (Labandeira, Labeaga and López-Otero, 2017[105]; Zhu et al., 2018[106]; Havranek, Irsova and Janda, 2012[107]; Brons et al., 2008[108]; Espey, 1998[109]; Dahl, 2012[110]).

Published estimates vary markedly across studies. Considering residential, commercial and industrial actors' elasticities, Labandeira, Labeaga and López-Otero (2017[105]) find central estimates for energy elasticities of –.221 in the short run, and –.584 in the long-run. They highlight large differences across energy commodities, with the largest elasticities for gasoline (-.293, -.773), natural gas (-.180, -.684) and diesel (-.153, -.443), and lower values for electricity (-.126, -.365) and heating oil (-.017, -.185). Other studies, however, find markedly lower price elasticities for gasoline, providing central estimates of -.09 in the short run and -.31 over longer time horizons (Havranek, Irsova and Janda, 2012[107]). A range of country characteristics can shape these differences, for instance fuel demand is typically more elastic in densely populated areas and those well-served by public transport.

But the wide range of estimates is also driven by empirical methods and measurement choices, including time horizons. Most studies focus on short-run elasticities and assume that the responsiveness to price changes is independent of the initial price level. In reality, elasticities and price levels vary over time. Households may be unable to adjust their consumption of fuels quickly. But in the medium term, they may invest into new heating systems, improved insulation, and energy efficient transport assets. Indeed, these responses are a key policy objective of carbon pricing and ignoring them is therefore problematic. A further limitation is that demand elasticities are typically estimated linearly, without allowing them to vary depending on the magnitude of price changes (Immervoll et al., 2023[13]). In effect, this approach predominantly captures continuous changes in consumption of a given good (intensive margin), but not complete shifts between consumption categories once prices surpass specific thresholds (extensive margin, such as transitioning entirely from cars to public transport or bicycles). The latter can be particularly important in the context of efforts to lower emissions.

A comparatively small literature examines differences in price elasticities across socio-economic and income groups – see e.g. Wadud, Graham and Noland (2010[111]), who identify the number of vehicles owned, number of wage earners and household location as determinants of price elasticity. The same study assesses the importance of behavioural responses for the distributional impact of a gasoline tax, finding that the inclusion of heterogeneous behavioural responses does not alter the distributional profile of the tax, a finding also echoed in a study of carbon pricing by Renner, Lay and Greve (2018[97]). As noted in Section 5.2, there is no consensus on whether low-or high-income households are more responsive to fuel price increases, with some other studies finding stronger responses among low-income households (West and Williams, 2004[95]), while others find larger elasticities for higher incomes (Zhu et al., 2018[106]).

In summary, households' responses to price changes in energy commodities are larger in the long run than the short run, and they differ across energy types, although differences are often small to moderate. For all energy commodities, increases in prices are associated with a less than proportional decrease in consumption. Households will therefore typically face larger energy bills when carbon prices go up, even after considering behavioural responses. Some studies suggest that behavioural responses play a limited role in determining the overall distributional impact of price changes, but evidence on the difference in behavioural responses across household types remains inconclusive, partly due to methodological and data-related challenges.

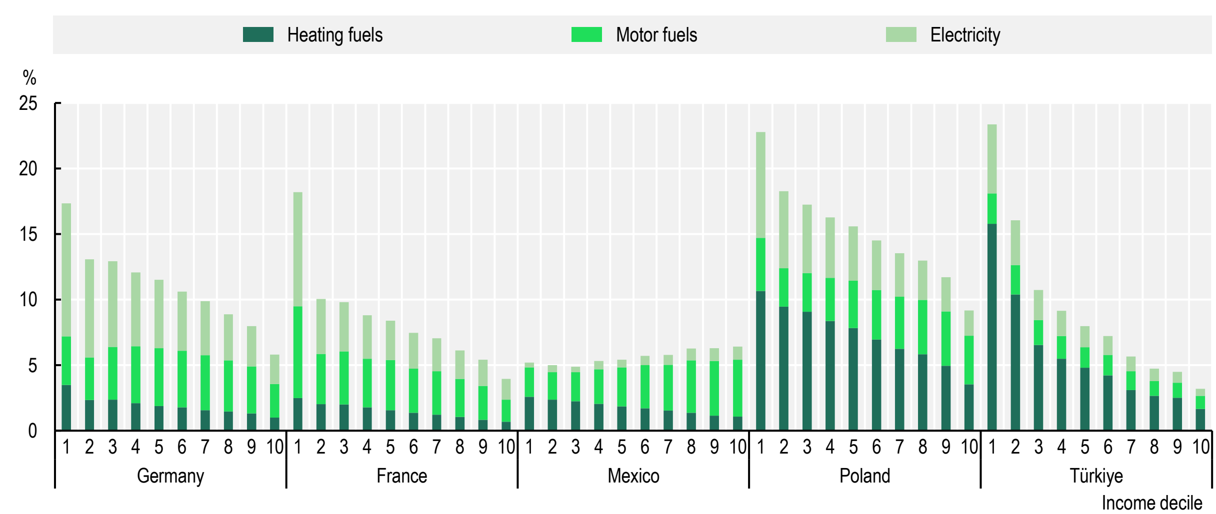
5.3.1. Energy spending is one key driver of household emissions

Carbon prices affect household budgets both directly through households' own fuel consumption, and indirectly via the consumption of other goods and services that give rise to CO_2 emissions during the production process. The direct effect is shaped by the pattern of expenditures on heating and transport (fossil-)fuel (Figure 5.4). The figure also shows spending on electricity, which is a derived good, whose production can be fuel intensive.[16] Energy-related emissions embodied in the full set of derived goods, including, e.g. food and public transport, form one part of the overall carbon footprints presented in the next sub-section.

Poor households save less than the rich, or they dissave, and total consumption therefore accounts for larger portions of their income than for better-off households. In four of the five countries included in Figure 5.4, such a regressive spending pattern holds also for energy consumption. This is particularly visible in Poland and Türkiye, where low-income households spent more than one fifth of their incomes on energy.[17] Spending on electricity and heating is also regressive in the other European countries. This makes them particularly vulnerable to energy poverty.[18] But the share of resources devoted to some categories of energy can in fact increase with income. Spending shares for motor fuel are increasing with income in Mexico and Poland, reflecting both income inequality and unequal car ownership. In Germany, motor fuel spending is mostly flat. Mexico is the only country where richer households devote bigger portions of their income to energy overall, confirming that energy can be a luxury item in middle-income countries.[19] Average spending shares also vary strongly across countries, with plausible drivers including average incomes, climatic factors, as well as energy taxation and subsidies.

Figure 5.4. Poorer households typically spend large parts of their income on energy, but spending is "top-heavy" in some middle-income countries

Household expenditures on fuel and other energy, as a percentage of disposable income, by income decile



Note: Groups 1-10 refer to income deciles (equivalised disposable household income). Heating fuel includes expenditure on gas (natural gas and town gas), liquified hydrocarbons, kerosene and other liquid fuels, coal and other solid fuels. Motor fuel includes expenditure on diesel and petrol for transportation.
Source: OECD calculations using household budget surveys (2015 for EU countries, 2016 for Mexico, 2019 for Türkiye) and WIOD input-output data (for electricity).

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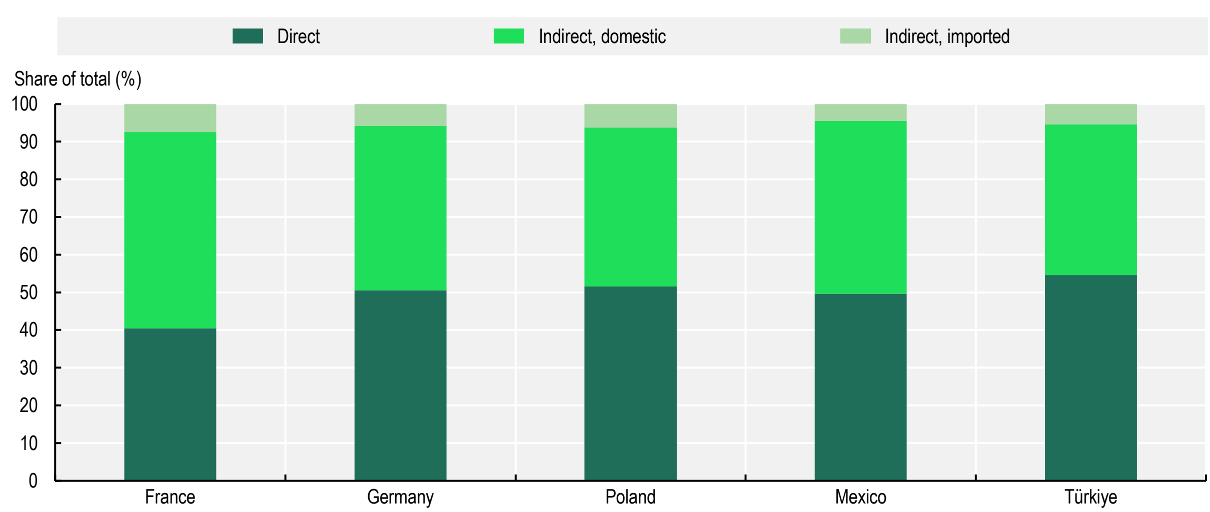
5.3.2. Who pollutes the most? Carbon footprints linked to household consumption

Energy consumption is a key driver of emissions, but it is not the only one. There are several reasons why energy spending is only a partial indicator of households' carbon footprints. First, emissions from electricity generation vary enormously between countries, by a factor of 15 across the five countries considered here.[20] Relatedly, for each of the main fuel consumption categories, emissions vary by type of fuel (see Annex Figure 5.B.1), as do prices before accounting for carbon pricing. For lower-income or rural households, domestic fuels can include high shares of solid fuels (coal, coke, peat, firewood), which have much higher emission factors than liquid fuel. Emission factors are lower for natural gas, an energy source that can be more common in urban areas. Motor fuels are commonly more expensive than domestic fuels and produce fewer emissions per energy unit than firewood, coal, or heating oil. Per unit of fuel expenditure, emissions – and therefore also the effect of a given carbon price – thus tend to be higher for domestic fuels than for motor fuels.

Second, non-fuel expenditures account for a large share of household spending.[21] Per unit of spending, fuel use creates more emissions than other consumption, but due to the size of non-fuel spending, the production of non-fuel goods and services is a significant driver of carbon footprints. Across the five countries, direct emissions from households' own use of fossil fuels mostly account for around half of the total emissions linked to consumption (Figure 5.5). These estimates incorporate all household consumption, following the "consumer responsibility" principle (see figure note). Fuel spending was a lesser driver of total emissions in France, partly reflecting the balance of spending on fossil fuels and electricity, but also the types of fuel (coal and other solid fuel, liquid fuel, gas) used by households and in production processes.[22] Emissions linked to imported inputs or final goods (other than fuel) are also significant but comparatively small, accounting for less than 10% of emissions in each of the five countries. (This small share is reassuring in the context of the chapter's later estimates of carbon price burdens, which do not account for differential carbon price trends in source countries.)

Figure 5.5. Fuel expenditure is not the only driver of households' carbon footprints

Emissions from fuel ("direct") and non-fuel ("indirect") consumption, in percentage of total



Note: "Direct" includes households' own consumption of fossil fuels, both domestically sourced and imported. "Indirect, domestic" includes households' own non-fuel, domestically sourced consumption. "Indirect imported" accounts for emissions linked to all other non-domestically sourced inputs and consumption goods. Estimates are based on the "consumer responsibility" principle, accounting for all household consumption. They therefore attribute emissions to the country where the final good is consumed, and this differs from the emissions per capita that are physically released in a given country. It is important to account for the consumption of imported goods in order to determine the carbon price embedded in households' consumption baskets.
Source: OECD calculations using IEA emissions factors for different fuels, World Input-Output Database (WIOD) as well as household budget surveys (2015 for EU countries, 2016 for Mexico, 2019 for Türkiye).

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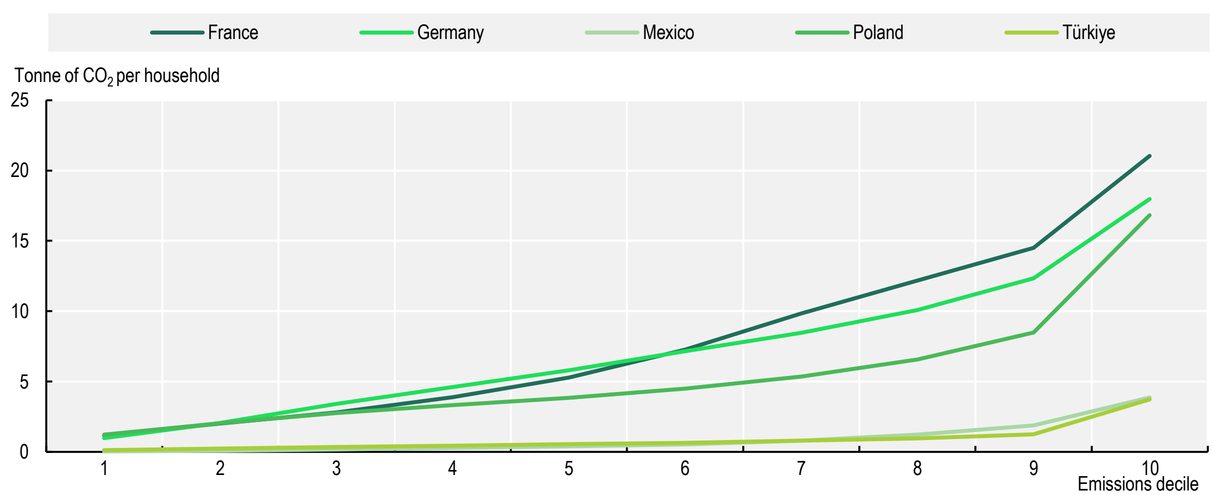
Quantifying indirect emissions embodied in non-fuel consumption is thus crucial for assessing distributional effects. Embodied emissions are not observed directly. Consumption patterns, and their carbon content, vary in complex ways between countries and households, making the net effect impossible to anticipate without careful modelling. Results in the remainder of this chapter trace emissions from both direct and indirect consumption to individual households, using the modelling approach summarised in Annex 5.A.

Across countries, differences in carbon footprints are very large, reflecting various factors, including levels of development, population density, consumption patterns, and production technology. Figure 5.6 shows emissions linked to household consumption across countries, at different points of the national emissions distribution (rather than the income distribution). Average emissions (not shown) range from around 1 tonne of CO_2 per household and year in Mexico and Türkiye, to 6 tonnes in Poland, and 8 to 9 tonnes in France and Germany. Median emissions of German households were nearly as high as for households at the 8th decile of the Polish emissions range. The average consumption for the top 10% emitting households in Mexico and Türkiye produced the same amount of emissions as the bottom 3rd decile in Germany. These country differences in emissions attributed to domestic household consumption can be much bigger than those in terms of per-capita emissions that are physically released in each country (compare with Figure 5.3).

Figure 5.6. Emissions from household consumption are very unequal across and within countries

Emissions from household consumption, tCO_2 per household at different points in the national emissions distribution



Note: Average emissions across the national emissions distribution (not income distribution), from lowest-emitting to the highest-emitting households. The ranking variable is emissions linked to household consumption, equivalised to account for household size. Estimates follow the "consumer responsibility" principle, accounting for all household consumption, including both domestically produced and imported goods. They therefore attribute emissions to the country where the final good is consumed, and this differs from the emissions per capita that are physically released in a given country.
Source: OECD calculations using IEA emissions factors for different fuels, World Input-Output Database (WIOD) as well as household budget surveys (2015 for EU countries, 2016 for Mexico, 2019 for Türkiye).

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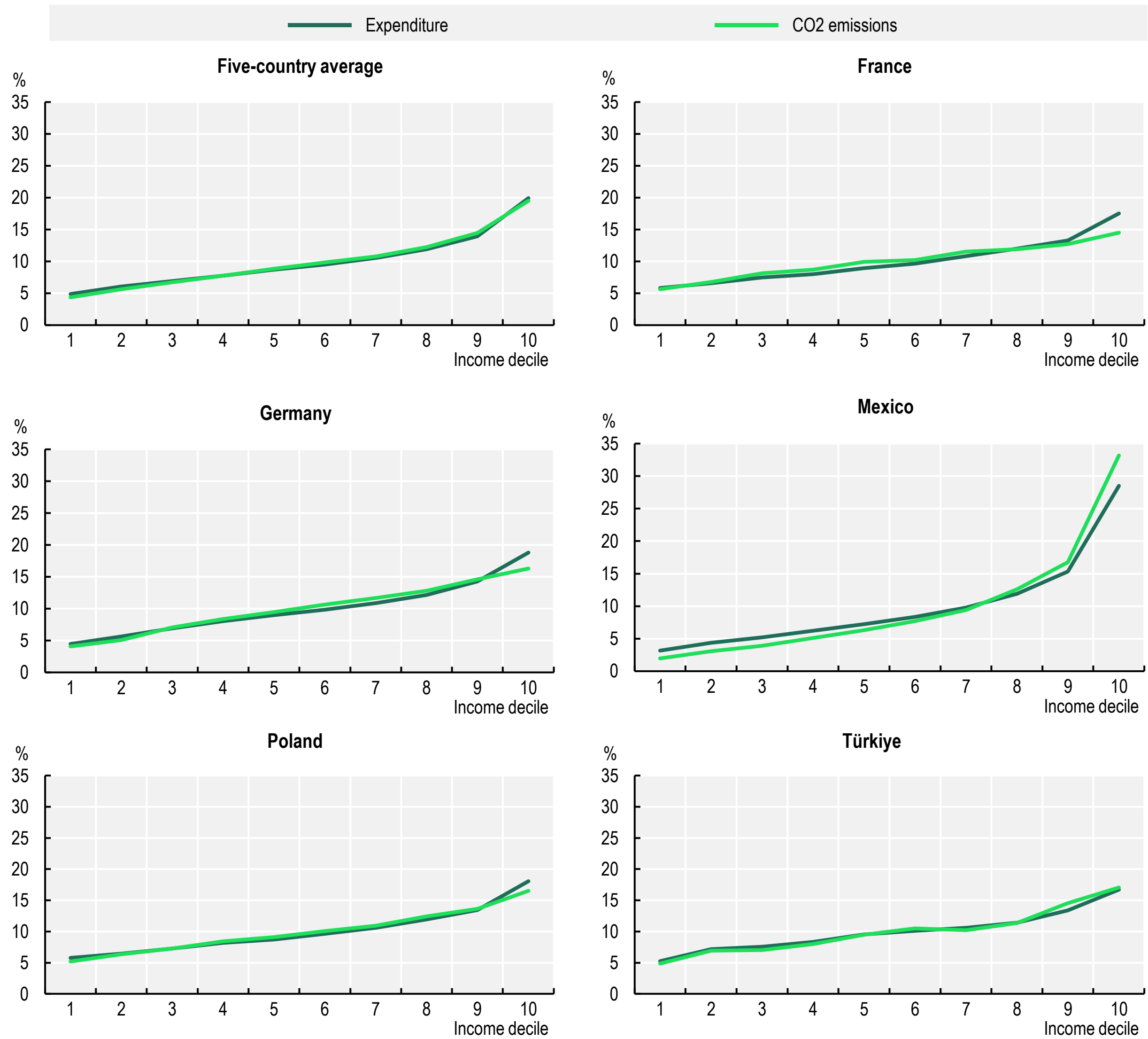
Within countries, the key driver of emissions disparities between poor and rich households is total consumption. In the five countries, on average, high-income households (top 10%) spent 4.5 times as much as the poorest 10% (Figure 5.7, top-left panel). Spending inequality was lowest in France and Poland (total spending for the top and bottom 10% differ by a factor of 3) and highest in Mexico (a factor of 9). Emissions associated with consumption therefore also rose strongly with income. On average across countries, profiles of total spending and emissions are very similar, pointing to the importance of total spending levels as a driver of carbon footprints. The findings on the income gradient of consumption-based emissions echo those found in Chancel, Bothe and Voituriez (2023[112])'s recent study, even though the results presented here are less skewed.

Figure 5.7. Carbon footprints are much bigger at high income levels, but in some countries low-income households consume greater shares of high-emission goods

Household expenditure and emissions shares of total, by (disposable) income decile



Note: Average expenditure (resp. emissions) by income group (equivalised disposable household income) as a percentage of overall expenditure (resp. emissions). Estimates follow the "consumer responsibility" principle, accounting for all household consumption, including both domestically produced and imported goods. They therefore attribute emissions to the country where the final good is consumed, and this differs from the emissions per capita that are physically released in a given country.
Reading: in Poland, expenditure from the lowest income decile accounts for about 6% of total national expenditure and expenditure from the highest income decile accounts for about 18%. About 5% of emissions accrued to the lowest income decile while 16.5% of emissions accrued to the highest income decile.
Source: OECD calculations using IEA emissions factors for different fuels, World Input-Output Database (WIOD) as well as household budget surveys (2015 for EU countries, 2016 for Mexico, 2019 for Türkiye).

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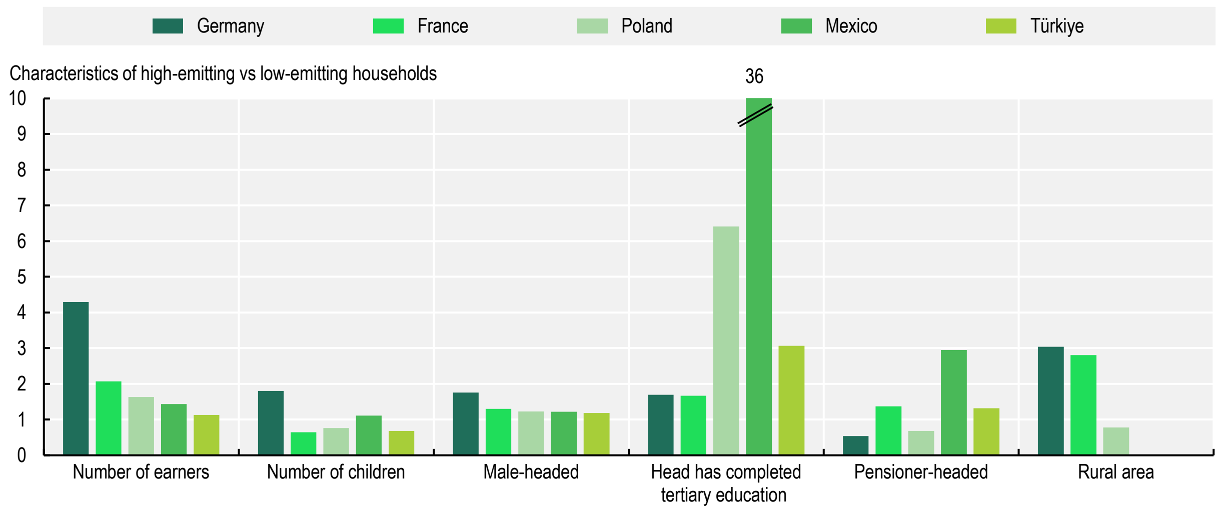
But results for individual countries highlight that emissions can be reduced not only by spending less, but also by spending differently.[23] In addition to total spending, the share of spending on particularly carbon-intensive items differs across income groups as well. Due to carbon-intensive necessities, including categories of energy and food, emissions per spending unit can be higher at the bottom of the distribution. Consumption among high-income households, although much larger than for poorer households in total, is then less carbon *intensive*. Figure 5.7 shows such a pattern in several high-income countries (France, Germany, Poland): for instance, in France, similar shares of total expenditure and carbon emissions accrue to the lowest income decile (resp. 5.8% and 5.6%) whereas the share of total expenditure was higher than that of emissions for the highest income decile (17.5% versus 14.5%). But differences are largely driven by consumption of the highest-income groups (top 10%) and differences in the incidence of emissions and total spending are small or very small in most individual countries and in the five countries on average. Calculations for Mexico indicate that the richest households not only consume more, but that their consumption is also associated with higher carbon emissions per spending unit: 3.2% of total expenditure and 1.9% of total carbon emissions accrue to the lowest income decile, while 28.5% of total expenditure and 33.2% of total carbon emissions accrue to the highest income decile. Section 5.4 discusses implications of these results for strategies to compensate households for carbon price burdens.

An exclusive focus on emissions differences by income misses many other characteristics that may drive the reliance on high-emitting products. As noted in the literature review, past research has often focussed on income-emission gradients. Yet, a number of studies have documented large carbon-footprints disparities *within* income groups, pointing to the importance of drivers other than income. These may, for instance, include age, household size, or living in a rural area rather than a city – for the latter, see e.g. recent findings by the Swedish National Institute of Economic Research (Konjunktur Institutet, 2023[113]) – but also individuals' consumption habits and environmental considerations. The broader social stratification of GHG emissions vary by country and can drive patterns of public support for, or resistance to, carbon pricing policies.[24] These patterns need to be understood to design policy packages that do not disproportionately harm disadvantaged groups. A granular picture of emissions by demographic group is also needed for anticipating future emission trends and policy priorities, notably in the context of population ageing (Tian et al., 2023[114]).

Figure 5.8 compares a range of household characteristics between high-emitting and low-emitting households (see figure notes). Emissions in some EU countries are strongly related to the number of earners in the household, likely reflecting the importance of motor fuel for commuting purposes. Relatedly, in several countries, high emissions are more likely in rural areas, reflecting longer commuting times and typically different heating provisions and older housing stock with less insulation (urban/rural flags are not available from the Mexican and Turkish budget survey). There is also a notable gender dimension to carbon emissions with more male-headed- households among the top emitters, consistent with prevailing gender income gaps. The education gradient is also notable, and tertiary education is a particularly strong correlate of high emissions in Mexico and Poland. In practice, these and other characteristics are correlated, potentially strongly so. Future work should further analyse carbon footprints for a range of household characteristics, while controlling for others.[25]

Figure 5.8. Various household characteristics shape carbon footprints

Household characteristics at different emission levels (see figure note)



Note: Ratios compare socio-economic characteristics between high-emitting households (the top 10% of emissions) and low-emitting households (the bottom 10% of emissions) as follows. Number of earners and number of children in the household: Ratio of average numbers of earners and children per household; Other categories: Ratio of number of households in a rural area, or headed by a male, by a person with completed tertiary education, or by a pensioner. Urban/rural indicators are not available from the Mexican and Turkish household budget surveys. Reading, using the example of Germany: The average number of earners in the top 10% emitting households is 4.3 times that in the bottom 10% emitting households (note that the reason for this large relative difference is that almost 80% of the bottom 10% emitting households in Germany had no earner – and the average number of earners in the top 10% emitting households is 1.4). Reading is equivalent for "number of children". For the other categories, ratios relate to the number of households in the top 10% and bottom 10% emitting households: the number of households located in rural areas, and the number headed by a male, by somebody with tertiary education, and by a pensioner. In other (less technical) terms, in Germany, high-emitting households were three times more likely to live in a rural area than low-emitting households.

Source: OECD calculations using IEA emissions factors for different fuels, World Input-Output Database (WIOD) as well as household budget surveys (2015 for EU countries, 2016 for Mexico, 2019 for Türkiye).

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5.3.3. Policy changes: Who paid for recent carbon pricing measures?

Households' carbon footprints are a primary determinant of carbon pricing burdens. But they are not the only one, as real-world carbon pricing measures do not apply uniformly, and not all emissions are therefore priced equally. For instance, excise taxes, carbon taxes and emissions trading systems can, and often do, vary substantially between industry and fuel type. For instance, in the 72 countries covered by the OECD ECR database, the road transport sector faces the highest carbon rates (rates above EUR 60 and EUR 120 per tonne of CO_2 mostly occur in that sector), followed by the electricity and off-road transport sectors. In the industry and building sectors 72% and 64%, respectively, of emissions remain unpriced, while almost three-quarters of emissions in the electricity sector face a positive carbon price (OECD, 2023[8]). The correspondence between household emissions and their carbon price burden is thus neither perfect nor straightforward, and depends on the specific design of carbon pricing measures.

The period between 2012 and 2021 saw considerable policy innovation in the area of carbon pricing. While carbon prices mostly fall far short of those needed for meeting key mitigation commitments, OECD countries often raised them significantly over the period. Initial carbon prices in 2012 and the pace of subsequent changes varied, however, as did policy levers (Section 5.1 and Figure 5.2 above). Elgouacem et al. (forthcoming[14]) gives further details on specific reforms in the five countries. In four of the five countries included in the empirical analysis effective carbon rates increased in (constant) Euro terms – in most of them substantially so. ETS prices and coverage increased in all EU countries, approximately doubling ECRs in

Germany and Poland and increasing them by a smaller proportion in France. Mexico raised excise taxes by a large margin compared to 2012 values. France introduced a carbon tax. The ECR in Türkiye fell by about 80% of the 2012 value in EUR terms, though carbon prices in fact increased in national currency, which is relevant when considering the impact relative to household incomes. France had the highest ECR in 2021 among the five countries. They were the lowest in Mexico and Türkiye in absolute EUR terms, though with potentially significant impacts relative to household living standards.

Over the 2012-21 period, household burdens resulting from higher carbon prices were mostly muted overall. Figure 5.9 reports household burdens from recent reforms across the income spectrum. In four of the five countries, the additional cost for an average household's consumption basket was 1% of income or less. This is small, both relative to recent annual inflation rates, and relative to cumulative inflation over the decade prior to the cost-of-living crisis.[26] Average additional burdens were the largest in Poland, at 2.3% of household income, but they were negligible in Türkiye (see figure notes).

Carbon price burdens were more sizeable for some income groups, however, and effects were mostly regressive. In four of the countries, carbon price increases had a regressive impact overall, with consumption baskets of low-income households impacted more heavily. In addition to consumption patterns, initial (pre-reform) fuel prices also play a role, as they can differ significantly between fuel type. Where cheaper and higher-emitting fuels are disproportionately used by lower-income groups, they will see a greater impact of carbon prices on the prices they pay, both in absolute and in relative terms.

While lower-income households mostly saw the biggest impact relative to their incomes, losses for (lower) middleclass households can be of a similar order of magnitude. The regressive impact is most notable in Türkiye, where burdens were small on average but significant in the bottom third of the income distribution, and in Poland, where the bottom decile group saw costs rise by more than 4% of their income. In France, estimated burdens for the bottom decile were three times those for the top decile, while in Germany, they were approximately twice as big. An exception to the regressive patterns is Mexico, with bigger relative burdens among high-income households, reflecting the very top-heavy pattern of energy spending that has been documented for some middle income countries as discussed earlier, and may also be related to geographic / climatic factors (Figure 5.4).

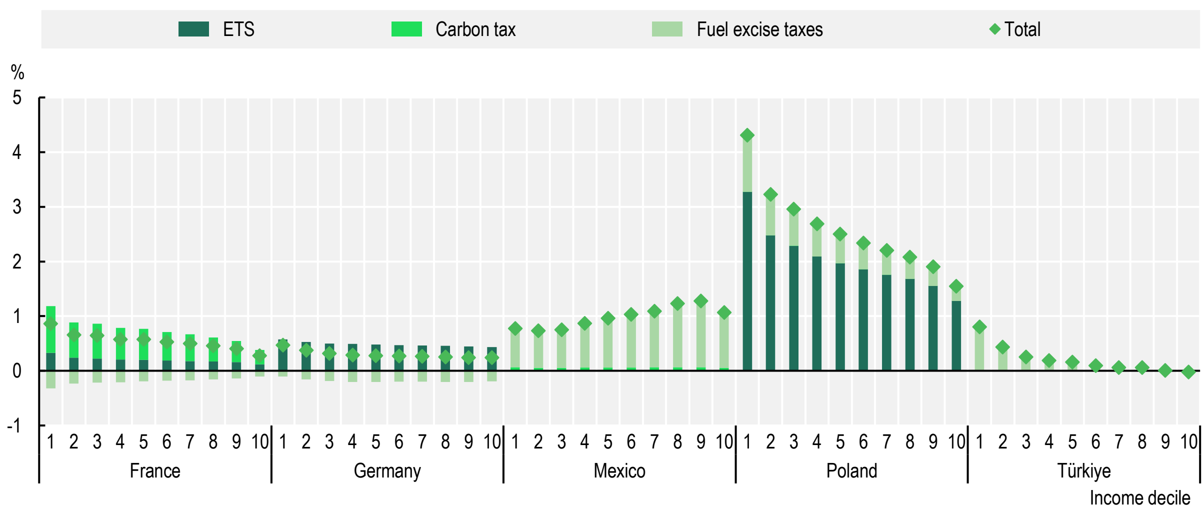
The specific impact on household budgets depends on the type and design of carbon pricing:

- Since excise taxes are levied directly on energy spending, the incidence of an increase partly mirrors patterns of households' energy consumption (compare Figure 5.9 and Figure 5.4). But excise taxes can also drive prices of non-fuel items. In Türkiye, increases were biggest in sectors affecting food prices (agriculture and fisheries), which account for a big share of spending by low-income households. Similarly, excise taxes in Poland changed little for households' fuel purchases, but they went up substantially in agriculture and fisheries, exerting upwards pressure on food prices.
- In four of the five countries, new or increased explicit carbon taxes played no role for overall carbon prices during the 2012-21 period. The exception, with notable regressive impact, is France, where the *Contribution Climat Énergie* was introduced in 2014. It was subsequently increased but then kept unchanged since 2018 following a moratorium on previously planned increases in the wake of the so-called "yellow vest" protests.
- In EU countries, sizeable changes in household burdens were due to rising prices for emissions certificates (ETS) and/or their extension to additional sectors. Depending on their design, ETS can impact fuel prices for final consumers. For instance, a national ETS introduced in 2021 in Germany (*Nationales Emissionshandelssystem*) applies specifically to fuel suppliers and therefore affects fuel prices charged to consumers ("direct" impact). "Indirect" effects of ETS on the prices of non-fuel items tend to be larger, however (see Elgouacem et al. (forthcoming[14]) for breakdowns of household burdens into direct and indirect impacts). Indeed, during the 2012-21 period, increased EU ETS permit prices had little impact on fuel prices for final consumers but exerted upwards pressure on household budgets through the price of non-fuel items, notably in Poland.

Overall, household burdens depend strongly on the specific patterns of carbon pricing across sectors. There is a huge spread of prices in practice, both in any given year, and when considering carbon price changes over time (OECD, 2023[8]). This chapter's mapping from sectors to consumption goods captures this heterogeneity. By contrast, reform assessments based on simple "stylised" carbon pricing scenarios, such as a uniform rate applying to all emissions, are likely to miss key aspects of the distributional impacts of real-world policy trajectories. Moreover, as illustrated in some of the results, concurrent or sequential carbon pricing reforms in different policy areas can produce complex distributional effects, amplifying, or offsetting each other in terms of their impact on households.

Figure 5.9. Carbon pricing measures during the past decade: Burdens for households

Percentage of disposable income, 2012-21



Note: Change in the cost of household-specific consumption baskets, as a share of disposable household incomes, taking consumption baskets (2015 in EU countries, 2016 in Mexico and 2019 in Türkiye) and the fuel mix and carbon intensity of consumption (using the 2016 vintage of the environmentally extended World Input-Output Database – WIOD) as fixed. The changes in carbon pricing burdens are thus only driven by changes in carbon pricing and neither by changes in consumption behaviour nor by changes in the fuel mix and carbon intensity of consumption (see Section 5.2 and Box 5.3 for more details on this assumption). Effective carbon rates for 2012 and 2021 are converted to real terms to match the corresponding household budget survey vintage. Averages by income decile (equivalised disposable household income). For the average household, burdens from carbon pricing reforms were as follows. France: +0.53% of total household income, Germany: +0.50%, Mexico: +1.03%, Poland: +2.34%, Türkiye: +0.09%. ETS: Emission Trading Systems. Changes are computed against the status quo, and do not account for the distributional impacts of inaction.
Source: OECD calculations using OECD Effective Carbon Rates data, IEA emissions factors for different fuels, household budget surveys (2015 for EU countries, 2016 for Mexico, 2019 for Türkiye) and World Input-Output Database (WIOD).

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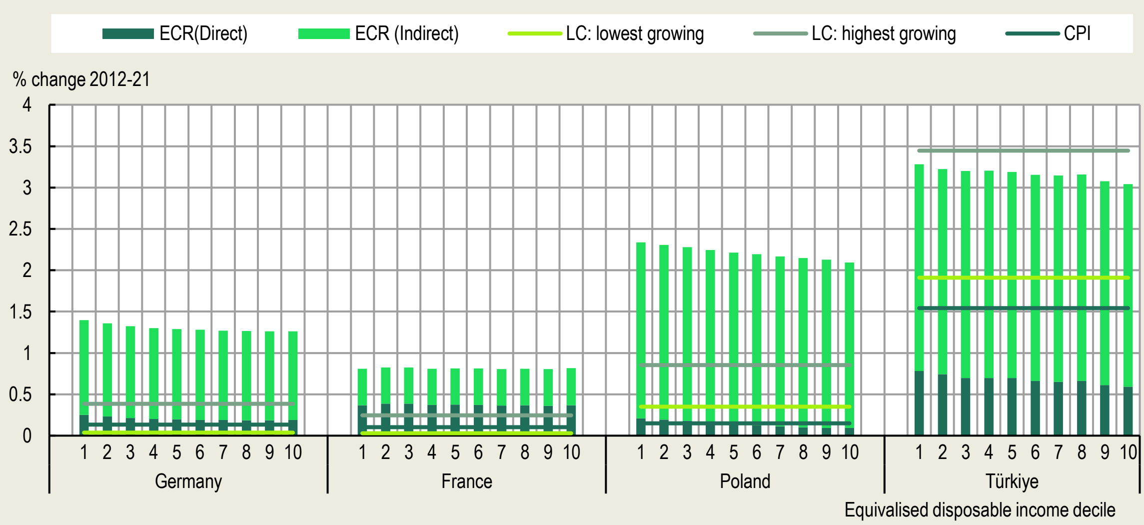
The welfare impact of carbon price changes depends not only on the carbon price, but also on the growth of labour earnings, which may inform the rate of growth of individual and, hence, household labour income.[27] Indeed, if carbon prices increase at a faster (resp. lower) rate than earnings, then purchasing power (conditional on interactions with other policies such as taxation and benefits) is likely to fall (resp. increase). This can also help inform the impact of carbon prices on the real value of wages. While combining earnings changes and carbon price changes at the individual level is beyond the scope of the analysis conducted in this chapter, Box 5.4 presents some results when comparing the distribution of carbon price changes relative to the mean sectoral labour earnings growth (as proxied by labour cost growth) over the 2012 to 2021 period.

Box 5.4. Evolution of labour costs and carbon prices

Figure 5.10 below reports the growth rate of (nominal) effective carbon rates (ECRs) for households compared with inflation (the growth rate of prices, using the consumer price index – CPI) and labour costs (in the sectors with the highest and lowest growth rates). For almost all countries, carbon prices in households' budgets grew faster than inflation for all income deciles, indicating the increasing share of purchasing power subject to carbon prices. However, average labour costs also grew over that period, and at a rate faster than inflation. While the data used in the analysis for this chapter prevents the disaggregation of labour cost changes for individual households, Eurostat labour cost data enables the disaggregation of labour costs by (broadly-defined) sector, which enables the calculation of growth rates of labour costs for the sector with the highest increase and the sector with the lowest increase. For Germany, France and Poland, the growth of ECRs in household budgets was higher than labour costs growth in the sector with the highest growth rate. Türkiye experienced the opposite, with the ECR growth rate for households lower than the labour costs growth rate in the highest growth sector. This indicates that in France, Germany and Poland, the welfare effects of increase in carbon prices possibly tended to be negative (i.e. earnings increased less than prices), while welfare effects in Türkiye were possibly positive for individuals in the sectors with the highest earnings growth.

Figure 5.10. Growth rates of carbon prices (ECR), of the consumer price index and of labour costs 2012-21, by country



Note: Mexico does not appear in the graph for lack of comparable labour costs evolution data. This figure reports the average labour cost growth of the lowest growing sector, the highest growing sector, the average CPI growth, and the relative change in nominal ECRs between 2012 and 2021 by household (equivalised disposable) income decile. ECR: Effective Carbon Rates. LC: Labour Cost. CPI: Consumer Price Index.

Reading: for instance, for the first decile in Germany, the relative change in nominal ECRs is the difference between the average ECR paid by households in the first decile in Germany in 2021 and in 2012 divided by the average ECR paid by households in Germany in 2012.

Source: Eurostat labour costs data, https://ec.europa.eu/eurostat/web/labour-market/information-data/labour-costs and OECD calculations using OECD Effective Carbon Rates data, IEA emissions factors for different fuels, household budget surveys (2015 for EU countries and 2019 for Türkiye) and World Input-Output Database (WIOD)

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5.4. Recycling carbon pricing revenues to limit losses for households

Revenues from carbon pricing are substantial, even if current carbon prices are well below the rates that would be in line with agreed mitigation commitments. Already in 2018, total carbon price revenues averaged around 1.3% of GDP across OECD and G20 countries.[28] In a number of OECD countries, this is a similar order of magnitude as key categories of social spending, such as working-age income support or social services other than health.[29] As part of broader policy packages, channelling some or all revenues from carbon pricing back to households allows governments considerable scope for cushioning losses and shaping the distributional profile. Such compensation can reduce the regressive impacts of carbon pricing. Moreover, it can also have a role when burdens are not regressive, as carbon pricing can pose affordability challenges for some households, even when its impact across households is uniform or progressive.

Figure 5.11 illustrates the potential of revenue recycling for limiting household losses, and for making parts of the population better off than without the introduction of the 2012-21 carbon pricing measures. It focuses on the four countries where estimated burdens are significant, without Türkiye (where additional burdens from policy changes were very small). For tractability reasons, estimates are based on the simplest of the revenue recycling scenarios, an equal lump-sum transfer to all households.[30,31] The scenario is hypothetical and intended to inform discussions about more tailored compensation strategies. Akin to a universal basic income, uniform lump-sum payments are often less redistributive than targeted social transfers. When conceived as a standalone benefit that replaces other transfers, a basic income is difficult to finance without substantial tax increases and may be regressive in the sense that many vulnerable groups could be worse off by losing the targeted support they used to receive in exchange for the flat basic income (Browne and Immervoll, 2017[115]). However, in the context of a carbon tax, lump-sum compensation is an option that is frequently discussed. It builds on a novel revenue source and can be introduced "on top of" existing transfers, without needing to substitute for them. It is also simple to communicate and, as everyone receives a recurring payment, it can act as a signal that the carbon tax aims to alleviate climate change, without raising household burdens overall. Universal lump-sum payments to all households are sometimes argued to be a suitable revenue recycling option (Klenert et al., 2018[98]).[32]

Panel A of Figure 5.11 shows the shares of losers in each income group when the entire carbon pricing revenue is redistributed in the form of uniform lump-sum payments.[33] Across the four countries, a majority towards the top of the income spectrum lose out, because, for households spending large amounts on fuel and other goods, carbon price burdens are likely to exceed the lump sum. By contrast, most (70% or more) of households in the bottom income decile benefit or have no additional burden. These households have low expenditures (in absolute terms), and the flat-rate transfer therefore offsets or exceeds the effect of carbon prices for many of them.[34] Even among low-income groups, the lump-sum transfer leaves some losers, however, highlighting the limitations of simple across-the-board compensation and the potential horizontal inequality this could lead to.

There may be scope for compensation strategies that achieve short-term distributional objectives at a lower fiscal cost.[35] One way of doing so is simply to reduce the per-capita transfer. Indeed, in practice, less than the full revenue from carbon pricing may be available for financing compensation measures. The link between the size of the lump-sum and the number of losers is shown in Panel B. For each spending share, the figure shows how many would lose out. With no compensation at all, household members see unchanged incomes while higher carbon prices translate into higher expenditures, making all of them worse off. As transfers increase, the share of losers eventually declines. For some of the policy changes analysed here, ensuring that a majority are better off appears possible with less than the full carbon price revenues dedicated to income transfers. In Mexico, a very unequal income distribution and the comparatively small burdens of low and middle-income households mean that a majority are better off, even with only 20% of revenues channelled back to households via lump-sum transfers. In Mexico, there is therefore significant budgetary space for other purposes, such as scaling up programmes that support and accelerate the net-zero transition, by tackling households' underinvestment in energy efficiency, or facilitating the reallocation of jobs towards less carbon-intensive production – for example through unemployment insurance and active labour-market policies – see D'Arcangelo et al. (2022[116]) and Chapters 3 and 4.[36]

Fiscal, equity, efficiency and effectiveness considerations can call for carefully tailored compensation strategies, however. For carbon pricing reforms in France and Germany, a uniform lump-sum transfer that prevents a majority from losing out would use up almost the entire carbon pricing revenue. And as noted above, a majority (albeit small) of Poles would be worse off even with full revenue recycling. This suggests that care needs to be taken when committing resources from carbon pricing: where household compensation consumes all or most of additional revenues, the potential for financing other programmes may be limited. This, as well as horizontal inequality (as highlighted by the non-negligeable share of losers within income deciles – see Figure 5.11, Panel A), calls for efforts to reduce the fiscal costs from direct compensation measures, by linking transfer amounts to households' support needs (which may be income-related or related to other factors, such as rural versus urban considerations), while maintaining the price signals consistent with the objective of lowering emissions.[37] Many countries that have introduced some form of recycling of carbon price revenues have indeed targeted transfers to those most in need (Box 5.5). The importance of well-targeted support measures has become all the more salient with the recent energy crisis (Hemmerlé et al., 2023[117]). Informing tailored and, therefore, cost-effective support strategies is indeed one argument for a detailed and regular monitoring of the distribution of carbon price burdens (Douenne and Fabre, 2020[118]).

Box 5.5. Recycling carbon revenues to compensate households: Policy examples

Marten and Van Dender (2019[119]) take stock of the use of revenues from different carbon pricing measures across 40 OECD and G20 economies – see also World Bank (2019[120]). As other "Pigouvian" taxes, carbon pricing is typically not intended as a stable source of financing and will subside as it achieves relevant emissions-reduction objectives. And similar to other government revenues, those from carbon pricing are subject to competing demands, and this may limit the scope for earmarking them for income transfers. Yet, there are several reasons why carbon revenues could play a significant redistributive role. First, at commonly discussed carbon price trajectories, prospective revenues are sizeable (see main text). Second, although rising carbon prices are designed to narrow the tax base eventually, this is a gradual process and, initially, the negative impact on government revenues can and should be compensated by increasing rates further. Carbon price revenues are set to decline at some point, but this is a matter of decades, not years; Third, redistribution and associated social protection has a key enabling role by cushioning adjustment costs for affected households and facilitating voter support. The associated resource needs are therefore arguably temporary, rather than permanent, and can thus be financed through a temporary revenue source.

There are several examples of carbon pricing earmarked for income transfers and related social protection programmes:

- **New Zealand**: The 2022 budget established a Climate Emergency Response Fund based on proceeds from its emissions trading system. Initiatives that are eligible for funding include those that reduce vulnerability or exposure to climate change or addresses distributional consequences of climate change and mitigation policies.
- **Austria**: The 32.50 EUR/t carbon tax measure enacted in 2022 recycles all revenue in the form of cash payments. The system uses location-based targeting, whereby residents in regions with greater dependence on carbon-heavy activities (e.g. private transport if public transport is comparatively difficult to access) receive more support (OECD, 2022[72]).

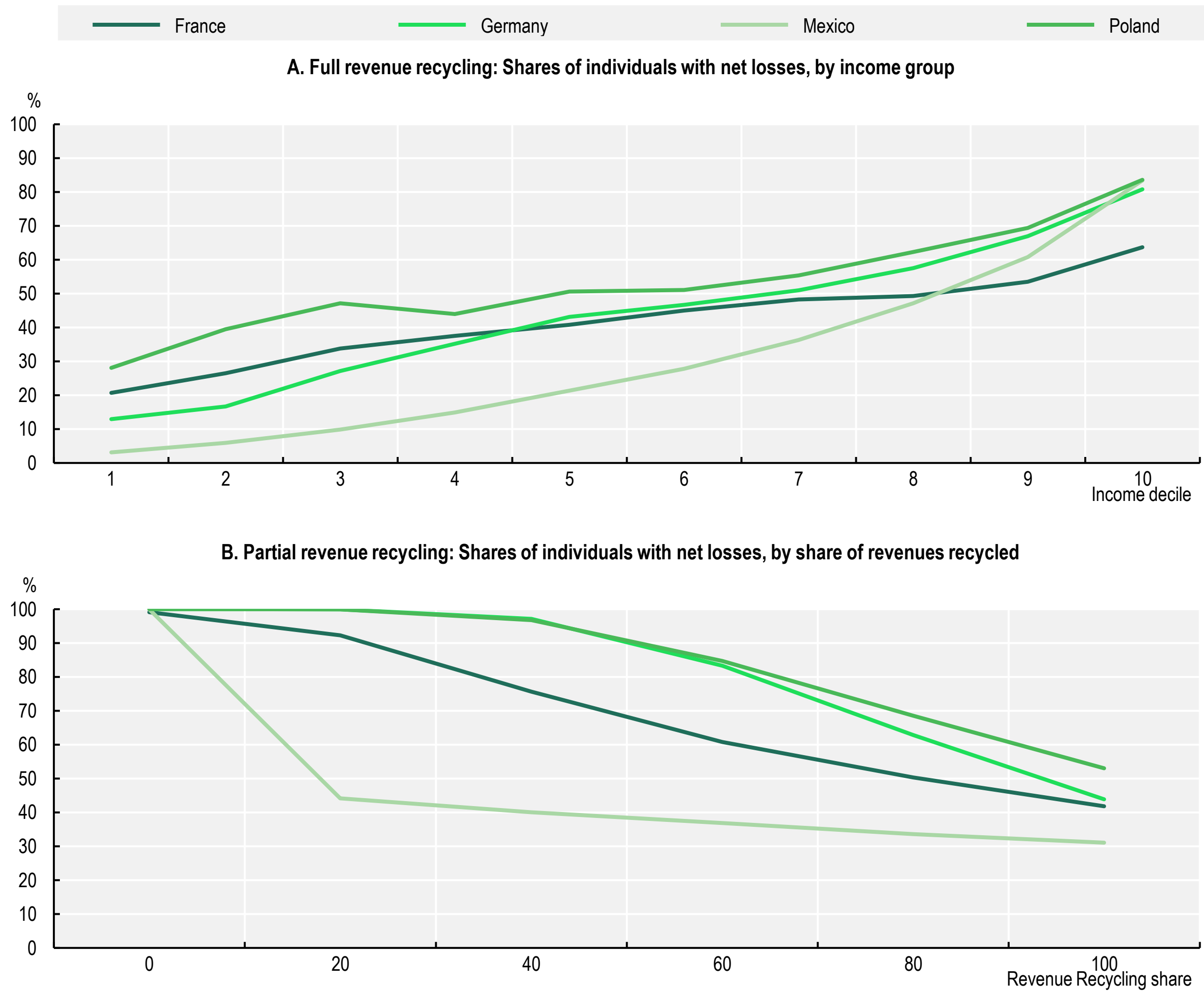
- **Switzerland**: A carbon tax of 12 CHF/t was introduced in 2008 and raised in steps to 120 CHF/t in 2022. It currently raises annual revenues of about CHF 1.2 billion, with two-thirds distributed as a lump-sum transfer, in the form of reduced health insurance rates (FOEN (Swiss Federal Office for the Environment), 2023[121]).
- **Ireland**: A 48.50 EUR/t carbon tax was put in place in 2010, employing a "soft" type of earmarking, with a political commitment to use a share of revenues for raising social assistance benefits for households with children, and to provide retraining for workers in carbon-intensive sectors. The 2020 budget raised carbon taxes by 6 EUR/t and ring-fenced the proceeds, including for protecting vulnerable households and workers.
- **British Columbia, Canada**: British Columbia has a Climate Action Tax Credit, which is a quarterly payment that helps offset the impact of the carbon taxes paid by individuals and families. In April 2024, British Columbia's carbon tax rate rose from CAD 65 to CAD 80 per tonne of CO_2e – to protect affordability, revenues generated by this increase are to be directed to carbon tax relief for British Columbians through enhancements to the Climate Action Tax Credit.
- **Canada (eight provinces)**: Eight Canadian provinces (Alberta, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island and Saskatchewan) redistribute carbon tax revenues back to households through the Canada Carbon Rebate – formerly known as the Climate action incentive payment (CAIP).

Source: Immervoll (forthcoming[122]) and ELSAC Policy Questionnaire. Canadian support measures: www.canada.ca/en/revenue-agency/services/child-family-benefits/canada-carbon-rebate.html and www2.gov.bc.ca/gov/content/taxes/income-taxes/personal/credits/climate-action, accessed 3 June 2024.

As for redistribution policies more generally, there can be trade-offs between environmental goals, equity objectives and others, including simplicity, strengthening work incentives, or addressing other pre-existing challenges. In general, adding additional objectives (such as reducing unrelated tax burdens), tends to leave less fiscal space for redistribution or for furthering climate-change mitigation. For instance, a common argument for environmental tax reform is that it may create a "double dividend", by simultaneously improving environmental and economic conditions, through lowering harmful emissions, and creating fiscal space for reducing distortionary taxes, e.g. on labour (Pearce, 1991[57]; Ekins et al., 2011[123]; Antosiewicz et al., 2022[124]; García-Muros, Morris and Paltsev, 2022[125]). Such a policy approach is sometimes considered on efficiency grounds (Guillemette and Château, 2023[126]). But, unlike redistributive cash transfers, lowering progressive income taxes provides little to no support to the poorest and may render carbon price packages more regressive than alternative compensation schemes (Rausch, Metcalf and Reilly, 2011[30]; Immervoll et al., 2023[13]). Bundling carbon pricing with labour-tax reductions can nevertheless be an attractive option from a political economy point of view, notably if there is empirical evidence that employment gains would be sizeable, including among groups who are strongly affected by higher emission charges – see Chapter 3.

In practice, revenue recycling options require careful policy design taking into account several considerations, such as the time-lag between revenue collection and redistribution or legal constraints on earmarking of revenues. A recent report by Cardenas Monar (2024[127]) highlights some of these.

Figure 5.11. 2012-21 carbon pricing measures with revenue recycling (lumps-sum payments)



Note: Household compensation takes the form of uniform lump-sum transfers to each individual. Income deciles in Panel A refer to equivalised disposable household income. In order to remain agnostic as to the use of the remaining revenue, the modelling does not include the distributional impacts that the share of revenue not used for revenue recycling may have.
Source: OECD calculations using OECD Effective Carbon Rates data, IEA emissions factors for different fuels, World Input-Output Database (WIOD) and household budget surveys (2015 for EU countries and 2016 for Mexico).

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5.5. Concluding remarks

This chapter assesses the impact of carbon pricing policies on households, discussing different channels for distributive effects and outlining an approach for quantifying household burdens stemming from higher consumption expenditures. The empirical assessment estimates carbon footprints for individual households in five countries and traces carbon prices from inputs to consumers across complex value chains. It employs granular data from the OECD's Effective Carbon Rates database to estimate burdens from a wide range of carbon pricing reforms introduced during the 2012-21 period.

Results largely confirm commonly held views about carbon pricing as impacting low-income and middle-income groups in particular, even though emissions attributed to their consumption are only a fraction of those linked to high-income households. In the period under study, carbon pricing reforms often imposed only small burdens on households. After 2021, governments have sought to provide support to households and firms (e.g. through reduced carbon prices in the road transport sector) and inflation also reduced the real value of effective carbon rates in some cases. As current carbon prices remain well below levels that are considered in line with national and international climate commitments, future increases may be sizeable and rapid in some countries. The mostly regressive nature of reforms examined in this chapter show that the distributional impacts of future policy changes need to be scrutinised closely, both for reasons of equity and to ensure that reforms have the backing of voters.

The comparative results highlight big differences in distributional impacts between countries and policy measures, suggesting a number of policy levers for avoiding or limiting detrimental distributional impacts. Governments have employed a range of carbon pricing measures. The design of these matters not only for achieving environmental objectives but also for distributional outcomes. Carbon pricing revenues also provide leeway to compensate households. Uniform lump-sum compensation to all households is straightforward to implement, but it is, by definition, poorly targeted, which increases the cost of compensation measures and may limit the capacity to finance other priority programmes from carbon-pricing revenues. Untargeted compensation also fails to ensure adequate protection for some vulnerable households.

One prominent debate in the literature on recycling carbon pricing revenues relates to the so-called "equity-pollution dilemma" (Scruggs, 1998[128]; Heerink, Mulatu and Bulte, 2001[129]; Beiser-McGrath and Busemeyer, 2023[130]). This refers to a situation where low-income households spend larger portions of their resources on carbon-intensive goods and services than the rich, and redistributing to the poor can be expected to increase total emission levels (an example of what is sometimes also referred to as the "rebound effect" of climate change mitigation). Any trade-offs between equity and environmental objectives can present a formidable challenge, as households in poverty or material deprivation consume too little, rather than too much, and redistribution presents one key strategy for improving their living standards. Some country-specific studies have documented such a dilemma (Sager, 2019[131]). Results in this chapter confirm that total emissions from consumption are much higher at the top of the income distribution, but that emissions intensities (emissions relative to spending) can indeed be greater at lower income levels.

The results nuance earlier ones in three ways, however. First, the dilemma does not apply universally for all types of carbon pricing. For instance, fuel and energy do not always behave like necessities and data presented in this chapter shows that middle-income and high-income households sometimes do spend larger shares of their income on transport fuel. Second, apart from the highest income group (top 10%) overall emissions intensities appear to differ only marginally between income groups, and carbon footprints are increasing in income and much higher for the top income group. In one country (Mexico), emissions intensities are significantly greater for high-income households, indicating that redistribution can simultaneously strengthen equity and environmental goals. Moreover, emissions vary not only by income but by other household characteristics as well. This points to opportunities to side-step possible trade-offs between reducing emissions and tackling inequality, e.g. by tailoring compensation strategies to characteristics such as region or age rather than to income as such. Finally, the results suggest that even partial revenue recycling can make many lower-income households better off. Retaining the remaining revenues to tackle underinvestment in energy efficiency (potentially complemented by the general budget), notably among disadvantaged groups, can help low-income households to reduce their reliance on carbon-intensive consumption and therefore address the underlying driver of any equity-pollution dilemmas.

The urgency of the climate change mitigation agenda suggests that one priority would be the regular monitoring of distributional impacts of past and prospective carbon pricing reforms and associated compensation measures, and the systematic communication of results to voters and stakeholders.[38] Future research by the OECD could extend the applications in other country contexts than those presented in this chapter to deepen understanding the drivers of gains and losses and better assess the resulting policy challenges and the political economy of carbon pricing.

Moreover, further analysis could consider the distributional impact of trade-related carbon leakage (whereby the introduction or intensification of domestic climate policies potentially leads to increased imports of more carbon-intensive products) and policy measures to tackle it, drawing on multi-region input-output data from the OECD Inter-Country Input-Output (ICIO) database (Smith et al., forthcoming[132]). Future work should also explore relaxing some of the assumptions made in the present analysis (Elgouacem et al., forthcoming[14]). One such assumption is the proportionality of carbon content and spending in a given spending category, as in reality emissions per spending unit can be expected to differ by price level, e.g. between budget and luxury restaurants or between discount and premium holiday travel. Explicit modelling of behavioural responses to carbon price changes also represents an interesting avenue for future research, and the recent period of large price swings represents an opportunity to study this more closely. Finally, carbon pricing is one instrument in the portfolio of climate change mitigation policies and understanding the distributional impacts of other mitigation policies is equally important.

The research agenda for assessments of distributional impacts is also closely linked to the broader evolving evidence on the economic impact of climate change, and of policies to avert it. A key question concerns the counterfactual that is adopted in distributional studies. While the status quo, as adopted in this chapter, can be a natural starting point, any losses also need to be compared with the cost of policy *inaction* or, vice versa, the benefits of mitigation that are the very rationale for climate-change mitigation (Tovar Reaños and Lynch, 2022[133]) – see also Chapter 2. The scale of economic damages from climate change remains uncertain (Auffhammer, 2018[134]; Howard and Sterner, 2022[135]), though recent studies tend to find they are very large and significant (Bilal and Känzig, 2024[136]). In the long run, however, they are by definition of the same order of magnitude as carbon prices that internalise all the negative externalities of GHG emissions.

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Annex 5.A. Methodology: Carbon emissions from household consumption and resulting carbon price burdens

A household's overall carbon price burden is a function of their consumption patterns (what and how much they consume) and the respective carbon prices assigned to these consumed goods and services. Estimating carbon price burdens at the household level involves assessing both direct emissions from fuel consumption and indirect emissions from the production of goods and services (including energy related expenditures such as electricity or public transport). This requires information on the impact of carbon prices on fuel prices, on the price of all other goods and services, and information on the structure of households' consumption baskets. The impact of carbon prices on fuels is directly related to their carbon content and can be calculated using the carbon content of fuels per monetary unit. The impact of carbon prices on all other products requires information on energy consumed in the production process of goods and services.

A companion paper provides details on each of the key steps of the modelling framework, and how it was implemented in the context of this chapter (Elgouacem et al., forthcoming[14]). It describes:

- the effective carbon rate (ECR) data;
- the Input-Output (IO) model, which captures carbon emissions by sector and allows quantifying the pass-through of carbon taxes from inputs to the price of final consumer products and services;
- the matching of input-output data with a household budget survey (HBS), which is needed to compute the carbon footprint from household consumption.

The ECR, IO and HBS data are a suitable basis for distributional analysis, as they are very granular – for instance, WIOD data differentiates between 56 industries and HBS data includes information for 301 (Eurostat data), 282 (Turkish data) and 745 (Mexican data) expenditure categories. Yet, as each data source uses different classification systems, several transformations are needed to enable links between them.

Input-Output modelling

Modelling the level of CO_2 emissions from household consumption requires economy-wide data that capture carbon emissions by sector, and production linkages between sectors. This chapter employs the World Input Output Data (WIOD). The IO methodology, introduced by Leontieff (1951[137]) and discussed extensively by Miller and Blair (2009[138]) employs a matrix mapping the monetary flows between sectors and regions. A technology matrix contains input coefficients for all sectors in all regions and enables the calculation of economy-wide input requirements, which gives the input needed by a sector in one region from every other sector in all regions to produce one (monetary) unit of output.

The chapter employs an environmentally extended IO model, linking products to the indirect carbon emissions that occur in the course of production (Kitzes, 2013[139]). For each household, direct and indirect emissions are added to get final CO_2 emissions from household consumption. Dividing emissions entry-wise by each sector's output gives the level of CO_2 emissions per monetary unit of the sector's output vector. Direct emissions F_{dir} are released through households' consumption of motor and domestic fuels. They are computed for one euro worth of fuels using fuel-price data from the IEA (to calculate the carbon content of fuels per monetary unit) and carbon content per kWh per fuel sourced from the IPCC 2006 Guidelines for National Greenhouse Gas Inventories.

Matching ECR and input-output data with household expenditures

To approximate the carbon footprint from households' consumption, it is necessary to match IO data with information on expenditure as reported in household budget surveys (HBS). HBS data commonly reports households' consumption expenditure across different consumption purposes (COICOP), while WIOD tables report household final consumption expenditure in industry outputs terms (here, NACE rev 2). The integration of HBS data into multi-sectoral models is described in Mongelli, Neuwahl and Rueda-Cantuche (2010[140]) and Cazcarro et al. (2020[141]). Matching information from WIOD tables to HBS data involves translating goods by expenditure purpose into industry outputs using a bridging matrix, which maps the use of a product to satisfy a consumption purpose, so that the i^{th} element of matrix $B = [b_{ij}]$ represents the use share of industry product j for consumption purpose *i.* As COICOP categories from HBS do not correspond directly to NACE sectors as recorded in WIOD, the matching procedure involves a crosswalk from COICOP to CPA (Classification of products by activity) to NACE using a bridging matrix (Cai and Vandyck, 2020[142]) and involving four main steps; (i) transforming COICOP to CPA; (ii) matching budget shares to CPA categories by aggregating COICOP categories into budget shares and calculating the weighted sum of CPA contributions to budget shares; (iii) matching CPA categories to WIOD using national supply tables that link CPA inputs to each industry output; (iv) assigning the relative contribution of each sector in the country to the appropriate consumption good / budget share.

Challenges and limitations

There is a growing literature on modelling the distributive impact of environmental taxes. All models abstract from the full complexity of the real world. This chapter makes a number of modelling choices to keep the empirical illustration transparent and tractable, and they should be kept in mind when interpreting results:

- **Scope of GHG emissions data**. The current approach approximates the emissions from energy use that can be traced to consumer spending, via fuel use recorded in household consumption data and via input-output data. This scope is consistent with the historical ECR data, which covers levies on emissions from energy use. Process-related CO_2 emissions, and emissions of other GHG, including methane, account for substantial shares of overall emissions, notably in food production. These are currently not accounted for. But have been added in recent ECR data and could be included in distributional analysis if and when granular emissions data become available.
- **Data quality and consistency**. When combining data from various sources such as the OECD Effective Carbon Rates, Household Budget Survey, and International Energy Agency fuel price data, inconsistencies in data quality and classification can arise. These discrepancies can affect the accuracy of the estimations of carbon price burdens at the household level. Ensuring data compatibility and rectifying any mismatches is crucial, yet challenging, given the varied nature of these datasets. This limitation highlights the importance of continuous efforts to improve data quality and harmonisation in environmental economic research.
- Need for **accurate translation between data classification systems**. The integration of diverse datasets necessitates precise alignment of classifications and terminologies used across sources. Misalignment can lead to errors in estimating carbon price burdens at the household level. Meticulous attention to detail and careful translation processes are vital to ensure the integrity and reliability of our findings.

- The **reference period** of the simulations is relevant, as household circumstances, consumption patterns and prices change over time, as do preferences, including for consumption. Both the Input/Output data and household budget surveys refer to 2015, which represents an intermediate year during the 2012-21 period. It therefore relates to prices and consumption prior to the recent cost-of-living crisis, and sidesteps the COVID-related distortions of consumption and production patterns that affects the most recent available household consumption data.
- **Impact of traded inputs and final goods**. Multi-region input-output models allow accounting for the differential carbon prices across countries, and their potential impact on domestic consumer prices in global value chains. The companion paper illustrates this approach in the context of a single-country study (Immervoll et al., 2023[13]). By contrast, calculations in this chapter currently assume that price changes are the same for domestically produced inputs and consumer products, and for imported ones. Following a hike in carbon prices, consumer prices will in practice tend to rise by less than the full increase in the short term when carbon prices in source countries are lower, and this is the rationale for balancing provisions such as carbon border carbon adjustment schemes. But consumer prices can also rise by more than the domestic carbon price increase, if carbon charges in source countries increase faster than they do domestically. Related OECD work is ongoing, using multi-region input-output data from the OECD Inter-country Input-Output (ICIO) database (Smith et al., forthcoming[132]). Building on this work, future extensions can analyse distributional effects accounting for the impact of differential carbon pricing across countries.
- Beyond their immediate effect on consumption expenditures, carbon taxes and other climate-change mitigation measures also alter the incomes of the owners of the different factors of production, including natural resources, “brown industry” equity and labour (Rausch, Metcalf and Reilly, 2011[30]; Metcalf, 2021[143]). Relatedly, changing input prices and consumer demand trigger labour-market adjustments through a reallocation of jobs from high-carbon to low-carbon industries and activities and employment effects can be a specific focus in public debates. The medium-term gains and losses from labour-market adjustments can be difficult to quantify and are not reflected in the approach presented here but may be sizeable for some groups (see Chapters 2 and 3 in this publication).
- Beyond their effect on consumption expenditures, carbon pricing and other climate-change mitigation measures also alter the incomes of the owners of the different factors of production (see Box 5.1). These are not accounted for in the present analysis.

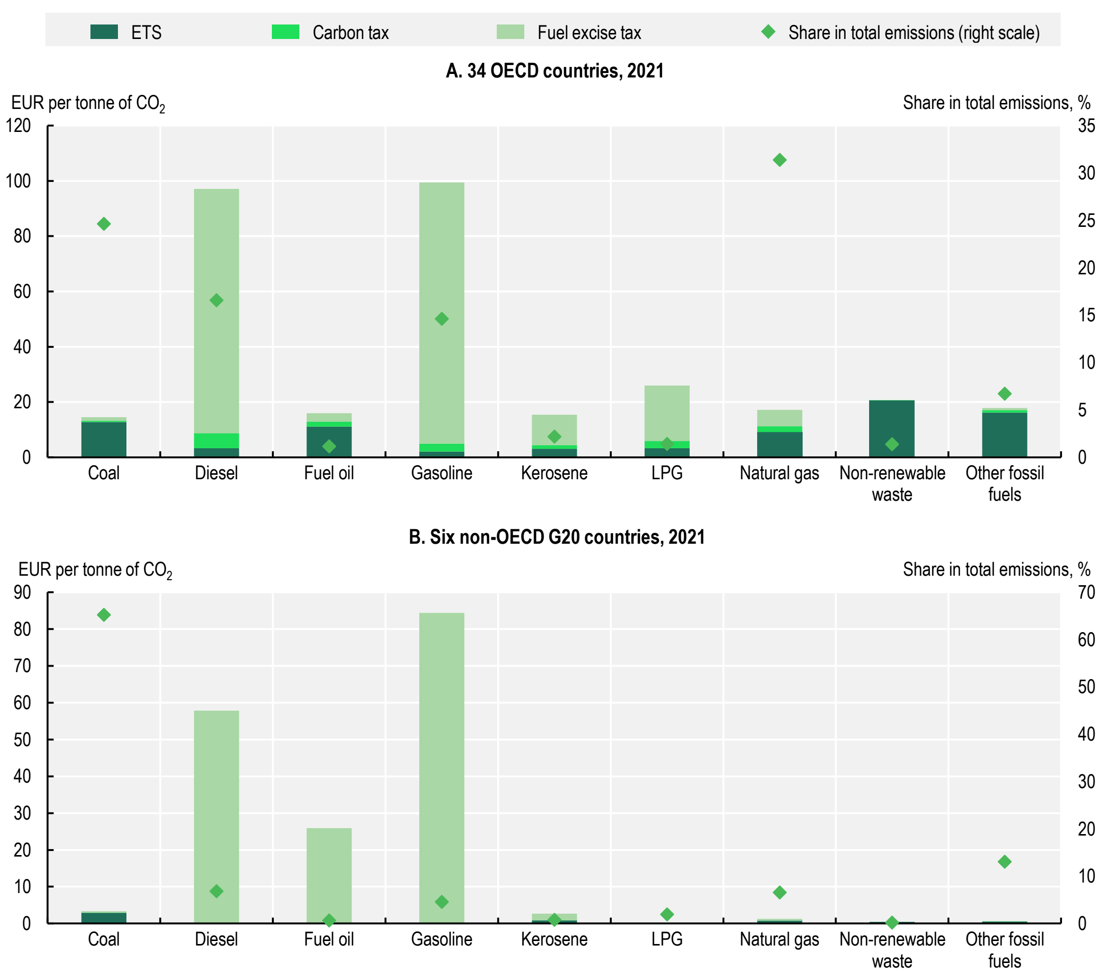
Annex 5.B. Effective Carbon Rates methodology and further considerations

Sectors, users and fuels

This section provides further details on sectoral, user and fuel breakdown in the database.

The Effective Carbon Rates database covers CO_2 emissions from energy use from six sectors that together span all energy uses and also covers other GHG emissions (i.e. emissions from methane (CH_4), nitrous oxide (N_2O), F-gases[39] and process CO_2 emissions) excluding Land use change and Forestry (LUCF)[40] (Annex Table 5.B.1). Fuels are grouped into nine categories (Annex Table 5.B.2), effective carbon rates and emissions by fuel type are shown in Annex Figure 5.B.1.

Annex Figure 5.B.1. Effective carbon rates and share of CO_2 emissions



Note: Effective carbon rate averages are emissions weighted. ETS: Emission Trading Systems. LPG: Liquefied Petroleum Gas.
Source: Effective Carbon Rates database.

StatLink https://stat.link/1egyw4

Annex Table 5.B.1. ECR sectors and users

Sector	Definition	Energy users
Road transport	Fossil fuel CO_2 emissions from all primary energy used in road transport.	Road
Electricity	Fossil fuel CO_2 emissions from primary energy used to generate electricity (excl. auto-producer electricity plants which are assigned to industry), including for electricity exports. Electricity imports are excluded.	Main activity producer electricity plants
Industry	Fossil fuel CO_2 emissions from primary energy used in industrial facilities (incl. district heating and auto-producer electricity plants).	Adjusted losses in energy distribution, transmission and transport; Adjusted energy industry own use; Adjusted transformation processes; Auto-generation of electricity; Chemical and petrochemical; Construction; Food and tobacco; Industry not elsewhere specified; Iron and steel; Machinery; Mining and quarrying; Non-ferrous metals; Non-metallic minerals; Paper, pulp and print; Sold heat; Textile and leather; Transport equipment; Wood and wood products
Buildings(*)	Fossil fuel CO_2 emissions from primary energy used by households, commercial and public services for activities other than electricity generation and transport.	Commercial and public services; Final consumption not elsewhere specified; Residential
Off-road transport	Fossil fuel CO_2 emissions from all primary energy used in off-road transport (incl. pipelines, rail transport, aviation and maritime transport). Fuels used in international aviation and maritime transport are not included.	Domestic aviation; Domestic navigation; Pipeline transport; Rail; Transport not elsewhere specified
Agriculture & fisheries	Fossil fuel CO_2 emissions from primary energy used in agriculture, fisheries and forestry for activities other than electricity generation and transport.	Agriculture; Fishing
Other GHG (excl. LUCF)	All other GHG emissions include methane, nitrous oxide from agriculture; fugitive emissions from oil, gas and coal mining activities; waste; non-fuel combustion CO_2 emissions from industrial processes (mainly cement production), N_20 and CH_4 emissions from industrial processes and F-gas emissions. Excludes LUCF emissions. Excludes CO_2 emissions from fuel combustion which are already reported in the agriculture & fisheries sector.	n.a.

Note: Estimates of primary energy use are based on the territoriality principle, and include energy sold in the territory of a country but potentially used elsewhere (e.g. because of fuel tourism in road transport). Own classification based on information on energy flows contained in the IEA's extended world energy balances (IEA, 2020[64]) and "other GHG" reported in the Climate Watch dataset (2024[20]). GHG: Greenhouse Gases. ECR: Effective Carbon Rates. LUCF: Land Use Change and Forestry.
(*) In Effective Carbon Rates editions prior to the 2023 edition (OECD, 2023[8]), this sector was referred to as "Residential and Commercial".
Source: OECD (2016[15]), *Effective Carbon Rates: Pricing CO2 through Taxes and Emissions Trading Systems*, https://doi.org/10.1787/9789264260115-en and OECD (2022[12]), *Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action*, https://doi.org/10.1787/e9778969-en.

Annex Table 5.B.2. Fuel category breakdown

Energy type	Fuel category	Energy Products
Fossil fuels	Coal and other solid fossil fuels	Anthracite; Bitumen; Bituminous coal; Brown coal briquettes; Oven coke; Coking coal; Gas coke; Lignite; Oil shale; Patent fuel; Peat; Peat products; Petroleum coke; Sub-bituminous coal
	Fuel oil	Fuel oil
	Diesel	Gas/diesel oil excluding biofuels
	Kerosene	Jet kerosene; Other kerosene
	Gasoline	Aviation gasoline; Jet gasoline; Motor gasoline
	LPG	Liquefied Petroleum Gas
	Natural gas	Natural gas
	Other fossil fuels and non-renewable waste	Additives; Blast furnace gas; Coal tar; Coke oven gas; Converter gas; Crude oil; Ethane; Gas works gas; Lubricants; Naphtha; Natural gas liquids; Other hydrocarbons; Other oil products; Paraffin waxes; Refinery feedstocks; Refinery gas; White and industrial spirit; Industrial waste; Non-renewable municipal waste
Biofuels	Biofuels	Bio jet kerosene; Biodiesels; Biogases; Biogasoline; Charcoal; Municipal waste (renewable); non-specified primary biofuels and waste; Other liquid biofuels; Primary solid biofuels

Note: Energy products are defined as in IEA (2020[64]). Emissions from the combustion of biofuels are not included in this analysis (see discussion in OECD (2023[8])).
Source: OECD (2022[12]), *Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action*, https://doi.org/10.1787/e9778969-en.

Carbon taxes, fuel excise taxes and ETSs

This subsection provides further details on estimation of rates and prices for taxes and emissions trading as well as coverage – based on Annex A of OECD (2016[15]). Indeed, data on ETS permit prices and coverage is originally gathered for the **Effective Carbon Rates** (ECR) database. The Effective Carbon Rates database then builds on the **Taxing Energy Use** (TEU) database, which gathers fuel excise tax and carbon tax data.

Carbon tax rates

Carbon taxes may be set following two approaches: a fuel-based approach, in which case the tax is explicitly linked to fuels, or a direct emissions approach, in which case the tax is directly levied on GHG emissions.

If established following a fuel-based approach, carbon tax rates are usually set for each fuel on the basis of their CO_2 content. The carbon content of a fuel can be calculated as follows: common commercial units of fuels (e.g. kilogram for solid fuels, litre for liquid fuels, cubic metre for gaseous fuels) can be converted into energy units (e.g. GJ or MWh) using calorific factors from the IEA World Energy Statistics and Balances (IEA, 2024[144]). Energy units can then be converted into tonnes of CO_2 using IPCC emissions conversion factors (IPCC, 2006[145]), volume 2).

In case there is a fixed rate per unit of CO_2, the result is a uniform carbon tax, a desirable feature from a cost-effectiveness point of view. However, some carbon taxes may specify different rates for different fuels or users even in carbon terms. *For administrative purposes*, for each fuel, the tax can be translated into tax rates per litre, kilogram, cubic metre or gigajoule of energy. For instance, Annex Table 5.B.3 illustrates what a carbon tax rate of EUR 30/tCO_2 would translate into for different energy categories. These taxes can only apply to CO_2 emissions from energy use, but are relatively straightforward to administer.

Annex Table 5.B.3. From tax rates per tonne of CO_2 to rates per common commercial unit of fuel

Energy category	Rate per tonne of CO_2	Equivalent rate per commercial unit of fuel
Coal and other solid fossil fuels	EUR 30/tCO_2	6.24 eurocent per kilogramme
Fuel oil	EUR 30/tCO_2	8.94 eurocent per litre
Diesel	EUR 30/tCO_2	7.99 eurocent per litre
Kerosene	EUR 30/tCO_2	7.58 eurocent per litre
Gasoline	EUR 30/tCO_2	6.86 eurocent per litre
LPG	EUR 30/tCO_2	4.75 eurocent per litre
Natural gas	EUR 30/tCO_2	5.13 eurocent per cubic metre

Note: OECD calculations based on IEA (2024[144]), *World Energy Statistics and Balances*. The values shown are based on average carbon content of these energy categories across the 44 countries covered in the 2018 *Effective Carbon Rates* database. Actual carbon emissions associated with combusting the respective fuel may vary depending on local fuel characteristics. LPG: Liquefied Petroleum Gas.
Source: Table 3.1 of OECD (2019[146]), *Taxing Energy Use 2019: Using Taxes for Climate Action*, https://doi.org/10.1787/058ca239-en.

If established following a direct emissions approach, the tax is levied on GHG emissions directly. These taxes can apply beyond CO_2 emissions from energy use, e.g. also to the other GHG category (i.e. CH_4, N_2O, F-gases and CO_2 from industrial processes, see Annex Table 5.B.1). However, these require monitoring, reporting and verification systems, which may provide challenges, including emissions measurement and administrative complexity.

Carbon tax rates are gathered by user and fuel as of 1 April of the year under consideration (or the latest available date before that if not available) – e.g. 1 April 2021 for ECR 2021.

Fuel excise tax rates

Fuel excise taxes are the most significant component of ECRs – still in 2021. These taxes are typically levied per physical unit (e.g. litres in the case of liquid fuels, kilograms in the case of solid fuels, cubic metres in the case of gaseous fuels), or per energy content (e.g. GJ or kWh), and not by reference to the carbon content of the fuel. However, using the reverse process to that described for carbon tax rates, fuel excise tax rates can be translated into effective tax rates on the carbon content of the fuel due to the proportional relationship between fuels and their carbon content (Annex Table 5.B.4). Hence, in terms of their behavioural impact they are similar to a fuel-based carbon tax, albeit less consistent from an environmental perspective in the approach to the rates applied (since rates are generally not designed to align with CO_2 content).

Support measures for fossil fuel consumption that are delivered through the tax code, such as excise or carbon tax exemptions, rate reductions and refunds are included.

Fuel excise tax rates are gathered by user and fuel as of 1 April of the year under consideration (or the latest available date before that if not available) – e.g. 1 April 2021 for ECR 2021.

Annex Table 5.B.4. From tax rates per common commercial unit of fuel to tax rates per tonne of CO_2

Fuel	Rate per common commercial unit	Equivalent rate in EUR per tonne of CO_2
Coal and other solid fossil fuels	10 eurocent/kg	48.1
Fuel oil	10 eurocent/L	33.6
Diesel	10 eurocent/L	37.5
Kerosene	10 eurocent/L	39.6
Gasoline	10 eurocent/L	43.7
LPG	10 eurocent/L	63.2
Natural gas	10 eurocent/m^3	58.5

Note: OECD calculations based on IEA (2024[144]), *World Energy Statistics and Balances*. The values shown are based on average carbon content of these energy categories across the 44 countries covered in the 2018 *Effective Carbon Rates* database. Actual carbon emissions associated with combusting the respective fuel may vary depending on local fuel characteristics. LPG: Liquefied Petroleum Gas.
Source: Adapted from Table 3.1 of OECD (2019[146]), *Taxing Energy Use 2019: Using Taxes for Climate Action*, https://doi.org/10.1787/058ca239-en.

Emissions trading systems permit prices

The Effective Carbon Rates 2023 report covers permit prices from emissions trading systems in the 72 countries of the database, encompassing supra-national, national and subnational jurisdictions. Emissions trading systems exist in 34 of the countries studied.

Average permit prices at auctions are calculated across a year if the data is available. An average is taken to smooth price fluctuations, where possible. For some emissions trading systems, price information is only available for part of the year, in which case an average across the available dates is calculated, or for a single auction or date, in which case this price is used. Due to data availability issues, secondary market prices rather than auction prices are used in the calculation for certain systems.

Permit prices are gathered for the year under consideration (e.g. over 2021 for ECR 2021).

Estimation of coverage of carbon pricing instruments

Tax rates are gathered by energy user (see Annex Table 5.B.1) and fuel (see Annex Table 5.B.2), which then directly translates into the base covered by these taxes.

ETS coverage is an *estimate* as it applies to emissions of a facility subject to an ETS and does not distinguish between fuels. For most systems, ETS coverage is estimated by reference to verified emissions data at facility level or at aggregated facility level (e.g. firm). Where this is not available, broader measures are used such as the share of sectoral emissions covered. These emissions covered by ETSs are then matched where possible at a user-level, else, at a sector-level.

Finally, carbon taxes are often entirely or partially alleviated if the energy user is subject to an ETS. This is reflected once the TEU database is merged with the ETS information to generate the Effective Carbon Rates.

Further considerations

The ECR database covers pricing instruments that apply to a base that is directly proportional to energy use or GHG emissions. It therefore excludes taxes and fees that are only partially correlated with energy use or GHG emissions. These include vehicle purchase taxes, registration or circulation taxes, and taxes that are directly levied on air pollution emissions (e.g. the Danish tax on SOX or the Swedish NOx fee). Production taxes on the extraction or exploitation of energy resources (e.g. severance taxes on oil extraction) are not within the scope of instruments covered either, as supply-side measures are not directly linked to domestic energy use or emissions.

The database covers specific taxes (i.e. taxes that apply per unit of good as opposed to ad-valorem taxes, which depend on the good's price) and taxes that affect the relative price of carbon-intensive goods. In line with these two criteria, value added taxes (VAT) or sales taxes are not accounted for. Indeed, in principle VAT applies equally to a wide range of goods, so does not change the relative prices of products and services (i.e. it does not make carbon-intensive goods and services more expensive relative to cleaner alternatives). In practice, differential VAT treatment and concessionary rates may target certain forms of energy use, thereby changing their relative price (OECD, 2015[147]). However, quantifying the effects of differential VAT treatment is beyond the scope of the database. One reason is that such an exercise would require extensive price information, which is generally not available for all energy products. In addition, fully accounting for VAT would require information on the sellers and purchasers of energy because the way that VAT is designed means that no net VAT is charged on taxable supplies between VAT-registered businesses. Also, electricity excise taxes do not treat fossil fuels in a differential manner as compared to clean sources and are therefore not part of the ECR indicator.

The ECR database includes support measures for fossil fuel consumption that are delivered through the tax code, such as excise or carbon tax exemptions, rate reductions and refunds, which are pervasive in energy tax and carbon pricing systems. This is different from the Net ECR (nECR) database, which includes also fossil fuel subsidies that lower pre-tax prices. The availability of preferential treatment varies substantially across countries, and even within a country such preferential treatment frequently changes over time. As a result, simply comparing statutory rates (also sometimes referred to as standard or advertised rates) across countries and time would be misleading. More precisely, certain energy users or GHG emitters frequently enjoy preferential treatment that effectively reduces prices on energy or emissions. Therefore, effective tax rates measured by the database are adjusted accordingly irrespective of whether countries report such policy measures as tax expenditures (OECD, 2022[12]).[41]

Interpreting Effective Carbon Rates

Comparisons across countries and sectors

Mitigation policy packages vary with many factors, including country circumstances, policy objectives and targeted sectors. Carbon pricing is a core mitigation policy in some countries, while others rely more on non-carbon price-based instruments, e.g. regulation or technology support. This may be due to many factors, including administrative capacity, historical context, the technical and methodological challenges of pricing emissions, and political constraints. The approach to carbon pricing instruments itself also varies with these factors. For instance, fuel excise taxes are more common than carbon taxes and ETSs and in general were initially introduced to raise revenue (so that aligning them better with climate goals often requires reform). Carbon taxes may require less administrative capacity to implement than ETSs, as they are generally based on the carbon content of fuels. On the other hand, ETSs, while generally requiring sophisticated monitoring, reporting and verification mechanisms, can face fewer political barriers to implementation.

Effective carbon rates depend on the sectoral composition of a country's emissions.

In particular, in 2021, the road transport sector faces the highest rates, while the majority of other GHG emissions aside CO_2 from energy generation (CH_4, N_2O, F-gases and CO_2 from process) face no carbon price. The difference of ECRs between sectors may have various explanations. High taxation rates in the road transport sector may also reflect the pricing of other externalities caused by road transport, such as air pollution, accidents, congestion and noise,[42] or can reflect revenue raising objectives. Indeed, the different externalities present in each sector provide a clear economic rationale for effective carbon rates to vary by sector, even though the greenhouse gas externality is equal everywhere. On this point, it can be worth noting that transport externalities may also be priced using different instruments such as congestion charges or vehicle taxes. A country using those instruments could then have lower fuel excise tax rates in the road transport sector because it addresses externalities in that sector through different instruments. This would then lead to a lower ECR. Low carbon pricing of other GHG emissions may come from the challenges of measuring these emissions, making it a challenge to price them directly. Given political constraints facing carbon pricing and different abatement opportunities in different sectors, setting higher prices on larger emissions bases can be more challenging than for narrower emissions bases.

Sectoral shares can substantially vary across countries and this variation influences average ECRs at the country level. Countries with a high share of road transport sector emissions tend to have higher average ECRs.

On one end of the spectrum, diesel and gasoline, which are primarily used in the road transport sector, are subject to the highest fuel excise tax rates (translating to respectively EUR 70 and EUR 85 per tonne of CO_2 on average in 2021), which also relates to their historically broad tax base used by countries to raise revenue. On the other end of the spectrum, coal and other solid fossil fuels, which are mostly used in the industry and electricity sectors face relatively low effective carbon tax rates (at an average of EUR 5.4 per tonne of CO_2 in 2021). Fuels such as LPG and natural gas, which are used in the buildings sector, stand in the middle, with average ECRs at about EUR 8/tCO_2 and EUR 10.6/tCO_2 respectively. These fuels often face reduced tax rates or exemptions, particularly when applying in the residential sector.

Effective Marginal Carbon Rates versus Effective Average Carbon Rates

Most emissions trading systems distribute part or all of emissions allowances for free, at least during the inception phase. Auctioning or fixed price selling of allowances is generally gradually introduced into systems as they become more mature. In 2021, the share of free allocation of allowances varies widely across systems, ranging from a 100% in Japanese subnational ETSs (Tokyo and Saitama), for instance, to almost 0% in RGGI and the Massachusetts Limits on Emissions from Electricity Generators (310 CMR 7.74).

While free allocation of allowances does not affect the marginal price signal, it does affect the *average* price signal, which in turn affect economic rents and thus can influence investment decisions. Free allocations do not change the marginal price signal faced by firms because even if entities receive free allocations, reducing their emissions allows them to sell extra permits while emitting more requires them to buy additional permits. And even if they emit exactly what they have been allocated, they face an opportunity cost as they forgo the income they would have gotten from reducing their emissions and selling those extra permits. However, the average[43] price paid by entities for permits does depend on the level of free allocation received. Flues and Van Dender (2017[148]) show that permit allocation rules affect economic rents and that in practice they tend to do so in a way that favours more carbon-intensive technologies.

The wedge created by free allocation of allowances between the marginal and average carbon prices may be captured by using the share of free allocations incurred by an installation, subsector, sector or country but it may also be captured by the Effective Average Carbon Rates (EACR) and Effective Marginal Carbon Rates (EMCR) indicators. The EMCR is the main indicator used in this report: the ECR summarises the *marginal* carbon rates faced by subsectors, sectors or countries. The EACR, on the other hand, summarises the *average* carbon rates faced by subsectors.

Free allocation can result in windfall profits in certain sectors. The mechanism is that even when receiving free allocation of allowances, firms still face opportunity costs, i.e. the marginal cost of carbon. If they can adjust pricing and then pass-through this cost to consumers, the free allocation becomes a rent. In practice, this depends on many factors, including the allocation regime, the competition in the sector, demand and supply elasticities, carbon intensity of production, and international trade exposure of the sector (Quirion, 2007[149]; Hobbie, Schmidt and Möst, 2019[150]). These are all factors that impact pass-through of carbon costs to consumer prices.

Hence, the underlying assumption of using EMCRs (i.e. ECRs) to infer prices on consumers is that there is full marginal cost pass-through regardless of the permit allocation method, and free allocation is a rent for all firms. Using EACRs would imply the assumption that there are no windfall profits.

Notes

[1] The scale of economic damages from climate change and, hence, from the absence of mitigation efforts, remains uncertain (Auffhammer, 2018[134]; Howard and Sterner, 2022[135]). But potential welfare losses are very large – for example, Bilal and Känzig (2024[136]) find that the macroeconomic damages from climate change could be six times larger than previously estimated and estimate that world GDP per capita would be 37% higher today had no warming occurred since 1960. Distributional implications are also large, since higher-income groups are more likely to cope with, or to shield themselves from, the effects of rising temperatures (Davis and Gertler, 2015[167]; Calvin et al., 2023[60]; Emmerling, Andreoni and Tavoni, 2024[155]). For instance, for Latin America and the Caribbean, a recent IBRD study suggests that 78 million poor people or more live in areas that are highly exposed to climate-related shocks (Inter-American Development Bank, 2023[156]) – see also Chapter 2.

[2] These concerns are not new, however. For instance, during the 2008 US presidential campaign, both Hillary Clinton and John McCain supported carbon cap-and-trade legislation but nonetheless called for temporary suspension of the federal gasoline tax (Bosman, 2008[151]).

[3] For instance, revenues from fuel excise taxes, carbon taxes and permit prices in 2018 averaged around 1.3% of GDP across OECD and G20 countries. Using disaggregated data by sector and fuel type, and accounting for emission reductions in response to higher prices, D'Arcangelo et al. (2022[11]) find that a moderate carbon price floor of EUR 60/tCO_2 would roughly double revenues to 2.5% of GDP, with much larger increases in countries with high emission intensities but low current carbon prices.

[4] Carbon taxes and emissions trading systems (explicit carbon pricing) but also implicit carbon pricing through fuel excise taxes.

[5] According to the Intergovernmental Panel on Climate Change (IPCC), maintaining the current emission levels until 2030 will irremediably compromise the chances to keep global warming below 1.5 degrees above the average for the pre-industrial era (Calvin et al., 2023[60]).

[6] Price-based measures can co-exist with other mitigation approaches, for instance, by combining hard emissions limits with carbon pricing in cap-and-trade (emissions-trading) schemes. While there are downsides to cap-and-trade schemes, the explicit ceiling on emissions side-steps uncertainties surrounding emissions reductions that can be achieved with price increases alone, while a market-based price mechanism facilitates cost-effectiveness (by allowing firms with higher abatement costs to purchase from those with lower abatement costs).

[7] The social cost of carbon is the economic cost caused by an additional tonne of CO_2 emissions or its equivalent. It rests on the concept of internalising externalities, considering both inter- and intra-generation equity (Nordhaus, 1991[56]).

[8] The World Bank estimates that 23% of global emissions were covered by a carbon price in early 2023, up from just 5% in 2010 (World Bank, 2023[169]).

[9] All G20 countries excluding Saudi Arabia.

[10] Calculating the social cost of carbon is fraught with difficulties, including estimating GDP losses resulting from global temperature increases, weighing catastrophic risks whose probability and magnitude are

inherently uncertain, and choosing a suitable discount rate for possibly catastrophic climate-related costs (Howard and Sterner, 2017[152]).

[11] These numbers are for 34 OECD countries (Australia, Austria, Belgium, Canada, Chile, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, New Zealand, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, the United Kingdom and the United States), and for 6 non-OECD G20 countries (Argentina, Brazil, China, India, Indonesia), in 2021.

[12] In OECD and G20 countries, coal is predominantly used in the electricity and industry sectors, where carbon prices stem mostly from emissions trading systems. The average ECR on coal is EUR 11 per tonne of CO_2 in OECD countries and 3.4 in non-OECD G20 countries. Diesel and gasoline are principally used in the road transport sector (gasoline almost entirely so), with carbon prices mostly due to fuel excise taxes. ECR rates are much higher, at respectively EUR 84 and 89 per tonne of CO_2 in OECD countries and respectively EUR 58 and 84 in non-OECD G20 countries (High tax rates in this sector may also reflect revenue raising objectives or to a certain extent, the pricing of other externalities caused by road transport, such as air pollution, accidents, congestion and noise). Natural gas is principally used in the electricity, industry and buildings sectors. It is covered by fuel excise taxes and emissions trading systems, and rates are similar to coal in OECD countries. Its use in the buildings sector (commercial and residential heating) frequently presents reduced fuel excise tax rates, especially when applying to household consumption. Average ECRs are EUR 12.6 per tonne of CO_2 in OECD countries and EUR 1.3 per tonne in non-OECD G20 countries.

[13] i.e. comparative across countries for comprehensive carbon pricing reforms, using the same methodology.

[14] See also Rausch, Metcalf and Reilly (2011[30]). Some studies suggest that accounting for firms' behavioural response can reduce any regressivity of carbon pricing and other environmental taxes. This is primarily through any lower returns to equity in some sectors, which predominantly accrue to higher-income households (Metcalf, 2023[153]; Rausch and Schwarz, 2016[154]), though these households also stand to gain from any increasing returns to "green" capital.

[15] Household emissions sum up to less than the full carbon footprint of final demand a country, with government consumption and investment being the remaining components. These could be attributed to households in principle, including by attributing emissions to household savings that finance investment. This is not attempted here, but see, e.g. Starr et al. (2023[160]) for the United States.

[16] IEA reports the following 2021 emission factors for electricity, in $kgCO_2e$ per kWh. France: 0.05; Germany: 0.34; Mexico: 0.43; Poland: 0.76; Türkiye: 0.38.

[17] While drawing down wealth can be one factor behind very high spending shares among low-income groups, under-reporting of income has also been shown to play a role in household expenditure surveys, which are not designed to prioritise income measurement (Brewer, Etheridge and O'Dea, 2017[162]).

[18] For instance, in 2022, 9.3% of the EU population declared that they were not able to keep their home adequately warm (Eurostat, 2023[168]). This means that poor households do not only spend a relatively high share of their budget on energy, but that they still face considerable budget constraints as their energy needs may be even higher than the effective expenditure levels.

[19] A progressive pattern of energy spending is increasingly uncommon among high-income countries, but it has been documented for some OECD members with lower GDP levels (Immervoll et al., 2023[13]). Spending can be substantially more top-heavy in emerging economies and lower-middle-income countries outside the OECD area. Patterns vary between middle-income countries, with studies pointing to climatic factors, inequality in housing and access to utility grids, as well as sizable energy subsidies. In addition, low-income households may source substantial shares of energy outside the market, e.g. in the form of peat or firewood. See Steckel et al. (2021[93]) and, e.g. Pachauri (2004[157]) for India, Irfany and Klasen (2017[158]) for Indonesia.

[20] See endnote 16 for the different emission factors for electricity (as reported by the IEA).

[21] Non-fuel related expenditures may be broken down into categories according to the Classification of Individual Consumption According to Purpose (COICOP). These include food, beverages, tobacco, clothing and footwear, housing, gas and water, furnishings, household equipment, health, transport, information and communication, recreation, sport, culture, education services, restaurants and accommodation services, insurance and financial services, personal care and social protection, individual consumption expenditure of non-profit institutions serving households and of general government. Households' indirect carbon emissions are driven by both the carbon intensity of these consumption categories but also by the expenditure devoted to these categories. In most countries, and across income deciles, the housing, gas and water category represented the main source of emissions across income deciles. Food and transport are also generally important. Services such as education and recreation have low energy intensities and generally represent the lowest household indirect emissions. The share of emissions from each category is reasonably consistent across the income distribution.

[22] See Figure 5.4 and Annex Figure 5.B.1.

[23] These estimates are in line with those found in national studies for the countries included, e.g. for France (André et al., forthcoming[163]). For the United States, Starr et al. (2023[161]) report emission shares of 4% and 24%, respectively, for the bottom and top deciles, with large increases of emissions at the very top, e.g. 6% of the total for the top 1% and 2.3% of the total for the top 0.1%.

[24] For instance, in an analysis of emission inequalities in France, Pottier et al. (2021[159]) note that "the size of the dwelling increases with income and distance from urban centres […] the first factor to account for variability of emissions is the heating system: this has little to do with income but more to do with settlement patterns, which constrain access to the various energy carriers".

[25] See Lévay, Goedemé and Verbist (2023[165]) for references to (the small number of) multi-variate studies. Sager (2019[131]) undertakes such an exercise for the United States and also calculates the contribution of different population characteristics / groups to the evolution of carbon emissions over time.

[26] These results are by and large explained by the fact that the carbon price increases in this period were much smaller than what would be needed to successfully transition to a net-zero emission economy (see e.g. the Introduction). It is easy to conjecture that much larger carbon price hikes would have a more significant impact even on average household burdens.

[27] This holds in particular in countries where the majority of the labour market is formal.

[28] See the Introduction of this chapter. In addition, carbon pricing instruments are often themselves subject to value added tax (VAT) at full or reduced rates, and this has both budgetary and distributional

consequences. VAT is not currently accounted for in the results reported here. Incorporating such interaction effects with other tax instruments is a topic for future extensions.

[29] Across OECD countries, 2019 expenditures on income support for the working-age population and on non-health social services average, respectively, 3.6% and 2.3% of GDP. 8 countries spent less than 2% of GDP on working-age income support, and 18 spent less than 2% on non-health social services. See OECD Social Expenditure Database, www.oecd.org/social/expenditure.htm.

[30] The available information in the analysis conducted in this chapter – i.e. income and other information in household budget surveys – is not sufficiently granular for simulating more targeted social benefits or, e.g. labour-tax reductions. The required matching with income data is beyond the scope of this comparative study. See, however, Immervoll et al. (2023[13]) for an example of such an approach in a country-specific context.

[31] The lump-sum transfers in these cases are therefore the same as the average carbon price burden. Results account for carbon price burdens at the household level, and therefore capture the variability of gains and losses across and within income groups, which remain hidden when assessing average burdens by decile.

[32] Lump-sum redistribution, however, also comes with many drawbacks, which are further discussed below. These include the importance of targeting transfers due to fiscal, equity, efficiency, and effectiveness reasons.

[33] Across populations as a whole, recycling all the revenue from 2012-21 carbon pricing reforms mostly creates more gainers than losers, with a smaller share of reform losers than winners in Mexico (31%), followed by France (42%) and Germany (44%). In Poland, carbon price burdens were highly concentrated at the bottom of the income distribution, and a lump-sum transfer would offset the burdens of slightly less than half of the population, leaving 53% worse off.

[34] The particular shape of the curves reflects the incidence of carbon price burdens shown earlier. They are also driven by inequalities within income groups. For instance, greater disparities of spending on fuel and other high-emission consumption items in the lower parts of the income distribution can translate into significant numbers of people with sizeable burdens, who may then be net losers even after a lump-sum transfer.

[35] For instance, the recent OECD survey of the European Union assumes that 30% of carbon pricing revenues are returned to households (OECD, 2023[164]).

[36] Behavioural responses to price changes in subsequent periods are not accounted for here. They would alter the patterns of gains and losses, with results depending on the specific price and budget elasticities across population groups. Past work suggests that behavioural adjustments are modest in the short term and evidence is mixed on their distributional profile (see Box 5.3). Moreover, on average, a rebalancing of household consumption towards lower-emitting goods reduces household burdens and carbon price revenues by the same proportion. In combination, this makes it unlikely that behavioural responses would substantively alter the shares of gains and losses reported here. The country-specific behavioural modelling reported in Immervoll et al. (2023[13]) supports such a conjecture.

[37] Recent findings, however, highlight equity-efficiency trade-offs when seeking to address horizontal equity concerns such as rural-urban gaps (Labrousse and Perdereau, 2024[74]).

[38] Surveys suggest that one factor behind weak support for carbon pricing measures is limited public knowledge about their environmental effectiveness (which tends to be underestimated), and the likely burdens for households and their regressivity (which tends to be overestimated). See Dechezleprêtre et al. (2022[7]) for a summary of that evidence.

[39] HFCs, PFCs, and SF_6.

[40] The abbreviation LUCF is used (as opposed to the term LULUCF, i.e. land use, land-use change, and forestry) to emphasise that the underlying GHG emissions data is sourced from the CAIT dataset (Climate Watch, 2024[20]), which does not rely on countries' official inventories reported to the UNFCCC (OECD, 2022[12]).

[41] This represents a different approach from the OECD's Inventory of Fossil Fuel Support (OECD, 2021[166]). See Box 1.2 of OECD (2022[12]) for additional details on the difference in approaches.

[42] While the former externality would not be present if a full switch to electric vehicles (EVs) took place, the other three externalities would remain.

[43] i.e. overall price divided by the amount of emissions.

Annex A. Statistical annex

Sources and definitions

The tables of the statistical annex show data for all 38 OECD countries where available. Data for Argentina, Brazil, China, India, Indonesia, Peru, South Africa and non-OECD EU Member States are also compiled and included in a number of datasets.

The standard tabulations (Tables A to R of previous editions of the Employment Outlook) are replaced by web links pointing to data and indicators reported in the new OECD central data repository OECD Data Explorer, https://data-explorer.oecd.org/, which contains all data available. Some additional web links entitled Table S to W complete the statistical annex referring respectively to data and indicators on statutory minimum wages, trade union density, collective bargaining coverage and synthetic indicators of employment protection. A richer set of labour market data and indicators is accessible in the OECD Data Explorer. The metadata section of the online datasets reports definitions, notes and sources retained in national data sources.

In general, Tables A to K report annual averages of monthly and quarterly estimates based on labour force surveys. Those shown for European countries in Tables A to C and G to K are mainly data from the European Labour Force Survey (EU-LFS), which are more comparable and sometime more consistent over time than national LFS results. Data for the remaining Tables L to V are from a combination of survey and administrative sources or national reporting for Table W.

OECD Data Explorer contains both raw data and indicators for longer time series and more detailed individual characteristics and type of main job such as data by age group, gender and employee job tenure, part time employment, involuntary part time employment, temporary employment, duration of unemployment. The data portal includes more data series than those shown in the web links of the Statistical Annex, such as, the distribution of employment by weekly usual hours worked intervals, potential labour force so-called people marginally attached to the labour force, etc. The online database contains additional series on working time, earnings and features of institutional and regulatory environments of labour markets. Among these are the following:

- Annual hours actually worked per person in employment for comparisons of trends over time
- Employment by long usual weekly hours worked in the main job
- Average gross annual wages per dependent employee in full time equivalent unit
- Distribution of gross earnings of full-time workers by upper earnings decile limits and by gender and earnings dispersion measures and gaps (by gender and age)
- Statutory minimum wages – levels and ratio of minimum to mean and median wages
- Public expenditure on labour market programmes, number of beneficiaries and inflows into the labour market
- Trade union density and collective bargaining coverage
- Synthetic indicators of employment protection

Major breaks in series

Tables A to K: Most of the breaks in series in the tables occurred for any of the following reasons: changes in survey design, survey questionnaire, survey frequency and administration, revisions of data series based on updated population census results. These changes may have affected the comparability over time of employment and/or unemployment levels and to a certain extent the ratios reported in the aforementioned tables:

- **Change in the measurement of the labour force status and methodology in the European Labour Force Survey since 2021:** Data between 2020 and 2021 are affected by a break in series in Tables A-C and G-K. The size and direction of the breaks vary by country and statistics as reported in the national documentations on Eurostat website. See: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_Labour_Force_Survey_-_new_methodology_from_2021_onwards.
- **Introduction of a continuous survey producing quarterly results**: Austria (2003/04), Brazil (2011/12), France (2002/03), Germany (2004/05), Hungary (2005/06, monthly results), Iceland (2002/03), Italy (2003/04), Luxembourg (2002/03, quarterly results as of 2007) and Türkiye (2013/14).

  Data revisions in the following OECD countries:

  - 2009 to 2015: Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.
  - Australia (since 2017), Denmark (2021), Italy (2018-20), Spain, Portugal and Sweden (since 2021) and Poland (2015).
  - Chile: Re-estimation since 2010 implementing the quality estimation standards for household surveys set by the National Statistics Institute of Chile.
- **Redesign of labour force survey**: Introduction of a new survey in Chile since April 2010 (see below), Germany (2010/11), Hungary (2002/03), Poland (2004/05), Portugal (2010/11) and Türkiye (2004/05 from quarterly to monthly results). Israel (2011/12), change from quarterly to monthly survey results and a change from "civilian" to "total" labour force (including those who are in compulsory or permanent military service). New Zealand (2015/16), the survey includes non-civilian personnel. Annual results for Colombia in 2020 are averaged over three-quarters (Q1, Q3 and Q4) as a result of the COVID-19 pandemic outburst and suspension of the survey in the 2nd quarter. Since July 2020, a new edition of the continuous quarterly survey was re-introduced in Mexico (Encuesta Nacional de Ocupación y Empleo, New edition ENOE^{N}) after its suspension in April 2020 following the COVID-19 pandemic outburst and lockdown measures. It was replaced in Q2 by a telephone interview survey (ETOE) with partial results. The annual results are averages of three-quarters (Q1, Q3 and Q4). For the United Kingdom (2003/04), data for Tables A to C are annual averages of quarterly estimates from the Annual Population Survey (APS); prior to 2004, they refer to the spring quarter (April-June) Labour Force Survey (LFS). Data for Tables G to K are annual averages of quarterly estimates from APS from 2016 onwards.
- **Change in the operational definition of employment:**
  - Neat application of the criterion of "at least one hour worked in a gainful job" in the Chilean Nueva Encuesta Nacional de Empleo (NENE), a quarterly continuous survey, from April 2010 onward.

- **Change in the operational definition of usual working time:**
  - In Israel, the Labour Force Survey questionnaire was expanded and changed since January 2018. Workers absent from work are asked "how many hours they usually work". This affects the number of workers reporting usual weekly hours worked in their main job prior and after 2018 notably Table G on the incidence and composition of part-time employment according to a common 30-hour threshold-based definition.
- **Change in the operational definition of unemployment regarding:**
  - Active job-search methods: in particular a change from registration to contact with the public employment service: France (2002/03) and Spain (2000/01).
  - Duration of active job search: In Australia (2014/15), the duration of unemployment has been replaced by duration of job search. In Belgium (2010/11), the duration of job search has been changed from an unlimited duration to previous four weeks including the survey reference week. In Chile (2009/10), the duration of active job search has been shortened from last two months to previous four weeks including the survey reference week.
  - Availability to work criterion: In Sweden (2004/05), the work availability criterion changed from the reference week to two weeks from the reference week to be consistent with the operational definition in other EU countries. In Chile, the work availability criterion did not exist prior to 2010 in the Encuesta Nacional de Empleo (ENE) and was introduced in the Nueva Encuesta Nacional de Empleo (NENE) since April 2010. It has been fixed to two weeks from the end of the reference week.
  - Persons on lay off considered as employed instead of unemployed: Norway (2005/06).
  - Other minor changes: Australia (2000/01) and Poland (2003/04).
- **Changes in the questionnaire with impact on employment and unemployment estimates:** Germany (2010/11): new questionnaire design ensures better coverage of small jobs. This led to a higher-than-normal annual employment increase. Impact on employment and unemployment statistics in New Zealand (2015/16) with the inclusion of army personnel. Spain (2004/05): impact on employment and unemployment and impact on unemployment estimates in Norway (2005/06) and Sweden (2004/05).
- **Change from seasonal to calendar quarters:** Switzerland (2009/10) and the United Kingdom (2005/06). However, there is no break in series between 2005 and 2006 for the United Kingdom as calendar quarter based historical series are available since 1992.
- **Introduction of new EU harmonised questionnaire**: Sweden (2004/05) and Türkiye (2003/04).
- **Change in lower age limit from 16 to 15 years:** Iceland (2008/09), Norway (2005/06) and Sweden (2006/07).
- **Change in lower age limit from 15 to 16 years**: Italy (2007/08).
- **Change in data collector in Denmark since the first quarter of 2017:** the LFS response rate increased and resulted in a significant break in series between 2016 and 2017.
- In Norway, as of 2006 age is defined as years reached at the survey reference week, instead of completed years at the end of the year, as in previous years.
- **Inclusion of population controls based on census results in the estimation process:** Mexico (2009/10) and Türkiye (2006/07).
- In Japan, data for Table I on temporary employees has a break in series between 2013 and 2017.

Table A. Employment/population ratios by age and gender

As a percentage of the population in each age group and each gender.

OECD Data Explorer • Employment and unemployment by five-year age group and sex - indicators

Table B. Labour force participation rates by age and gender

As a percentage of the population in each age group and each gender.

OECD Data Explorer • Employment and unemployment by five-year age group and sex - indicators

Table C. Unemployment rates by age and gender

As a percentage of the total labour force in each age group and each gender.

OECD Data Explorer • Employment and unemployment by five-year age group and sex - indicators

Table D. Employment/population ratios by educational attainment, latest year

Persons aged 25-64, as a percentage of the population in each gender.

OECD Data Explorer - Archive • Educational attainment and labour-force status

Table E. Labour force participation rates by educational attainment, latest year

Persons aged 25-64, as a percentage of the population in each gender.

OECD Data Explorer - Archive • Educational attainment and labour-force status

Table F. Unemployment rates by educational attainment, latest year

Persons aged 25-64, as a percentage of the labour force in each gender.

OECD Data Explorer - Archive • Educational attainment and labour-force status

Table G1. Incidence of part-time employment by age and gender

As a percentage of part-time employment in each age group and each gender.

OECD Data Explorer • Incidence of full-time and part-time employment based on OECD-harmonised definition

Table G2. Women's share in part-time employment by age

As a percentage of part-time employment in each age group.

OECD Data Explorer • Gender share of part-time employment

Table H1. Incidence of involuntary part-time employment by age and gender

As a percentage of total employment in each age group and each gender.

OECD Data Explorer • Incidence of involuntary part time employment

Table H2. Involuntary part-time employment as a share of part-time employment by age and gender

As a percentage of part-time employment in each age group and each gender.

OECD Data Explorer • Incidence of involuntary part time employment

Table I1. Incidence of temporary employment by age and gender

As a percentage of dependent employment in each age group and each gender.

OECD Data Explorer • Employment by permanency of the job - Incidence

Table I2. Women's share in temporary employment by age

As a percentage of dependent employment in each age group.

OECD Data Explorer • Share of women in temporary employment by permanency of the job

Table J. Incidence of job tenure shorter than 12 months by age and gender

As a percentage of total employment in each age group and each gender.

OECD Data Explorer • Employment by job tenure intervals - frequency

Table K. Incidence of long-term unemployment, 12 months and over by age and gender

As a percentage of total unemployment in each age group and each gender.

OECD Data Explorer • Incidence of unemployment by duration

Table L. Average annual hours actually worked per person in employment

National accounts concepts unless otherwise specified (Hours per person per year).

OECD Data Explorer • Average annual hours actually worked per worker

Table M. Real average annual wages

Average wages in in constant 2022 prices at 2022 USD PPPs for private consumption expenditures.

OECD Data Explorer • Average annual wages

Table N. Earnings dispersion by gender

OECD Data Explorer • Decile ratios of gross earnings

Table O. Incidence of high and low pay by gender

OECD Data Explorer • Incidence of low and high pay

Table P. Relative earnings: Gender gap

OECD Data Explorer • Gender wage gap

Table Q. Relative earnings: Age gap

[OECD Data Explorer • Wage gap by age]

Table R1. Public expenditure in labour market programmes

As a percentage of GDP.

[OECD Data Explorer • Labour Market Programmes]

Table R2. Participant stocks in labour market programmes

As a percentage of the labour force.

[OECD Data Explorer • Labour Market Programmes]

Table S. Real hourly minimum wages

Statutory minimum wages in constant 2022 prices at 2022 USD Purchasing Power Parities (PPPs) for private consumption expenditures.

[OECD Data Explorer • Real minimum wages at constant prices]

Table T. Minimum wage relative to mean and median earnings

As a percentage of median earnings of full-time employees.

[OECD Data Explorer • Minimum relative to average wages of full-time workers]

Table U. Trade union density

As a percentage of the number of employees.

[OECD Data Explorer • Trade union density]

Table V. Collective bargaining coverage

As a percentage of eligible employees with the right to bargain.

[OECD Data Explorer • Collective bargaining coverage]

Table W1. Strictness of employment protection – individual and collective dismissals (regular contracts)

Index varying from 0 to 6, from the least to the most stringent.

[OECD Data Explorer • Strictness of employment protection]

Table W2. Strictness of employment protection – temporary contracts

Index varying from 0 to 6, from the least to the most stringent.

[OECD Data Explorer • Strictness of employment protection]

OECD Employment Outlook 2024

THE NET-ZERO TRANSITION AND THE LABOUR MARKET

The transition to net-zero emissions by 2050 will have profound impacts on the labour market and the jobs of millions of workers. Aggregate effects on employment are estimated to be limited. But many jobs will be lost in the shrinking high-emission industries, while many others will be created in the expanding low-emission activities. This edition of the *OECD Employment Outlook* examines the characteristics of the jobs that are likely to thrive because of the transition ("green-driven jobs"), including their attractiveness in terms of job quality, and compares them to jobs in high-emission industries that tend to shrink. The cost of job displacement in these latter industries is assessed along with the trajectories of workers out of them towards new opportunities, and the labour market policies that can facilitate job reallocation. Particular attention is devoted to upskilling and reskilling strategies to facilitate workers' transition into fast-growing, green-driven occupations. The distributive impacts of climate-change mitigation policies are also examined, with a focus on carbon pricing and options to redistribute its tax revenue to those most impacted. As usual, the first chapter of the Outlook assesses recent labour market developments (including wage trends), but also provides an update of the OECD Job Quality indicators.

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