# 4 Skills for the green transition

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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**<br>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.<br>**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.<br>**Writing**: Communicating effectively in writing as appropriate for the needs of the audience.<br>**Speaking**: Talking to others to convey information effectively.<br>**Mathematics**: Using mathematics to solve problems.<br>**Science**: Using scientific rules and methods to solve problems. |
| **Process skills**<br>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.<br>**Active Learning**: Understanding the implications of new information for both current and future problem-solving and decision-making.<br>**Learning Strategies**: Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.<br>**Monitoring**: Monitoring/assessing performance of yourself, other individuals, or organisations to make improvements or take corrective action. |
| Cross-functional skills | |
| **Social skills**<br>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.<br>**Co-ordination**: Adjusting actions in relation to others' actions.<br>**Persuasion**: Persuading others to change their minds or behaviour.<br>**Negotiation**: Bringing others together and trying to reconcile differences.<br>**Instructing**: Teaching others how to do something.<br>**Service Orientation**: Actively looking for ways to help people. |
| **Complex problem solving skills**<br>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**<br>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.<br>**Technology Design**: Generating or adapting equipment and technology to serve user needs.<br>**Equipment Selection**: Determining the kind of tools and equipment needed to do a job.<br>**Installation**: Installing equipment, machines, wiring, or programmes to meet specifications.<br>**Programming**: Writing computer programmes for various purposes.<br>**Operations Monitoring**: Watching gauges, dials, or other indicators to make sure a machine is working properly.<br>**Operation and Control**: Controlling operations of equipment or systems.<br>**Equipment Maintenance**: Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.<br>**Troubleshooting**: Determining causes of operating errors and deciding what to do about it.<br>**Repairing**: Repairing machines or systems using the needed tools.<br>**Quality Control Analysis**: Conducting tests and inspections of products, services, or processes to evaluate quality or performance. |
| **System skills**<br>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.<br>**Systems Analysis**: Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.<br>**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**<br>Developed capacities used to allocate resources efficiently | **Time Management**: Managing one's own time and the time of others.<br>**Management of Financial Resources**: Determining how money will be spent to get the work done, and accounting for these expenditures.<br>**Management of Material Resources**: Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.<br>**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.

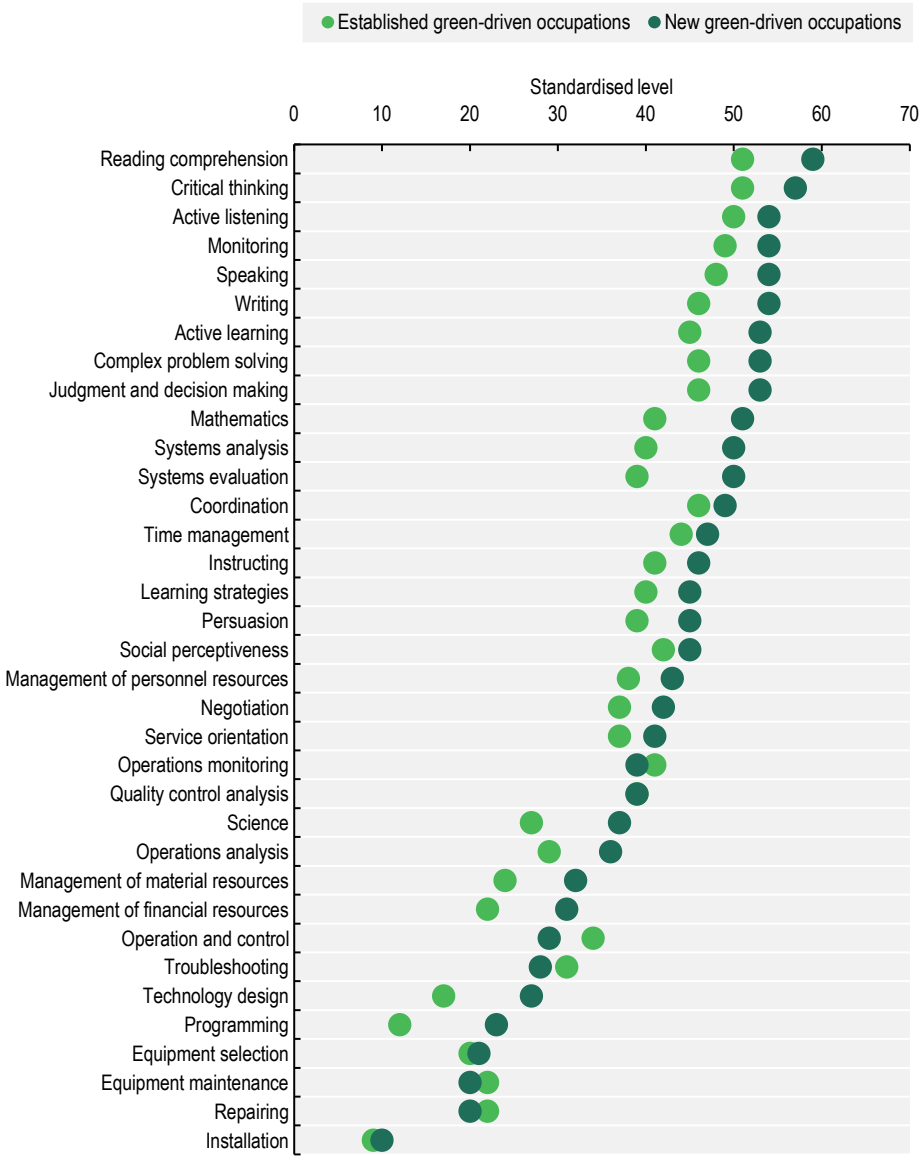
### *4.2.2. Green-driven occupations require great proficiency of information processing skills*

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.

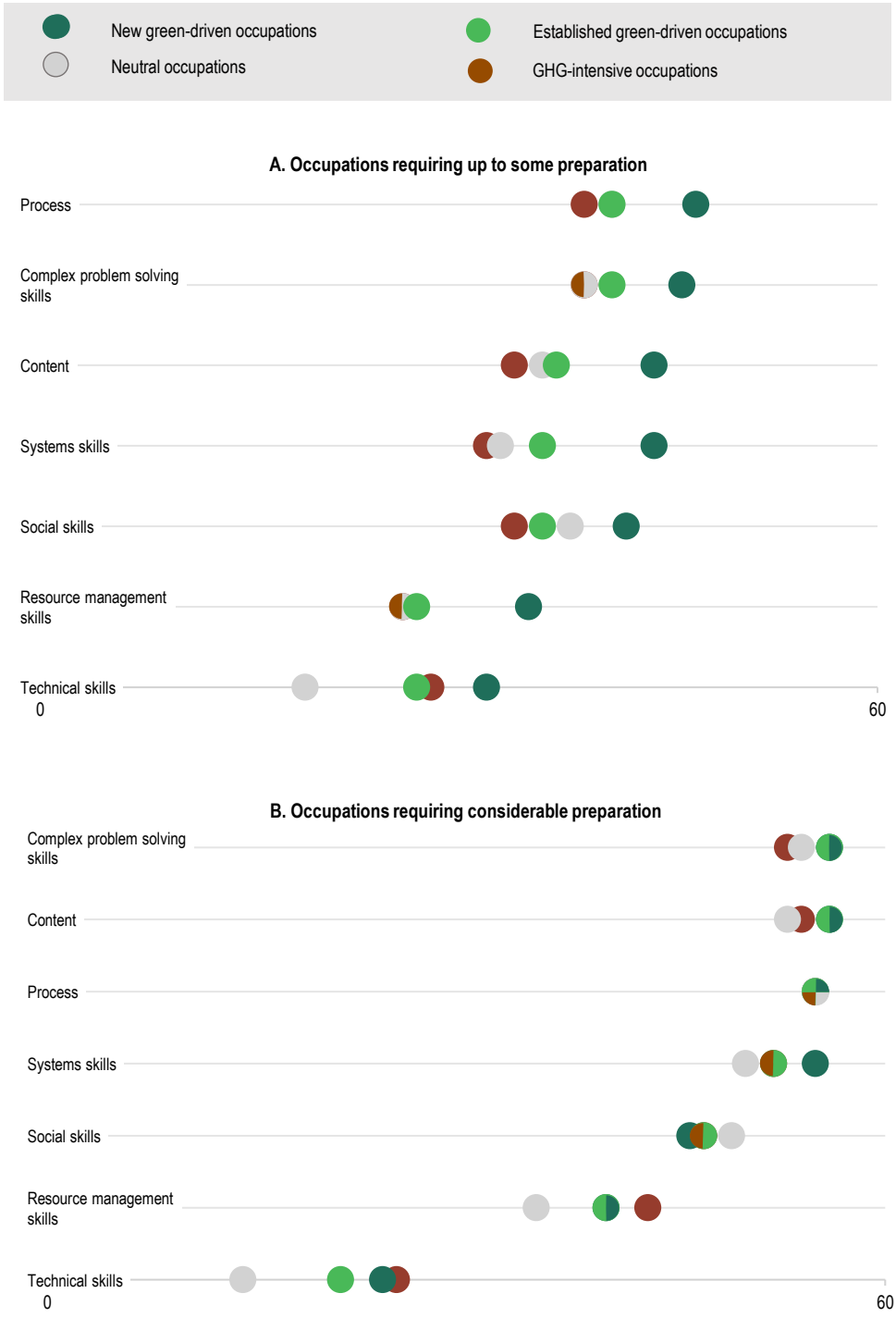
To make the results easier to interpret and ensure sufficiently large sample sizes, the five original job zones developed by O*NET have been aggregated into two categories: occupations requiring "up to moderate preparation" and occupations requiring "at least considerable preparation".[13] In particular, 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 | | | | | |
| Dredge Operators | 19 | | | | | |
| Railroad Brake, Signal, and Switch Operators and Locomotive Firers | 18 | | | | | |
| Airline Pilots, Copilots, and Flight Engineers | 48 | | | | | |
| Captains, Mates, and Pilots of Water Vessels | 24 | | | | | |
| Aircraft Mechanics and Service Technicians | 19 | | | | | |
| Aircraft Cargo Handling Supervisors | 24 | | | | | |
| Rail Yard Engineers, Dinkey Operators, and Hostlers | 17 | | | | | |
| Commercial Pilots | 30 | | | | | |
| Sailors and Marine Oilers | 20 | | | | | |
| Rail Car Repairers | 18 | | | | | |
| Signal and Track Switch Repairers | 22 | | | | | |
| Ship Engineers | 21 | | | | | |

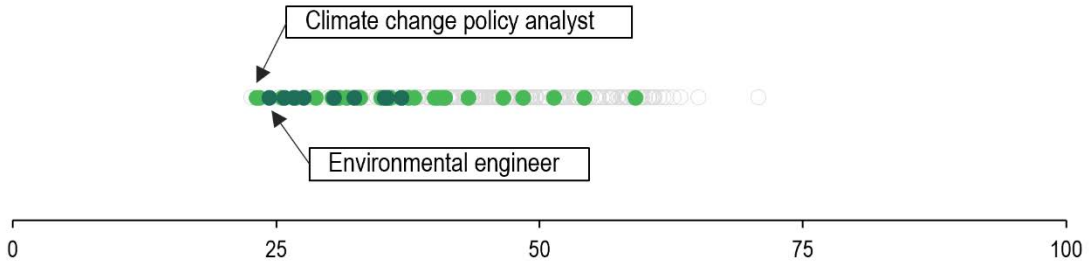
Note: The table presents the standardised distance (in a 0-100 scale) between each GHG-intensive occupation and its closest green-driven or neutral occupation (column "Distance to closest occ."). The table also shows the top 5 most similar occupations based on skill distances (columns "#1" to "#5"), 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

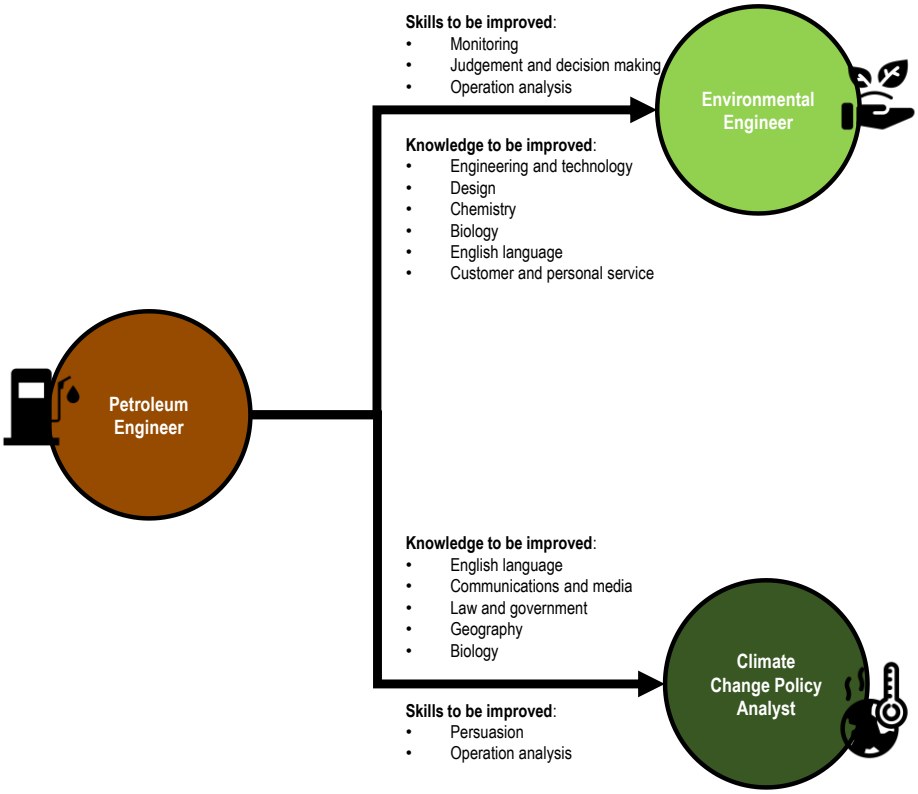



Note: Each dot in the figure represents an occupation (grey and white dots are neutral occupations, light green dots are established green-driven occupations, dark green dots are new green-driven occupations). Dots are ranked based on their skill distance with petroleum engineers – dots on the left (right) 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.

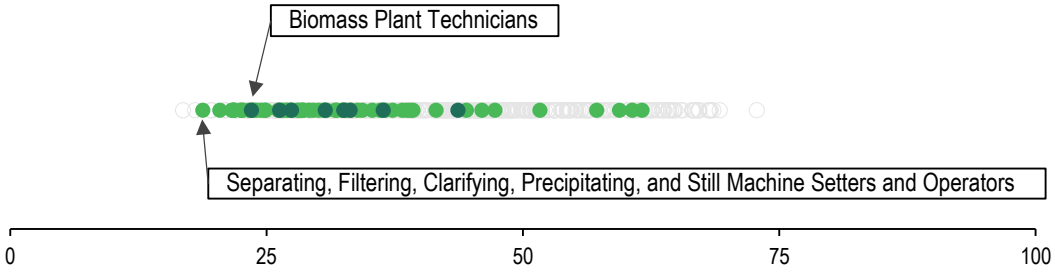
### Box 4.4. How petroleum engineers are driving the renewable revolution in Texas

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

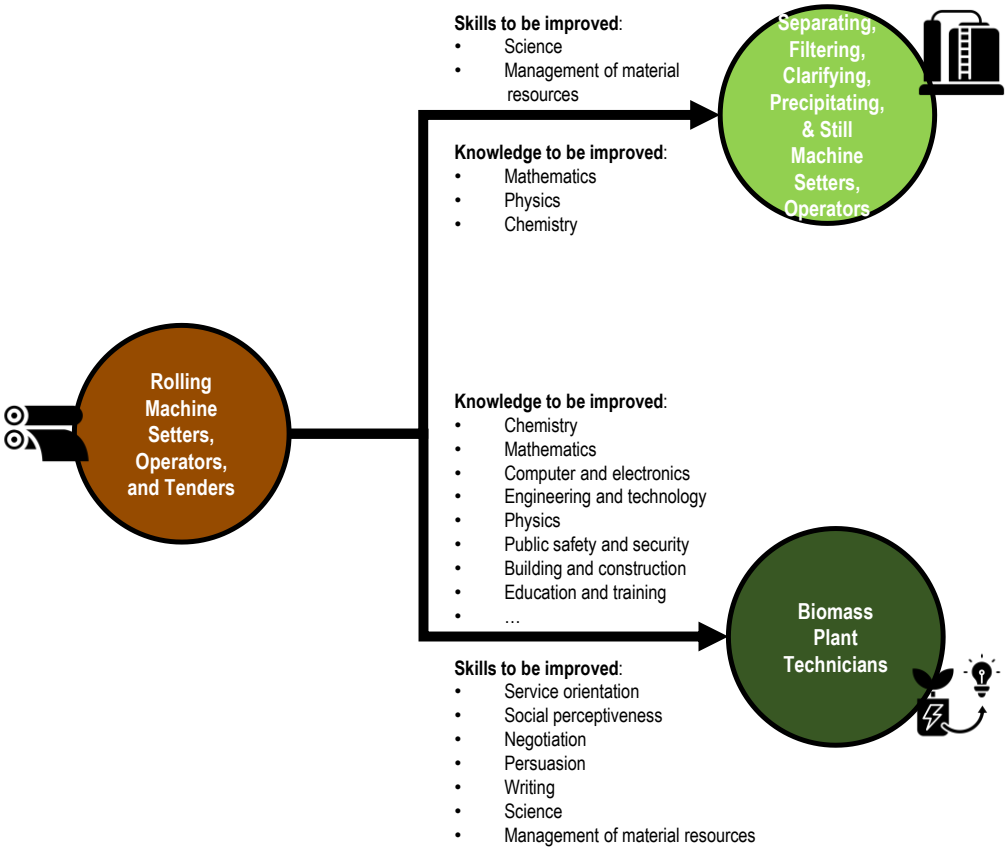



Note: Each dot in the figure represents an occupation (grey and white dots are neutral occupations, light green dots are established green-driven occupations, dark green dots are new green-driven occupations). Dots are ranked based on their skill distance with rolling machine setters, operators and tenders – 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.

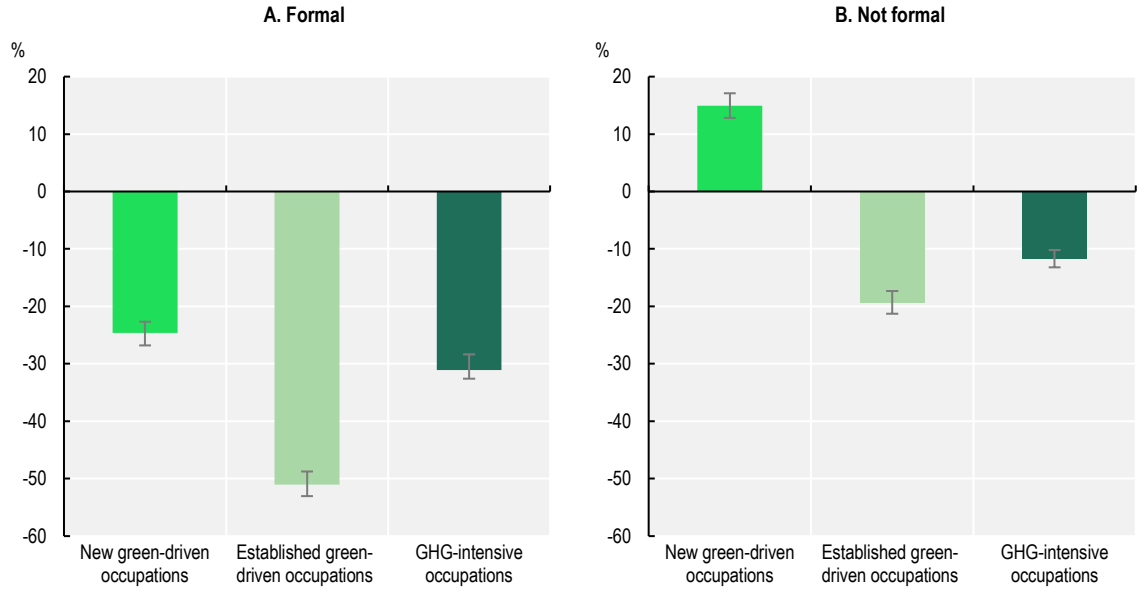
### *4.3.2. Adult learning needs to be aligned with the needs of the green transition*

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.