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CEDEFOP

Tracking the green transition in labour markets

Using big data to identify the skills that make jobs greener

POLICY BRIEF

POLICY BACKGROUND

In this section

Translating EU ambitions into regional action is crucial to successful green transition

Data-driven initiatives support the implementation of the European Green Deal

The labour market and skills impact of green transition lacks coverage by indicators

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Translating EU ambitions into regional action is crucial to successful green transition

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The European Green Deal and its industrial plan is the EU's broad and multifaceted response to climate change. It is the bloc's policy framework for transitioning from an economy that relies on fossil fuels and practices harming the environment to one that prioritises sustainability, environmental protection, and carbon neutrality.

Green transition is also about embracing the circular economy to promote recycling, reducing and reusing waste to minimise resource consumption and environmental impact (Cedefop 2023b). On the way to a carbon-neutral economy, to attain the goals laid down in the European Green Deal and European Climate Law by 2050, Europe's competitiveness will hinge on its ability to innovate and to develop and mainstream clean technologies. Ensuring that green transition benefits all citizens, including vulnerable groups, is at the core of the EU's approach. Alongside pursuing greentech innovation and upscaling, creating green jobs, addressing social inequalities, and providing access to clean and affordable resources are headline priorities.

As regions in the EU differ in terms production of goods and services, labour market structure and employment, regional GHG emissions and challenges vary significantly. The green transition cannot be just without designing and implementing regional pathways and solutions. Some regions face job losses in traditional industries; in others, greening leads to job creation in particular sectors. The workforce skilling needed in the transition requires close collaboration between regional governments, education institutions, and businesses to align training with evolving market demands. Systems monitoring the green transition at regional level will be essential to assess progress, to evaluate policy effectiveness and to ensure that sustainability, environmental protection, and carbon reduction goals and targets are met.

...the **European Green Deal** helps the EU transition to an economy that prioritises **sustainability, environmental protection and carbon neutrality**...

...**green transition** is also about embracing the **circular economy** and reducing and reusing waste to **minimise resource consumption and environmental impact**...

...**skilling needed** in the transition **requires close collaboration** between regional governments, education institutions, and businesses **to align training with evolving market demands**...

Data-driven initiatives support the implementation of the European Green Deal

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The European Strategy for Data introduced in 2020 aims to accelerate the growth of the European economy and leverage the potential of data for the benefit of society. As part of the strategy, the European Commission committed to investing in shared European data spaces. The Green Deal Data Space (GDDS) aims to empower policy-makers, businesses, researchers, and individuals in Europe and globally collectively to address climate change and move to a circular economy. It also facilitates pollution reduction, biodiversity preservation, tackling deforestation, and regulatory compliance.

The Green Transition Navigator – an innovative platform harnessing over two decades of trade data – offers insights into green opportunities, competitiveness, transition risks, and future green diversification potential for countries and regions. Policy-makers, businesses, and other stakeholders can leverage such information to make informed decisions on sustainable economic development and to capitalise on emerging green markets.

The European Space Agency (ESA) has completed the first phase of the green transition information factory, a pioneering pilot project showcasing the untapped potential of space technologies to support the green transition in Austria. The factory's Solar energy site suitability assessment & trade-off tool provides a comprehensive analysis of solar irradiance and solar energy potential across the country. The Wind energy site suitability assessment & trade-off tool has a similar purpose for the development of wind farms. The green transition information factory is to be scaled up to cover the whole of Europe.

Eurostat's Statistics for the EGD monitors green transition via 26 indicators covering three domains:

- **reducing our climate impact:** e.g. the share of zero-emission vehicles registered in the year; greenhouse gas emissions;
- **protecting our planet and health:** e.g. the share of total utilised agricultural area occupied by organic farming);
- **enabling a green and just transition**: e.g. the share of population unable to keep the home adequately warm due to financial reasons.

Total greenhouse gas emissions dropped 10% between 2019 and 2023, mainly thanks to the transition in the energy supply sector ([1]). Public investment in alternative energy resources such as solar and wind, funded by the REPowerEU Plan, accelerated in response to the turmoil on energy markets following Russia's invasion of Ukraine in 2022. By setting the 2030 EU renewable energy consumption target at 42.5% (with a 2.5% indicative top up to reach 45%), the revised renewable energy directive announced in October 2023 further raised expectations of the energy sector to contribute to green transition.

([1]) Eurostat. Air emissions accounts for greenhouse gases by NACE Rev. 2 activity. env_ac_aigg_q.

In 2022, only two EU Member States (Finland and Sweden) met the 2030 target. In some larger countries, such as Germany, Spain and France, the share of renewable resources in overall energy consumption, increased by around 20%. In some smaller-sized countries, such as Malta and The Netherlands, the increase was more than half; in Luxembourg the share of renewables in energy consumption more than doubled (Figure 1).

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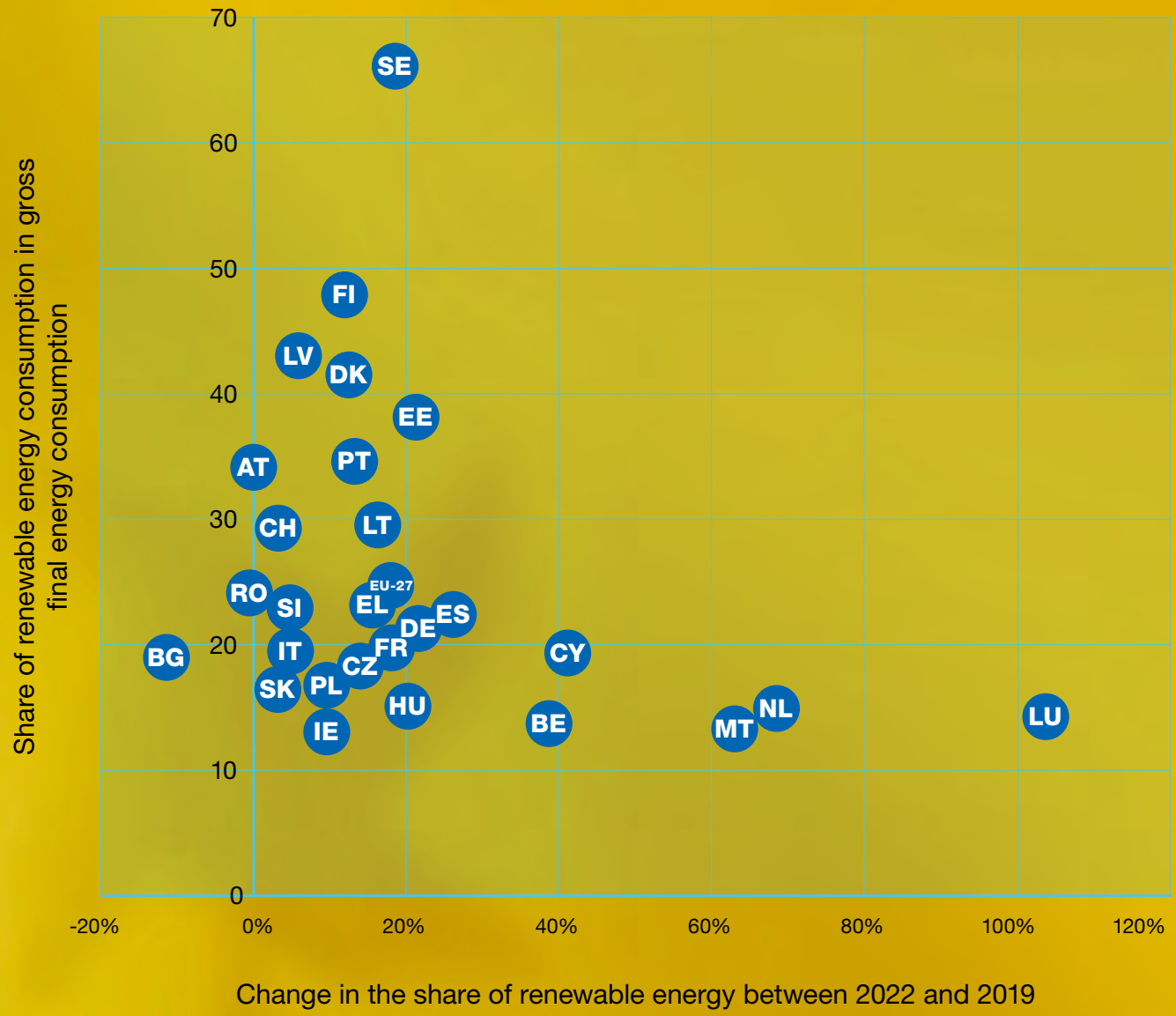
Figure 1. **Share of renewables in energy consumption (2022) and change (2019-22)**



Source: Eurostat. Share of renewable energy in gross final energy consumption by sector SDG_07_40.

The labour market and skills impact of green transition lacks coverage by indicators

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Monitoring the green transition's labour market impact and its effect on skills in demand is vital for anticipating labour market imbalances and addressing worker and skills shortages. Ideally, indicators monitoring and anticipating current challenges linked to green transition should track employment and skills trends in sectors advancing and championing environmental sustainability, renewable energy, energy efficiency and the circular economy.

Across the more than 30 composite indicators & scoreboards on European Green Deal implementation, only a few include measuring the importance of human capital. These include the World Economic Forum energy transition index, the Eco-innovation scoreboard, and the Global Green Growth Institute index. While these indicators capture the employment dimension of green transition, none of them evaluate skills and skill mismatches. Such information is crucial to identify skills areas and labour market segments where education, training and skilling for the green transition are needed.

Monitoring labour market trends and skills needs in the green transition can be challenging. Data quality varies across regions and many conventional data sources lack granularity in terms of jobs, tasks and skills. In the past, finding data to adequately measure and interpret labour market change brought about by greening was often a struggle. With the advent of big data based on online job advertisements (OJA), the situation has been improving. A study by the Joint Research Centre (JRC) summarising possible ways to identify green occupations in Europe shows that, with some restrictions, job advertisement data are one of the most promising sources (Vona, 2021).

Cedefop has teamed up with Eurostat to build the web intelligence hub online job advertisement (WIH-OJA) database. The database has been used to develop a data-driven method (Box 1) to map how the greening of economies in Europe impacts labour markets. This gives detailed insight into changes in occupations brought about by the green transition and makes it possible to identify the green transition skills most in demand. By presenting several illustrative findings, this policy brief demonstrates the potential of using online job advertisements in the context of monitoring the labour market and skills dimensions of the green transition.

...**indicators**...should track... trends in sectors advancing and championing **sustainability, renewable energy, energy efficiency and the circular economy**...

...**it is crucial** to identify skills areas and labour market segments where **education, training and skilling for the green transition are needed**...

...**Cedefop** has used the web intelligence hub online job advertisement **(WIH-OJA) database** to map the labour market impact of greening...

Box 1. **Cedefop's green skills methodology: greenness and green pervasiveness explained**

The main assumption in the Cedefop approach is that the presence of skills needed for the green economy in online job ads defines whether or not an occupation is green and how green it is. A green occupation must include at least one such skill. What skills are considered green is guided by the skills found in the market: following on from the bottom-up approach methodology (NESTA, 2021), Cedefop has compiled a bag of green-related words, which includes green technologies, tasks, roles, tools and skills. The following reports, documents, frameworks and taxonomies were used to create it:

- Classification of environmental protection activities (CEPA 2000);
- Classification of resource management activities (CReMA);
- IRENA Global Renewables Outlook 2020;
- Linkedin 'green' skills;
- SGG Singapore green economy skills;
- Joint Research Centre's GreenComp framework;
- O*NET and ESCO green classifications.

Cedefop used a list of 140 words in English obtained from these publications to train a machine-learning model. The list of green skill terms was enhanced with lexicon variations using 6 million OJAs collected in 2019 in the UK. The enhanced list, with 182 extracted terms in English, was subsequently translated by national experts for all languages covered in the WIH-OJA system and used for ontology-based extraction. The sample of observations extracted from OJAs was also validated by national experts to confirm and create a valid training dataset. Using cosine similarity, each green skill term became associated with the ESCO green skills taxonomy. Where such association did not exist, the term was added as a new green skill term. Most identified green transition skills terms cover technologies, sustainability principles or aspects pointing towards corporate social responsibility (Figure 2).

To understand better how each occupation is impacted by 'green transition' two indicators were constructed: green pervasiveness and greenness.

- **Green pervasiveness** means omnipresence of green skills in the OJAs and is calculated as the ratio of all OJAs with at least one green skill to the total number of OJAs in occupations, sectors, countries, or other analysis categories.
- **Greenness** compares the number of green skills to the total number of skills found in online job ads in such categories.

While the approach is cutting-edge, one of its key limitations is underestimating green occupations in the economy. In online job ads for green occupations which include the green dimension in the job title (e.g. sustainable engineer), employers may refrain from mentioning other green skills in the description of job requirements. Information about the 'greenness' of a position may also not be included in the part of an online job ad that describes skills requirements to potential candidates, but present in the part which describes corporate mission or vision (e.g. 'we're committed to driving energy efficiency and addressing global environmental challenges' or 'the company's mission is to create a sustainable brand'). Some green transition skills terms cannot be detected because new technology has only started to emerge. This is less of a problem in the longer term, as such skills will be eventually detected by algorithms that track emerging skills.

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Figure 2. **Green transition skills extracted from online job advertisements**

NB: Only green transition skills present at least 200 000 times are presented.

Source: WIH-OJA data.

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EVIDENCE

In this section

Wholesale and retail trade employers need to accelerate their green transition

OJAs help uncover roles crucial to renewable energy

OJAs help monitor circular economy practice uptake

Big data increases opportunities to monitor the green transition regionally

Skills supporting lean manufacturing help construction sector green transition

Green computing skills reduce the environmental impact of technology

Regulatory change likely to increase demand for sustainability reporting expertise and skills

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Wholesale and retail trade employers need to accelerate their green transition

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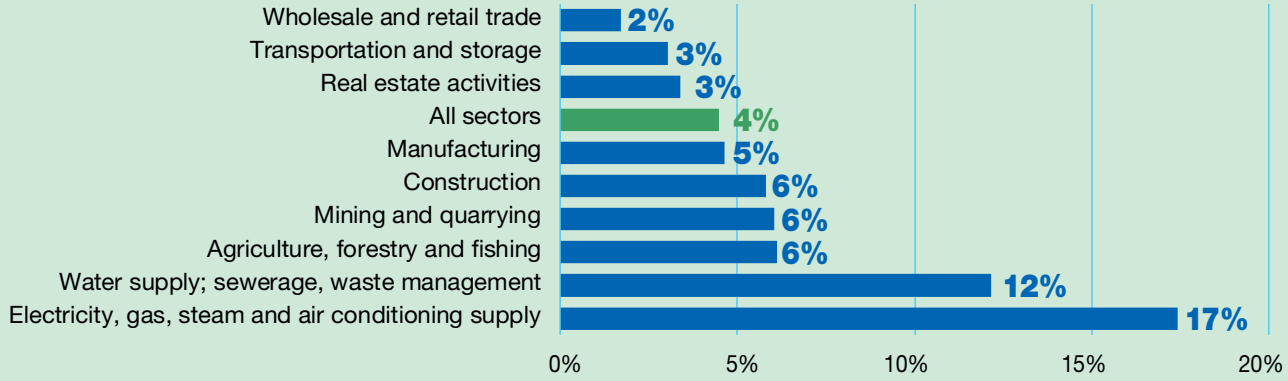
As industries and organisations become greener, demand for workers with green expertise will surge. Companies will increasingly rely on people with skills and expertise in lean manufacturing, renewable energy technologies, environmental engineering, waste management, green computing, resource efficiency, and environmental management. It will be crucial to invest in education and training programmes to equip the workforce with the necessary green transition skills to meet labour market needs and to contribute to a more sustainable future.

Green pervasiveness in skills demand (defined in Box 1) increased from 3% in 2019 to 5% in 2022. This signals that employers translate commitment to achieving European Green Deal goals into greening operations. Among high climate impact sectors ([2]) demand for skills for the green transition is highest in energy, where 17% of online job ads included at least one such skill. It is lowest in wholesale and retail trade, where only in 1 in 50 job ads (2%) were green skills mentioned (Figure 3).

Jobs in the trade sector will need rapidly to become greener. It is estimated that up to 2030 retailers and wholesalers need to invest around EUR 120-300 billion to make their operations carbon neutral. A further EUR 15-35 billion will be needed to shift from linear to circular business models and systems. Trade employers also need to increase human capital investment and invest EUR 25-30 billion to upskill their workforce: this is 40-60% more than what the sector spends now. Reskilling the trade workforce for green roles, tasks, and skills amounts to an investment of EUR 500 million to EUR 3 billion (EuroCommerce 2022).

Figure 3. **Average green pervasiveness in high climate impact sectors in EU27**



NB: Averages calculated using online job ads published in 2019-22.
Source: WIH-OJA.

([2]) High climate impact sectors are those listed in NACE Sections A to H and Section L (defined in Commission Delegated Regulation (EU) 2022/1288).

OJAs help uncover roles crucial to renewable energy

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Recent trends in the energy sector naturally translated into more demand for renewable energy professionals (Cedefop 2023c). The job vacancy rate in the energy sector almost doubled from 1.0% to 1.9% between 2019 (pre-COVID) and the 4th quarter of 2023 ([3]). While official vacancy statistics help track vacancy trends in the sector, they do not give insight into the renewable energy occupations or profiles in demand.

Where occupational data are available, using them in the context of green transition is challenging, given that many occupations relevant for renewable energy have only recently emerged.

Even information at the 4-digit level of the international classification of occupations (ISCO) will not capture many contemporary job roles in energy, as the last ISCO update took place in 2008 (Box 2).

Jobs for renewable and solar energy sales consultants, which are currently classified as technical, and medical sales professionals are cases in point. Looking at the 5-digit level, there is enormous variation between countries when it comes to the composition of this group. In recent years, jobs for renewable sales professionals' accounted for half of the online job ads for technical and medical sales professionals in Germany; in Italy this was only 15% (Figure 4, upper panel).

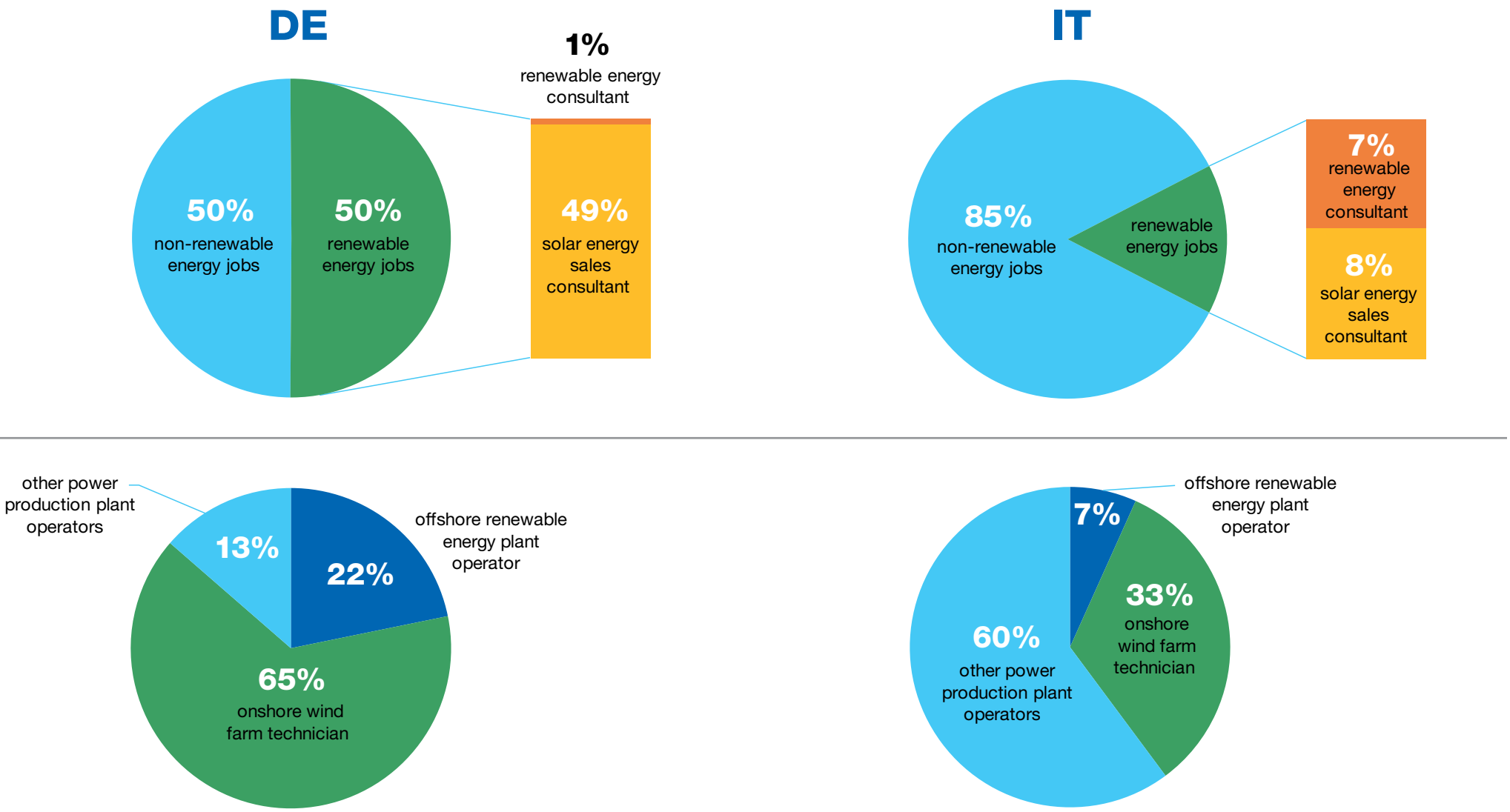
([3]) Eurostat.ob vacancy statistics by NACE Rev. 2 activity, occupation and NUTS 2 regions – quarterly data.

Stark differences are also visible in the demand for power plant operators (Figure 4, lower panel). In Germany 65% of online job ads for such operators were for onshore wind farm technicians, double the share observed for Italy (33%). Online job ads for offshore renewable energy plant operators represented 22% of the total demand for power plant operators in Germany, three times the share observed in Italy (7%). Understanding the composition of demand for professionals in other renewable energy sectors (including geothermal, solar, hydroelectric or nuclear) would require occupations to be classified at the 5-digit level or even lower.

Box 2. Granular data are essential for monitoring 'green' occupation demand

Information about job title present in online job ads in the WIH-OJA database is processed to match it with an ISCO code to derive information about demand for occupations. Many roles relevant for the green economy today, which did not exist when ISCO was last updated in 2008, are labelled as 'occupations not elsewhere classified'. In the period from 2018 to end-2022 the share of such occupations in the total volume of green occupations rose to 12%, meaning that, in 2022, 420 000 online job ads could not be effectively classified (Figure 5).

Figure 4. **Demand for technical and medical sales professionals (upper panel) and power plant operators (lower panel) by occupation (ISCO 5-digit) in Germany and Italy.**



Source: WIH-OJA.

Figure 5. OJAs advertising occupations classified as green (millions) and share of occupations not elsewhere classified (%), EU (Q3 2018-Q4 2022)

NB: O*NET taxonomy used to classify which occupations are green.

Source: WIH-OJA.

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Difficulties in pinpointing the nature of occupations make the analysis of the green economy, and the skills it requires, challenging. This is more so because some ISCO 4-digit occupation groups – apart from roles directly linked to renewable energy – also include occupations not relevant for the sector. Therefore, analysis at ISCO 4-digit level may lead to an overestimation of demand. Cedefop analysis of roles for the renewable energy market based on technical and medical sales representatives (ISCO 2433) illustrates this. Of all online job ads for such sales representatives in Germany, Spain, Italy, and Finland, only 1% was for renewable energy consultants and 4% for solar energy consultants. The lion's share (95% of OJAs) was for medical sales representatives, technical sales reps, or another sales occupation outside of the energy sector.

Using the ESCO-based 5-digit level occupation classification greatly improves understanding of the nature and structure of demand for some green transition occupations. For example, for power production plant operators (ISCO 3131), the majority of OJAs (64%) is for onshore (64%) or offshore (17%) wind farm technicians.

...**difficulties in pinpointing the nature of occupations** make the analysis of the green economy challenging...

...Cedefop analysis shows that using **ISCO 4-digit level** may lead to **overestimation of demand**...

...the **ESCO-based 5-digit classification** greatly improves understanding of the **nature and structure of demand** for some green transition occupations...

OJAs help monitor circular economy practice uptake

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Eurostat's circular economy indicator takes a sectoral perspective, considering employment in recycling, repair and reuse and rental and leasing. With this approach, the employment share of the circular economy across EU countries does not exceed 3% ([4]). The total employment impact of going circular is higher because mainstreaming the circular economy requires the involvement of a broad range of occupations at different value chain, business process and product life stages.

Monitoring employment needs in the circular economy can be challenging. Alongside core occupations playing critical roles in material reuse, recycling and minimising waste, there are also jobs and roles that enable the transition to a circular economy by fostering innovation and mainstreaming circular practices across sectors. Examples are design and digital technology occupations that contribute to the development of sustainable products, services, and systems. Some occupations indirectly facilitate and enable the broader adoption of circular economy principles. These include the jobs of public sector workers tasked with policy development, regulation, or with funding initiatives that promote circular practices and sustainability (Circle Economy, 2021).

OJA-powered analysis monitoring the uptake of circularity via the number of mentions of the term circular economy by employers shows that the number of times it is mentioned almost doubles every year and gives insight into the most in-demand occupations. The most sought-after circular economy profiles in the period 2018-22 were research and development managers. Such managers plan, direct and coordinate research to develop new or improved technical processes, products, knowledge, or utilisation of materials, contributing to resource use efficiency.

Engineers (industrial, production or environmental) were the second most in-demand circular economy profile. Those engineers with systems thinking expertise, are adept at analysing complex systems and identifying opportunities for optimisation and innovation. Such skills are an asset because becoming circular requires holistic understanding of material flows, resource efficiency, and waste reduction at various stages of production, consumption, and disposal. The increasing demand for systems analysists can be linked to the expanding use of artificial intelligence and data science tools,

([4]) Eurostat. Persons employed in circular economy sectors [CEI_CIE011]

...**mainstreaming the circular economy** requires **the involvement of** a **broad range of occupations** at different value chain, business process and product life stages...

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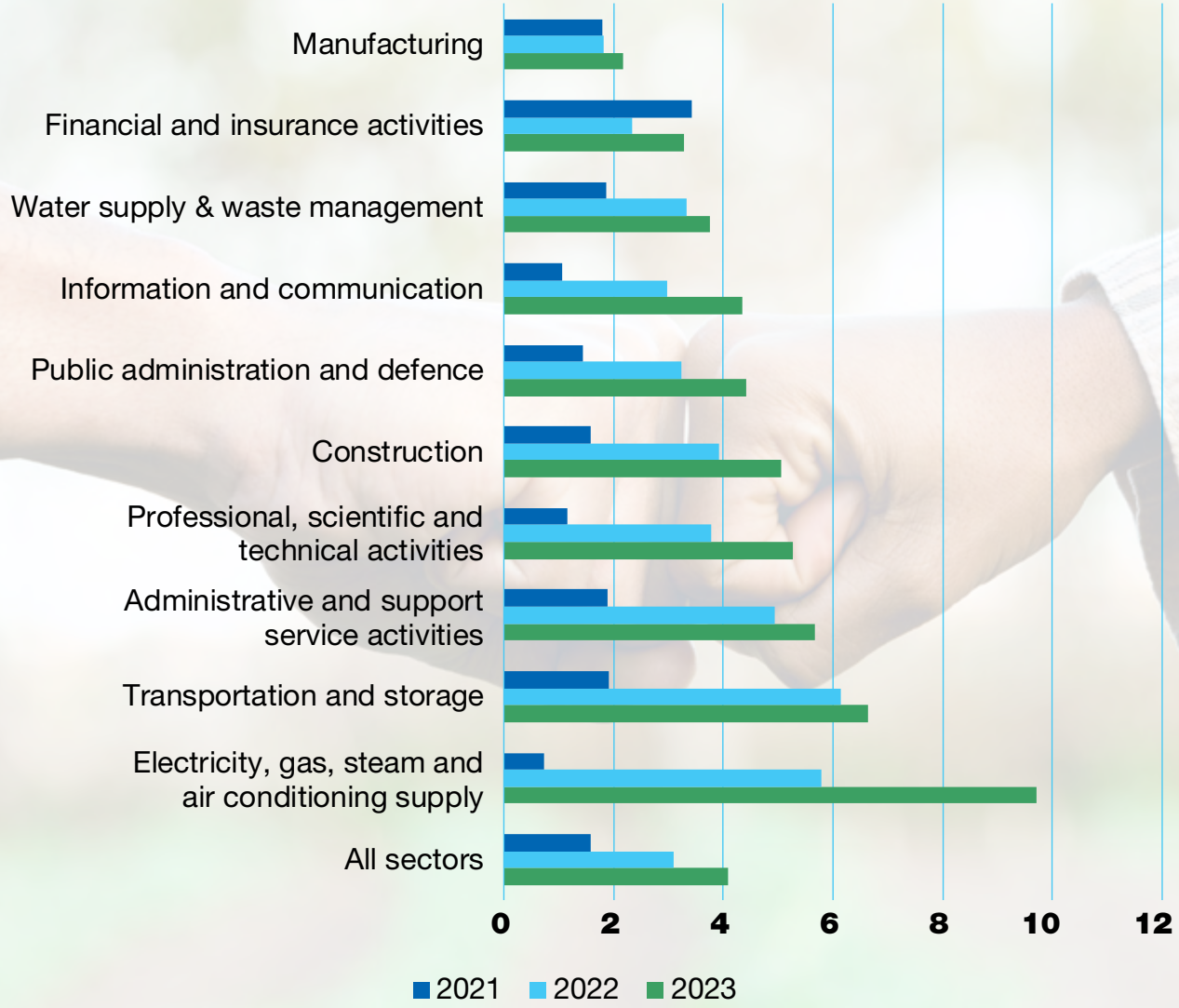
...becoming circular requires **holistic understanding of material flows, resource efficiency, and waste reduction** at various stages of production, consumption, and disposal...

Figure 6. **Growth of term 'circular economy' presence in OJAs by sector (2020 base year)**



NB: top ten sectors.

Source: WIH-OJA.

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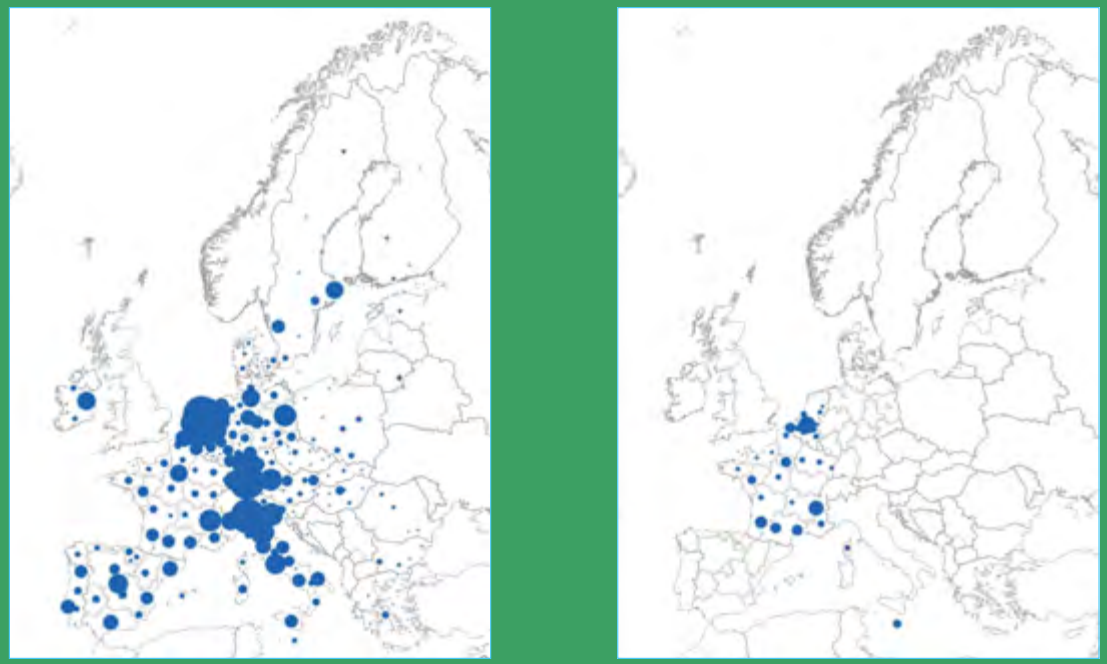
which analyse large amounts of industrial data to find the best economic circular solutions.

Terms such as life cycle analysis or industrial symbiosis can also be used in OJA analysis to track demand for workers that implement circular economy approaches. Industrial symbiosis starts from the premise that what is a waste for one company might be an asset for another. It allows companies in the steel, chemicals, energy, food and other sectors to reduce their use of energy and raw materials via industrial synergies and inter-company economic optimisation solutions. The 'electricity, gas, steam and air-conditioning supply' sector has been most active in industrial symbiosis, according to research covering Italy, Latvia and Finland (see de Theije, Ruben, 2021). Cedefop's OJA analysis shows that in this sector, the number of circular economy mentions has grown fastest in recent years (Figure 6).

...in the electricity, gas, steam and air-conditioning supply sector...**growth in online job ads mentioning circular** has been fastest in recent years...

Big data increases opportunities to monitor the green transition regionally

Figure 7. **Number of OJAs mentioning skills related to solar energy technologies in EU27**



NB: Region could not be determined for 25% of OJA. Only regions with more than 100 (left panel) and 5 (right panel) observations are shown.
Source: WIH-OJA.

The EU solar energy strategy adopted in May 2022 aims to accelerate the deployment of solar technologies across the Member States. As regions with abundant sunlight tend to be more suitable for solar power generation, the demand for skills related to solar energy technologies (e.g. calculate solar panel orientation, install concentrated solar power systems) is higher in southern EU regions than it is in northern ones. However, with solar panel technology advancing and increasingly capable of capturing diffused sunlight to generate electricity, even on cloudy days, solar technology is becoming more common in places where it has not been present much so far.

Public incentives aimed at reducing the cost of solar energy technology installation and uptake may translate into increased demand for workers with solar energy knowledge, skills and expertise (Figure 7, left panel).

The city of Brussels offered its inhabitants bonuses for the installation of solar water heaters and Maltese citizens had access to grants for the purchase and installation of such heaters. The public purse was also used to fund purchases by individuals of solar water heaters in France. Such public initiatives may be linked to the higher demand for workers installing water heating in these regions (Figure 7, right panel).

Skills supporting lean manufacturing help construction sector green transition

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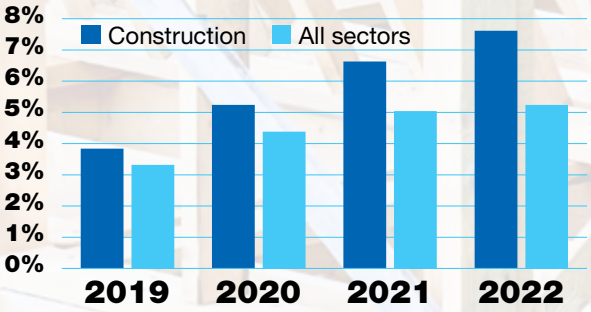
The construction sector appears to be ahead in the green transition, as green pervasiveness (Box 1) is 2 percentage points higher than average (Figure 8). Nevertheless, resistance to change in the sector stands in the way of large-scale adoption of innovative and sustainable technologies (Hofman et al., 2022). Construction companies also struggle to make the necessary investments due to the rising costs of labour, energy and raw materials (Atradius, 2023). Skills shortages in construction also hinder achieving the ambitious EU green goals set for the sector.

Between 2019 and 2022 companies in the construction sector that looked for green profiles were mainly recruiting construction supervisors, engineering professionals, civil engineers and research and development managers. Lean manufacturing – a production principle targeting the elimination of waste and improvements in efficiency – was the most sought-after green skill for all advertised green occupations ([5]). Employers expect construction supervisors to have knowledge and expertise to ensure safety and to safeguard the environment. Apart from ensuring that construction activities comply with safety regulations and standards, they need to consider environmental impact. This will help protect biodiversity, conserve natural resources (e.g. water, energy, materials, and land) and reduce or eliminate the sources of pollution.

Environmental engineering – a field of knowledge centred around ensuring that societal development and the use of water, land and air resources are sustainable – was the second most in-demand skill across online ads for green jobs targeting civil engineers. Core tasks of civil engineers include developing technical solutions, ensuring compliance with environmental standards, managing water supply, sewerage, surface water and groundwater quality, remediation of contaminated sites, and management of solid waste. Environmental engineering and skills to facilitate the energy transition are often jointly required for engineering professionals recruited for greening construction.

Figure 8. **Green pervasiveness of advertised jobs in the EU construction sector**



Source: WIH-OJA.

...**skills shortages** in construction **hinder achieving** the **ambitious EU green goals** set for the sector...

...**environmental engineering** and **skills to facilitate the energy transition** are often jointly required for **engineering professionals**...

([5]) Lean manufacturing construction practices include Building information modelling (BIM), the Last planner system, Kaizen events, Integrated project delivery, and 5s processes. See also https://www.msuite.com/the-5-principles-of-lean-manufacturing-in-construction/

Green computing skills reduce the environmental impact of technology

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Every aspect of modern information technology and the steady increase in using computers and generating data comes at a cost of growing CO_2 emissions. All electronic devices (including computers) contribute to waste generation and contain many toxic substances. Disposed electronic devices are responsible for up to 40% of all global lead in landfills (Rajkumar et al., 2021). All sectors using electronic devices can make a difference in reducing their environmental impact.

It is not surprising that EU employers attach high importance to green computing skills (also known as green IT or sustainable IT), a term coined in 1992 that currently stands for using virtual computing technologies to minimise energy consumption and reduce environmental waste during computer usage. The demand for green computing skills confirms the engagement of employers in curbing the negative impact of their activities on the environment.

One of the aims of green computing is reducing energy consumption by increasing server utilisation rates in organisations; this translates into skills needs across various occupations. Demand for green computing skills is highest for various IT professional roles (Figure 9). Alongside promoting lower energy consumption by designing energy-efficient devices, green computing is also linked to responsible recycling by extending product life cycle, and to sustainable manufacturing via less use of hazardous materials in production. For business and administration professionals, and numerical and material recording clerks involved in computational tasks in accounting or inventory management, green computing skills help them use more energy-efficient data storage and management methods. Green computing practices are also crucial to sustainable innovation, because they encompass the development of new products or services that are environmentally friendly and profitable. Jointly with greater awareness among employers of the impact of digital services, this translates into demand for science and engineering professionals with green computing skills.

...**modern information technology** and the steady increase in using computers and generating data comes at a **cost of growing CO_2 emissions**....

...**demand for green computing skills** confirms the engagement of employers in **curbing the negative environmental impact** of their activities...

...**green computing practices** support **green innovation**...and translate into demand for science and engineering professionals...

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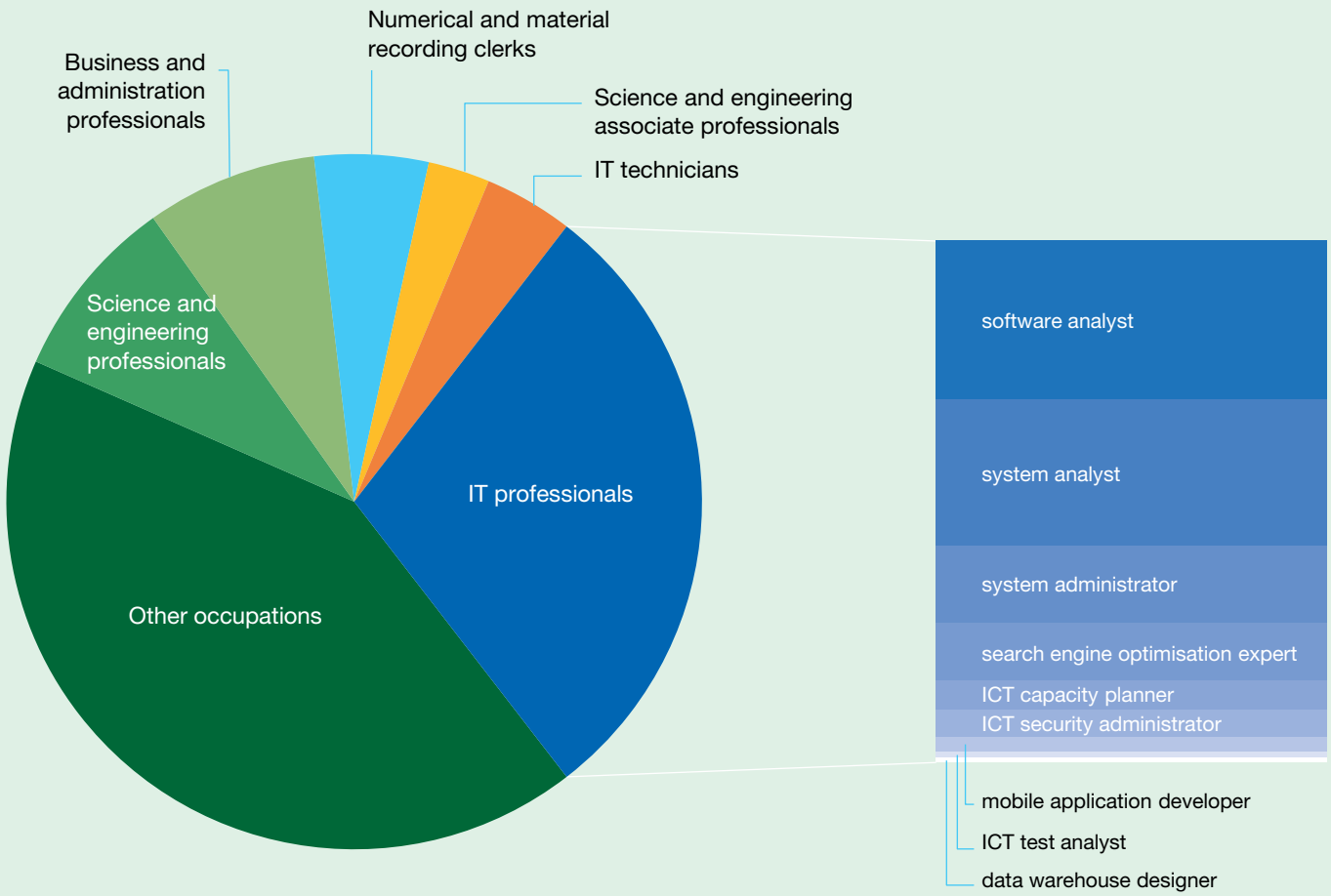
Figure 9. **Green computing skills demanded by employers in the EU by ISCO 2-digit occupation and ISCO 4-digit IT occupations (Q3 2018 – Q1 2023)**



Source: WIH-OJA data.

Regulatory change likely to increase demand for sustainability reporting expertise and skills

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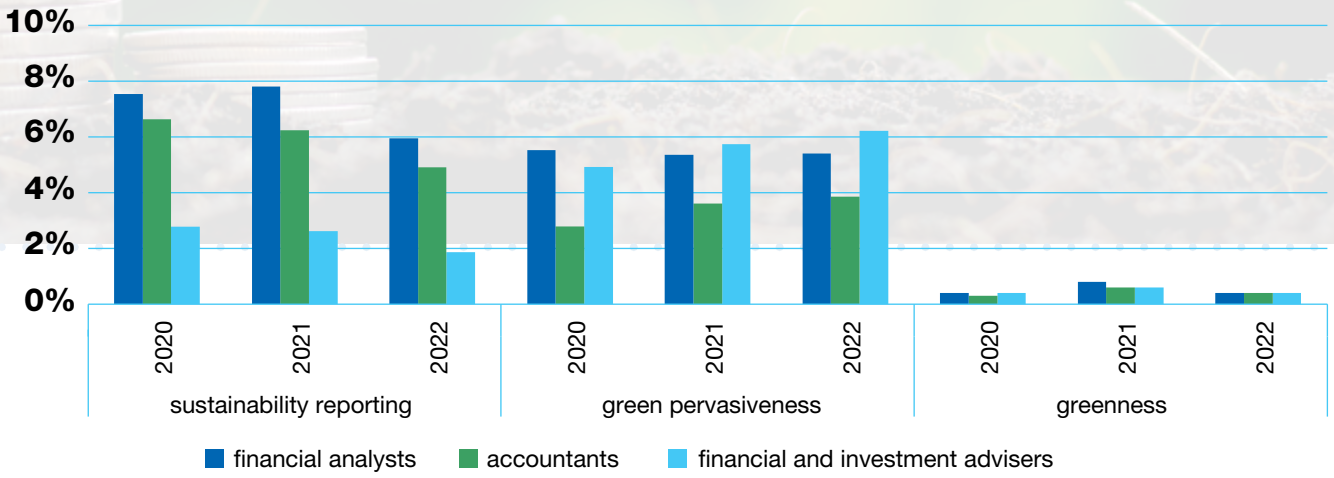
The Corporate Sustainability Reporting Directive (CSRD), which entered into force on 5 January 2023, signals a significant shift towards greater transparency and accountability in how businesses report their environmental, social, and governance (ESG) impacts. The directive introduced European Sustainability Reporting Standards (ESRS) to improve the quality and scope of sustainability reporting across the EU. Under the new directive, including information about sustainability alongside financial results is a mandatory requirement for companies. A notable feature of these standards is the emphasis on transparency, not just within the companies' immediate operations but across their entire value chains. This broad scope means that companies have to report on sustainability practices that extend beyond their direct activities, and to include aspects of their suppliers' and partners' operations.

The regulatory change is expected to influence finance and accounting, impacting skills, responsibilities, and practices. While, over time (Figure 10), the presence of green skills slightly increased for accountants and financial advisers, the average presence of green skills in online job ads for finance professional roles was quite low, at below 6%. Although the greenness of finance roles remains modest, sustainability reporting was already among the top 10 skills required by employers recruiting finance professionals. The change in regulation will likely create new roles, such as environmental sustainability goals controller, to help companies prepare for sustainability-related disclosure and assurance requirements ([6]).

([6]) Eight key takeaways for the accountancy profession facilitating sustainable development and net zero transitions.

Figure 10. **Demand for green skills for finance professional roles in the EU**



Source: WIH-OJA data.

...**European Sustainability Reporting Standards (ESRS)** ...improve the quality and scope of sustainability reporting across the EU....

CONCLUSIONS

In this section

OJA analysis vitally contributes to monitoring skill needs for the green economy

OJAs can be used for short-term skills needs forecasts

OJA analysis informs curricula and programme updates

OJA analysis supports updates of occupation and skills classifications

Information from OJAs helps map the severity of labour and skills shortages

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OJA analysis vitally contributes to monitoring skill needs for the green economy

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Online job advertisements have advantages compared to more traditional sources of information (e.g. surveys, administrative data) because they provide more granular information on jobs and occupations (e.g. in terms of skills or at regional level) almost in real-time. OJA-powered analysis is gaining traction in labour market analysis on the impact of structural change and twin (green and digital) transition.

A recent review of labour market literature leveraging OJAs (Napierala & Kvetan, 2023) uncovered many cases of such online information. Alongside occupational (e.g. skills requested in public health jobs) and sectoral analysis (e.g. skills trending in manufacturing), OJAs can also be used for tracking skills needs in emerging jobs (e.g. computer scientist positions) or identifying skills trends in existing jobs (e.g. changes in journalists' skills linked to generative AI).

OJA-powered analysis is a booming sectoral skills anticipation tool, as shown, for instance, by the competence survey of the technology industry in Finland (Technology Industries of Finland, 2023). Public pledges and commitments to tackle climate change have encouraged researchers to leverage OJAs as a data source to compare skills requirements in high and low-carbon jobs (Saussey et al., 2022). The examples of Cedefop work presented in this policy brief showcase the enormous potential of green transition analysis driven by big data. Such analysis provides novel insight into the skills needed in 'green' roles (e.g. in the renewable energy sector and in the circular economy) and into regional differences in 'green' skills demand. It also opens up opportunities to track how employers react to and change skill requirements to comply with new environ mental regula tion (e.g. for finance professionals). More detailed analysis of the labour market impact of green transition in the EU is available on Cedefop's web portal

The following SkillsOVATE dashboards are available:

- green renewable energy occupations
- greening in occupations
- greening in sectors
- greening in regions

...**OJA-powered analysis** is gaining traction in **labour market analysis** on the impact of **twin (green and digital) transition**...

...OJA-powered analysis is a **booming sectoral skills anticipation tool**...with enormous potential...

...OJA analysis can help **track** how employers **react** to and **change skill requirements** to comply with regulation...

OJAs can be used for short-term skills needs forecasts

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It is well known that OJAs are not complete job-skills profiles. Many skills sets useful in a job tend to be left implicit. This is, for instance, the case for using Microsoft office software, which is present in only 11.3% of online job ads, much lower than would be expected in today's labour market (Sostero & Tolan, 2022).

For skills needs that are less commonly considered a given or not logically linked to job title (e.g. baking skills for a baker), it is possible to forecast whether demand for skills is expected to grow in particular occupations (e.g. green computing skills for software developers or waste management expertise for municipal workers). The WIH-OJA Cedefop and Eurostat project, which so far has produced five years of time series data, makes it possible to leverage the information for such purposes. Cedefop has started integrating OJA-based information into its skills forecast tool to provide more detailed short-term skills anticipation as part of its online webtools.

Advanced approaches to tracking greening trends over time are needed to ensure unbiased results: data collection from the web is susceptible to interruptions (e.g. when portal owners block access to web scrapers or crawlers) that result in information losses. Cedefop and Eurostat are together developing a tailored times series method to address such challenges. Once a new regulation on European statistics is in force, securing source stability of websites and portals over time will become less of an issue, making it easier to detect greening trends over time and their implications ([7]).

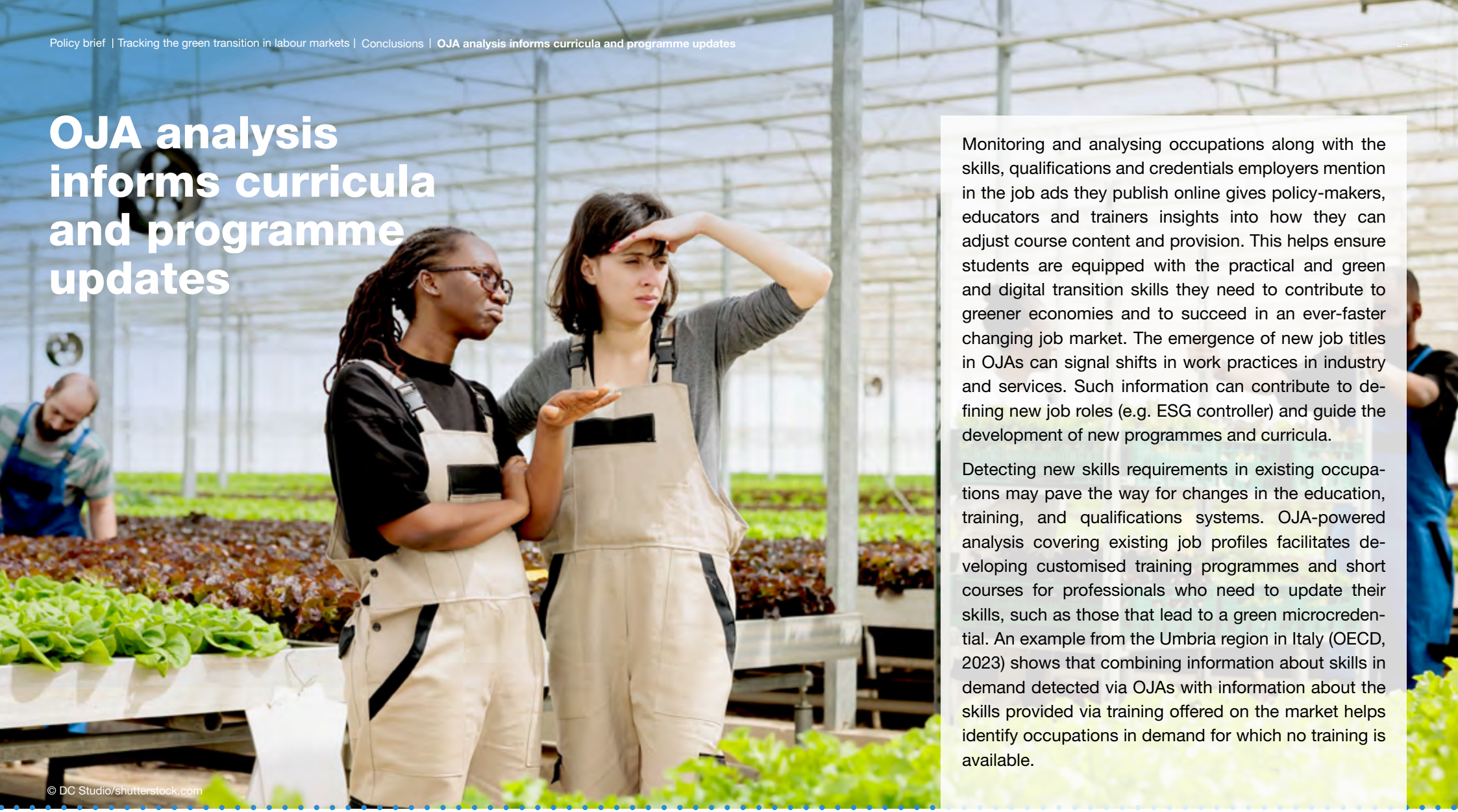
([7]) The regulation introduces the obligation for private data holders to share information with national statistical institutions and tasks the European Commission (Eurostat) to use it to produce European official statistics.

...5 years of OJA data collection makes it possible to forecast whether **demand for skills is expected to grow** in particular occupations...

...**Cedefop** has started integrating OJA-based information into its skills forecast tool to **provide more detailed short-term skills anticipation...**

...as data collection from the web is susceptible to interruptions and information losses, **advanced approaches to track greening trends** are needed...

OJA analysis informs curricula and programme updates



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Monitoring and analysing occupations along with the skills, qualifications and credentials employers mention in the job ads they publish online gives policy-makers, educators and trainers insights into how they can adjust course content and provision. This helps ensure students are equipped with the practical and green and digital transition skills they need to contribute to greener economies and to succeed in an ever-faster changing job market. The emergence of new job titles in OJAs can signal shifts in work practices in industry and services. Such information can contribute to defining new job roles (e.g. ESG controller) and guide the development of new programmes and curricula.

Detecting new skills requirements in existing occupations may pave the way for changes in the education, training, and qualifications systems. OJA-powered analysis covering existing job profiles facilitates developing customised training programmes and short courses for professionals who need to update their skills, such as those that lead to a green microcredential. An example from the Umbria region in Italy (OECD, 2023) shows that combining information about skills in demand detected via OJAs with information about the skills provided via training offered on the market helps identify occupations in demand for which no training is available.

...analysing **occupations** and **skills, qualifications and credentials** in OJA gives insight into how **course content and provision** can be adjusted...

...**new job titles** emerging from OJAs can **signal shifts in industry and services** and contribute to **defining new job roles**...

...OJA analysis of **existing job profiles** facilitates developing **customised training programmes** for professionals...

OJA analysis supports updates of occupation and skills classifications

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Analysis of occupations and in-demand skills based on OJA content makes visible to what extent, and in which respects, emerging occupations differ from existing ones. For example, Malandri et al. (2021) analysed skills for data engineers and data scientists, occupations that are classified in the same ESCO occupation group. They conclude that, in the real labour market, these two IT profiles do not have similar skills requirements. Comparison of the skills requested by employers for ICT and statisticians confirmed that each has distinctive skills, which justifies keeping these two occupations separately classified (Lovaglio et al., 2018).

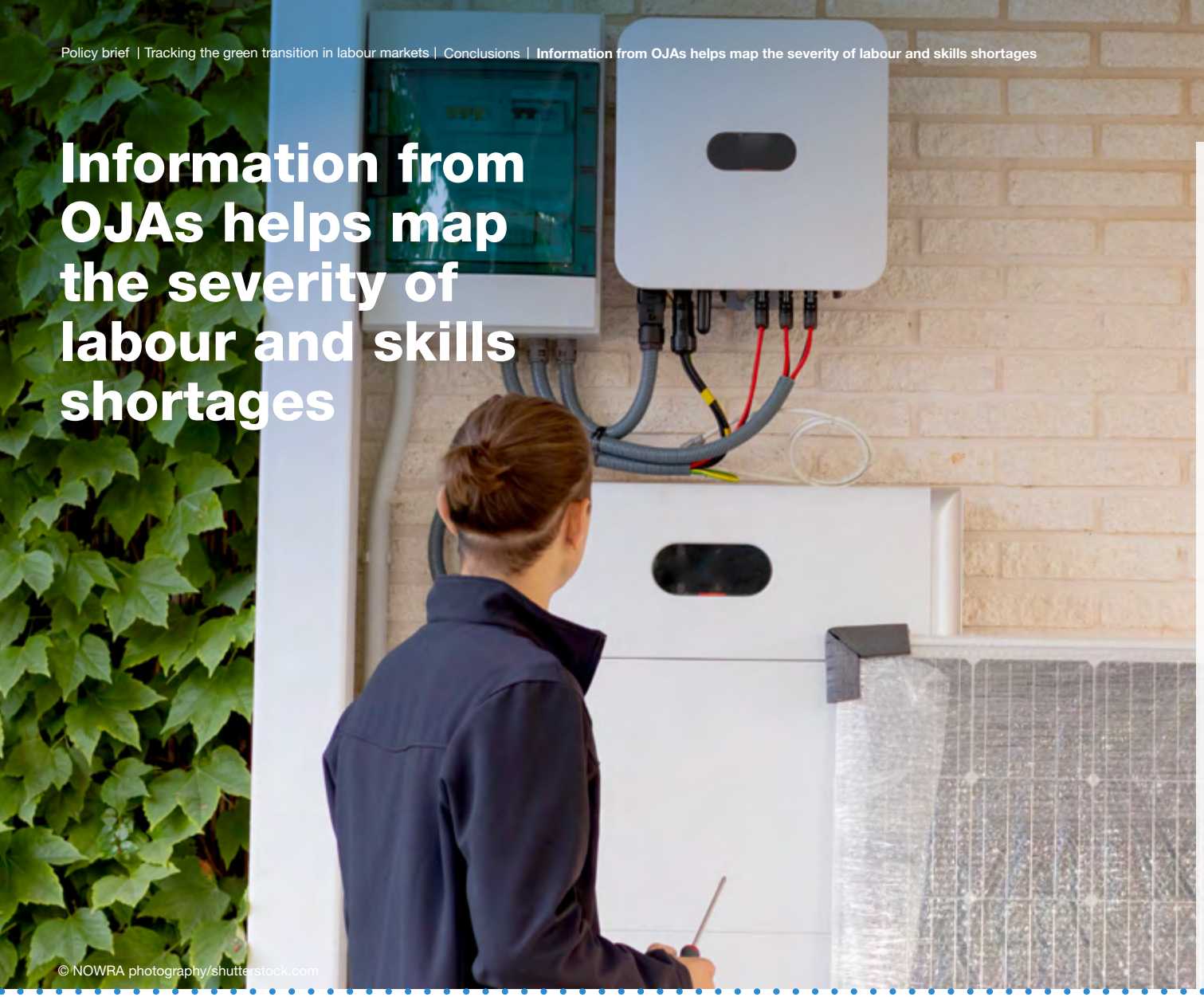
Alongside online CVs, course descriptions in the Qualification dataset register, National occupation and classification mapping tables and stakeholders' inputs, online job ads are used by the team developing the European multilingual classification of skills, competences and occupations (ESCO). OJAs have become crucial in updating occupation profiles, investigating the links between them, and tracking and updating the essential or non-essential skills jobs require. The Cedefop emerging skills detection tool will feed the ESCO team with regular updates, which can be leveraged to keep the classification up to date as greening and digitalisation progresses. Cedefop is also exploring the skills data in OJAs to analyse occupations for which the job title cannot be classified (i.e. which end up as 'not elsewhere classified'). Such information supports ISCO updates led by the International Labour Organization (ILO).

...**OJA-based analysis of occupations and in-demand skills** shows to what extent and how **emerging occupations differ from existing ones**...

...**OJAs** have become crucial in **updating occupation profiles and tracking and updating the skills they require**...

...**Cedefop OJA work helps** keep classifications up to date as **greening and digitalisation progresses**...

Information from OJAs helps map the severity of labour and skills shortages



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While demand-side information alone is not sufficient to grasp labour and skills shortages fully, understanding the structure of unmet demand (e.g. average duration of online job ads posted), gives an impression of the severity of shortage problems. Employers that struggle to fill jobs for some profiles will advertise them longer than they do for profiles where supply can readily meet demand.

In many countries employers who struggle to find staff on the national labour market are formally obliged to perform a so-called 'Labour market needs test' before starting recruitment efforts for workers from outside of the EU27 (EMN, 2021). The employer must advertise the job vacancy (e.g. in Ireland for 28 days) using the portal of the public employment services (PES). PES is obliged to pass information about such vacancies to the European Employment Services (EURES), which supports the free movement of workers in the EU. Most of activities provided by national and regional PES are now digitalised and the EURES portal presents the vacancies online. Feeding these EURES vacancies into the WIH-OJA system facilitates identifying bottleneck occupations and skills and improves prospects for addressing them so that they do not become obstacles in the green and digital transition.

...**demand-side** information alone is **not sufficient** to grasp **labour and skills shortages** fully, but gives an impression...

...the **posting duration** of OJAs signals **shortages** because **employers** facing them **advertise jobs longer**...

...feeding **EURES vacancies** into the **WIH-OJA system** facilitates identifying bottleneck occupations and skills...

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POLICY BRIEF

Tracking the green transition in labour markets:

using big data to identify the skills that make jobs greener

While crucial for policy-making and implementation, monitoring labour market trends and skills needs in the green transition can be challenging. Conventional data sources lack granularity and regional detail and are often not suitable for capturing emerging green transition skills and job profiles. This policy brief demonstrates the potential of using big data analysis of online job advertisements in the context of green transition. It presents illustrative examples of the impact of greening in sectors and occupations, and showcases how big data can be leveraged to facilitate the transition.

Project info: Skills intelligence
Project contacts: Cedefop expert, Joanna Napierala
Cedefop expert, Vladimir Kvetan
Cedefop expert, Jasper van Loo

CEDEFOP | European Centre for the Development of Vocational Training

Europe 123, Thessaloniki (Pylea), GREECE
Postal address: Cedefop service post, 57001 Thermi, GREECE
Tel. +30 2310490111, Fax +30 2310490020, Email: info@cedefop.europa.eu

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