International Labour Organization

ILO brief

Research Brief

November 2025

Measuring the Greenness of Jobs in Emerging Economies: A Big Data Text Analysis Approach[1]

Isaure Delaporte[2], Verónica Escudero[2], Willian Adamczyk[2]

Key points

- This brief presents a **novel methodology** that combines big data, natural language processing (NLP), and a refined ILO green dictionary (472 terms across nine environmental sustainability domains) to identify green tasks and measure the greenness of jobs.
- Applied to vacancy data, the method produces **country-specific and time-varying measures of green-task intensity**, with demonstrated feasibility in four middle-income economies where traditional labour market data are limited.
- Findings show that **green vacancies, which have a relatively higher green task intensity, demand a broad mix of competencies**—both core and technical skills, across cognitive, socio-emotional and manual domains, as well as green-specific skills.
- In some contexts, green vacancies are associated with **better wages and desirable working characteristics**, though benefits are **uneven across countries and occupations.**
- The approach provides a **practical tool to fill evidence gaps** and inform inclusive skills and labour market policies that align sustainability with decent work.

Introduction

The transition to a greener economy is reshaping industries and labour markets worldwide, creating new types of jobs and transforming existing ones. Green jobs—defined by the ILO as decent jobs that contribute to preserving or restoring the environment—play a central role in advancing sustainable development (ILO 2013; UNEP, ILO, IOE, et al. 2008; ILO 2016; 2023a). Yet, despite their growing importance, persistent challenges remain when it comes to defining and measuring green jobs. The boundaries between green and non-green jobs are often blurred, as many occupations integrate environmentally relevant tasks without being exclusively green (Bowen and Kuralbayeva 2015). Reliable identification is particularly difficult in low- and middle-income countries, where labour market information systems are not fully established and/or face resource constraints, and standardised statistics such as labour force surveys or administrative records rarely capture environmental dimensions of work and often lack data on decent work dimensions (ILO 2011).

Equipping workers with the skills needed for this transformation is essential to ensure that the green

[1] We are grateful to all participants of the green working group at the ILO and in particular to Hae Kyeung Chun, Marek Harsdorff, Takaaki Kizu, Hannah Liepmann, Valentina Stoevska and Olga Strietska-Ilina for contributions and constructive feedback, which greatly improved the green dictionary.

[2] Skills, Active Labour Market Policies and Policy Evaluation Team at the Research Department of the ILO.

transition is both just and sustainable (ILO 2011; 2018; 2023b). Evidence shows that environmental transformations are already shifting skill requirements: green jobs tend to demand higher levels of cognitive and technical skills, formal education, and cross-cutting competencies such as collaboration and adaptability (Consoli, Marin, Marzucchi, et al. 2016; Marin and Vona 2019; Borgonovi, Lanzi, Seitz, et al. 2023). However, important gaps in evidence remain—particularly regarding regional disparities, job quality, and how to ensure just transitions for all workers (Bulmer, Pela, Eberhard-Ruiz, et al. 2021; Hamilton, Song, Cui, et al. 2022).

Addressing these gaps requires improved measurement of both *green skills*—specific competencies directly linked to environmental sustainability—and the broader set of *skills for green jobs*, which include cognitive, socio-emotional and manual skills needed to adapt to new technologies and processes (ILO 2011; 2015; Escudero, Liepmann, and Podjanin 2024; Adamczyk, Boehmer, Delaporte, et al. 2025). Yet, no universally accepted measurement standard exists, despite efforts ranging from the ILO's Skills for a Greener Future report (ILO 2019) to tagging green tasks in occupational classifications such as O*NET in the United States.

Recent advances in big data and natural language processing (NLP) offer promising new tools to fill this gap. By analysing online job vacancies, applicants' résumés, and other digital labour market data, NLP methods can detect green tasks using keyword dictionaries. Building on the work of Granata and Posadas (2024), this brief introduces a refined ILO green dictionary that groups environmentally relevant terms into nine environmental sustainability domains. This approach applied to vacancy data provides dynamic, country-specific and time-varying measures of green tasks intensity, enabling systematic classification of green jobs, green occupations, and the identification of demand-supply mismatches (see Chapter 4 of the 2026 ILO Flagship report on Lifelong Learning and the Skills of the Future).

Understanding these dynamics is critical for designing skills and lifelong learning policies that ensure workers and enterprises are equipped to thrive in more sustainable economies. By generating evidence on the prevalence of green tasks within various roles, their sectoral and occupational patterns, and their relationship to wages and job quality, this brief contributes to strengthening the foundations for an inclusive green transition.

The next section presents the methodology, with three subsections detailing the taxonomy of the ILO green dictionary, the implementation of the dictionary on vacancy data, and the identification of green vacancies and green occupations. The brief then turns to applications and findings, focusing on two dimensions: first, a comparison of the skills profiles of green and non-green vacancies, and second, an analysis of wages and working characteristics associated with green vacancies in selected countries.

▶ Methodology

Taxonomy

The methodology is centred on identifying and classifying green tasks that are essential for advancing sustainable development and environmental resilience. In particular, we adopt a narrower and operational definition aligned with a task-based approach. While green skills refer to the broader concept, our measurement is more closely aligned with skills required to perform green tasks.

To achieve this, an ILO green dictionary—a structured compilation of environmentally relevant terms—was developed and designed for text analysis that can be applied across diverse labour market datasets. While these keywords are not full task statements, their presence in job ads serves as a proxy for green tasks. Their identification in job descriptions suggests that the associated jobs require the skills to perform those green tasks (i.e. green skills). This pragmatic approach, commonly used today in the green-task related literature, aligns with how green skill trends are often tracked in vacancy data (Granata and Posadas 2024; Vona, Marin, Consoli, et al. 2018).

Our approach builds on but goes beyond the green dictionary developed by Granata and Posadas (2024). Their dictionary is based on a review of over 70 papers and reports in labour and environmental economics, contained 308 green terms (called narrow dictionary) and an additional 347 potentially green terms (called broad dictionary) spread across 14 categories. We adopted the narrow version of their dictionary, expanded the list further, reorganized the taxonomy into nine categories, and broadened coverage by integrating new sources and refining classification practices.

Specifically, our dictionary includes words, expressions, and full terms directly associated with environmentally sustainable concepts. To expand and update the scope of the dictionary, we incorporated terminology from major international references, including UNEP's *State of Finance for Nature* (2023), the joint ILO–IUCN *Decent Work in Nature-based Solutions* (2024), and the UN Climate Technology Centre and Network *CTCN Technology Taxonomy* (2017). These sources ensure that the dictionary reflects current global priorities and emerging trends in sustainability.

To validate and refine the dictionary, we engaged in consultations with ILO specialists in just transition towards environmental sustainability, skills and labour market analysis. This collaborative review helped ensure relevance, remove redundancies, and strengthen classifications. The final dictionary includes 472 keywords organized into nine distinct domains—for example, *alternative energy systems* (e.g. "renewable energy", "solar power", "green hydrogen"), *energy efficiency and consumption* (e.g. "energy audit", "insulation", "smart grid"), and *sustainable building and construction* (e.g. "green building", "sustainable materials", "urban greening"). These domains provide a structured framework for capturing the presence and intensity of green tasks in labour market data (see Table 1 for the list of domains and Table A.1 in the appendix for the complete list of keywords).

The dictionary was also translated into Spanish, Portuguese, and Russian to enable multilingual applications. In each language, exception lists were carefully designed to avoid false positives where terms could be misinterpreted as green. A systematic context check was carried out for twenty potentially ambiguous words, retaining only those used correctly in at least 75 per cent of cases.

A final methodological difference with Granata and Posadas (2024) lies in implementation. While their approach relied on word roots and partial matches, our dictionary uses full words combined with lemmatization techniques to capture word variations while minimizing noise. This improves precision and reduces the risk of spurious matches when analysing large-scale text data.

Implementation

Having established the green taxonomy, the next step is to apply it to labour market data. The green dictionary was applied to online job vacancy data for four countries—Brazil, the Russian Federation, South Africa, and Uruguay (see Box 1). These countries were selected because representative vacancy data were available and, as middle-income economies, they provide valuable insights into contexts where evidence on green jobs and skills remains limited.

▶ Box 1. Data sources

- **Uruguay and Brazil:** Data were drawn from BuscoJobs, a private job-search platform, covering job vacancies (2010-2023) and applicants' job spells over the same period.
- **Russian Federation and South Africa:** Data were obtained from Adzuna, a job aggregator. For both the Russian Federation and South Africa, the datasets span April 2016–December 2021.

Both the dictionary and the open-text content of vacancies were pre-processed to ensure compatibility, following the methodology used to generate skills variables (see Adamczyk, Boehmer, Delaporte, et al. 2025), with specific adaptations for green tasks.

The pre-processing pipeline consisted of several steps:

1. Tokenization: segmenting text into words and components.
2. Normalization: converting all text to lowercase and removing special characters.
3. Stopword removal: eliminating common, non-informative words while retaining relevant dictionary terms in each language.
4. Lemmatization: reducing words to their root forms to standardize variation (e.g. *installing* → *install*).

After pre-processing, a rule-based NLP classification method was applied. Dictionary terms were systematically matched to the text of job advertisements. The algorithm then counted the frequency of each green task occurrence, aggregated them into broader subcategories, and converted them into binary indicators: a value of one was assigned if at least one relevant term from a subcategory appeared in a job posting, and zero if not.

This methodology, which relies on NLP was first developed to create broader skills categories such as cognitive, socio-emotional and manual skills in the Uruguayan context in Escudero, Liepmann, and Podjanin (2024) and later refined and extended to additional countries (Adamczyk, Boehmer, Delaporte, et al. 2025. A key advantage of this methodology is its adaptability: it can be applied across diverse country contexts without assuming that occupational task structures are uniform across countries or static over time. By accounting for cross-country and temporal variation, the approach delivers a granular understanding of labour market dynamics, supporting national and regional policy design for an inclusive green transition.

Measuring the greenness of jobs

With the green tasks' variables constructed, the analysis then moves from identifying tasks and skills to classifying vacancies. At this stage, the green dictionary is complemented with the ILO skills dictionary to capture the broader set of competencies required in each vacancy (see Escudero, Liepmann, and Podjanin 2024; Adamczyk, Boehmer, Delaporte, et al. 2025). The green dictionary captures environmentally relevant tasks, while the skills dictionary provides a comprehensive classification of cognitive, socio-emotional, and manual skills. Combining the two makes it possible to measure both the presence of green tasks and the broader skillsets required in each vacancy.

We can then proceed to calculate for each vacancy the share of green tasks relative to all required skills and tasks. Based on this share, vacancies can be classified into three categories:

1. **Non-green vacancies**: vacancies for which the share is equal to 0 (no mention of green tasks), encompassing both neutral and brown jobs.
2. **Lighter green vacancies**: vacancies with a positive share of green tasks among all skills and tasks but below the mean for all green vacancies.
3. **Darker green vacancies**: vacancies with a share of green tasks among all skills and tasks equal to or above the mean for all green vacancies.

Table A.2 in the appendix provides a few examples of vacancy descriptions classified as green, illustrating how the criteria are applied.

The methodology also makes it possible to classify ISCO-08 two-digit occupations by their degree of greenness. For each occupation, the greenness score is calculated by summing all green tasks identified in vacancies belonging to that occupation and dividing this by the total number of tasks and skills listed across those vacancies. Based on this share, occupations are grouped into quintiles: those in the lowest quintile are considered non-green, those in the highest quintile are classified as darker green, and the remaining three quintiles are categorized as lighter green. The resulting ratio captures the relative intensity of green content in each occupation.

While our methodology provides a detailed view of the greenness of jobs, it is important to acknowledge certain limitations inherent to big data approaches. Online job postings may not always reflect the complete set of skills and tasks associated with a given job, as some are assumed or taken for granted and therefore not explicitly mentioned. This can lead to an underreporting of green tasks or overall skills.

Moreover, online vacancies do not represent the entire labour market, as they tend to be more concentrated in certain sectors and occupations. To address this issue and broaden coverage, in a separate research exercise we apply the ILO green dictionary directly to occupational task descriptions from the ISCO-08 manual. Here, the share of green tasks is computed for each ISCO-08 four-digit occupation, which can then be aggregated at the two-digit level and grouped into quintiles to distinguish non-green, lighter green, and darker green occupations. The details of this exercise are presented in Adamczyk, Delaporte, Escudero, and Liepmann (forthcoming).

Applying the task-based approach to both online vacancies and ISCO-08 occupational descriptions yields broadly consistent classifications of green occupations. Each approach, however, serves different research purposes. Using occupational descriptions allows the greenness classification to be linked to LFS data, ensuring broader representativity across sectors and occupations, and a methodology that is applicable worldwide and comparable across countries' labour markets. By contrast, classifying job vacancies directly by their level of greenness exploits the granularity and temporal variation of online data, enabling analysis of country-specific dynamics, providing real-time insight into how green skill demand evolves. Furthermore, vacancy data allow us to track changes in green task content within occupations over time—an essential feature for analysing how related skills evolve in dynamic labour markets. The broad complementarity between both methods offers reassurance regarding the robustness and representativeness of the ILO approach based on online vacancy data.

Building on the vacancy-based framework, the following section presents comparative evidence across countries, occupations, and job attributes examining green and non-green vacancies.

▶ Table 1: The ILO green dictionary: terms, definitions and sources by sustainability domain

Sustainability Domain	Definition	Sources
Alternative Energy Systems	Alternative Energy Systems emphasizes the generation of sustainable energy from various natural sources, focusing on technologies and resources that reduce dependence on fossil fuels. Alternative energies include renewable sources but allows for the inclusion of non-renewable sources that are low carbon, such as nuclear power.[3]	Janser (2018); Granata and Posadas (2024); Stang and Jones (2011); Stoevska and Hunter (2012); CTCN (2017)
Energy Efficiency and Consumption	Energy Efficiency and Consumption focuses on optimizing energy usage, reducing waste, and improving the overall sustainability of energy consumption. This category includes various technologies, practices, and strategies designed to minimize energy use while maintaining or enhancing performance across different sectors. Efficiency is crucial for reducing global energy demand, minimizing carbon emissions, and achieving sustainability goals.	Janser (2018); Granata and Posadas (2024); Stang and Jones (2011); Stoevska and Hunter (2012)
Sustainable Building and Construction	Sustainable Building and Construction focuses on creating and promoting structures that minimize environmental impact through the use of eco-friendly materials and energy-efficient designs.	Janser (2018); Granata and Posadas (2024); ILO-IUCN (2024); CTCN (2017)
Emissions, Pollution, and Sustainable Transportation	Emissions, Pollution, and Sustainable Transportation focuses on the reduction of harmful environmental impacts through improved air quality, waste management, and the adoption of low-emission transportation technologies.	Janser (2018); Granata and Posadas (2024); Stang and Jones (2011); Stoevska and Hunter (2012)
Recycling and Waste Management	Recycling and Waste Management focuses on strategies and technologies that minimize waste, extend product lifecycles, and promote the sustainable use of resources. It plays a crucial role in the circular economy, reducing environmental impact by reusing materials and diverting waste from landfills.	Janser (2018); Granata and Posadas (2024); Stang and Jones (2011); Stoevska and Hunter (2012); ILO-IUCN (2024)
Sustainable Agriculture, Forestry, and Food Production	Sustainable Agriculture, Forestry, and Food Production focuses on practices that promote the long-term health of ecosystems while meeting human needs for food and timber. It emphasizes methods that protect natural resources, enhance biodiversity, and minimize environmental impact.	Granata and Posadas (2024); UNEP (2023); CTCN (2017)
Natural Resource Conservation	Natural Resource Conservation focuses on the responsible management, protection, and restoration of ecosystems, ensuring the sustainable use of natural resources while preserving biodiversity and mitigating environmental risks. It encompasses strategies to minimize human impact, promote resilient landscapes, and safeguard water, land, and wildlife.	Granata and Posadas (2024); Stoevska and Hunter (2012);UNEP (2023); ILO-IUCN (2024)
Environmental Awareness	Environmental Awareness focuses on fostering knowledge, education, and engagement in sustainability issues, empowering individuals and communities to take action toward a healthier planet. It plays a key role in promoting environmental responsibility, sustainable behaviours, and informed decision-making.	Granata and Posadas (2024)
Environmental Certifications and Compliance	Environmental Certifications and Compliance represents the frameworks, standards, and regulations that ensure businesses, organizations, and industries adhere to environmental protection principles, sustainability goals, and legal requirements.	Granata and Posadas (2024); Janser (2018); Stoevska and Hunter (2012)

Notes: The table presents the categorisation of terms included in the ILO green dictionary, grouped by sustainability domain and accompanied by definitions and key references.
Source: Authors' elaboration.

▶ Applications and findings

The analysis now moves beyond identifying which vacancies are green to examining how they differ from non-green vacancies in terms of skills, wages, and working attributes. The findings shed light not only on the complexity of skill requirements but also on the extent to which green vacancies may offer different labour market opportunities, both in terms of wages and broader non-wage job attributes.

[3] Following ILO terminology, nuclear energy is considered low-carbon but not renewable, while nuclear fusion is considered renewable. Accordingly, in the ILO green dictionary, the nuclear-related terms *nuclear energy*, *nuclear fuel*, *nuclear power* and *nuclear fusion* are categorised under "alternative energy systems" and marked separately (in orange) to reflect this distinction. This approach ensures clarity in terminology without implying endorsement or exclusion of specific technologies.

Comparing skills profiles

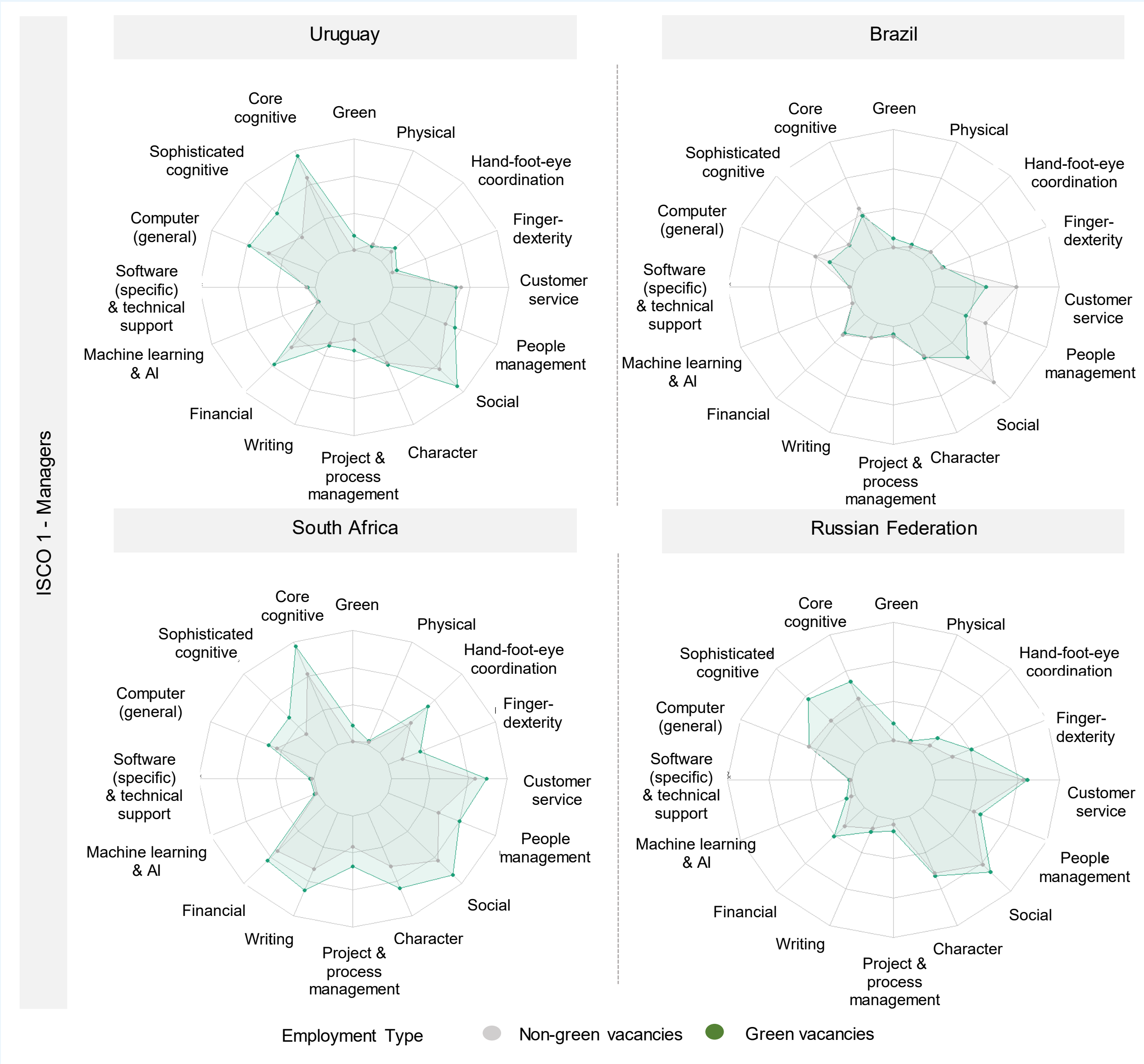
Green vacancies are defined by the presence of at least one green task, but they also demand a broader set of skills that go beyond environmental awareness and technical know-how. These broader set of *skills for green jobs* include, in addition to green-specific skills, both core and technical skills, across cognitive, socio-emotional, and manual domains that support adaptability to new technologies and processes. Using the comprehensive skills framework (Escudero, Liepmann, and Podjanin 2024; Adamczyk, Boehmer, Delaporte, et al. 2025), we examine how these broader skill sets manifest in green vacancies compared to non-green ones.

In the existing literature, the evidence, primarily from high-income countries, shows that green jobs tend to require more complex skills than non-green jobs. They are more intensive in analytical, technical, and abstract skills (Vona, Marin, Consoli, et al. 2018), associated with higher education and training requirements (Consoli, Marin, Marzucchi, et al. 2016), although some research suggests that transitions to green jobs may only require targeted upskilling (Bowen and Kuralbayeva 2015). Much less is known, however, about these dynamics in low- and middle-income countries.

Our analysis provides new evidence from four middle-income economies by comparing skill requirements within occupations, thereby controlling for the large variation in skills across occupational groups. Two ISCO-08 categories at the 1-digit level are analysed in depth: Managers (ISCO 1) and Elementary Occupations (ISCO 9). The results in Figures 1 and 2 highlight clear patterns:

- Among managers, green vacancies in the Russian Federation, Uruguay, and South Africa require more advanced cognitive skills, computer literacy, project and financial management, and socio-emotional skills related to teamwork and people management. Differences between green and non-green vacancies in management roles are most pronounced in South Africa, while in Brazil the gap is minimal or even reversed for certain skills.
- Among elementary occupations, green vacancies also tend to require broader skillsets, although the difference in skillsets with non-green vacancies are less pronounced. In South Africa, they demand higher levels of core cognitive and physical skills while in the Russian Federation, finger dexterity and customer service skills stand out. In Brazil, however, non-green vacancies in elementary occupations show slightly higher skill requirements.

▶ Figure 1. Skill profiles for green vs non-green vacancies in ISCO occupational group 1, by country



Notes: The further a marker is from the centre, the more important is a given skill. The outermost ring corresponds to 90 per cent of vacancies mentioning a skill.
Source: Vacancy data from BuscoJobs for Uruguay (2010-2023) and Brazil (2010-2023), and Adzuna for South Africa (2016-2021) and the Russian Federation (2016-2021).

▶ Figure 2. Skill profiles for green vs non-green vacancies in ISCO occupational group 9, by country

Notes: The further a marker is from the centre, the more important is a given skill. The outermost ring corresponds to 90 per cent of vacancies mentioning a skill.
Source: Vacancy data from BuscoJobs for Uruguay (2010-2023) and Brazil (2010-2023), and Adzuna for South Africa (2016-2021) and the Russian Federation (2016-2021).

Wages and working characteristics

Green vacancies not only differ in skills but also in employment conditions. Using online vacancy data for Uruguay, South Africa, and the Russian Federation, we compare posted wages for three occupational groups (ISCO 1, 7, and 9). The results reported in Figure 3 can be summarised as follows:

- For managers (ISCO 1), green vacancies command a wage premium in all three countries, which is larger in Uruguay and the Russian Federation.
- For craft and related trades (ISCO 7), a premium appears only in the Russian Federation, while Uruguay shows higher wages for non-green vacancies and South Africa shows no difference.

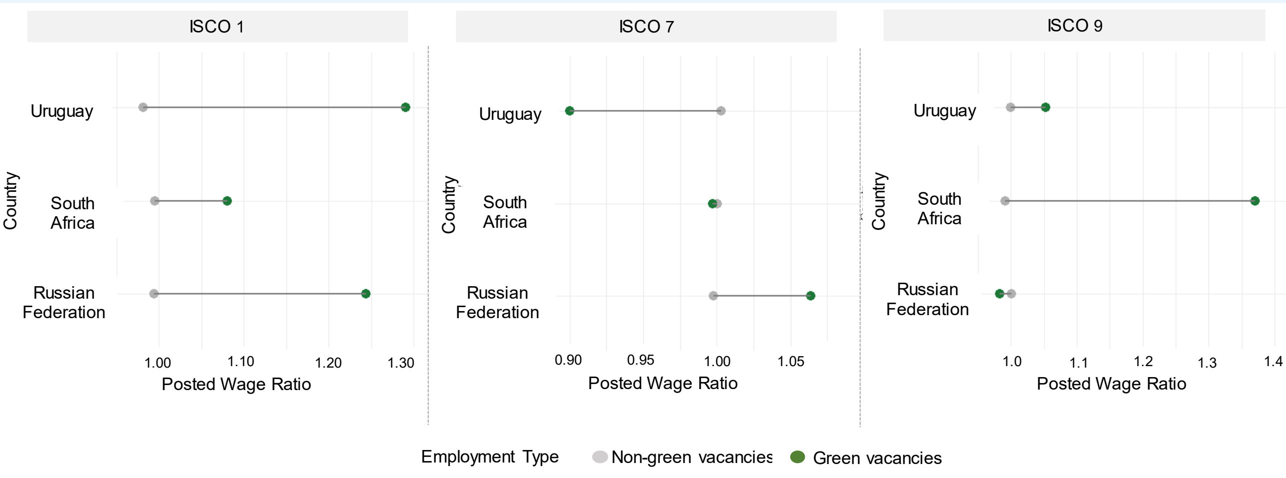
- For elementary occupations (ISCO 9), South Africa stands out: green vacancies are associated with significantly higher wages, while Uruguay and the Russian Federation show little difference.

Overall, wage premiums for green vacancies are most evident in higher-skilled occupations, while patterns are far more mixed for mid- and lower-skilled roles—highlighting that the benefits of higher greenness depend heavily on both occupation and country context.

Beyond wages, we also examine non-wage job attributes using the taxonomy and methodology developed by Adamczyk, Delaporte, and Escudero (2025). The results presented in Figure 4 show that opportunities for career development is the most frequently advertised job attribute in green vacancies across countries and occupational groups. Other recurring attributes include teamwork, positive work environment, and societal impact, particularly in managerial positions. By contrast, labour rights, social protection benefits and other job attributes such as bonuses, overtime pay, job security, or schedule flexibility are mentioned far less often.

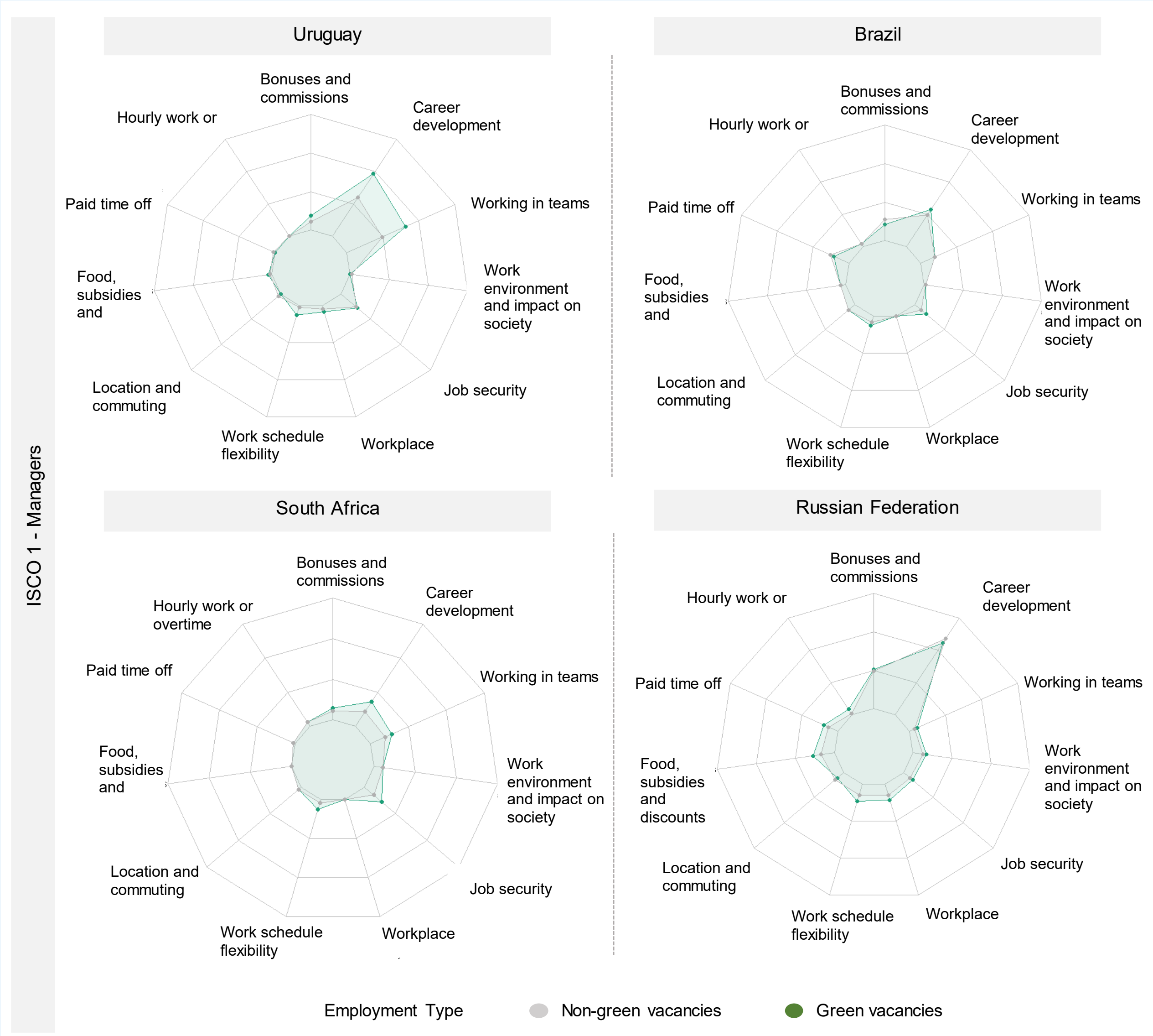
The greater prevalence of desirable job attributes in green vacancies may reflect several factors identified in the literature. OECD and Cedefop (2014) associate it to the higher demand for skilled workers in low-carbon industries—such as managers, engineers, and technicians—where these competencies are associated to improved job quality, career security, health, and work–life balance. Green firms, often innovative and technology-driven, also tend to have more progressive management practices attentive to job quality. Similar patterns appear elsewhere: in Colombia, green jobs are less likely to be informal (OECD 2023); in Argentina, they concentrate in knowledge-intensive, higher-productivity sectors, offering better wages and opportunities (Ernst et al. 2019); and in the United States, they require higher skill levels, education, and training than non-green jobs (Consoli, Marin, Marzucchi, et al. 2016).

▶ **Figure 3. Posted wage ratios for green vs non-green vacancies in ISCO occupational groups 1, 7 and 9, Uruguay, South Africa, and the Russian Federation**



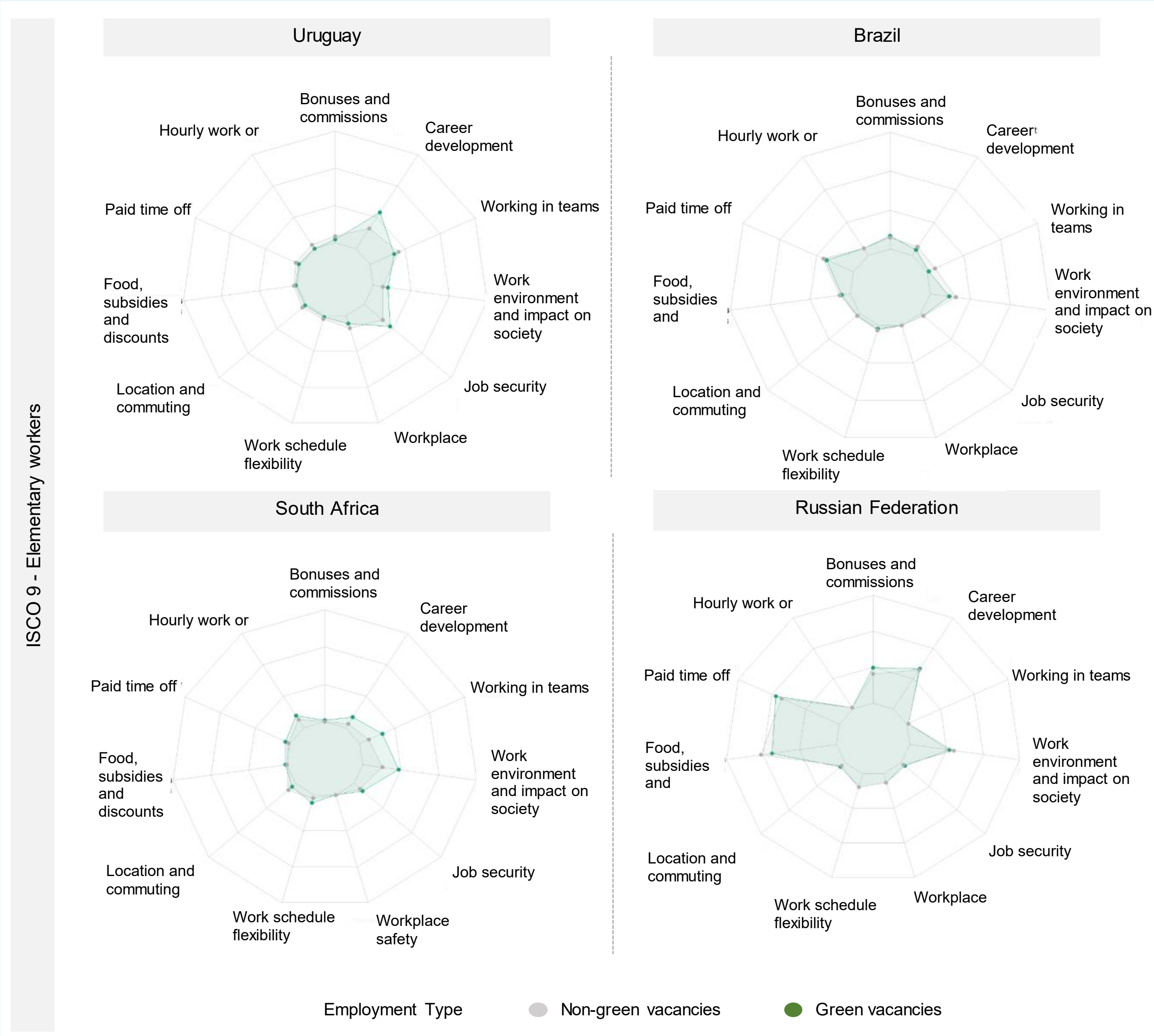
Notes: This graph displays the posted wage ratios for non-green vacancies (grey points) and green vacancies (green points) across selected countries. These are defined as the average posted wage for non-green (or green) vacancies divided by the average for all vacancies within each country–occupation cell. The horizontal lines connect the two types within each country, showing the relative wage differences. These are reported separately for three occupational groups (ISCO 1 – Managers, ISCO 7 – Craft and related trades and ISCO 9 – Elementary occupations).
Source: The analysis uses vacancy data from BuscoJobs for Uruguay (2010-2023), and Adzuna for South Africa (2016-2021) and the Russian Federation (2016-2021). Brazil was left out of the analysis due to insufficient information on posted wages.

▶ Figure 4. Prevalence of non-wage job attributes for green vs non-green vacancies in ISCO occupational group 1, by country



Notes: The further a marker is from the centre, the more important is a given attribute. The outermost ring corresponds to 70 per cent of vacancies mentioning a job attribute.
Source: Vacancy data from BuscoJobs for Uruguay (2010-2023) and Brazil (2010-2023), and Adzuna for South Africa (2016-2021) and the Russian Federation (2016-2021).

Figure 5. Prevalence of non-wage job attributes for green vs non-green vacancies in ISCO occupational group 9, by country



Notes: The further a marker is from the centre, the more important is a given attribute. The outermost ring corresponds to 70 per cent of vacancies mentioning a job attribute.
Source: Vacancy data from BuscoJobs for Uruguay (2010-2023) and Brazil (2010-2023), and Adzuna for South Africa (2016-2021) and the Russian Federation (2016-2021).

Conclusions

Taken together, these findings show that the green transition is reshaping both skill demands and job characteristics. Green vacancies in both managerial and elementary occupations typically require a broader mix of competencies than non-green vacancies—including core and technical skills, across cognitive, socio-emotional and manual domains as well as green-specific requirements—and in some contexts they are associated with better wages and more desirable employment characteristics. However, these advantages are not uniform across countries or occupations: in some settings, non-green vacancies offer comparable or even better wages. Furthermore, some countries still exhibit relatively low shares of green vacancies.

Beyond these substantive insights, the brief also demonstrates the value of combining big data analysis with carefully designed taxonomies. By applying the ILO green dictionary alongside the ILO broader skills classification, we show how vacancy data can be transformed into actionable indicators of green skills and jobs. This methodological innovation allows systematic, comparable measurement across countries and over time, filling critical evidence gaps—particularly in middle-income economies where evidence on the topic is limited.

The implications are twofold. First, the approach enables policymakers and researchers to track the evolution of green skills demand and job characteristics with greater precision, providing an empirical basis for skills anticipation and lifelong learning strategies. Second, the findings underscore the importance of targeted, comprehensive and inclusive skills policies. Preparing workers for green roles requires not only investments in green-specific competencies but also in versatile, transferable competencies that allow workers to adapt to changing demands. Ensuring that work in the green economy provides decent wages and working conditions is equally essential to prevent new labour market inequalities (or exacerbate already existing ones).

For low- and middle-income countries, these insights are particularly valuable. As the green transition advances, policies informed by robust, data-driven evidence will be crucial to ensure that environmental sustainability goes hand in hand with decent work and inclusive development.

▶ References

Adamczyk, Willian, Simon Boehmer, Isaure Delaporte, Verónica Escudero and Hannah Liepmann. 2025. "Developing a New Method to Uncover Skills Trends in Emerging Economies Using Online Data and NLP Techniques". ILO Methodological Brief. https://doi.org/10.54394/HQQX3200.

Adamczyk, Willian, Isaure Delaporte and Verónica Escudero. 2025. "Measuring Quality of Employment in Emerging Economies: A Methodology for Assessing Job Amenities Using Big Data". ILO Methodological Brief. https://doi.org/10.54394/YNLL0477.

Adamczyk, Willian, Isaure Delaporte, Verónica Escudero and Hannah Liepmann. Forthcoming. "Measuring Green Skills and Green Jobs: A Cross-Country Analysis Using Harmonized Labour Force Survey Microdata". ILO Research Brief.

Borgonovi, Francesca, Elisa Lanzi, Helke Seitz, Ruben Bibas, Jean Fouré, Hubert Plisiecki and Laura Atarody. 2023. "The Effects of the EU Fit for 55 Package on Labour Markets and the Demand for Skills". OECD Social, Employment and Migration Working Papers, No. 297. https://doi.org/10.1787/6c16baac-en.

Bowen, Alex and Karlygash Kuralbayeva. 2015. "Looking for Green Jobs: The Impact of Green Growth on Employment". GRI Policy Brief. Grantham Research Institute on Climate Change and the Environment. https://www.lse.ac.uk/granthaminstitute/publication/looking-for-green-jobs-the-impact-of-green-growth-on-employment/.

Bulmer, Elizabeth Ruppert, Kevwe Pela, Andreas Eberhard-Ruiz, and Jimena Montoya. 2021. "Global Perspective on Coal Jobs and Managing Labor Transition Out of Coal". https://www.worldbank.org/en/topic/extractiveindustries/publication/global-perspective-on-coal-jobs-and-managing-labor-transition-out-of-coal.

Consoli, Davide, Giovanni Marin, Alberto Marzucchi and Francesco Vona. 2016. "Do Green Jobs Differ from Non-Green Jobs in Terms of Skills and Human Capital?". *Research Policy* 45 (5): 1046–1060. https://doi.org/10.1016/j.respol.2016.02.007.

Ernst, Christoph, Ana Sofía Rojo Brizuela, and Daniele Epifanio. 2019. "Green Jobs in Argentina: Opportunities to Move Forward with the Environmental and Social Agenda". Economic Commission for Latin America and the Caribbean (ECLAC / CEPAL)..

Escudero, Verónica, Hannah Liepmann and Ana Podjanin. 2024. "Using Online Vacancy and Job Applicants' Data to Study Skills Dynamics". In *Big Data Applications in Labor Economics*, Part B, edited by Benjamin Elsner and Solomon W. Polachek, 35–99. Research in Labor Economics, vol. 52B.

https://doi.org/10.1108/S0147-91212024000052B023.

Granata, Julia, and Josefina Posadas. 2024. *Why Look at Tasks When Designing Skills Policy for the Green Transition? A Methodological Note on How to Identify Green Occupations and the Skills They Require*. World Bank Policy Research Working Paper No. 10753. http://documents.worldbank.org/curated/en/099507304172419760.

Hamilton, Caitlin, Jiawei Song, Ryna Cui, Colin Olson and Diyang Cui. 2022. "Evaluating Provincial-Level Employment Challenge during the Coal Transition in China". *Advances in Climate Change Research* 13 (5): 729–737. https://doi.org/10.1016/j.accre.2022.08.006.

ILO. 2013. "Guidelines Concerning a Statistical Definition of Employment in the Environmental Sector", *19th International Conference of Labour Statisticians*, Geneva, 2–11 Oct. (Geneva), Pp. 29–33.

———. 2015. *Anticipating Skill Needs for Green Jobs: A Practical Guide*. https://www.ilo.org/publications/anticipating-skill-needs-green-jobs-practical-guide.

———. 2016. "What Is a Green Job ?" https://www.ilo.org/resource/article/what-green-job.

———. 2018. *World Employment Social Outlook 2018: Greening with Jobs*. https://researchrepository.ilo.org/esploro/outputs/995218839002676.

———. 2019. *Skills for a Greener Future: A Global View*. https://researchrepository.ilo.org/esploro/outputs/995219302602676.

———. 2023a. Resolution concerning a just transition towards environmentally sustainable economies and societies for all. International Labour Conference. 111th Session. https://www.ilo.org/resource/ilc/111/resolution-concerning-just-transition-towards-environmentally-sustainable.

———. 2023b. *The ILO Strategy on Skills and Lifelong Learning 2030*. https://researchrepository.ilo.org/esploro/outputs/995319472602676.

Janser, Markus. 2018. *The Greening of Jobs in Germany*. IAB Discussion Paper 14/2018. https://doku.iab.de/discussionpapers/2018/dp1418.pdf

Marin, Giovanni, and Francesco Vona. 2019. "Climate Policies and Skill-Biased Employment Dynamics: Evidence from EU Countries". *Journal of Environmental Economics and Management* 98: 102253. https://doi.org/10.1016/j.jeem.2019.102253.

OECD. 2023. *Making Development Happen: Transición Verde y Formalización Laboral En Colombia*. Paris. https://www.oecd.org/content/dam/oecd/es/publications/reports/2023/01/transicion-verde-y-formalizacion-laboral-en-colombia_0cbba217/54d4ed8f-es.pdf

OECD and Cedefop. 2014. *Greener Skills and Jobs*. OECD Green Growth Studies. OECD. https://doi.org/10.1787/9789264208704-en.

Stang, Sharon, and Carrie K. Jones. 2011. *Counting Green Jobs: Developing the Green Technologies and Practices (GTP) Survey*. US Bureau of Labor Statistics Statistical Survey Paper. https://www.bls.gov/osmr/research-papers/2011/st110150.htm

Stoevska, Valentina, and David Hunter. 2012. *Proposals for the Statistical Definition and Measurement of Green Jobs*. https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40dgreports/%40stat/documents/meetingdocument/wcms_220734.pdf

Strietska-Ilina, Olga, Christine Hofmann, Mercedes Durán Haro and Shinyoung Jeon. 2011. *Skills for Green Jobs: A Global View – Synthesis Report Based on 21 Country Studies*. ILO. https://researchrepository.ilo.org/esploro/outputs/995341593402676.

UNEP. 2023. *State of Finance for Nature 2023*. UNEP. https://www.unep.org/resources/state-finance-nature-2023 .

UNEP, ILO, IOE and ITUC. 2008. *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World*. https://labordoc.ilo.org/permalink/41ILO_INST/j3q9on/alma994251803402676.

Vona, Francesco, Giovanni Marin, Davide Consoli and David Popp. 2018. "Environmental Regulation and Green Skills: An Empirical Exploration". *Journal of the Association of Environmental and Resource Economists* 5 (4): 713–753. https://doi.org/10.1086/698859.

▶ Appendix

▶ Table A.1: The ILO green dictionary: selected keywords and expressions by sustainability domain

Label	Sustainability domain	Selected keywords/expressions
G01	Alternative Energy Systems	Alternative energy, alternate fuel, biodiesel, bioenergy, biofuel, biological fuel, biogas, biomass, biodigester, clean energy, clean technologies, desalination, electrolysis, efuel, electrofuel, ekerosene, emethane, ethanol, ethanol emissions, ethanol footprint, ethanol management, ethanol offset, ethanol reduction, fuel cell, geothermal, green energy, hybrid power, hydroelectric, hydrogeology, hydropower, green hydrogen, blue hydrogen, hydrogen fuel, nuclear energy, nuclear fuel, nuclear power, nuclear fusion, photovoltaic, pv, renewable energy, renewable source, solar, solar energy, solar photovoltaic, solar thermal, solar power, solar panels, solar water, solar heating, ocean power, ocean energy, marine power, marine energy, tidal power, tidal energy, offshore power, offshore energy, offshore wind, osmotic power, osmotic energy, waste energy, wind assessment, wind energy, wind farm, wind field, wind operation, wind power, wind project, wind system, wind technology, wind turbine, windmill
G02	Energy Efficiency and Consumption	Cogeneration, detect hot spots, efficiency heat, improve heat, efficiency light, efficiency retrofitting, efficient heat, efficient light, energy advise, energy audit, energy conservation, energy label, energy efficiency, energy efficient, improve energy, energy loss, energy management, energy reduction, energy saving, equipment effectiveness, equipment efficiency, fuel economy, fuel efficiency, insulation, climate proofing, lean manufacturing, led bulb, led light, li ion, lithium, lithium ion battery, solid state battery, sulfur battery, sodium battery, zinc battery, material efficiency, minimize energy, minimize electric energy, passive house, programmable thermostat, reduce energy, reduce electricity, saving energy, smart grid, smart home, smart power grid, energy grid integration, renewable grid integration, use efficiency, weatherization, energy storage, measure energy use, power storage, pressure losses
G03	Sustainable Building and Construction	Green building, net zero building, low carbon building, zero energy building, green cement, low carbon cement, low carbon construction, green steel, sustainable architecture, sustainable design, sustainable materials, compressed earth blocks, urban greening, green infrastructure, nature based infrastructure, sustainable infrastructure, natural infrastructure, smart building, sustainable construction, ecofriendly construction, green urban planning
G04	Emissions, Pollution, and Sustainable Transportation	Air emissions, air quality, air sampling, blower door, brownfield, capture use gases, carbon capture, carbon credit, carbon dioxide, carbon emissions, carbon footprint, carbon offset, carbon output, carbon reduction, carbon sequestration, carbon disclosure, carbon tax, carbon market, carbon pricing, carbon standard, carbon reporting, carbon inventory, cbam, carbon border, carbon neutral, ipcc guidelines, ipcc inventory, clean spills, contaminate, contaminants, decontaminate, decontaminants, contaminated site, decarbon, deodorize water, dust dispersion, emissions analysis, emission control, emission reduction, emissions control, emissions inspection, emissions monitoring, emissions reduction, emissions standards, emissions trade, net zero asset, net zero emissions, vehicle emissions, emissions testing, ghg, greenhouse gas, greenhouse effect, groundwater protection, harmful emission, hazard analysis, hazardous substances, hazardous waste, hazmat, hazwoper, hazardous waste operations emergency response, highway barrier, landfill gas, monitor landfill, gas landfill, leachate, low carbon, measure emission, methane, methane emissions, methane footprint, methane management, methane offset, methane reduction, noise control, noise dead, noise protection, odour control, ozone, pollution, radioactive containment, radioactive waste, reduce carbon, reduce toxic, sewage, soil erosion, soil protection, soil quality, soil sampling, soil test, soil report, test air, testing air, testing water, tests soils, toxic waste, vibration control, waste clean, waste water, wastewater, water quality, water sample, water testing, water treatment, bicycle, bike, eco mobility, ecomobility, electric car, electric drive, electric aviation, electric flying, electromobility, hybrid vehicle, hybrid electric, hybrid car, new energy vehicle, hydrogen aviation, hydrogen propulsion, maximize vehicle use, electric vehicles, transportation efficiency, sustainable aviation
G05	Recycling and Waste Management	Biodegradable, biodegradation, circular economy, greening economy, composting, durability, litter control, recycling, recycle, recyclable, reclaim steel, refrigerant reclaiming, reduce waste, remanufacturing, renewable material, renewable resource, reuse, waste management, waste reduction, waste treatment, ewaste, plastic removal, plastic footprint, plastic reuse, plastic cleanup, reduce plastic, reduce microplastic, microplastic cleanup, microplastic removal, collect waste, garbage collection, refuse collection, solid waste, hazardous waste, nonhazardous waste, waste recovery, waste grinding, waste shredding, waste crushing, demolition waste, treatment disposal, toxic disposal, compost production, nuclear waste, waste encapsulation, recovery materials, recovery waste, secondary raw material, metal reclaim, collect used oil, collect used fat, disposal used oil, disposal used fat
G06	Sustainable Agriculture, Forestry, and Food Production	Agronomy, agroecology, agrophenology, biochar, climate smart, drip irrigation, precision irrigation, no till, organic, organic farming, recultivate, regenerative, sustainable agriculture, sustainable farming, conservation agriculture, subsistence farm, indigenous agriculture, ipm, integrated pest management, wild plant, forest, foresters, forestry, sustainable forestry, reforestation, afforestation, forest protection, plant forest, forest maintenance, agro forestry, agroforestry, tree planting, crop diversification, crop rotation, cover crop, shade agriculture, sustainable horticulture, sustainable fishing, artisanal fishing, aquaculture, aqua culture, sustainable livestock, insect protein, sustainable protein, plant based meat, plant based protein, optimal grazing, grazing intensity, green manure, silvoarable, silvopasture, green ammonia

G07	Natural Resource Conservation	Affecting earth, atmospheric, biodiversity, biological diversity, biological hazard, biotope, climate protection, coastal protection, resource conservation, nature conservation, natural conservation, conserve resource, conserve nature, conserve natural, deforestation, drought, eco friendly, ecofriendly, ecology, ecologist, ecological, ecosystem, protecting ecosystems, eco tourism, ecotourism, nature tourism, sustainable tourism, effect weather, environmental assessment, environmental impact, environmental protection, environmental restoration, environmental testing, erosion control, extinguishing fire, fire detection, fire prevention, fire protection, fire suppression, firefight, flood control, floods, forecast weather, weather prediction, greenfield, habitat, natural environment, hazards life, land protection, land restoration, land repurposing, landscape protection, landscape restoration, sustainable land management, desertification, minimize raw material, monitor water, natural garden, natural resource, natural resource management, natural reserve, natural risk, natural risk management, paperless, protect environment, protect water, reduce water, regrow, ground water remediation, environmental remediation, remediation, reduce consumption, renaturation, storm water, stormwater, testing earth, tree care, water conservation, water efficiency, water management, water meter, water monitor, water resource, efficiency water, water saving, wild animal, wild life, wilderness, wildlife, habitat protection, catchment rehabilitation, catchment restoration, wetland management, natural capital, natural heritage, natural systems, nature based enterprise, nature based solution, nature positive, biosphere protection, restoration peatland, restoration mangrove, restoration saltmarsh, restoration seagrass
G08	Environmental Awareness	Climate change, eco citizenship, ecocitizenship, environmental, global warming, sustainable, sustainability, esg, environmental social governance, environmental awareness, environmental engineer, environmental knowledge, environmental science, environmental scientist, environmental studies, soil science, sustainable production, responsible production, conscious consumption, conscious consumerism, sustainable consumption, responsible consumption, environmental sustainability
G09	Environmental Certifications and Compliance	Leed, ohsas, six sigma, forest stewardship council, msc asc, marine stewardship council, aquaculture stewardship council, eubio, rainforest alliance, energy star, green seal, iscc, international sustainability carbon certification, breeam, green globe, cercla, comprehensive environmental response compensation liability act, environmental auditing, environmental compliance, environmental law, environmental liability, environmental permit, environmental regulation, health environment, green procurement, environmental tax, myclimate, net zero banking, net zero insurance, net zero business, sec climate disclosure, ngfs, network greening financial system, greening financial system

▶ Table A.2: Top 5 of the vacancy postings considered dark green, South Africa

ISCO code	ISCO label	Matched keywords/expressions for green
13	Production and specialised services managers	solar, waste management, desalination, sewage, water treatment, sustainable
21	Science and engineering professionals	environmental, forestry, erosion control, water quality
21	Science and engineering professionals	environmental, environmental law, air quality, water management
22	Health professionals	environmental protection, environmental, pollution, waste management
25	Information and communications technology professionals	sustainability, climate change, ghg, water management, waste management, esg, environmental

Contact details
Verónica Escudero (escudero@ilo.org)
Isaure Delaporte (delaporte@ilo.org)

International Labour Organization
Route des Morillons 4
CH-1211 Geneva 22
Switzerland

T: +41 22 799 6913
E: research@ilo.org
DOI: https://doi.org/10.54394/JKGV7887