Green Jobs

Upskilling and Reskilling
Vietnam's Workforce for a Greener Economy[1]

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Overview

Vietnam made ambitious international commitments related to phasing out coal and achieving net zero at COP-26 in 2021, which have significant implications for jobs. As part of the government's effort to realize these commitments, the *National Green Growth Strategy for the 2021-2030 period* (NGGS) identified the creation of green jobs as one of its strategic directions. Green jobs creation is vital to both allow a green transition and to ensure an inclusive process through which individuals benefit from a green transition. To implement this direction, the Government has issued an action plan – Decision 882/2022 – that defines line ministries' and agencies' roles and responsibilities for creating green jobs.

Yet the absence of an official definition and baseline measurement of green jobs in Vietnam is hindering the formulation and adoption of skills development policies for green jobs. The Ministry of Planning and Investment (MPI), particularly the General Statistics Office (GSO), is mandated to develop a methodology for measuring green jobs and establish a system to monitor indicators of green jobs. On the other hand, the Ministry of Labor, Invalids and Social Affairs (MoLISA) must anticipate the demand for green skills and green jobs based on sectoral strategies, adapt the labor market information system to monitor the need for green jobs, enhance job matching, and integrate the demand for green jobs and green skills in the vocational education and training system. Nevertheless, there has been no systematic analysis of green jobs in Vietnam, and even less analysis of their skills requirements and implications for skill development policies.

This policy note aims to advance the understanding of green jobs in Vietnam and establish a baseline on their prevalence, characteristics, and skills requirements. For the first time, the note identifies and analyzes profiles of green jobs and jobs in green industries in Vietnam context, using two complementary approaches. The task-based method has been applied in work recently conducted in Indonesia (Granata and Posadas 2022; Posadas et al. 2023), which builds on the literature on green jobs and green skills in OECD countries (see (Vona et al. 2018) for a rereview). On the other hand, the output-based approach assesses the stage of green industries, which has been mentioned in several strategies for green growth in Vietnam. In addition, the note provides a detailed examination of the task content, skills and educational requirements of top green jobs in Vietnam context, helping to inform skills development strategies to support green growth. This examination was done based on primary data on Vietnam's top 20 high- and medium-skilled green occupations collected by the Vietnam Green Jobs Survey (GJS). Results from the survey not only corroborate findings related to the greenness of jobs based on international task descriptions but also shed light on whether skills required in such jobs are green-specific or more transferable.

What are green jobs? Conceptual definitions and empirical identification

The concept of green jobs has not been universally agreed upon. Green jobs have been defined by three main approaches: output-, process-, and task-based, which are often combined. The output-based approach focuses on the final products and services and whether they contribute to lessening the adverse environmental impacts and/or conserving the environment. The process-based approach refers to the production processes of goods and services, including integrating energy-saving technologies, reducing water, and reusing material. The task-based approach focuses on green tasks that "can either be assigned with the goal of producing greener outputs or of reducing the firm's environmental footprint […] no matter the environmental footprint of the industry in which they are employed" (Granata and Posada, 2022). In Vietnam, both the output-based and task-based approaches have been used to define green jobs in Government documents. However—as is the case internationally—there has been no official definition of green jobs.

This note uses task-based and output-based approaches to measure green jobs in Vietnam. The advantage of the task-based approach is that it allows identifying how the greening of the economy is

shaping jobs' task content and skills requirements. The task-based approach also allows the identification of the skills required to perform these tasks well and helps inform policymakers whether these skills are green-specific or can be transversal. It is useful to inform skills development policy. The output-based approach identifies industries that produce goods and services that lessen the environmental impact and considers all occupations demanded in these industries. Quantifying the number of jobs employed in these industries is vital to understand how much labor demand could expand with the increasing production of goods and services in these industries. It is helpful to inform sectoral policies.

Which jobs are green in Vietnam? Characteristics, distribution, and potential for further greening

Using the task-based approach, 39 out of the 441 occupations in the LFS 2021 are green. Green jobs comprise only a small share of total employment: 3.6 percent; accounting for 1.7 million jobs. The top five occupations with the highest GTI index are environmental protection professionals, environmental engineers, refuse sorters, meteorologists, and rangers (professionals) (Table ES. 1).

Table ES. 1: List of top 10 green occupations in Vietnam identified by the task-based approach

VSCO 2020	Occupational title	GTI (green)	Share of employment in 2021 (%)
2133	Environmental protection professionals	85.7	0.01
2143	Environmental engineer	83.3	0.03
9612	Refuse sorters	83.3	0.16
2112	Meteorologists	77.8	0.00
2445	Rangers (professionals)	75.0	0.04
9611	Garbage and recycling collectors	75.0	0.11
3132	Incinerator and water treatment plant operators	50.0	0.01
3355	Rangers (associate professionals)	50.0	0.01
7124	Insulation workers	50.0	0.03
3119	Physical and engineering science technicians not elsewhere classified	40.0	0.01

Source: World Bank staff calculation based on GTI toolkit and LFS 2021.

In addition to the 39 green occupations, another 88 occupations have the potential to become green. These potential green jobs account for 41 percent of total employment, showing the significant benefits that can result from greening the Vietnam economy. With appropriate policy measures, for example, promoting high-tech farming and/or organic agriculture, a large share of the workforce can be mobilized in the green transition in Vietnam, especially for workers in agriculture.

As defined by the task-based approach, green jobs exist in all industries, further indicating the vast areas of interventions to green the economy. Industries with the highest concentration of green jobs are electricity, gas, and water supply (23 percent), mining and quarrying (5 percent), as well as market services (5 percent). These industries might not provide environmental goods and services directly, but they include green occupations: for example, environmental engineers in mining and quarrying. Moving to potential green jobs, agriculture has the highest concentration of such jobs, at 83 percent.

With the output-based approach, at 4.8 percent of total workers (2.2 million jobs), the share of workers in green industries is slightly larger than the share of workers in green jobs (3.6 percent), but one needs to be mindful of the caveat that jobs in green industries may not be green. Even with our conservative classification of industries, the output-based approach has the disadvantage of including all workers in an industry, including counting workers that do not carry out a green task, for instance, a receptionist in a solar panel manufacturing plant.

Green jobs in Vietnam are more likely concentrated in the Red River Delta, the Northern and Southern Central Coast, and the Mekong River Delta regions. Potential green jobs, on the other hand, are more likely to be dominant in provinces in the Northwest and Central Highland regions, which reflects the high intensity of jobs in agriculture and forestry in these regions, and is consistent with the high rate of poverty in these mountainous areas (World Bank 2022a).

The share of green jobs and jobs in green industries has been stable between 2016 and 2021, indicating their resilience to shocks such as COVID-19; however, the share of potential green jobs has decreased. The declining trend is due to the structural change away from agriculture that has occurred since the mid-2000s, and most jobs with green potential concentrate on skilled agriculture, forestry, and fishery. Excluding agriculture, the share of potential green jobs becomes relatively stable.

Green jobs and jobs in green industries are male dominated. More than 80 percent of green jobs are held by men, compared with 52 percent of non-green jobs, although male domination decreases among jobs with higher GTI. Jobs in green industries employ 78 percent male workers, compared to 52 percent male workers in non-green industries.

Green jobs are more likely to be formal than non-green jobs, while potential green jobs are less formal, even when excluding agriculture. About 43 percent of green jobs are formal, versus 33 percent of non-green jobs. The share of formality of jobs in green industries is also higher than that of jobs in non-green industries, albeit to a lesser degree than green jobs. On the other hand, potential green jobs are not necessarily more formal than jobs without green potential. The low incidence of formality among potential green jobs reflects the high concentration of potential jobs in the agriculture, forestry, and fishery sector. However, even when excluding the agriculture sector, potential green jobs are less formal than the national average.

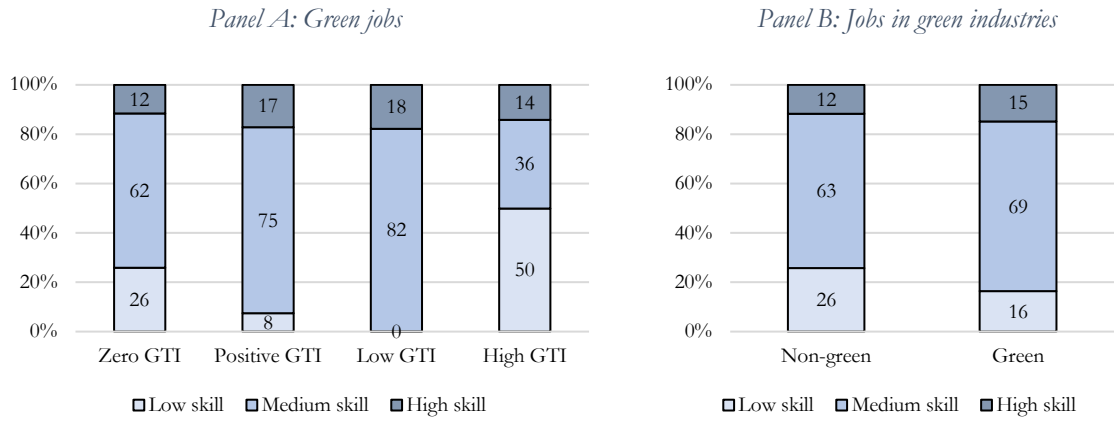
However, green jobs in Vietnam do not seem to provide a wage premium. Controlling for demographic characteristics (age, gender), geographic location (province), educational attainment, and industrial sector of the individual, green jobs do not pay more than non-green jobs and, for some occupations, pay less. The finding is surprising, given the higher formality rate of green jobs and the higher skill profile of green jobs. This finding differs from what has been found in previous studies using similar approaches, although these are primarily in high-income countries.

Skills Requirements for Green Jobs

Skill profile of green jobs – evidence from the LFS

Green jobs and jobs in green industries are higher-skilled. The share of medium- and high-skilled occupations among green jobs is higher than that of non-green jobs, at 92 percent and 74 percent, respectively (Figure ES.1, panel A). The proportion of medium- and high-skilled jobs is also higher in green industries: 84 percent, as opposed to 75 percent in non-green industries (Figure ES.1, panel B).

Figure ES. 1: Skill level distribution of green jobs, and of jobs in green industries



Source: World Bank staff calculation using and LFS 2021.

Workers in green jobs and green industries have higher levels of education than those in non-green jobs. While 30 percent of workers in non-green jobs attain elementary school or less, 25 percent of workers in green jobs do so. At more advanced levels of education, 17 percent of workers in green jobs have at least a university degree, compared with 11 percent of workers in non-green jobs. At the same time, within green jobs, higher levels of green intensity do not necessarily require higher education attainment: While 15 percent of workers in jobs with high green intensity have at least a university degree, 18 percent of workers in jobs with low green intensity do so. As with the educational distribution found among green jobs, workers in green industries are more educated than in non-green industries. Twenty-six percent of workers in green industries attain vocational training or university and above, compared with 19 percent of workers in non-green industries do so. On the other hand, workers in potential green jobs tend to have lower level of education than workers in jobs with no green potential, which is consistent with the high concentration agriculture among potential green occupations

Task-content and skills requirements of top green occupations – evidence from the Vietnam Green Jobs Survey

To understand the skills requirements of green jobs in Vietnam context and provide robustness check for the analysis that is based on international occupation classification, this note relies on primary data collected by the Vietnam Green Jobs Survey (GJS). The survey, carried out in February and March 2023, was designed to assess the profiling of tasks performed in green jobs in Vietnam as well as of the skills used in these green jobs. It includes the 20 greenest medium- and high-skilled occupations with a sample of 500 workers in five provinces, chosen based on their large population size, high share of green jobs, and geographical distribution.

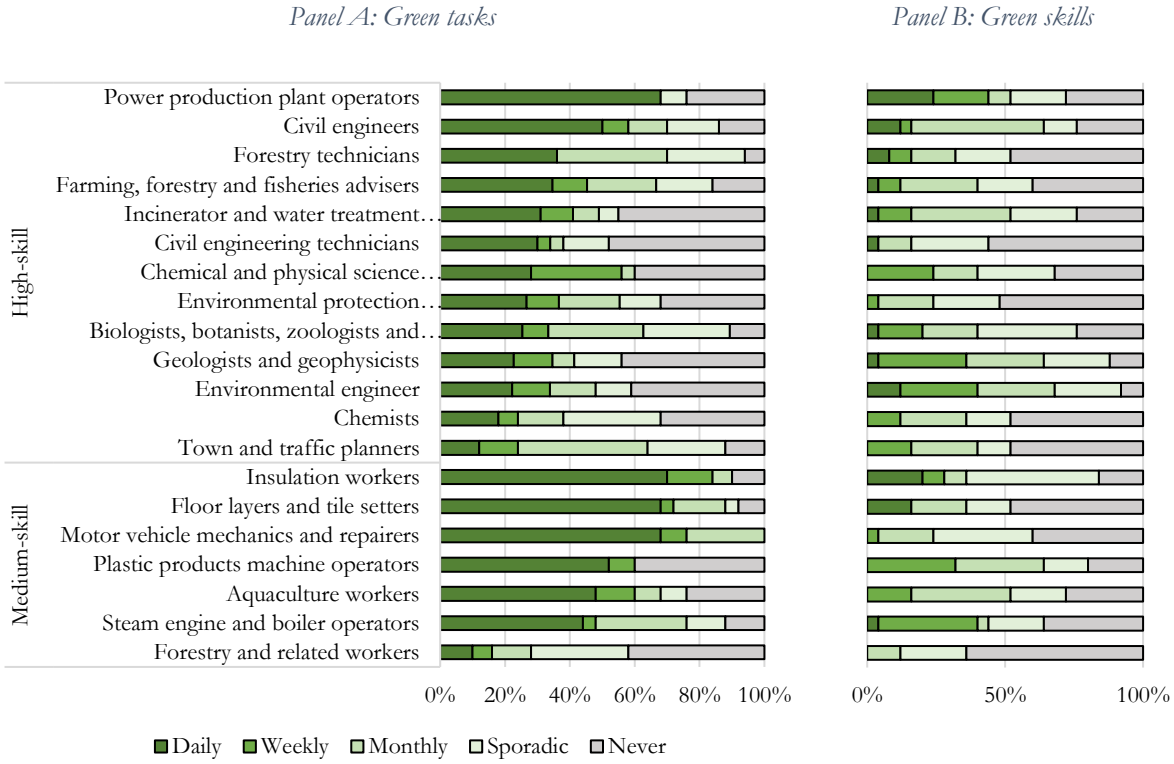
The GJS shows that green tasks are performed at high frequency among workers with green jobs, with 38 percent of respondents reporting performing green tasks at least daily.[2] Workers in medium-skilled occupations tend to perform green tasks more frequently than high-skilled ones. For example, among insulation workers, floor layers, and tile setters, as well as among motor vehicle mechanics and repairers, more than 65 percent of workers interviewed in the GJS report performing green tasks daily or more frequently (Figure ES.2, Panel A).

Despite the high prevalence of green tasks performed by workers in green jobs, green skills are used at a lower frequency, indicating that green tasks involve green skills as well as other skills

[2] Task statements in the VSCO handbook are included in the GJS for each surveyed occupation.

(Figure ES.2, Panel B). For example, power production plant operators have 68 percent of workers report that they perform green tasks daily or more often. However, only 24 percent of workers surveyed in this occupation report using green skills at the same frequency.

Figure ES. 2: Frequency of performing green tasks and using green skills



Source: World Bank staff calculation using GJS.

Note: The GJS asks respondents about the frequency of performing tasks and skills, particularly, "In your job, do you perform/use [tasks/skills]? If yes, what is the level of performance/use?" Green tasks are classified based on the GTI toolkit.

Importantly, problem-solving, technical, management, and digital skills complement green skills. The complementarity of green and other skills varies by the skill level of occupations. For example, high-skilled workers in green jobs are more likely to use managerial, problem-solving, and technical skills in addition to green skills. On the other hand, medium-skill workers in green jobs tend to complement green skills with technical, managerial, and reading skills.

Policies to prepare a greener workforce

Define green jobs following both the task-based and output-based approaches

Adopt the green jobs definition for the implementation of the green growth strategy. While the term "green jobs" has been used in the GGS, there is no consensus definition or baseline measurement of green jobs in Vietnam. From a skills development policy perspective, the task-based approach is much more informative than the output-based approach since it allows measuring the essential job-specific work activities needed to produce greener outputs. On the other hand, the output-based approach is useful to inform sectoral policies. The two approaches are complementary but given the heavier focus on an output-based approach, we recommend balancing attention to the task-based approach, including the potential for greening across industries.

Monitor green jobs' growth and characteristics

Mainstream the reporting of green jobs statistics to assess the labor market effects of green transition, using as well as revising 5-digit classification codes for occupations or industries that are green or have green potential. In addition, upon adopting definitions of green jobs, the GSO could publish statistical indicators on them using the LFS and the Economic Census. Such statistics on green jobs will provide the Government with a tool for (i) gaining a better understanding of the impact of "greening the economy" on the labor market and (ii) ensuring that effective policy measures and tools are formulated to respond to this shift to a greener economy.

Integrate information on green jobs and skills into the labor market information system (LMIS). At present, the Vietnam LMIS is at a nascent stage and needs to be improved to enhance the matching between workers and firms as well as to inform job seekers, students, and workers on growing and declining occupations and guide them, as well as the career and job counselors assisting them, in making their education, training, and job decisions. It is also needed to inform policymakers and training institutions on priority occupations and skills to train in.

Upskill and reskill the population for green jobs

As Vietnam has plans for a green transition, this policy note shows that these have benefits in terms of being formal and upskilling the Vietnamese workforce. Our findings indicate that Vietnam could potentially increase the number of green jobs in renewable energy, agriculture, and forestry in the coming years based on its recent plans and commitments. In addition, this note indicates a higher skill profile of green jobs, consistent with the policy suggestion that higher skills allow an easier match to a more green-intensive job (IMF 2022). This indicates that increasing green jobs can contribute to upskilling Vietnam's workforce.

To meet increased local and global demand there is a need to increase the supply of green skills to meet local and global demand. Globally, green workers are being hired more than non-green workers. The share of green talent in the global workforce increased from 9.6 percent in 2015 to 13.3 percent in 2021 (LinkedIn 2022), and this is likely to continue and accelerate; globally but also in Vietnam, given recent commitments. However, the number of students registering in relevant post-secondary programs is insufficient to meet the demand for green skills. Training programs must be updated to overcome this challenge considering changing skill demands.

Partnerships with the private sector can help identify the need for and improve training on green skills. For example, in the UK, the Skills Academy for Sustainable Manufacturing and Innovation (SASMI) is located in close proximity to a Nissan manufacturing plant in Northeast England. In Spain, the company Acciona operates the Acciona University program, which, in 2015, provided nearly 35 000 training hours to employees in green and environmental subjects in cooperation with the University of Alcalá (Madrid). Activities such as these can catalyze when they involve companies in the vanguard of green production processes and products and where they set ambitious standards in green skills for employees that can inspire other companies (CEDEFOD 2018).

In the end, what is needed is combining environmental and climate issues in education and training, upskilling workers more broadly, and an efficient labor market that can help grow green clusters and green jobs. This news indicates that skills development can continue fostering a broad set of skills while building green skills. An interesting example is that of Denmark, which integrated environmental and climate issues into its educational and vocational training systems, thereby setting the foundation for further green skills development at more advanced education levels. At the same time, Denmark does not have an explicit green jobs program but focuses on ensuring that the labor market is well-functioning (OECD 2017).

Make potential green jobs greener and better

Given that the number of potential green jobs is relatively high and most are in semi-skilled agriculture and forestry, Vietnam could increase the number of green jobs through greening potential green jobs, particularly in the agriculture sector. The new agriculture development strategy for the period of 2021-2030 and vision for 2050 approved recently highlights the development direction of the agriculture sector in an ecological, organic, circular, and low-carbon direction to improve growth quality, added value, competitiveness, and sustainable development while reducing pollution in agricultural production and rural areas, and promoting energy efficiency towards carbon neutralization by 2050.

Changing farming practices and adopting climate-smart agricultural solutions will help turn agriculture jobs from potential to green, but farmers need support to modify their production practices. Farmers need to be trained in agronomy and innovative agriculture technologies. In India, for example, farmers are trained to operate inexpensive "rotavator" rotary tillers and drum seeders to improve soil health and crop productivity. The Government's role will be critical to facilitate this process by providing training to farmers, including facilitating partnerships with the private sector for knowledge sharing or on-the-job training.

Improve access to green jobs

Introduce policies to increase access to green jobs among female workers and vulnerable groups. The findings suggest that male workers dominate green jobs, while green jobs require more fields of study in the sciences. While there are some improvements, enrolments in universities and TVET still follow traditional gender stereotypes, with more male students in technology-driven areas. Including women in apprenticeship and skills training for environmentally sustainable jobs is essential for overcoming disparities in the labor market and skill shortages in certain occupations.

1. Introduction

Vietnam made ambitious international commitments at COP-26 in Glasgow in 2021. The country committed to achieving net zero by 2050 and coal phase-out by the 2040s and reducing by 30 percent methane emissions by 2030. One year later, the signing of the Just Energy Transition Partnership (JET-P) Political Declaration established intermediate 2030 targets for peaking coal at 30.2GW, increasing renewable generation to 46.6 percent of the total energy mix, and peaking emissions at 170 MtCO2e. Before and after COP-26, the government issued many policy and strategic documents. The *National Master Plan for the 2021-2030 period* identified the green economy as one of the five key tasks for national development.[3] The *National Green Growth Strategy for the 2021-2030 period (NGGS)* set out three specific objectives: (i) reducing greenhouse gas (GHG) emissions; (ii) greening economic sectors, as well as (iii) greening lifestyles and promoting sustainable consumption.[4]

These commitments have implications for jobs, and the NGGS identified the creation of green jobs as one of its strategic directions; vital both to allow a green transition and to ensure an inclusive process through which individuals benefit from a green transition. To implement this direction, the Government has issued an action plan – Decision 882/2022 – that defines line ministries' and agencies' roles and responsibilities for creating green jobs. For instance, the Ministry of Labor, Invalids and Social Affairs (MoLISA) has an *Action Plan for the implementation of the NGGS* includes activities to (i) improve labor and social policies in line with the *NGGS;* and (ii) develop green jobs and training activities to support the creation of green jobs. Both dimensions are essential to ensure that a green transition is beneficial and inclusive: Workers need to move to green jobs. The latter is vital to allow the growth of green sectors and, across sectors, greener production processes. In addition, ensuring that a green transition benefits large population segments is also important.

While Vietnam has adopted objectives regarding green jobs, there is no consensus definition or baseline measurement of green jobs in Vietnam. The NGGS defines green jobs as "…jobs in agriculture, manufacturing, research and development, administrative and service activities, which contribute significantly to the conservation, restoration of environmental quality*".* This is a broad definition that focuses on one approach by industry. Other definitions have been proposed, and the need to develop a more advanced definition has been recognized. The Ministry of Planning and Investment (MPI), particularly the General Statistics Office (GSO), is mandated to develop a methodology for measuring green jobs and establish a system to monitor indicators of green jobs. MoLISA must anticipate the demand for green skills and green jobs based on sectoral strategies, adapt the labor market information system to monitor the need for green jobs, enhance job matching, and integrate the demand for green jobs and green skills in the vocational education and training system. MoLISA's *Action Plan* sets out six priority areas, including "Completing the system of legal instruments and policies" and "Training systems for human resources." Nevertheless, there has been no systematic analysis of green jobs in Vietnam, and even less analysis of their skills requirements and implications for skill development policies. Understanding and defining green jobs is new not only for Vietnam but also for many other countries.

Such a knowledge gap hinders adopting appropriate skills development policies for green jobs: Important questions arise: What is the skill level of green jobs? Are they primarily medium- and high-skilled, or are there a lot of low-skilled green jobs? In which occupations and sectors are they

[3] The task includes having efficient use of natural resources; ensuring energy, food, and water security; developing circular and green economy; protecting the environment; and being proactive in preventing natural disasters and response to climate change.

[4] Greening economic industries in this context can refer to both the greening of industries that lessen negative impacts on the environment and greening production practices that efficiently utilize natural and energy resources. This framework can be linked to both the task-content and output-based approaches later discussed in chapter 2 and applied throughout the note.

most prevalent? Who has access to them? Are green jobs better jobs? It has been shown that environmental regulation tends to increase demand for advanced cognitive and technical skills, for example, in the United States (Vona et al. 2018) and in European economies (Marin and Vona 2019). Therefore, a relevant question for skills development policies for Vietnam is: Can we expect the same phenomenon in the country given the current skill distribution of green jobs? Are there differences in access to green jobs across men and women, older and younger workers? Such questions can shed light on green jobs in Vietnam, the skills required in green jobs, and whether green job creation can be inclusive and socially just.

Concerning skills development policy, one question of interest is whether green jobs require heavy investments in a completely new set of skills, whether traditional skills can be adapted, or a combination of both. Plans for greening the economy may or may not be constrained by skills depending on the skills requirements of green jobs. If green jobs require a lot of skills specific to the green economy, for example, skills related to reducing GHG emissions, energy efficiency, minimizing waste, environmental assessment, or knowledge of sustainable materials, it would be essential to design programs with specific training and educational qualifications (ILO 2019). On the other hand, if green jobs involve transferable skills, programs that upgrade skills, such as on-the-job training, are needed to ensure a smooth green transition. Existing empirical findings are mixed. For example, Consoli et al. 2016 compared the skills required for green and non-green jobs and reported that higher levels of non-routine cognitive and interpersonal skills characterize green jobs. Similarly, Bowen, Kuralbayeva, and Tipoe 2018 report that green jobs require more on-the-job training and involve less routine and manual skills than non-green jobs. However, the difference is not significant in magnitude. Other studies suggest that green growth will require a mix of traditional and new green skills.

This policy note aims to fill the knowledge gap by (i) helping advance the understanding of green jobs in Vietnam, as well as (ii) establishing a baseline on their prevalence, characteristics, and skills requirements. There is no consensus definition of green jobs globally, and several approaches are being used in different countries, mainly in high-income economy contexts, for example, the United States and Europe. Other efforts to quantify green jobs in low- and middle-income countries remain limited and rely on assumptions that might not be applicable in other countries (for a discussion, see Granata and Posadas 2022). This policy note builds on work recently conducted in Indonesia, a middle-income country and aims to advance the understanding of green jobs in such a setting (Posadas et al. 2023).

This policy note uses two approaches to defining green jobs and jobs in green industries. It examines these jobs' distribution, quality, and skills requirements to inform skills development policy supporting Vietnam's green transition. The analysis is conducted using the task-based and output-based approaches to identify green occupations and industries, consequently, jobs in these occupations and industries. The task-based method has been applied in work recently conducted in Indonesia (Granata and Posadas 2022; Posadas et al. 2023), which builds on the literature on green jobs and green skills in OECD countries (see Vona et al. (2018) for a review). On the other hand, the output-based approach assesses the stage of green industries in Vietnam, which has been mentioned in several strategies for green growth in Vietnam. The two approaches are complementary and helpful in informing policy promoting green growth and job creation.

Furthermore, while primarily using international classifications, this policy note contributes to a better understanding of the classification for Vietnam by presenting the results of the Vietnam Green Jobs Survey (GJS) that examined the task intensity and skills requirements of green jobs. The survey was conducted from February to March 2023 and included Vietnam's top twenty high- and medium-skilled green occupations. The results of the survey help inform the type of skills required by green jobs, in other words, whether these skills are green-specific or more transferable. The survey also allows the assessment of the educational requirement for green jobs, both on the level of education and subject fields of study. The survey questionnaire was designed to enable comparisons with the recent effort to study

detailed skills in Vietnam (the Survey of Detailed Skills, World Bank forthcoming), hence allowing the comparison of skills in green occupations versus skills in the top growing occupations in Vietnam.[5]

To our knowledge, this is the first measurement of green jobs in Vietnam, providing a detailed picture of their occupational and skills profiles. Using the task-based approach, out of the 441 occupations in the Labor Force Survey 2021, 39 are green and another 88 have the potential to become green. The green jobs account for only 3.6 percent of total employment, a result that is consistent with existing international evidence, whilst potential green jobs take up 44 percent. Green jobs are more likely to be formal and also are higher-skilled than non-green jobs, although they do not seem to provide a wage premium. Potential green jobs, on the other hand, are less formal, even when excluding agriculture. Also, these green jobs and jobs in green industries are highly male dominated.

The note is organized as follows. Section 2 sets out the conceptual definitions of green jobs and the empirical identification of green jobs and jobs in green industries in Vietnam. Section 3 studies the prevalence of these jobs, their geographical concentration, and their characteristics, as well as assesses whether green jobs are of better quality than non-green jobs, particularly in terms of pay and formality. The analysis uses the Labor Force Survey and the Economic Census. Section 4 focuses on profiling skills in green jobs using the Labor Force Survey and the Vietnam Green Jobs Survey. Finally, section 5 draws policy recommendations based on the empirical findings, and Section 6 concludes.

2. Green jobs: conceptual definitions and empirical identification

2.1 What are green jobs? Conceptual definitions

The concept of green jobs takes its root in the green economy, which has not been universally agreed upon. When first coined in 1989, the term "green economy" reflected that economics could and should aid environmental policies (Pearce, Markandya, and Barbier 1989). The concept was initially limited to climate change and the reduction of CO_2 emissions and has evolved to include broader energy and resource efficiency and social dimensions. A green economy is defined by the United Nations Environment Programme (UNEP) as "one that results in improved wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP 2011).

Similar to the concept of green economy, there is no consensus on a universal definition of green jobs; green jobs have been defined by three main approaches: output-, process-, and task-based, which are often combined. An example is the definition by the International Labour Organization (ILO) and UNEP, which defines green jobs as decent jobs in any economic sector that contributes to preserving, restoring, and enhancing environmental quality through (i) the production of environmental outputs (goods and services – output based) or (ii) the use of environmentally friendly technologies in production (process-based) (UNEP et al. 2008). The output-based approach focuses on the final products and services and whether they contribute to lessening the adverse environmental impacts and/or conserving the environment. The process-based approach refers to the production processes of goods and services, including integrating energy-saving technologies, reducing water, and reusing material. Finally, the task-based approach focuses on green tasks that "can either be assigned with the goal of producing greener outputs or of reducing the firm's environmental footprint […] no matter the environmental footprint of the industry in which they are employed" (Granata and Posada, 2022).

Defining green jobs using the output-based approach focuses on specific sectors that produce goods (outputs) deemed environmentally beneficial and includes all occupations in the industry.

[5] The Survey of Detailed Skills interviewed 543 workers in 30 occupations that are either in-demand or that are of strategic importance for economic growth in Vietnam (World Bank forthcoming). The survey was annexed to the December 2021 round of Vietnam's Labor Force Survey and was carried out in five provinces Hanoi, Ho Chi Minh City, Da Nang, Vinh Phuc, and Dong Nai.

For example, the Environmental Goods and Services Sector (EGSS) classification classifies sectors according to producing goods and services for environmental protection and resource management (European Union 2016).[6] As an example of the focus of the definition, it excludes "wholesale and retail of environmental products, public transport, and products which may have a positive impact on the environment but are produced for health and safety at the workplace or to protect establishments against natural hazards and effects of climate change." Hence, the definition strictly refers to sectors that either directly serve an environmental purpose or produce specifically designed products that serve an environmental purpose. With this approach, all jobs in sectors that meet this criterion are considered green jobs, even if they do not directly contribute to green outputs. For instance, the receptionist of a power plant would be counted as having a green job.

Defining green jobs using the process-based approach focuses on how goods and services are produced. An example of such a definition by the Global Commission on the Economy and Climate (GCEC) is that "green jobs are those that support improving energy and resource material efficiency, limiting GHG emissions, minimizing waste and pollution, protecting, or restoring ecosystems, and/or supporting adaptation to climate change" (The Global Commission on the Economy and Climate 2018). This approach is often combined with the output-based approach, as in the ILO and UNEP definitions mentioned above.

Finally, defining green jobs using the task-based approach focuses on whether the jobs involve carrying environmentally friendly tasks. The literature on job task and skill content was sparked by digitalization and skill-biased technological change (SBTC), with a seminal paper on measuring the task and skill content of jobs by Autor, Levy, and Murnane from 2003. Francesco Vona and co-authors have applied this methodology to measure green jobs (Vona et al. 2018). The most prominent application of the task-content approach is the Occupational Information Network (O*NET) Green Economy Program (O*NET GEP). The objective of the O*NET GEP was to identify the occupations to be impacted by the greening of the economy (i.e., by green economic activities and technologies).

In Vietnam, both the output-based and task-based approaches have been used to define green jobs in Government documents. However—as is the case internationally—there has been no agreement on an official definition of green jobs. Following the output-based approach, articles 143 and 144 of the *Law on Environmental Protection 2020* sets out as a priority to develop an "environmental industry," which refers to "sectors in the Vietnam Standard Industrial Classification that provide technologies, equipment and products serving the environmental protection", while "environmental service refers to sectors that provide services to measure, control, limit, prevent or minimize water, air, and soil pollution; use national resources efficiently, treat waste and other pollutants; conserve biodiversity, and other relevant services".[7] The NGGS uses a definition that is also rather output-based although it also includes dimensions that can be seen as process--based: "...jobs in agriculture, manufacturing, research and development, administrative and service activities, which contribute significantly to the conservation, restoration of environmental quality".8 A combination of both task-based and output-based approach has been proposed by the Institute of Labor Studies and Social Affairs (ILSSA) to define green jobs as "decent and satisfactory job, created in

[6] Environmental protection activities include all activities and actions that have as their main purpose the prevent, reduction and elimination of pollution and of any other degradation of the environment. Resource management activities include the preservation, maintenance, and enhancement of the stock of natural resources and therefore the safeguarding of those resources against depletion.

[7] The official list of environmental industry and services in Vietnam is not yet available at the time of this publication but there have been efforts to promulgate a new decree that leads to a more precise definition and the creation of a new Vietnam Standard Industrial Classification code for manufacturing of environmental goods.

[8] In particular, but not exclusive, green job is helping to protect ecosystems and biodiversity, reduce energy consumption, materials, and water through highly efficient strategies, reduce carbon emissions economy and minimize or completely avoid all forms of waste and pollution.

different sectors of the economy to help preserve or restore the environment and bring about sustainable development. Therefore, green job(s) is (are) decent work that also (i) reduce the consumption of energy, raw materials, (ii) to reduce carbon emissions, (iii) minimize the creation of waste, pollutants, (iv) protect water resources, restore ecosystems and biodiversity; and (v) support adaptation to the effects of climate change" (ASEAN and ILO 2021).[9]

2.2 How to measure green jobs in Vietnam? – Application of the concepts

This note uses task-based and output-based approaches to measure green jobs in Vietnam. The two approaches have been used to identify and quantify green jobs using microdata (Posadas et al. 2023).[10] The process-based approach is useful when the main objective is understanding firms' labor needs to implement new technology or change a production process. However, it misses a close link to occupational and skills data necessary to design skills training (Discussion in Granata and Posadas 2022).

The advantage of the task-based approach is that it allows identifying how the greening of the economy is shaping jobs' task content and skills requirements: It is useful to inform skills development policy. The task-based approach also allows the identification of the skills required to perform these tasks well and helps inform policymakers whether these skills are green-specific or can be transversal. By looking at specific green tasks and linking tasks to occupations, the approach also allows for profiling occupations of green jobs. Occupational profiling is crucial in informing policymakers on the skills needed and training requirements that can prepare the workforce for embracing job opportunities created by the green transition.

The output-based approach identifies jobs in industries that produce goods and services that lessen the environmental impact and considers all occupations demanded in these industries: It is helpful to inform sectoral policies. The output-based approach identifies green industries, specifically whether the products and services produced in these industries lessen adverse environmental impacts and/or conserve natural resources. Quantifying the number of jobs employed in these industries is vital to understand how much labor demand could expand with the increasing production of goods and services in these industries. The transition to a green economy will have implications at the sectoral level. How important are green sectors to the overall economy? In which specific regions and communities, and how many workers are employed in these sectors and regions? Answering these questions is helpful for policymakers in evaluating the impact of the green transition on the labor market.

While it is useful for sectoral policies, the output-based approach presents many problems in terms of risks of misclassification of jobs. By focusing on a firm's output, the output approach leaves out jobs in firms that produce non-green outputs but implement green technologies. For example, a leather manufacturing firm may implement technologies to clean wastewater and employ workers in charge of this process. The output approach would ignore the jobs in the leather company. However, such a firm might use less energy in its production than a firm that produces organic produce – hence classified as green - but has high water consumption. On the other hand, it includes all jobs regardless of whether they involve green tasks. For example, it would include the receptionist at a firm producing a filter to purify the air.[11]

Given that the priority of this note is to inform skills policy development not only for current green jobs but to make existing jobs greener, we put more emphasis on the task-based approach, which is also much more established in the labor literature to inform skill development. While the output-

[9] The proposal has not yet been adopted in official government documents by the time of this publication.
[10] In addition to the task-content and the output-based approaches, the process-based approach and the skill approach have been used to estimate green jobs. See Posadas et al. (2023) for a review of common methods used to estimate green jobs, as well as the advantages and limitations of these methods, especially when applied to a developing country context.
[11] Some of the examples are borrowed from Granata and Posadas 2022.

based approach can provide insights to inform sectoral policy, it is less useful for skills policy development because it leaves jobs in firms that produce non-green outputs but implement green technologies. On the other hand, the task-based approach can reflect the dynamic and pervasive nature of jobs impacted by the green transition. These two approaches complement each other and differentiate between jobs that will need specific green skill investments and jobs without specific green skill investments but will have increased demand triggered by the expansion of the green economy.

Box 1: Definition of green terms used in this Note

Due to the diversity of definitions that refer to green jobs and other related "green" terminologies, the below-defined terms are used throughout this note and are aligned to identify the skills needed in the green transition.

Green jobs: Those jobs that involve tasks related to developing or applying technologies and practices that lessen the negative impacts on the environment. Green jobs will henceforth refer to the task-based approach, not the output-based one.

Potential green jobs: Those jobs that involve tasks that may be considered green or could be green if greener technologies are adopted.

Green tasks: Tasks are activities essential to producing the output for which the job was created. Green tasks are tasks performed in a position that involves developing or using green technologies.

Green skills: Skills are defined as necessary to perform a task well. Green skills are required in green jobs and are likely related to green tasks.

Jobs in green industries: All the jobs that produce green goods and services. Jobs in green industries hence refer to the output-based approach.

Green economy: the green economy encompasses the economic activity related to reducing the use of fossil fuels, decreasing pollution and GHG emissions, increasing the efficiency of energy use, recycling materials, and developing and adopting renewable sources of energy (National Center for ONET Development 2009).

Green goods and services: goods and services that benefit the environment or conserve natural resources. These goods and services, including research and development, installation, and maintenance, are sold to customers.

Source: Some definitions are adapted from Posadas et al. (2023).

The following subsections describe how the two approaches are applied in Vietnam. They closely follow the methodological notes of the task-based approach developed by Granata and Posadas (2022) and the application of the output-based and task-based approaches in Indonesia (Posadas et al., 2023). The description of how green jobs and jobs in green industries are identified in Vietnam can be found in Appendix A.

Task-based approach

The task-based approach uses the Green Task Intensity toolkit, which starts by classifying tasks into green, potential green, and non-green categories. The GTI toolkit classifies occupations in the International Standard Classifications of Occupations 2008 (ISCO-08) based on their task description. A

particular task is classified as green or potentially green if its description contains at least one green or potentially green term, respectively.[12]

The (potential) GTI then calculates the proportion of (potential) green tasks among the total number of tasks in an occupation. The Green Task Intensity (GTI) index is calculated as the proportion of green tasks to the total number of tasks in an occupation. The index is calculated separately based on green and potential green tasks, resulting in a GTI and a potential GTI for each occupation. Hence, the task-based approach allows green jobs to vary in intensity due to the number of green tasks performed in each occupation. One example of an occupation with a positive GTI index is chemists, which has two green tasks "developing procedures for environmental control, quality control and various other procedures for manufacturers or users" and "conducting programs of sample and data collection and analysis to identify and quantify environmental toxicants," out of a total of eight tasks, yielding a GTI index of 25. Another example of an occupation with positive potential GTI is deep-sea fishery workers, which have one potential green task "preparing and repairing nets and other fishing gear and equipment," out of a total of eight tasks, yielding a potential GTI index of 12.5.

$$GTI = \frac{Number\ of\ green\ tasks}{Total\ number\ of\ tasks} * 100$$

$$Potential\ GTI = \frac{Number\ of\ potential\ green\ tasks}{Total\ number\ of\ tasks} * 100$$

Potential green jobs are jobs in occupations whose (potential) GTI is larger than zero, but the analysis permits granular analysis and rates jobs depending on a greenness continuum. An occupation is classified as green (respectively potential green) if it contains at least one green (respectively potential green) task. While the first needed classification separates jobs into green and non-green, the advantage of the GTI is that it allows examining the intensity of the greenness and going beyond a binary classification. For ease of analysis, the index is then separately categorized into low category (GTI index less than 30) and high category (GTI index above 30) for both green and potential green occupations.

The GTI is then applied to 4-digit occupations in the Vietnam Standard Classification Occupations (VSCO) directly for 85 percent of the occupations, while text analysis following the GTI method is applied for the remaining 15 percent of occupations that have some differences between VSCO and ISCO. Some 85 percent of the VSCO 2020 occupations are exact translations of the ISCO-08 occupation titles and task statements. For the remaining eight percent of occupations, we apply text analysis to task content (see Table A1 in Appendix A for a description of each type of difference between ISCO-08 and VSCO 2020).

Output-based approach

The output-based approach follows the procedure conducted in Indonesia (Posadas et al., 2023) and adapts the classification of green industries in the United States to Vietnam's context. This adaptation fills the lack of systematical identification of green industries in emerging economies. The US Bureau of Labor Statistics categorizes green industries in the North American Industry Classification System 2007 (NAICS2007) (Bureau of Labor Statistics 2013).[13] The classification of potential green

[12] The classification of green tasks is based on a dictionary of green and potential green terms. Green terms refer to terms that are strictly environmentally friendly (e.g., "green energy", "photovoltaic", "environmental awareness"), while potential green terms include green terms as well as well as terms that could be green if greener technologies are adopted (e.g., "refuse collection", "crop").

[13] Out of the 1192 6-digit NAICS 2007 codes, 333 industries are classified as "potentially producing green goods and services". These industries represent 23 percent of all establishments and 20 percent of employment in the United States in 2010.

industries in the NAICS is matched to the International Standard Classification of Industry Revision 4th (ISIC) and the Vietnam Standard Classification of Industry (VSIC).[14]

A manual reclassification was carried out using detailed industries information from the Vietnam Standard Classification of Industries (VSIC) better to reflect the context of green industries in Vietnam.[15] The manual reclassification addresses a major caveat of the adaptation: the implicit assumption of similarity between outputs produced in the United States and Vietnam. For example, most agriculture industries in the United States are coded as potential green due to the potential for organic farming certified by USDA. However, since most of the agricultural production in Vietnam is not certified organic, these industries are revised from green to non-green. Also, most green manufacturing sectors are classified as green in the US context because their outputs might be eligible for certifications that are specific to the U.S. (for instance, the WaterSense certificates for efficient use of water, Energy Star for energy-saving products) or globally recognized certifications not yet widely adopted in Vietnam (such as the Leadership in Energy and Environmental Design (LEED). These manufacturing sectors are hence revised from green to non-green in VSIC. The description of the classification revision is in Appendix A.

Box 2: Summary of methodology and data

This box summarizes the steps and data used for the statistical analysis in the following sections.

Step 1: Identify green and potential green occupations and green, mixed, and non-green industries.

- For the task-based approach, link green ISCO occupations identified by the GTI toolkit to VSCO. The outputs of this step are the categorization of occupations (4-digit VSCO) by the share of green tasks.
- For the output-based approach, a crosswalk from the U.S. classification NAICS to VSIC (at 4-digit) is used to identify industries likely to produce outputs and services in the green economy. The output of this step is categorizing industries (4-digit VSIC) into green, mixed, and non-green. Then, the mixed industries are weighted by the share of green goods and services, and included with green industries (see
- 9 in the Appendix for the complete list of industries classified as mixed).[16]

Step 2: Merge green occupations and industries with individual and firm-level data. Outputs from Step 1 are merged with different databases:

- Task-based approach: The classification of green occupations and GTI index is applied to the Labor Force Survey (LFS) mainly for 2021 but also for previous years when examining changes over time.
- Output-based approach: The green VSIC classification is applied to firm-level data from the Economic Census 2017 covering all formal firms in Vietnam, except household businesses in agriculture, forestry, fishing, diplomatic missions, embassies, consulates, and international organizations operating in Vietnam.[17]

[14] See Appendix A for detail on the crosswalks.
[15] The classification is revised based on the VSIC Handbook, which contains titles of VSIC 5-digit and is provided by the Vietnam General Statical Office.
[16] The share of green goods and services produced in a VSIC 4-digit industry is estimated using the titles of VSIC 5-digit from the VSIC Handbook. For example, 4-digit industry 3511, electric power generation includes 35111 hydroelectricity, 35112 coal-fired, 35113 gas-fired, 35114 nuclear, 35115 wind, 35116 solar power, and 35119 other sources. The share of green goods and services in electric power generation is calculated as 5/7 because hydroelectricity, nuclear power, wind power, solar power and others are renewable energy sources, while coal-fired and gas-fired power is fossil fuel based.
[17] The Economic Census 2017, with reference to economic activities in 2016, was the most recent Economic Census available at the time of writing the paper.

3. Green jobs in Vietnam: characteristics, distribution, and potential for further greening

3.1. Which jobs are green in Vietnam? Occupations, industry, and evolution over time

Task-based approach

Using the task-based approach, 39 out of the 441 occupations in the LFS 2021 are green. The top five occupations with the highest green task intensity (GTI) index, in other words, the highest proportion of green tasks out of the total number of tasks, are environmental protection professionals, environmental engineers, refuse sorters, meteorologists, and rangers (professionals) (Table 1). The classification of some occupations may seem surprising, such as Plastic product machine operators. However, the occupation is included because one of its seven tasks is "recycling waste plastic materials," yielding a GTI index 14.2. Similarly, one of the nine tasks for Product and garment designers is "harmonizing aesthetic considerations with technical, functional, ecological and production requirements," yielding a GTI index of 11.1.

Green jobs comprise only a small share of total employment: 3.6 percent; accounting for 1.7 million jobs. These estimates corroborate existing findings employing similar complementary approaches, for example, in the US (2-6 percent, depending on different approaches and data sources; Georgeson and Maslin, 2019), Indonesia (2.3 percent; Granata and Posadas, 2022), and Cambodia (McKenna and Safir, forthcoming).

Table 1: Green occupations in Vietnam identified by the task-based approach

VSCO 2020	Occupational title	GTI (green)	Share of employment in 2021 (%)
2133	Environmental protection professionals	85.7	0.01
2143	Environmental engineer	83.3	0.03
9612	Refuse sorters	83.3	0.16
2112	Meteorologists	77.8	0.00
2445	Rangers (professionals)	75.0	0.04
9611	Garbage and recycling collectors	75.0	0.11
3132	Incinerator and water treatment plant operators	50.0	0.01
3355	Rangers (associate professionals)	50.0	0.01
7124	Insulation workers	50.0	0.03
3119	Physical and engineering science technicians not elsewhere classified	40.0	0.01
3257	Environmental and occupational health inspectors and associates	40.0	0.00
2131	Biologists, botanists, zoologists and related professionals	37.5	0.01
7234	Bicycle and related repairers	33.3	0.03
2263	Environmental and occupational health and hygiene professionals	30.0	0.00
2142	Civil engineers	28.6	0.27
2113	Chemists	25.0	0.01
2114	Geologists and geophysicists	25.0	0.01
2132	Farming, forestry and fisheries advisers	25.0	0.05
3112	Civil engineering technicians	22.2	0.06
6210	Forestry and related workers	22.2	0.18
3143	Forestry technicians	20.0	0.00
5409	Protective services workers not elsewhere classified	20.0	0.70
3111	Chemical and physical science technicians	16.7	0.01
3131	Power production plant operators	16.7	0.01
7122	Floor layers and tile setters	16.7	0.02
8182	Steam engine and boiler operators	16.7	0.01
7231	Motor vehicle mechanics and repairers	14.3	0.76
8142	Plastic products machine operators	14.3	0.28

9623	Meter readers and vending-machine collectors	14.3	0.00
2162	Landscape architects	12.5	0.01
2164	Town and traffic planners	12.5	0.02
2145	Chemical engineers	11.1	0.02
2149	Engineering professionals not elsewhere classified	11.1	0.04
2163	Product and garment designers	11.1	0.03
6221	Aquaculture workers	11.1	0.61
2141	Engineers in processing industry	10.0	0.03
1721	Agricultural, forestry, and aquaculture production managers in corporations,	8.3	0.00
1741	Agriculture, forestry, and aquaculture production managers in companies, firms, enterprises	8.3	0.02
Total			**3.60**

Source: World Bank staff calculation based on GTI toolkit and LFS 2021.

Note: The share in employment is the share (%) of total national employment in 2021, weighted by population weight. The sample includes a working-age population aged 15-64. It excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code not in VSCO 2020 (less than 0.01 percent of the sample).

Most green tasks performed by green occupations are related to natural resource conservation, climate change, and recycling and reuse of waste and materials (Table 2).[18] The green dictionary groups green and potential green terms into 14 main topic areas. Of the 39 green occupations, 27 contain green tasks that only fit into one topic area. The other 12 green occupations have tasks related to multiple topic areas. For example, environmental engineers perform green tasks related to the topic area of "climate change terms" (monitoring the progress of environmental improvement programs) and GHG reduction and pollution reduction and removal (advising corporations and government agencies of procedures to follow in cleaning up contaminated sites to protect people and the environment).

Table 2: Topic areas of green and potential tasks identified in Vietnam using the task-based approach

Topic areas of green tasks	Green tasks	Potential green tasks
Natural resource conservation	12	1
Climate change terms	16	0
Recycling and reuse of waste and materials	11	16
GHG reduction and pollution reduction and removal	5	1
Clean energy	5	0
Environmental regulations and compliance	3	0
Low-carbon mobility	1	5
Energy efficiency	1	2
Agriculture, forestry, and fish production	1	122
Repair	0	89
Multiple topic areas	41	2
Total green tasks	96	238

Source: World Bank staff calculation based on GTI toolkit

In addition to the 39 green occupations, another 88 occupations have the potential to become green. Potential green occupations have at least one task that includes a potential green term, such as "repair" and "crop." Most occupations with high potential GTI occupations are in medium-skilled agriculture and forestry (Table 3). Many workers are employed in occupations with the potential to become

[18] Topic areas include 1) Agriculture, forestry, and fish production, 2) Clean energy, 3) Climate change common terms, 4) Energy efficiency, 5) Environmental certifications, 6) Environmental knowledge, 7) Environmental regulations and compliance, 8) Environmental software, 9) GHG reduction and pollution reduction and removal, 10) Low-carbon mobility, 11) Low-polluting construction, 12) Natural resource conservation, 13) Recycling and reuse of waste and materials, and 14) Repair.

greener if green technologies are applied, for example, crop farm laborers (9.2 percent of total national employment in 2021) and house builders (4.5 percent of total national employment, Table 4).

Table 3: List of top ten potential green occupations, by potential GTI and by share in employment

VSCO 2020	Occupational title	Potential GTI	Share in employment
9205	Forestry laborers	88	0.80
6111	Field crop and vegetable growers	82	3.65
6112	Tree and shrub crop growers	82	3.24
3144	Aquaculture technicians	67	<0.01
6123	Apiarists and sericulturists	67	0.03
6114	Mixed crop growers	64	0.05
7233	Agricultural and industrial machinery mechanics and repairers	57	0.30
7412	Electrical mechanics and fitters	57	0.28
7422	Information and communications technology installers and servicers	57	0.09
8341	Mobile farm and forestry plant operators	57	0.06

Source: World Bank staff calculation based on GTI toolkit and LFS 2021.
Note: See Table 1.

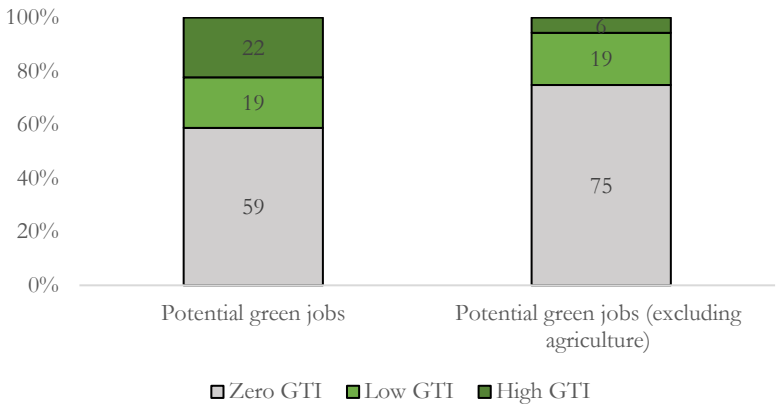
Table 4: List of top ten potential green occupations in Vietnam with the highest employment share

VSCO2020	Occupational title	Potential GTI	Share in employment
9201	Crop farm laborers	38	9.22
7111	House builders	14	4.47
6111	Field crop and vegetable growers	82	3.65
6112	Tree and shrub crop growers	82	3.24
8322	Taxi and van drivers	13	1.63
7531	Tailors, dressmakers, furriers, and hatters	18	1.55
9204	Garden and horticultural laborers	22	1.52
6121	Livestock and dairy producers	15	1.45
7212	Welders and flame cutters	13	1.06
8332	Heavy truck and lorry drivers	33	0.94
	Total (across top-10 potential GTI)		**28.72**
	Total other potential green occupations		**12.47**
	Total potential green occupations		**41.19**

Source: World Bank staff estimation based on GTI toolkit and LFS 2021.
Note: See Table 1.

These potential green jobs account for 41 percent of total employment, showing the significant benefits that can result from greening the Vietnam economy. With appropriate policy measures, for example, promoting high-tech farming and/or organic agriculture, a large share of the workforce can be mobilized in the green transition in Vietnam, especially for workers in agriculture. Even when the agriculture sector is excluded, one-fourth (25 percent) of non-agricultural jobs in Vietnam can become greener, which implies that the green transition in Vietnam can engage a significant number of non-farm workers (Figure 1).

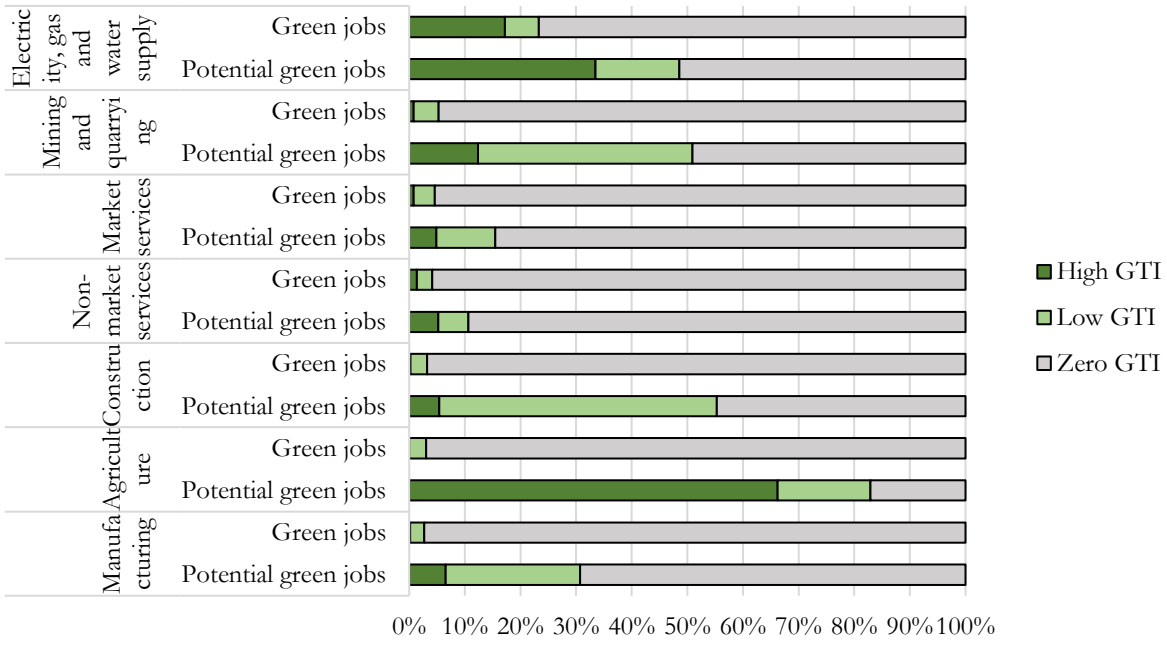
Figure 1: Prevalence of potential green jobs in Vietnam



Source: World Bank staff calculation using LFS 2021.
Note: The share of potential green jobs refers to the share of workers in potential green occupations identified by the task-based approach. High GTI refers to occupations with a GTI index above 30, Low GTI (0 < GTI index <30), and Zero GTI (GTI index=0). On sample size, see Table 1.

As defined by the task-based approach, green jobs exist in all industries, further indicating the vast areas of interventions to green the economy. Industries with the highest concentration of green jobs are electricity, gas, and water supply (23 percent), mining and quarrying (five percent), as well as market services (five percent) (Figure 2). These industries might not provide environmental goods and services directly, but they include green occupations: for example, Environmental engineers and Environmental protection professionals in Mining and quarrying. Moving to potential green jobs, agriculture has the highest concentration of such jobs, at 83 percent. Greening has considerable potential considering the high share of employment in this sector.

Figure 2: Concentration of green jobs and potential green jobs within broad industry groups



Source: World Bank staff calculation using LFS 2021
Note: See Figure 1.

Output-based approach

From the output-based approach, 40 of the 460 industries in the LFS 2021 are classified as green and another 58 as "mixed", henceforth all classified as green (Table 5). Green industries tend to concentrate in services (57 percent of 40 green industries) and manufacturing (37 percent). In more detail, these industries mainly include water supply and sewerage, manufacturing, as well as professionals, and other service activities. Mixed industries can partly contribute to protecting the environment or conserving natural resources while also generating negative impacts on the environment. An example of a mixed industry is electric power generation, which includes hydroelectricity, coal-fired, gas-fired, nuclear, wind, and solar power. While hydroelectricity, nuclear power, wind power, and solar power are renewable energy sources, coal-fired and gas-fired power is fossil fuel based and hence contributes to the generation of GHG emissions. The number of jobs in green industries accordingly includes the total number of jobs in green industries and a weighted number of jobs in mixed industries (see Table A9 in the Appendix for the full list of industries classified as mixed).[19]

Table 5: List of green industries in Vietnam identified by the output-based approach

Broad Industry group	VSIC 2018	VSIC 2018 Title	Share in employment
Agriculture	210	Silviculture and other forestry activities and propagation of forest trees	0.56
	240	Support services to forestry	0.02
		Total green industries in Agriculture	**0.58**
		Total mixed industries in Agriculture	**0.00**
Manufacturing	3311	Repair of fabricated metal products	0.01
	3312	Repair of machinery and equipment	0.06
	3313	Repair of electronic and optical equipment	0.02
	3314	Repair of electrical equipment	0.06
	3315	Repair and maintenance of transport equipment, except motor vehicles, motorcycles and other motor vehicles	0.04
	3319	Repair of other equipment	0.02
		Total green industries in Manufacturing	**0.21**
		Total mixed industries in Manufacturing	**0.57**
Electricity, gas and water supply	3600	Water collection, treatment and supply	0.11
	3700	Water drainage and wastewater treatment	0.02
	3811	Collection of non-hazardous waste	0.16
	3812	Collection of hazardous waste	0.00
	3821	Treatment and disposal of non-hazardous waste	0.02
	3822	Treatment and disposal of hazardous waste	0.00
	3830	Materials recovery	0.03
	3900	Remediation activities and other waste management services	0.00
		Total green industries in Electricity, gas and water supply	**0.35**
		Total mixed industries in Electricity, gas and water supply	**0.05**
Construction	4222	Construction of water supply and drainage works	**0.04**
		Total Other green industries in Construction	**0.10**

[19] The weights are estimated based on the share of green and non-green products in Vietnam.

Market services	4520	Maintenance and repair of motor vehicles and other motor vehicles	0.26
	4542	Maintenance and repair of motorcycles	0.53
	4774	Retail sale of second-hand goods in specialized stores	0.02
	4921	Passenger transport by urban buses	0.02
	4922	Passenger transport by urban, suburban and inter- provincial buses	0.02
	4929	Passenger transport by other buses	0.00
	4931	Urban and suburban passenger land transport (except transport via buses)	0.97
	7010	Activities of head offices	0.00
		Total green industries in Market services	**1.83**
		Total mixed industries in Market services	**0.27**
Non-market services	7211	Research and experimental development on natural sciences	0.01
	7212	Research and experimental development on engineering and technology	0.01
	7213	Research and experimental development on medical sciences	0.00
	7214	Research and experimental development on agricultural sciences	0.00
	8130	Landscape care and maintenance service activities	0.05
	8541	University training	0.19
	8542	Master training	0.02
	9103	Botanical and zoological gardens and nature reserves activities	0.01
	9511	Repair of computers and peripheral equipment	0.05
	9512	Repair of communication equipment	0.03
	9521	Repair of audiovisual and consumer electronics	0.17
	9522	Repair of household appliances and goods	0.12
	9523	Repair of footwear and leather goods	0.01
	9524	Repair of furniture and home furnishings	0.00
	9529	Repair of bicycles, watches, clocks and other personal and household goods n.e.c	0.09
		Total green industries in Non-market services	**0.75**
		Total mixed industries in Non-market services	**0.03**
		Total employment in green industries (incl. mixed)	**4.77**

Source: World Bank staff estimation based on BLS green classification and LFS 2021.

Note: See Figure 1.

At 4.8 percent of total workers and 2.2 million workers, the share of workers in green industries is slightly larger than the share of workers in green jobs (3.6 percent), but one needs to be mindful of the caveat that jobs in green industries may not be green. Even with our conservative classification of industries, the output-based approach has the disadvantage of including all workers in an industry, including counting workers that do not carry out a green task, for instance, a receptionist in a solar panel manufacturing plant. With this caveat in mind, the output-based approach nevertheless has the advantage of informing sectoral policies, particularly when these industries involve large numbers of workers. In Table 5, we see that green industries with the highest share of employment in 2021 are Urban and suburban passenger land transport (one percent), Silviculture and other forestry activities and propagation of forest trees (0.6 percent), Maintenance and repair of motorcycles (0.5 percent). Although some workers in these industries might not perform green tasks or use green skills, the green transition will have implications for

these jobs, for example, by increasing demand. Box 3 discusses the growth potential of jobs in renewable energy in Vietnam in response to the Government's recent policies to drive growth in the industry.

Box 3: Expansion of the renewable energy industry in Vietnam

There has been a rapid expansion of renewable energy industries in Vietnam in recent years, predominantly among solar and onshore wind energy. The government's policies have incentivized the expansion of the renewable energy industries. Under Politburo's Resolution 55 on the *Orientation of the National Energy Development Strategy by 2030* (Resolution 55), renewable energy is expected to form 15 to 20 percent of the primary energy mix by 2030, to 25-30 percent in 2045.

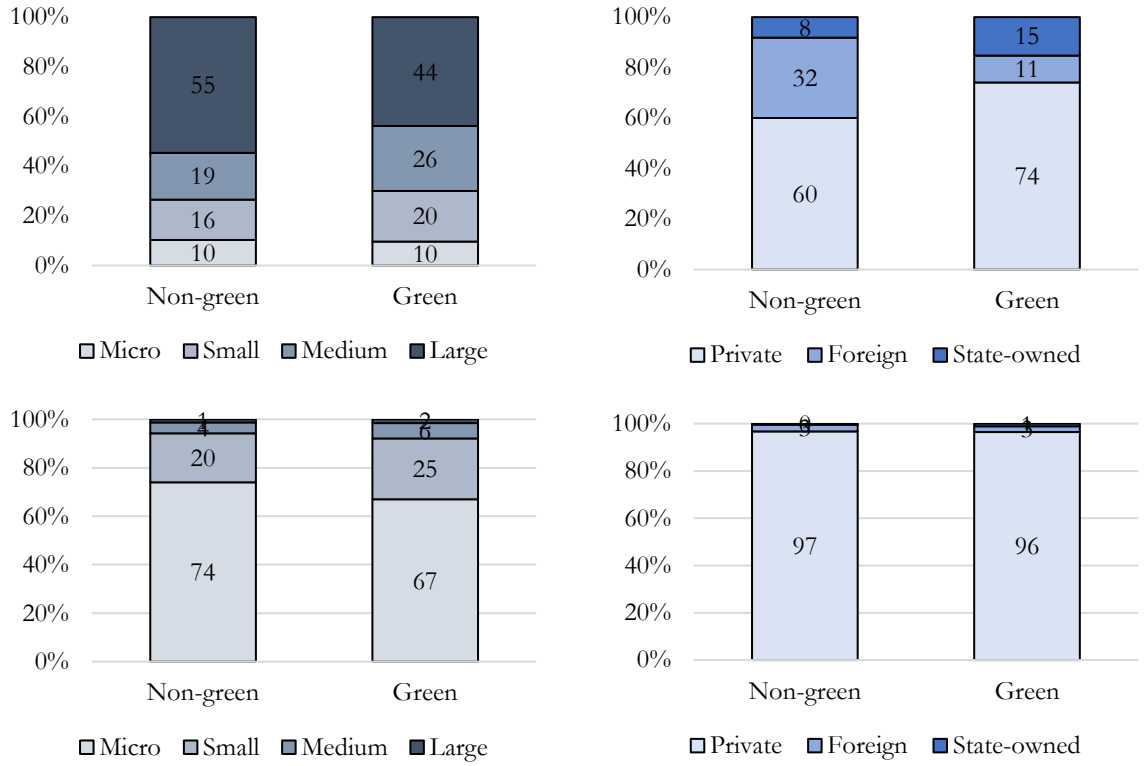
The expansion of domestic solar installations has been primarily induced by introducing high feed-in tariffs (FIT) for solar energy. FIT aims to accelerate investments in renewable energy technologies by offering cost-based compensation to renewable energy producers, thereby providing price certainty and long-term contracts to incentivize investments in renewable energy. The FIT for solar energy was introduced in 2019 at 9.35 US cents/kWh, reduced to 8.38 US cents/kWh in 2020, exclusively for solar rooftops (Nguyen 2022). The introduction of the FIT saw total capacity spurred from just 105 MW in 2018 to 17 GW in 2020 (Do et al. 2020). The unprecedented installations in 2020 resulted in significant economic activity and job creation. As installations shot up, the number of jobs in solar energy rose to 126,300 in 2020 (IRENA and ILO 2022) from less than 20,000 in 2018 (IRENA 2019). However, in 2021, the lack of installations and limited rooftop additions, in combination with the COVID-19 pandemic, led to a sizable reduction in the workforce, estimated to decline to 31,7000 jobs (IRENA and ILO 2022). This fluctuation indicates the vulnerability of these jobs, calling for lower uncertainty for investment in the industry.

Highly integrated into the global supply chains, renewable energy has driven Vietnam's trade in environmental products.[20] Between 2000 and 2020, the annual average growth of environmental goods export was 48 percent, and that of environmental goods import was 22 percent (World Bank 2022b). Exports of renewable energy products increased from US$ 3.5 million in 2002 to US$5.1 billion in 2020, accounting for more than half of total environmental goods exports. In parallel with increasing investment from foreign and domestic investors in renewable energy, the growing demand from abroad will likely create new jobs and require multiple skills. However, the high exposure to the global market could, at the same time, increase vulnerability, as jobs in the industries will be more vulnerable to international shocks.

There are no significant differences between firms across green and non-green industries regarding size or ownership. However, there are differences when weighing by workers, indicating that interventions with MSMES could support greening across many workers. Examining only the number of firms, there are no significant differences between firms in green and non-green industries (Figure 3, bottom panel). However, there are some differences when we weigh the number of workers in each firm: Firms in green industries are more likely to be small and medium compared to non-green industries (Figure 3). It has been shown that micro, small, and medium-sized enterprises (MSMEs) can play a key role in the greening of the economy due to their large quantity and high adaptability to adopt green technologies (ITC 2021; OECD 2018).

[20] Environmental products as per an Asia-Pacific Economic Cooperation and the WTO definition (World Bank 2022b).

Figure 3: Distribution of firms in green industries, by firm size and type of ownership (weighted by the number of workers in the top panel, unweighted in the bottom panel)

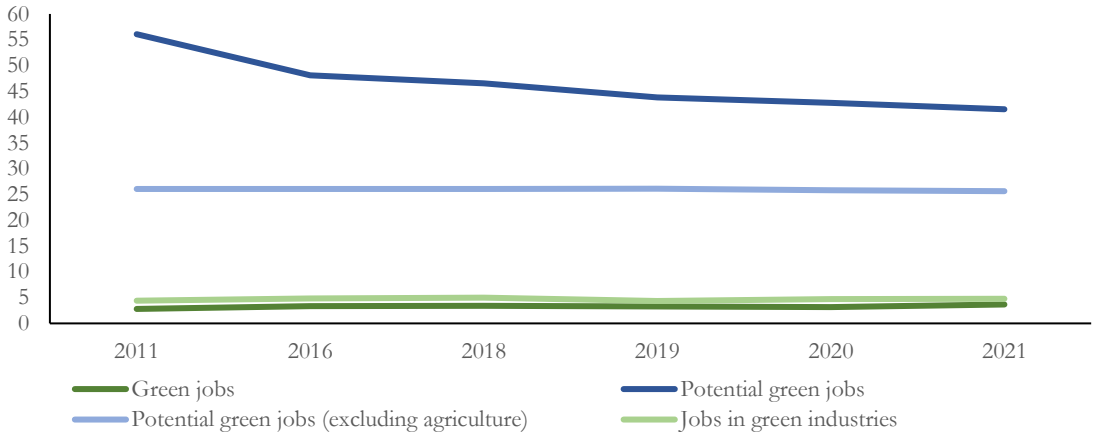


Source: World Bank staff calculation using Economic Census 2017.
Note: The sample includes formal business establishments operating in all economic forms except household businesses in agriculture, forestry, fishing, diplomatic missions, embassies, consulates, and international organizations. Firm size is based on the firm's labor, including the self-employed (zero workers outside of business owner), at the beginning of the reference year (2016). Micro: less than ten workers, small: 10-49 workers, medium: 50-249 workers, large: more than 250 workers.

Time trends

The share of green jobs has been stable between 2016 and 2021, indicating their resilience to shocks such as COVID-19; however, the share of potential green jobs has decreased. Green jobs increased from 2.8 percent in 2011 to 3.3 percent in 2016 and have been stable ever since, varying between 3.4 and 3.6 percent between 2018 and 2021 (Figure 4). On the other hand, the share of jobs with potential green has been declining from 56 in 2011 to 48 in 2016 to 41 percent in 2021. The declining trend is due to the structural change away from agriculture that has occurred since the mid-2000s, and most jobs with green potential concentrate on skilled agriculture, forestry, and fishery. When agriculture is excluded, the share of potential green jobs becomes relatively stable, around 26 percent. The share of jobs in green industries has also been relatively stable over the same period, from 5.0 percent in 2018, slightly declining to 4.3 percent in 2019, and increasing to 4.7 percent in 2020 and 4.8 percent in 2021. Interestingly, Vietnam's share of green jobs and jobs in green industries did not decline during the pandemic. The finding implies that green jobs and jobs in green industries can be resilient during economic shocks, and the green transition can be an essential tool for economic recovery (ITC 2021).

Figure 4: Share of green, potential green, and jobs in green industries 2011, 2016, and 2018-2021



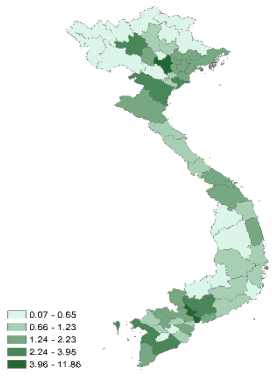
Source: World Bank staff calculation using LFS 2011, LFS 2016, LFS 2018-2021.
Note: The sample includes working age population aged 15-64 and excludes observations in high-level officials, military (0.63 percent of the sample in the LFS 2011, LFS 2016, LFS 2018-2021), and occupations that seem to have a wrong code that is not in VSCO 2020 (less than 0.01 percent of the sample in the LFS 2021) or VSCO 2008 (0.05 percent of the sample combining the LFS 2011, LFS 2016, LFS 2018-2020).

3.2. Where are the green jobs?

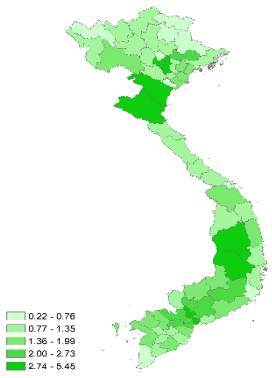
Green jobs in Vietnam are more likely located in the Red River Delta, the Northern and Southern Central Coast, and the Mekong River Delta regions, while potential green jobs are more spread out. Jobs in green industries also tend to be located in regions with a high share of green jobs, albeit with a lower intensity, e.g., in the Northern and Southern Coast and the Southeast (Figure 5). Jobs with green potential are more spread out across the country, which is not surprising given that a lot of them are in agriculture, which is spread out.

Figure 5: Share of green and potential green jobs and jobs in green industries

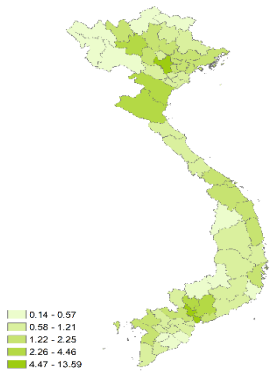
Panel A: Green jobs



Panel B: Potential green jobs



Panel C: Jobs in green industries



Source: World Bank staff calculation using LFS 2021.
Disclaimer: The map shown is for illustration purpose. The boundaries, color, denominations, and other information shown on any map in this work do not imply any judgement on the part of the World Bank Group concerning the legal status of any territory or the endorsement or acceptance of such boundaries.
Note: On sample size, see Table 1. The share of green and potential green jobs and jobs in green industries is the share of the total number of green/potential green/jobs in the country found in each province and adds up to one for each map.

A deeper look into the provinces shows that green jobs are more likely to be located in major cities where diverse economic activities cluster. Out of the 1.7 million green jobs estimated in Vietnam in

2021, 11.9 percent are in Ho Chi Minh City, and 10.0 percent are in Hanoi (Table 6). Other provinces with a high share of green jobs are Binh Duong (3.9 percent), Thanh Hoa (3.2 percent), and Bac Lieu (3.2 percent). These large cities attract more high- and medium-skilled jobs. Hence, observing a higher share of green jobs in these cities is unsurprising, given that green jobs tend to be higher skilled (see Section 4).

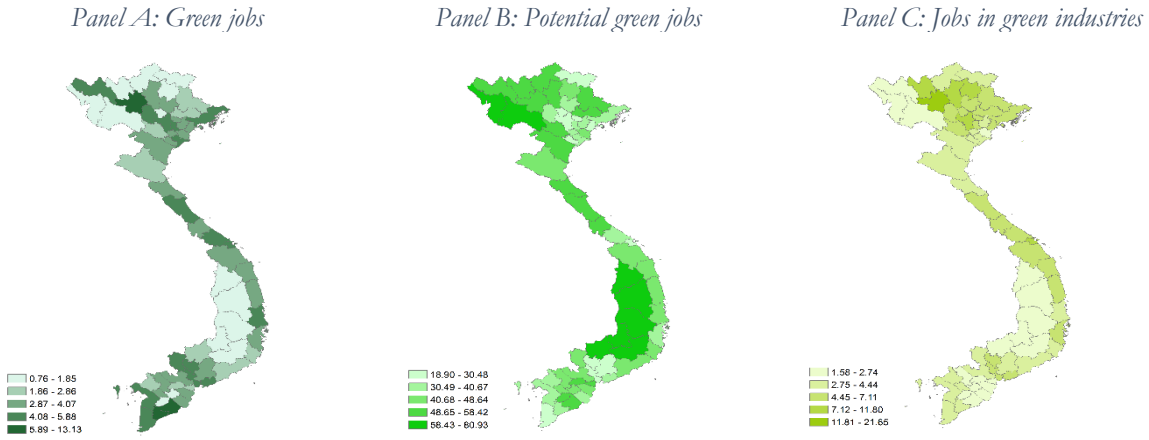
Table 6: Ten provinces with the highest share of green jobs and comparison with the share of all jobs

Province name	Share of green jobs	Share of all jobs
Ho Chi Minh City	11.9	9.1
Ha Noi City	10.0	7.9
Binh Duong	3.9	3.5
Thanh Hoa	3.2	3.9
Bac Lieu	3.2	1.0
Dong Nai	3.1	3.6
Kien Giang	2.9	1.8
Soc Trang	2.8	1.2
Yen Bai	2.7	0.7
Nam Dinh	2.4	1.8

Source: World Bank staff calculation using LFS 2021.
Note: See Figure 5. The share of total jobs is the total number of jobs in the country found in the province.

Similarly to the share of green jobs out of the country total, regions with higher intensity of green jobs – meaning a higher share of green jobs out of total jobs in the province, remain the Red River Delta, the Mekong River Delta, and the North Central Coast and South Central Coast regions (Figure 5).[21] These regions also have a high intensity of green jobs (Figure 6). Potential green jobs, on the other hand, are more likely to be dominant in provinces in the Northwest and Central Highland regions, which reflects the high intensity of jobs in agriculture and forestry in these regions, and is consistent with the high rate of poverty in these mountainous areas (World Bank 2022a). The results imply that with proper measures to make them green, potential green jobs can engage many vulnerable workers in the green transition.

Figure 6: Provincial intensity of green and potential green jobs and of jobs in green industries in 2021



Source: World Bank staff calculation using LFS 2021.
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[21] The intensity of green jobs is the share of green jobs to the number of total jobs in the province. Similar measures are calculated for potential green jobs and jobs in green industries. The measures reflect each province's greenness in terms of employment.

Note: On sample size, see Table 1. The provincial intensity of green jobs is the share of total jobs in the province that are green. Similar measures are calculated for potential green jobs and jobs in green industries.

The three provinces with the highest intensity of green jobs are Bac Lieu, Soc Trang, and Yen Bai; Bac Lieu is illustrative that green growth investments can generate good jobs. Bac Lieu ranks second in terms of share of green jobs as well as green jobs intensity in 2021, potentially due to the province's high share of the workforce in high-technology agriculture and aquaculture (such as high-technology shrimp farming) and renewable energy (Table 7, see Box 4 on Bac Lieu's green growth strategy). Yen Bai, a province with large forest areas in the Northwest region, ranks among the top in the intensity of green jobs because of the high share of the province's workforce in forestry (54 percent of total provincial employment).

Table 7: Top ten provinces with the highest intensity of green jobs in Vietnam in 2021

Province name	Intensity of green jobs (% out of total jobs in the province)	Share of green jobs (% out of total green jobs in the country)	Share of total jobs (% out of total jobs in the country)
Yen Bai	13.1		0.7
Bac Lieu	12.2		1.0
Soc Trang	8.5		1.2
Kien Giang	5.9		1.8
Quang Ninh	5.5		1.3
Quang Binh	5.1		0.8
Da Nang City	5.1		1.1
Ca Mau	5.0		1.2
Phu Tho	5.0		1.3
Ba Ria-Vung Tau	4.8		1.2

Source: World Bank staff calculation using LFS 2021.

Note: See Figure 6. The share of total jobs is the share of total green jobs in the country found in the province.

Box 4: Bac Lieu Province's strategy for green growth

To transform the economic structure towards green and sustainable growth, the province of Bac Lieu has chosen renewable energy as one of the top priority areas for strategic development. Specifically, the province focuses on attracting investment in industrial development of the renewable energy sector**,** including wind and solar energy and liquefied natural gas. Bac Lieu has the potential to develop the renewable energy sectors thanks to the province's long coastline, year-round sunny weather, and flat terrain. In addition to renewable energy, the other priority area for strategic development is agricultural development with a focus on hi-tech agriculture, improving the efficiency of shrimp and rice production.

Bac Lieu has become the leader in renewable energy in the Mekong Delta region and continues to attract significant investment (Viet Nam News 2023)**.** In late 2016, Bac Lieu proposed that the Government withdraw the Cai Cung thermal power plant project from the comprehensive power planning VII due to its potential risks to the province's environment. The move draws investment from new domestic and foreign businesses to renewable energy in the province. By the end of 2020, registered investment capital in renewable energy in Bac Lieu reached USD 5 billion. Since 2021, many renewable energy projects in the province have been put into service. In 2022, the province had eight operating wind energy farms onshore and offshore, with a total capacity of 469 MW, ranking third in the country.

Bac Lieu's focus on renewable energy attracts capital investment from foreign and domestic firms and can create jobs directly employed in the sector and support service industries. This would, in turn, contribute to creating green jobs and upgrading workers' skills in Bac Lieu province. In

2022, the Provincial People's Committee promulgated Implementation Plan 125/KH-UBND to support the development of the labor market until 2030. The plan includes several targets, the majority of which can be delivered by investing in green jobs, for example, (i) increase the number of skilled workers in line with labor market needs, (ii) create better jobs for workers (maintaining low unemployment rate, reducing the share of laborers working in agriculture), (iii) ensure a safe working environment for employees (increase participation in social insurance), (iv) invest in and develop job transactions and labor market information systems.

On the other hand, the Northwest, Northeast, and Central Highlands regions are lagging in share and intensity of green jobs while also being among the poorest regions, indicating potential benefits from greening. The provinces with the lowest intensity of green jobs tend to concentrate in these regions (Table 8), and these provinces are among those with the highest poverty rates. More specifically, six out of the top ten provinces with the lowest share of green jobs in 2021 are also among the top ten provinces with the highest poverty rate, namely Dien Bien, Son La, Bac Kan, Kon Tum, Gia Lai and Lao Cai (GSO 2021).

Table 8: List of ten provinces with the lowest intensity of green jobs in Vietnam

Province name	Intensity of green jobs	Share of jobs
Dien Bien	0.8	0.6
Bac Kan	1.0	0.3
Vinh Long	1.0	1.1
Gia Lai	1.0	1.9
Son La	1.1	1.1
Kon Tum	1.3	0.6
Dak Lak	1.3	2.3
Dak Nong	1.3	0.8
Hau Giang	1.4	0.7
Lao Cai	1.5	0.8

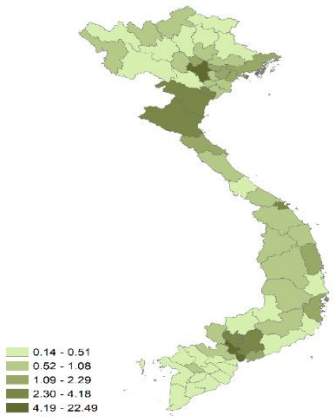
Source: World Bank staff calculation using LFS 2021.

Note: See Figure 7

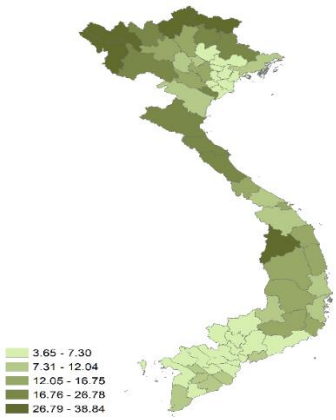
Firms in green industries tend to be located in regions where economic activities are concentrated. Still, the share of firms in green industries tends to be higher in the Northwest, the North Central Coast, and the Central Highlands region (Figure 7). The two large cities, Hanoi and Ho Chi Minh City attract 38 percent of firms in green industries, at 22 percent and 16 percent, respectively. The high share of firms in green industries in these two cities reflects the high share of firms in all industries, at 16 percent in Hanoi and 21 percent in Ho Chi Minh City. Interestingly, provinces with the highest intensity of firms in green industries are those located in regions that are less economically developed, with high rates of poverty, such as Ha Giang (39 percent of total firms in the province are in green industries), Dien Bien (33 percent), and Cao Bang (32 percent). The surprising results could be explained by the relatively small number of firms in these provinces included in the Economic Census, which only covers registered firms.

Figure 7: Share and intensity of firms in green industries, weighted by the number of workers

Panel A: Share of firms in green industries



Panel B: Intensity of firms in green industries



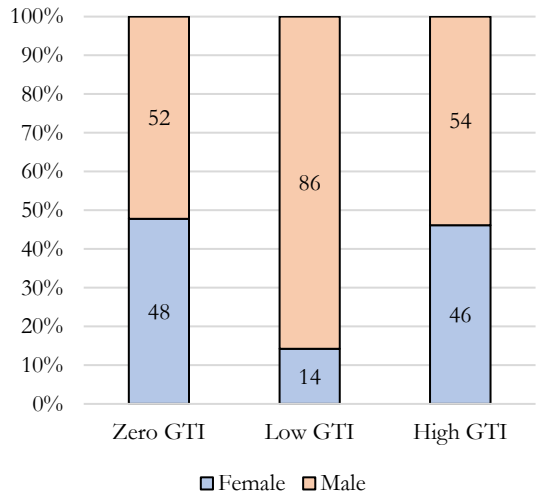
Source: World Bank staff calculation using Economic Census 2017.
Disclaimer: The map shown is for illustration purpose. The boundaries, color, denominations, and other information shown on any map in this work do not imply any judgement on the part of the World Bank Group concerning the legal status of any territory or the endorsement or acceptance of such boundaries.
Note: The share of firms in green industries is the share of provincial firms in green industries to national firms in green industries. The intensity of firms in green industries is the share of firms in green industries to the total number of firms in each province. Both estimations are weighted by the number of workers per firm.

3.3. Who has access to green jobs?

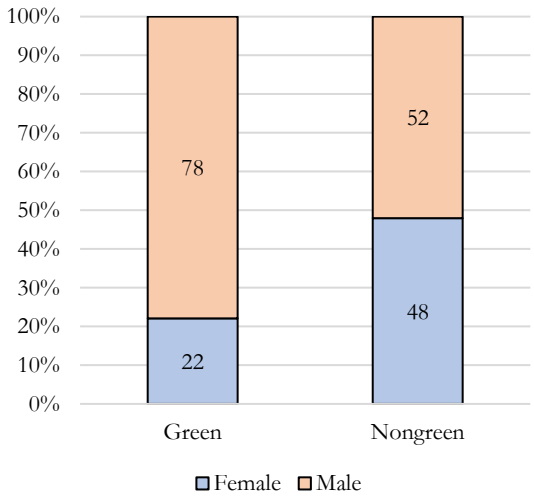
Green jobs are much more male-dominated than non-green jobs. More than 80 percent of green jobs are held by men, compared with 52 percent of non-green jobs, although male domination decreases among jobs with higher GIT (Figure 8, Panel A). Consistent with the task-based approach, jobs in green industries identified by the output-based approach are also male-dominated: Jobs in green industries employ 78 percent male workers, compared to 52 percent male workers in non-green industries (Figure 8, Panel B). Similarly, potential green jobs are dominated by males (Figure 8, Panel C), more so when agriculture is excluded (Figure 8, Panel D).

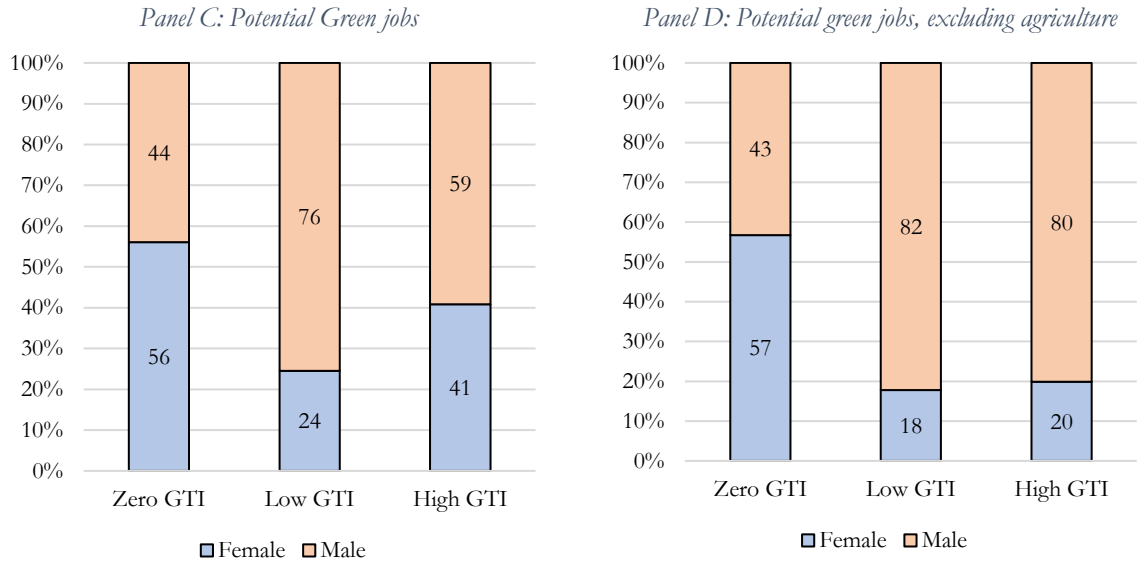
Figure 8: Gender distribution of green and potential green jobs, and jobs in green industries, in 2021

Panel A: Green jobs



Panel B: Jobs in green industries

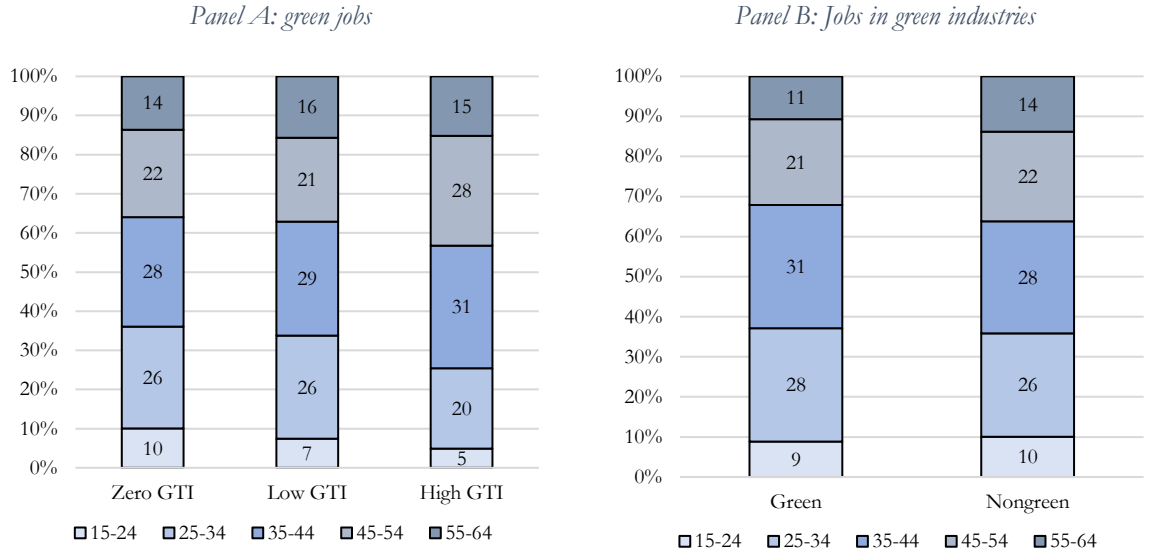




Source: World Bank staff calculation using LFS 2021.
Note: High GTI refers to occupations with a GTI index above 30, Low GTI (0 < GTI index <30), and Zero GTI (GTI index=0) for both green occupations and potential occupations, separately. The sample includes the working-age population aged 15-64. It excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code not in VSCO 2020 (less than 0.01 percent of the sample).

Green jobs, especially those with higher intensity, employ older workers than non-green jobs. For example, the share of workers under 35 years old is 25 percent in jobs with a high GTI versus 36 percent in non-green jobs (Figure 9, Panel A). While this difference does not hold for jobs with low GTI or jobs in green industries, the older age distribution of green jobs might imply barriers to entering green jobs for younger workers.

Figure 9: Age distribution of workers in green jobs and of jobs in green industries

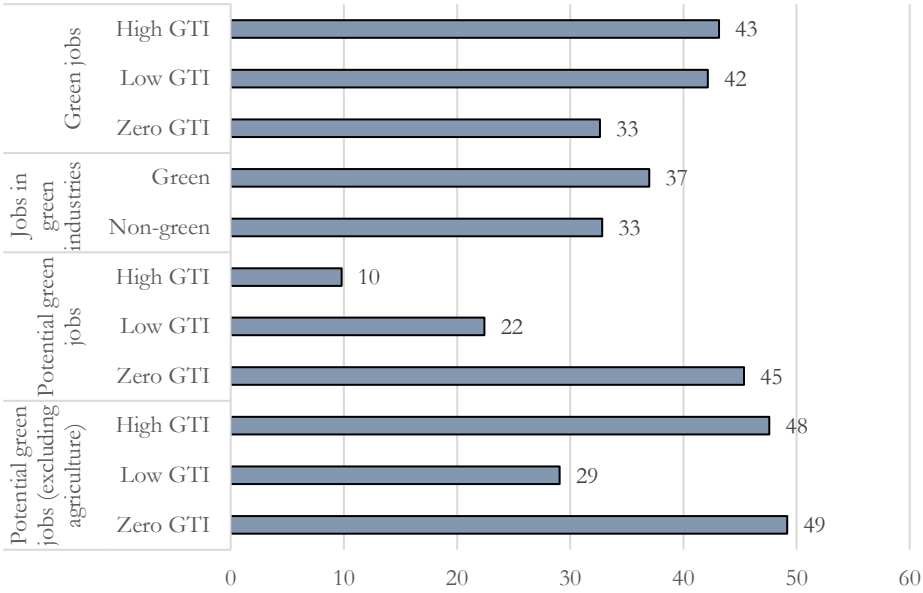


Source: World Bank staff calculation using LFS 2021
Note: High GTI refers to occupations with a GTI index above 30, Low GTI (0 < GTI index <30), and Zero GTI (GTI index=0). The sample includes the working-age population aged 15-64. It excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code not in VSCO 2020 (less than 0.01 percent of the sample).

3.4. Are green jobs better jobs? Wage premium and job quality

Green jobs are more likely to be formal than non-green jobs, while potential green jobs are less formal, even when excluding agriculture. About 43 percent of green jobs are formal, versus 33 percent of non-green jobs, where formal jobs are defined per the contribution to social security (Figure 10).[22] The share of formality of jobs in green industries is also higher than that of jobs in non-green industries, albeit to a lesser degree than green jobs (37 percent versus 33 percent). On the other hand, potential green jobs are not necessarily more formal than jobs without green potential. The low incidence of formality among potential green jobs reflects the high concentration of potential jobs in the agriculture, forestry, and fishery sector. However, even when excluding the agriculture sector, potential green jobs are less formal than the national average.

Figure 10: Share of formality among green jobs, potential green jobs, and jobs in green industries



Source: World Bank staff calculation using LFS 2021.

Note: High GTI refers to occupations with a GTI index above 30, Low GTI (0 < GTI index <30), and Zero GTI (GTI index=0) for both green occupations and potential occupations, separately. The sample includes the working-age population aged 15-64. It excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code not in VSCO 2020 (less than 0.01 percent of the sample). Formal employment refers to employees contributing to social security, employers, own-account workers, and cooperative members in formal production units. A production unit is formal if the firm is registered; all State-owned enterprises (SOEs) are assumed to be registered and hence formal.

However, green jobs in Vietnam do not seem to provide a wage premium. Controlling for demographic characteristics (age, gender), geographic location (province), educational attainment, and industrial sector of the individual, green jobs do not pay more than non-green jobs (see Table A12 in Appendix B for the regression results) and, for some occupations, pay less, in particular for managers, service and sales workers, and plant and machine operators.[23] The finding is surprising, given the higher formality rate of green jobs and, as later seen in Section 4, the higher skill profile of green jobs.

[22] ILO definition also includes having a work contract as a characteristic of a formal job. In our data, 88 percent of workers with a contract also have access to social security.

[23] The findings are robust when the agriculture industry is excluded, and when the sample is winsorized at one percent and five percent (in order to remove outliers).

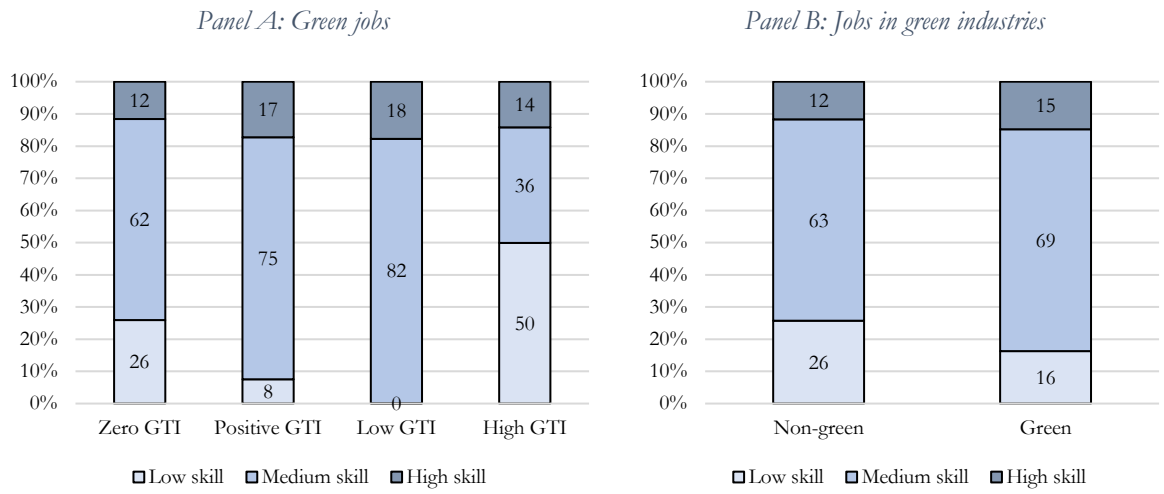
This finding differs from what has been found in previous studies using similar approaches, although these are primarily in high-income countries. For example, Vona, Marin, and Consoli (2019) show that green jobs in the US during 2006-2014 were highly skilled, commanded a four percent wage premium and the wage premium is higher among lower-skilled workers. In the UK, green jobs are associated with a wage premium, particularly at lower skill levels, even after controlling for the education and work experience of the individual (Valero et al. 2021). Using the broader definition of green jobs as defined by O*NET, Bowen, Kuralbayeva, and Tipoe (2018) find that in the US, low- and medium-skilled green jobs tend to pay higher wages than other jobs with the same skill level, but that for high-skilled jobs, the picture is somewhat mixed.[24]

4. Skills Requirements for Green Jobs

4.1 Skill profile of green jobs – evidence from the LFS

Green jobs and jobs in green industries are higher-skilled. The share of medium- and high-skilled occupations among green jobs is higher than that of non-green jobs, at 92 percent and 74 percent, respectively (Figure 11, panel A), which matches what has been found in high-income countries using similar approach, such as the United States (Vona et al. 2018) and the United Kingdom (Valero et al. 2021). The proportion of medium- and high-skilled jobs is also higher in green industries: 84 percent, as opposed to 75 percent in non-green industries (Figure 11, panel B).

Figure 11: Skill level distribution of green jobs, and of jobs in green industries, in 2021



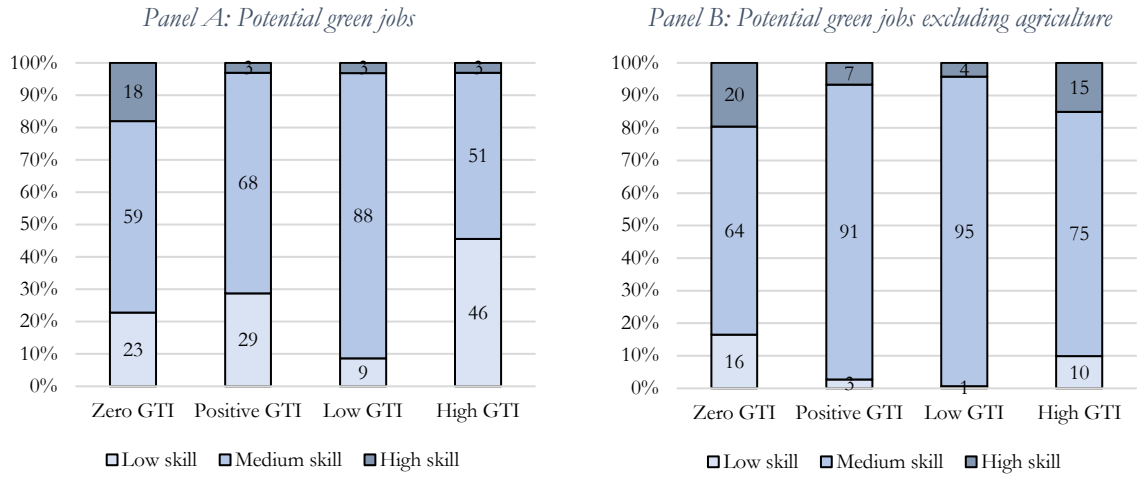
Source: World Bank staff calculation using LFS 2021
Note: The sample includes working age population aged 15-64 and excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code that is not in VSCO 2020 (less than 0.01 percent of the sample). High-skill includes "Managers", "Professionals", and "Technicians and associate professionals"; Medium-skill includes "Clerical support workers", "Skilled agricultural, forestry and fishery workers", "Craft and related trades workers", and "Plant and machine operators"; and Low-skill includes "Elementary occupations"

Jobs with green potential are more likely to be medium-skilled occupations, especially when excluding agriculture. A total of 68 percent of potential green jobs are medium-skilled compared to 59

[24] O*NET defines any occupation that will be affected by the green transition as a green job, including three subcategories according to the effect that greening will have on the tasks, skills, and knowledge required for the job. These are "(i) Green Increased Demand: existing jobs that are expected to be in high demand due to greening, but do not require significant changes in tasks, skills, or knowledge; (ii) Green Enhanced Skills: existing jobs that require significant changes in tasks, skills, and knowledge as a result of greening; (iii) Green New and Emerging: unique jobs (as defined by worker requirements) created to meet the new needs of the green economy" (O*NET 2010).

percent without green potential (Figure 12, Panel A). Compared with green jobs, potential green jobs are less likely to be high-skilled, at 3 percent of potential green jobs, versus 17 percent of green jobs. The large share of potential green jobs in agriculture, fishery, and forestry partly explains the lower skill profile compared to green jobs. When the agriculture sector is excluded, the share of high-skilled potential green jobs increases to seven percent, albeit remains lower than that of high-skilled workers in green jobs (Figure 12, Panel B). This suggests that creating green jobs in combination with appropriate skills development policies can help upgrade workers' skills.

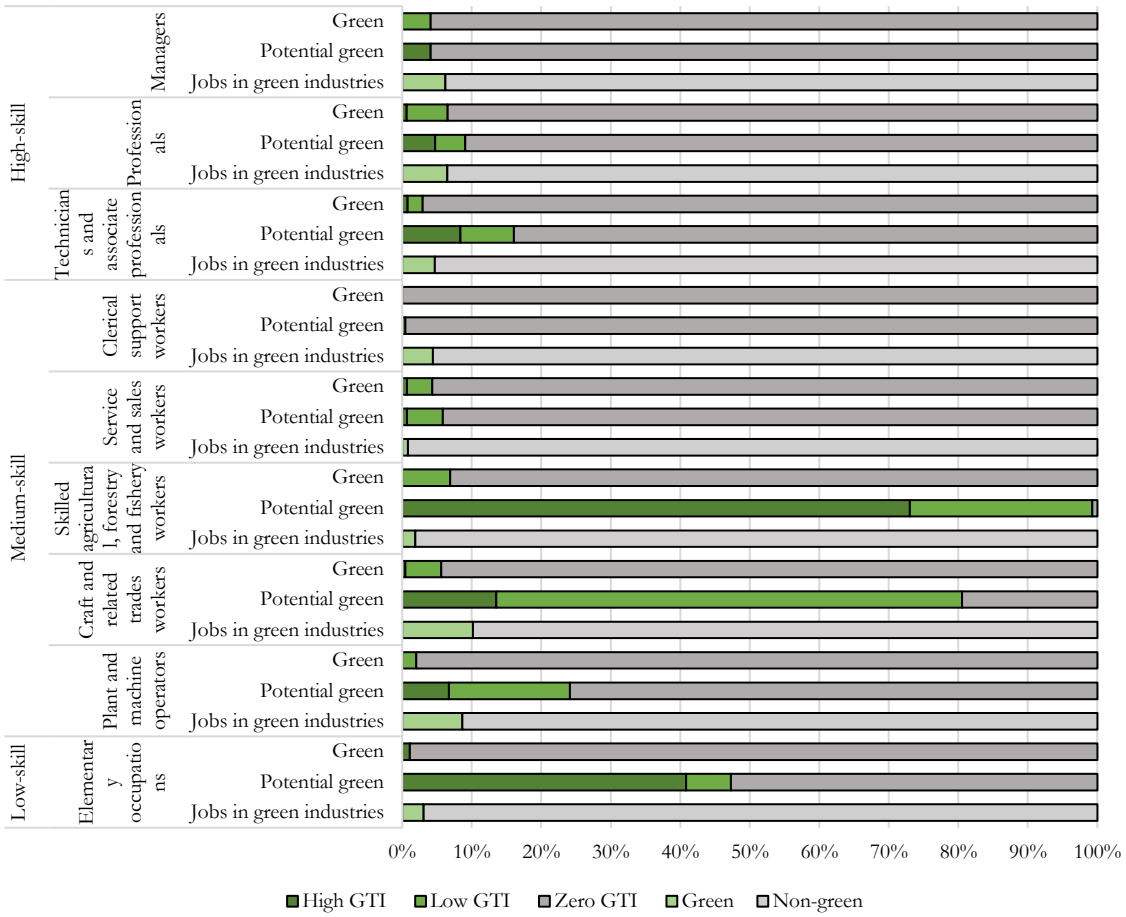
Figure 12: Skill level distribution of potential green jobs, including and excluding agriculture, in 2021



Source: World Bank staff calculation using LFS 2021
Note: The sample includes working age population aged 15-64 and excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code that is not in VSCO 2020 (less than 0.01 percent of the sample). High-skill includes "Managers", "Professionals", and "Technicians and associate professionals"; Medium-skill includes "Clerical support workers", "Skilled agricultural, forestry and fishery workers", "Craft and related trades workers", and "Plant and machine operators"; and Low-skill includes "Elementary occupations"

Looking deeper at the occupational distribution, occupation groups with the highest share of green jobs are in skilled agricultural, forestry and fishery occupations, professional occupations and craft and related trade occupations (Figure 13). Jobs in craft and related trade have the highest share of jobs in green industries, at 10 percent; plant and machine operators are second with nine percent of jobs in green industries. As mentioned, most skilled agriculture, forestry, and fishery jobs possess green potential (99 percent). These jobs include, for example, field crop and vegetable growers, mixed crop growers, forestry and related workers, and aquaculture workers, among other things. Given that the agriculture sector remains a crucial role in economic development in Vietnam, investment in greening the industry, for example, through sustainable agriculture, climate-smart agriculture, and high-technology agriculture, can increase the skills of many workers and improve their livelihood.

Figure 13: Occupational distribution of green jobs, potential green jobs, and of jobs in green industries, in 2021

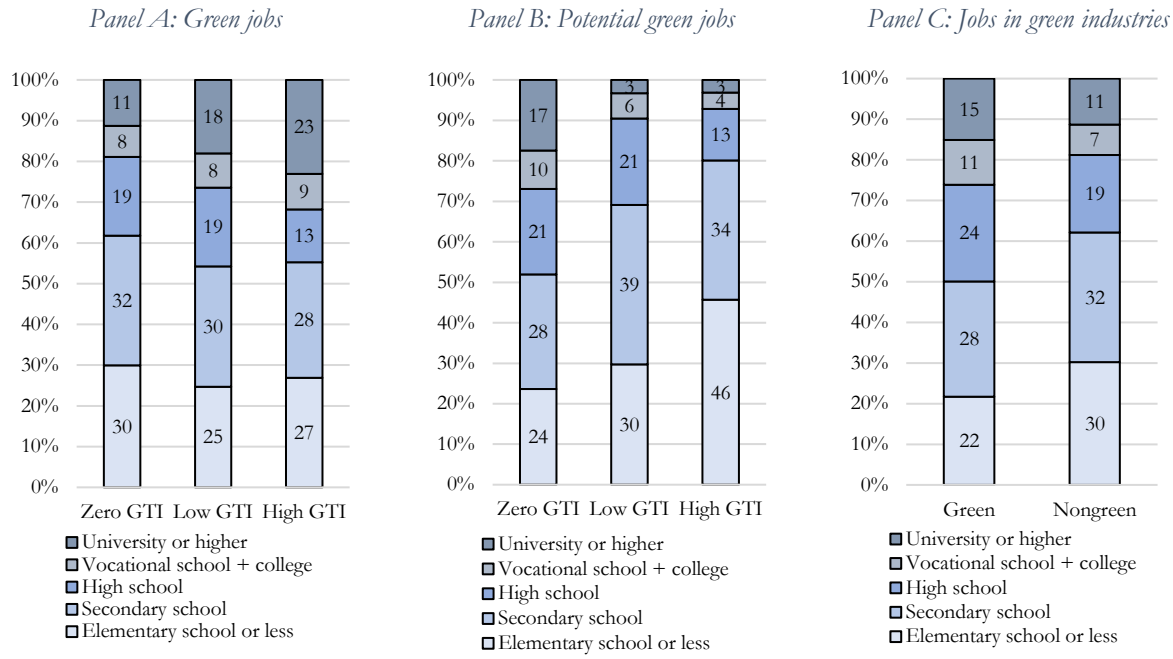


Source: World Bank staff calculation using LFS 2021
Note: High GTI refers to occupations with GTI index above 30, Low GTI (0 < GTI index <30), and Zero GTI (GTI index=0), for both green occupations and potential occupations, seperately. The sample includes working age population aged 15-64 and excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code that is not in VSCO 2020 (less than 0.01 percent of the sample).

Matching jobs' skills requirements, workers in green jobs and green industries have higher levels of education than those in non-green jobs. While 30 percent of workers in non-green jobs attain elementary school or less, 25 percent of workers in green jobs do so. At more advanced levels of education, 17 percent of workers in green jobs have at least a university degree, compared with 11 percent of workers in non-green jobs. At the same time, within green jobs, higher levels of green intensity often require higher education attainment: While 23 percent of workers in jobs with high green intensity have at least a university degree, 18 percent of workers in jobs with low green intensity do so (Figure 14, Panel A). As with the educational distribution found among green jobs, workers in green industries are more educated than in non-green industries. Twenty-six percent of workers in green industries attain vocational training or university and above, compared with 19 percent of workers in non-green industries do so (Figure 14, Panel C). The share of workers who went to elementary or less is 22 percent among workers in green jobs, while 30 percent of workers in non-green industries did so.

On the other hand, workers in potential green jobs tend to have lower level of education than workers in jobs with no green potential (Figure 14, Panel B). Within potential green intensity, workers in occupation with high potential GTI have less education than workers in occupation with low potential GTI. While 30 percent of workers in low potential GTI occupations went to elementary school or less, 46 percent of workers in high potential GTI occupations do so. The educational distribution of potential green jobs is consistent with the high concentration agriculture among potential green occupations.

Figure 14: Education distribution of green jobs and potential green jobs, in 2021



Source: World Bank staff calculation using LFS 2021

Note: High GTI refers to occupations with GTI index above 30, Low GTI (0 < GTI index <30), and Zero GTI (GTI index=0). The sample includes working age population aged 15-64 and excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code that is not in VSCO 2020 (less than 0.01 percent of the sample).

4.2 Task-content and skills requirements of top green occupations – Evidence from the Vietnam Green Jobs Survey

A shortcoming of only using the LFS and the GTI toolkit is that it still relies on an international definition and does not allow examining the skills requirements of green jobs. The Vietnam Green Jobs Survey (GJS), conducted for this report, helps overcome these shortcomings. The Vietnam Green Jobs Survey (GJS) was carried out in February and March 2023 and was designed to assess the profiling of tasks performed in green jobs in Vietnam as well as of the skills used in these green jobs. Compared to the LFS, the GJS has the advantage of: 1) Focusing on Vietnam and allowing assessing whether the ISCO-based GTI reflects the Vietnam case; 2) Going beyond simple measure of proportion of green tasks among total number of tasks and examining the frequency at which these tasks are performed; 3) Going beyond the task content of green jobs and examining skills used on the job, where the skills aren't only green skills but also cognitive, digital, managerial, and technical skills.

The survey includes the top 20 greenest medium- and high-skilled occupations, as measured by the GTI index, sampling 25 workers per occupation in five provinces in Vietnam. The 20 green occupations were chosen among the 37 green occupations classified by the GTI toolkit, and the priority was to select occupations with the highest GTI index. Therefore, we filtered out green occupations with less than 2000 observations (weighted) in the LFS 2021 (less than 0.005 percent of the national

employment) and two elementary occupations, refuse sorters and garbage and recycling collectors. The survey includes 500 observations and covers five provinces, chosen based on their large population size, high share of green jobs, and to be spread across the country: one large city (Ho Chi Minh City) and three regions - North (Hai Phong, Hai Duong), Central (Nghe An, Khanh Hoa), and South (Ho Chi Minh City). The survey was carried out with the Vietnam General Statistical Office (GSO).

Another advantage of the GJS is that it can be compared with the recently-conducted Survey of Detailed Skills (SDS) that covers 30 growing occupations in Vietnam. The SDS surveys workers in 30 occupations that are either in-demand or of strategic importance for economic growth, with a sample size of 543 respondents in the five provinces that are most economically active in the country in 2021, namely Ha Noi, Ho Chi Minh City, Da Nang, Vinh Phuc, and Dong Nai (see Box 5). The questionnaire of the GJS follows closely that of the SDS, with the only major deviation being the addition of a module on green skills. This compatibility allows for a useful comparison of the results.[25]

Box 5: The Survey of Detailed Skills

The SDS covers the 30 growing occupations that are either in-demand or of strategic importance for economic growth in Vietnam. These occupations accounted for 31 percent of national employment in 2018 (World Bank forthcoming)**.** Occupations selected in the SDS had to meet several criteria.

- Minimum sample. Occupations had to have a minimum sample of 20 respondents in the March and September 2021 rounds of the LFS in Vietnam's major employment centers (Ha Noi, Ho Chi Minh City, Da Nang, Vinh Phuc, and Dong Nai).
- Exclusion of residual occupations. Occupations could not be "residual occupations," that is, an occupation with "not elsewhere classified" in its title. These occupations tend to have vague descriptions.
- In-demand. Occupations had to have an employment level above the first quartile and have non-negative 1- and 3-year employment growth. These criteria were relaxed in some cases for occupations considered to be strategic to Vietnam's economic development.
- Digital transformation. Drawing on research on digital skills in Vietnam, jobs likely to be affected by digital transformation are selected. Education-related occupations that may influence the transfer of digital skills to workers were also selected.
- Megatrends. Occupations that may be affected by megatrends influencing Vietnam's growth trajectory, such as green growth, the 4th industrial revolution and automation, and aging were also included.
- Strategic sectors. Occupations relevant to strategic sectors for economic growth, particularly based on exports, were included. These sectors include electronics, textiles, and, to a lesser extent, machinery.

Out of the 30 occupations covered in the SDS, two are identified as green and seven are potential green by the GTI. The green occupations are civil engineers and motor vehicle mechanics and repairers. The potential green ones are mechanical engineers; electrical engineering technicians; house builders; welders and flame cutters; electrical mechanics and fitters; car, taxi and van drivers; heavy truck and lorry drivers (potential green occupations). Out of these nine occupations, the two green occupations are also included in the GJS. This overlap allows for the comparison of the results between the SDS and GJS: Analysis of the demographic and educational distribution, as well as the frequency of tasks and skills of respondents in the two overlapping occupations show consistent results.

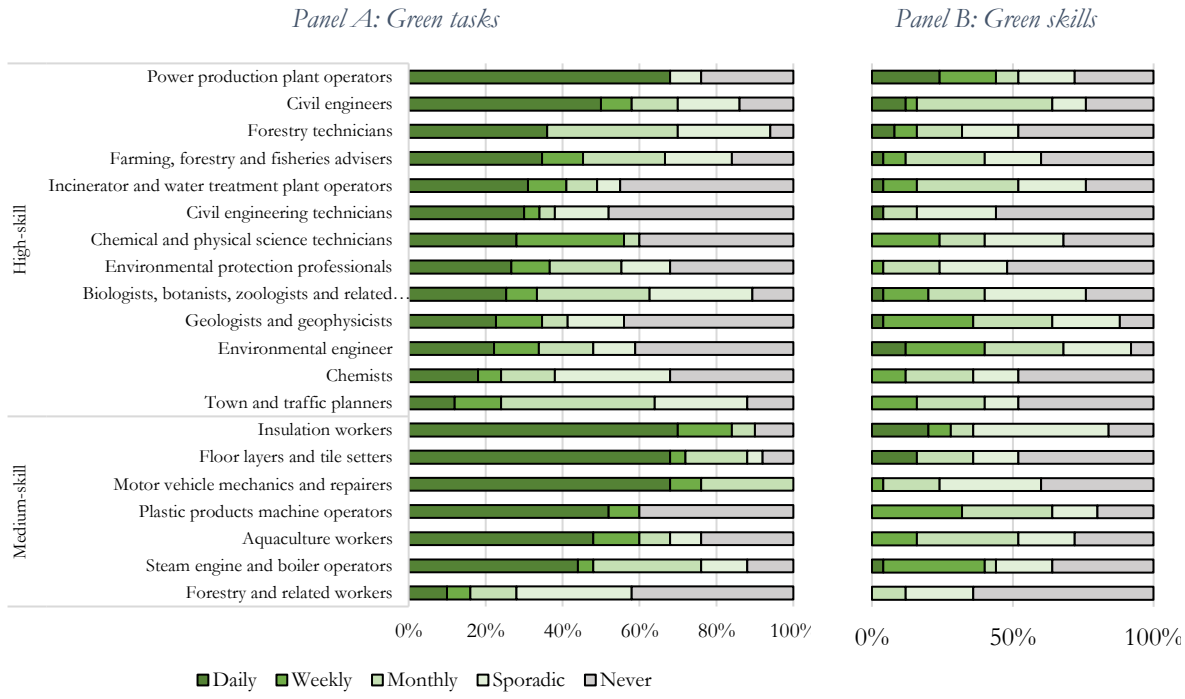
[25] The comparison is only illustrative given that the samples are different. However, the provinces are relatively similar in terms of economic development. Neither the SDS not the GJS include sampling weights given that they do not aim to be representative. However, they include a number of workers that is close to what is used in O*NET.

The SDS sample was drawn from the March and September 2021 LFS samples, which includes information about respondents' occupation at the VSCO 4-digit level. In total, 543 workers answered the survey. Of the 30 occupations selected, 15 had a sample size larger than 20 and only 6 smaller than 10. The SDS survey was conducted both in-person (67 percent) and through telephone interviews (33 percent) due to the COVID-19 pandemic. Its implementation was administered by the GSO and annexed to the December 2021 round of the LFS.

The GJS contributes to the growing efforts aimed at collecting information about detailed task and skills information in a low and middle-income country setting. In addition to the SDS, previous surveys adopt the tasks, skills, and education and experience modules from O*NET, for example Moroz, Nguyen, and Chu (2019) in Vietnam and World Bank and Bappenas (2021) in Indonesia. The main advantages of the GJS and SDS are i) the simplicity of the language used in explaining the tasks (e.g. "reading letters"), with examples that are easier to interpret, and ii) asking about the frequency of tasks performed and skills rather than asking respondents to rank their importance; the former is also likely easier to answer more accurately (see World Bank (forthcoming) for detailed methodological description of these surveys).

The GJS shows that green tasks are performed at high frequency among workers with green jobs, with 38 percent of respondents reporting performing green tasks at least daily.[26] Workers in medium-skilled occupations tend to perform green tasks more frequently than high-skilled ones. For example, among insulation workers, floor layers, and tile setters, as well as among motor vehicle mechanics and repairers, more than 65 percent of workers interviewed in the GJS report performing green tasks daily or more frequently (Panel A). Among high-skilled occupations, civil engineers are most likely to perform green tasks daily or more often (50 percent of respondents).

Figure 15: Frequency of performing green tasks and of using green skills

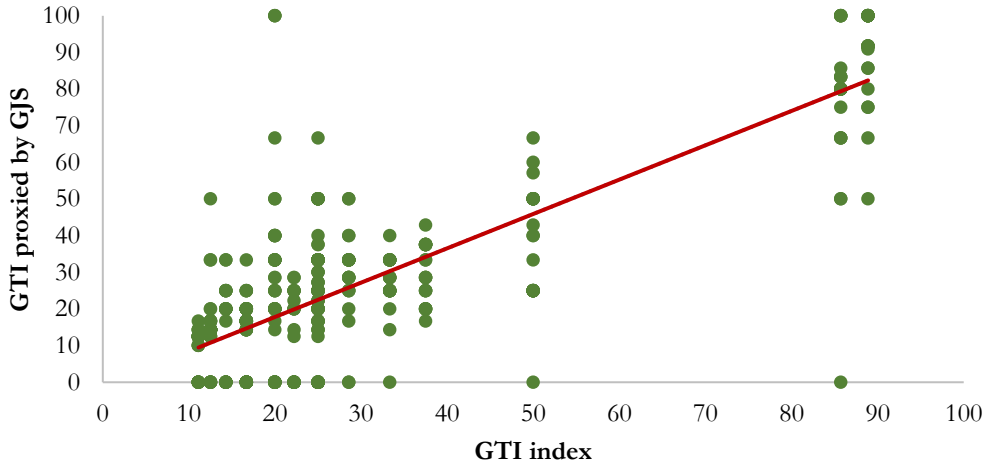


Source: World Bank staff calculation using GJS.
Note: The GJS asks respondents about the frequency of performing tasks and skills, particularly, "*In your job, do you perform/use* [tasks/skills]*? If yes, what is the level of performance/use?"* Green tasks are classified based on the GTI toolkit. Green skills are shown in Figure 17 and Table A16 in Appendix C).

[26] Task statements in the VSCO handbook are included in the GJS for each surveyed occupation.

Interestingly and reassuringly, the GTI toolkit reflects the intensity of green tasks observed in Vietnam. A proxied GTI index calculated from the GJS is positively correlated with the GTI (Figure 16). The proxy measures the share of green tasks to total tasks exercised monthly or more often, as reported by the GJS respondents. While it would need to be tested on a larger sample, the high correlation is encouraging and indicates that using ISCO-08 to classify occupations in Vietnam seems relevant to the local context.

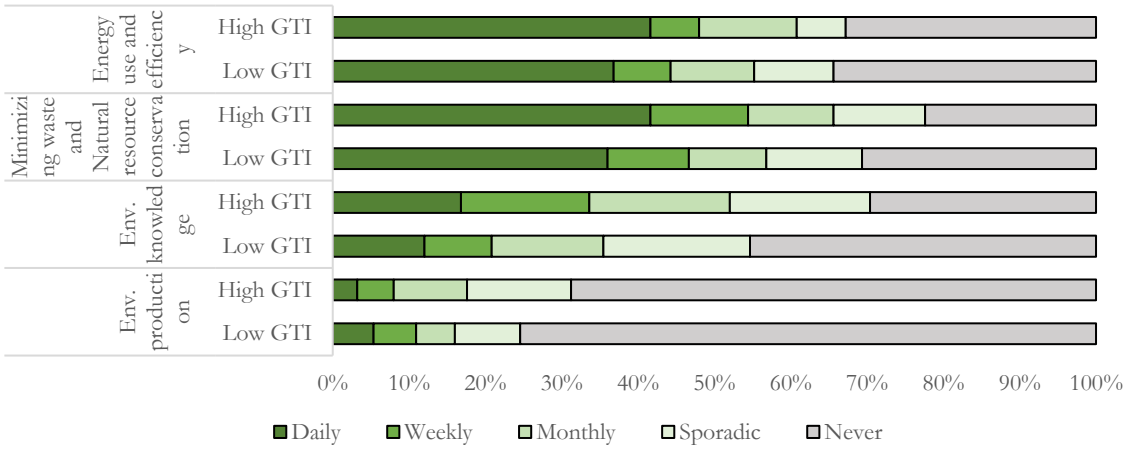
Figure 16: Correlation of the GTI index and the GTI proxy calculated in the GJS



Source: World Bank staff calculation using GJS and GTI toolkit.
Note: The GTI proxy is the share of green tasks to the complete tasks each respondent reports performing at least monthly.

Among the four types of green skills included in the GJS, those related to energy use and efficiency, as well as those related to reducing waste and conserving natural resources are practiced at higher frequency than those related to environmental knowledge and environmental production. While more than a third of the respondents report using skills in energy use and efficiency, minimizing waste, and conserving natural resources daily, only 13 percent report using skills related to environmental knowledge, and 5 percent report using skills related to producing renewable energy and environmentally friendly outputs. Interestingly, the frequency of using green skills does not vary significantly across different levels of green task intensity (Figure 17). The observed variation in the frequency of green skills used suggests that the green skill supply in Vietnam concentrates on improving energy efficiency and reducing waste, while the supply of green skills related to research and development of new technologies about the environment and/or producing new green products remains limited. Improving the latter's supply would allow the workforce to embrace new opportunities arising from the green transition.

Figure 17: Frequency of use of green skills by green skill type

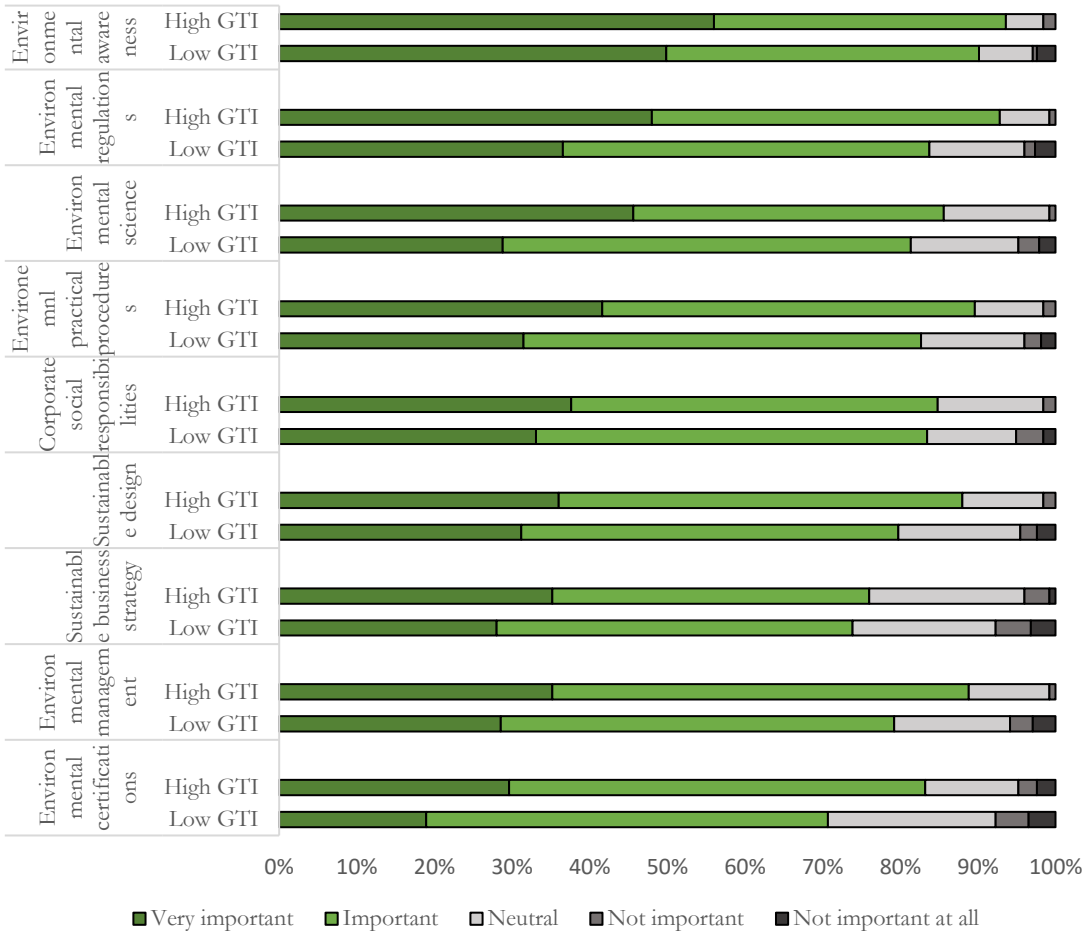


Source: World Bank staff calculation using GJS.

Note: The GJS asks respondents about the frequency of using green skills, in particular "*In your job, do you use* [skills]*? If yes, what is the level of use?".* Green skills include a) monitoring and optimizing the use of energy; b) minimizing waste and/or conserving natural resources, c) research, apply, or impart knowledge, plans or technologies about the environment; d) producing renewable energy or environmentally friendly outputs (see details in Table A16 in the Appendix C). Frequency of green skills is in order from most to least frequent: daily (daily or more frequent), weekly, monthly, sporadic (once several months or once several years), never. High GTI refers to green occupations with GTI index >=30, Low GTI (0<GTI index <30).

In addition to green skills, environmental knowledge is mentioned as very important or important in their work by the majority of respondents. Interestingly, the importance of environmental knowledge increases with the green task intensity for all types of environmental knowledge (Figure 18). The most important type of knowledge is related to environmental awareness, with 90 percent of respondents stage that the knowledge is important (40) or very important (51 percent). Knowledge related to environmental regulations and corporate social responsibilities are also deemed important by workers in green jobs. Given the limited prevalence of green certifications in Vietnam, knowledge related to environmental certifications ranks lowest in terms of importance compared to the other eight types of environmental knowledge included in the GJS.

Figure 18: Share of workers reporting the importance of different types of environmental knowledge



Source: World Bank staff calculation using GJS.
Note: The GJS asks respondents about the importance of environmental knowledge in their job, particularly, *"How do you rate the importance of* [type of environmental knowledge] *in the work you are doing*?" Details about the nine types of environmental knowledge are listed in Table A17 in Appendix C. High GTI refers to green occupations with a GTI index >30, and Low GTI (0<GTI index <30).

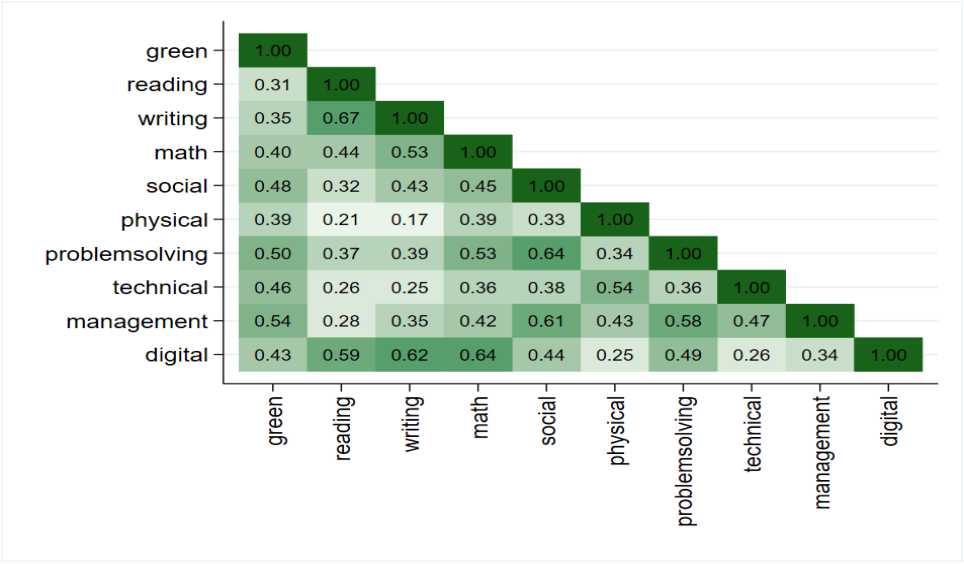
Despite the high prevalence of green tasks performed by workers in green jobs, green skills are used at a lower frequency, indicating that green tasks involve green skills as well as other skills (Panel B). A task is an action or a set of actions taken together to accomplish a goal, while a skill is the ability to perform a task well. Workers who report performing green tasks at high frequency do not necessarily report using green skills very frequently. For example, power production plant operators have 68 percent of workers report that they perform green tasks daily or more often. However, only 24 percent of workers surveyed in this occupation report using green skills at the same frequency, and 48 percent say that they never use green skills or only once for several months or years. Another striking example is environmental protection professionals, with a high GTI index of 86. While 55 percent of workers in this occupation report performing green tasks monthly or more, only 24 percent report using green skills at this frequency, and 76 percent responded that they never use green skills or only sporadically. This more profound look at the content of tasks performed by workers in green occupations implies that the skills required to perform green tasks are not all necessarily green.

And indeed, problem-solving, technical, management, and digital skills complement green skills. The complementarity of green and other skills varies by the skill level of occupations. For example, high-

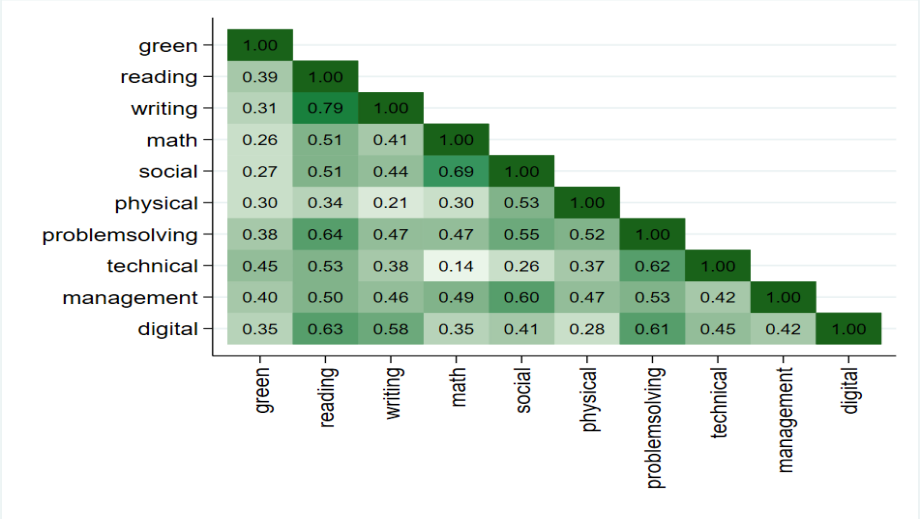
skilled workers in green jobs are more likely to use managerial, problem-solving, and technical skills in addition to green skills (Figure 19, Panel A). On the other hand, medium-skill workers in green jobs tend to complement green skills with technical, managerial, and reading skills (Figure 19, Panel B).

Figure 19: Correlation of green skills and other skill groups by level of skill

Panel A: High-skilled occupations



Panel B: Medium-skilled occupations

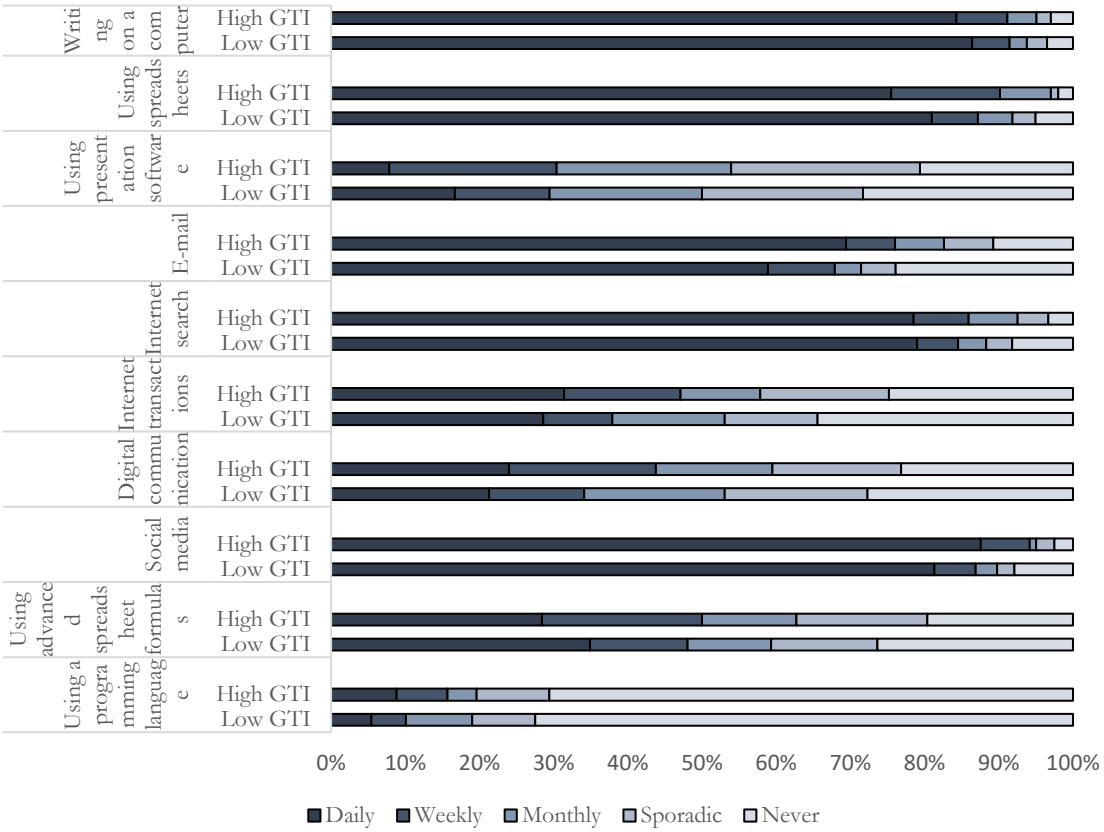


Source: World Bank staff calculation using GJS.
Note: For each respondent, the 49 skills are aggregated into ten skill groups, and the frequency of each skill group is calculated by taking the average of the frequency of use of skills in that group. Correlation between the ten skill groups is calculated across individuals using the averaged frequency per skill group. Skill classification is detailed in A11 in Appendix B. The sample includes 500 observations in the GJS, 175 observations in medium-skilled occupations, and 325 in high-skilled occupations.

Looking deeper into different types of digital skills, those used most frequently are related to writing on a computer, social media, and internet search, with some advanced digital skills used more often among medium-skilled than among high-skilled workers. More advanced digital skills, such as advanced spreadsheet formulas and programming language, are used less frequently than basic digital skills among workers in green jobs (Figure 20). However, interestingly, even medium-skilled green

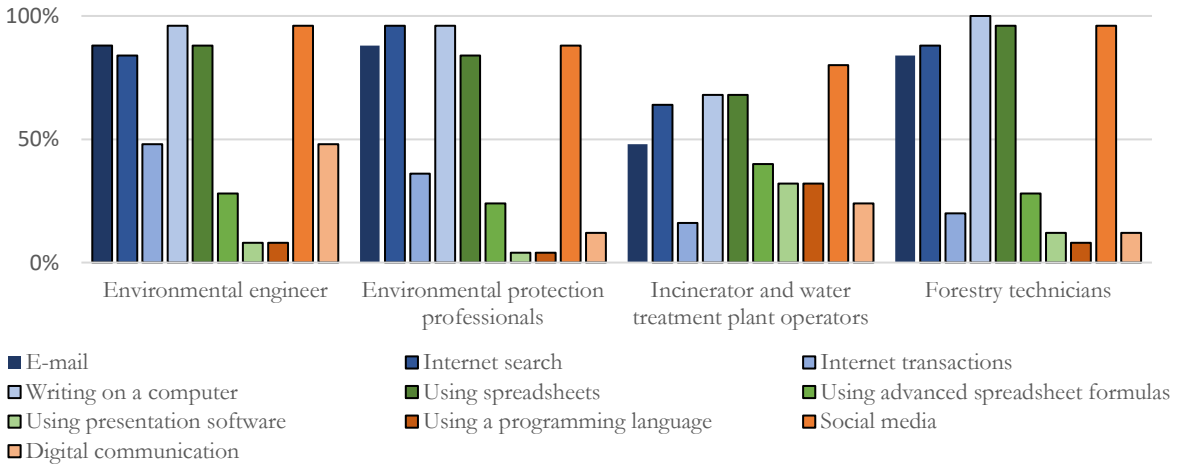
occupations use some advanced digital skills. For example, forestry technicians, incinerators, and water treatment plant operators use advanced spreadsheet formulas more often than environmental engineers and environmental protection professionals (Figure 21).

Figure 20: Frequency of use of each digital skill by GTI level



Source: World Bank staff calculation using GJS.
Note: The GJS asks respondents about the frequency of using digital skills, particularly "*In your job, do you use* [skills]*? If yes, what is the level of use?*". The frequency of digital skills is ordered from most to least frequent: daily (daily or more frequent), weekly, monthly, sporadic (once several months or once several years), and never. High (resp low) GTI refers to green occupations with a GTI index >=30 (GTI index <30).

Figure 21: Use of digital skills across occupations with different skill levels

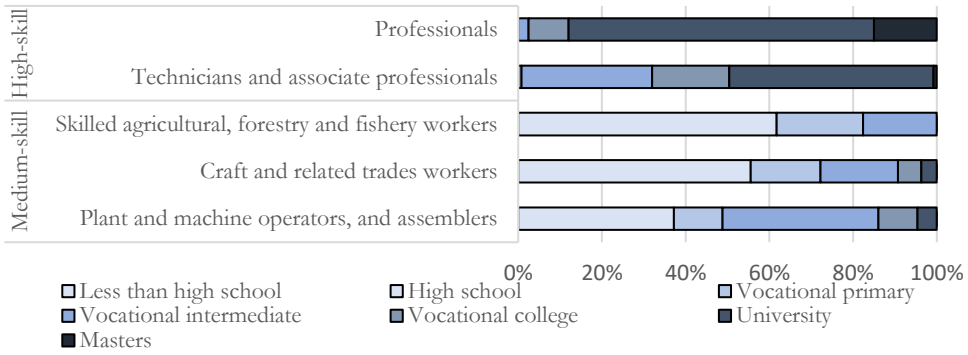


Source: World Bank staff calculation using GJS.
Note: See Figure 20

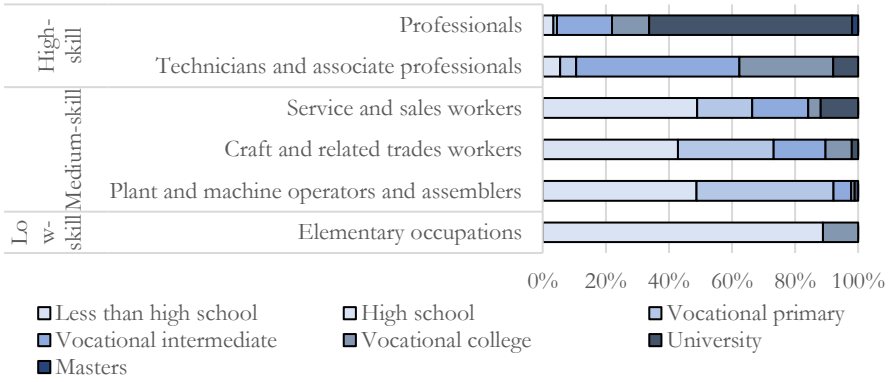
Moving to education requirements, they seem higher in green jobs when compared to workers in the top-growing occupations in Vietnam. For example, while 88 percent of professionals in green jobs state that a university degree is required, they are only 66 percent think so in the top-growing occupations. Similarly, at lower skill levels, 44 percent of plant and machine operators and assemblers in green jobs state that vocational college or higher is required, compared to 30 percent in the top growing occupations (Figure 22).

Figure 22: Share of workers reporting education level required for green jobs and top-growing occupations

Panel A: Top 20 green occupations



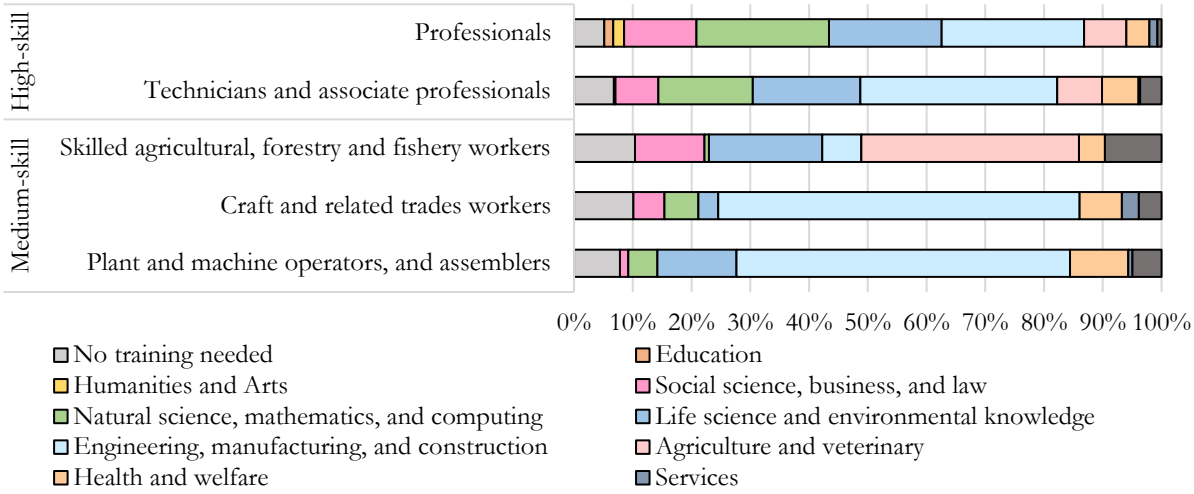
Panel B: Top 30 growing occupations



Source: SDS and World Bank staff calculation using GJS.
Note: The GJS and SDS ask, "*In your opinion, what level of education is required to do this job?*". Share of workers reporting level of education required for their job over the total number of workers in each occupation.

Higher-skilled green jobs require training in the sciences, while medium-skilled occupations require training in "engineering, manufacturing, and construction." More than half of green craft and related trade workers and plant and machine operators and assemblers state engineering, manufacturing, and construction as the top related field of study for their jobs (Figure 23). The relevance of this field of studies for green jobs is similar to that of the top growing occupations: 30 percent of green occupations (six out of 20) have at least half of workers reporting this field of studies as required, compared to that of 33 percent of the top growing occupations (10 out of 30). The second most relevant field of study for green jobs is natural science, mathematics, and computing (Table 13 in Appendix B shows the top three fields required in each green occupation).

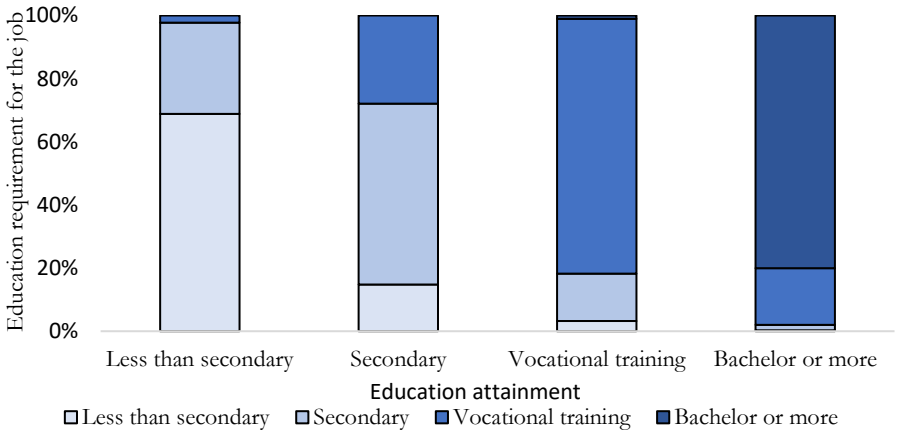
Figure 23: Field of studies required for green jobs



Source: World Bank staff calculation using GJS.
Note: The GJS asks, *"In your opinion, in order to perform the job you are doing, what is the field/ specialty that needs to be prioritized for training?"* The field of study is classified by the 1-digit International Standard Classification of Education (ISCED).

Workers with lower levels of education consider that their (green) job requires higher levels of education. About one-third of workers having less than secondary education believe that a higher level of education is required for their jobs, while 28 percent of workers with secondary education state that vocational training is needed for the jobs (Figure 24). The majority (80 percent) of respondents who have at least vocational training think that their level of education is adequate for the job. This implies that vocational training programs for green jobs could contribute to upskilling low- and medium-skilled workers.

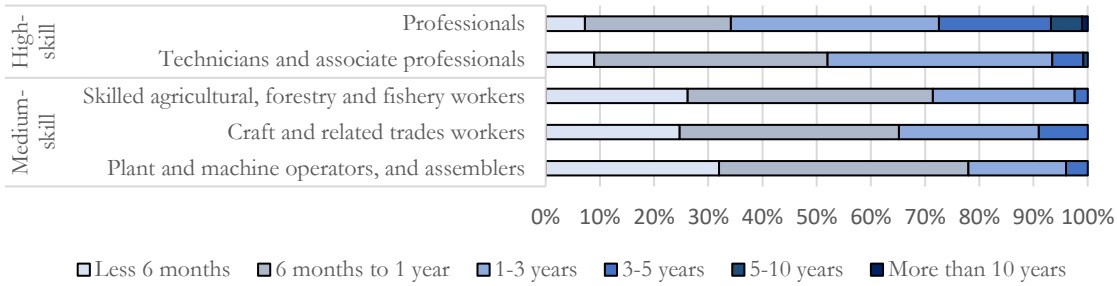
Figure 24: Training gap in green jobs by level of educational attainment



Source: World Bank staff calculation using GJS.
Note: The GJS asks respondents about the level of educational attainment and the level of education required for the job, in particular, "*What is the highest level of education you have achieved/completed?*" and "*In your opinion, what level of education is required to do this job?*"

At the same time, showing space for skills development for a green transition among current workers; for most occupations except for professionals, most workers believe they need up to 1 year of on-the-job training to perform their work. More than half of the GJS respondents state that their jobs require less than 6 months or less than one year of training (Figure 25).

Figure 25: Duration of employer training required for green jobs

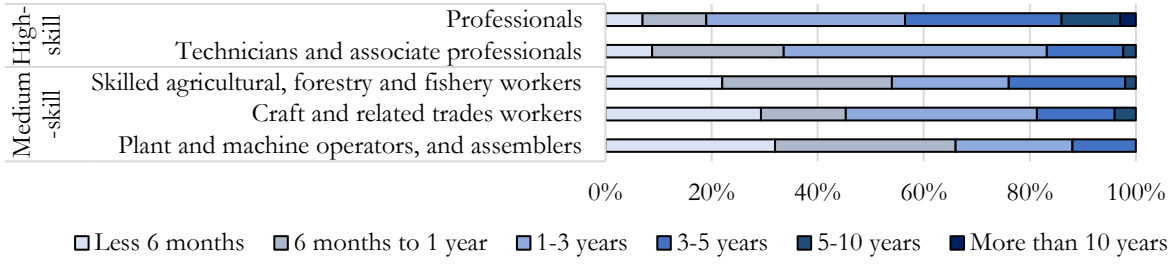


Source: World Bank staff calculation using GJS.
Note: The GJS asks respondents about the training required to perform their jobs well: "*In your opinion, to perform this job, how long does the employer need to train employees (directly or integrated)?"* Share of workers reporting level of training required for their job over the total number of workers in each occupation.

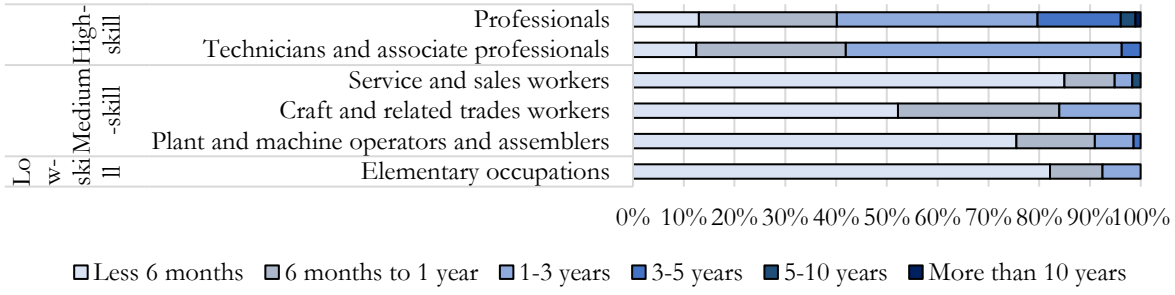
Consistent with the higher age among workers in green jobs documented in Section 3, working experience is important in medium-skilled jobs, and more so than for the top growing occupation. Eighty-one percent of professionals in the GJS believe that their jobs require one year of experience or more, while only 60 percent of respondents in the SDS believe so (Figure 26). For instance, while 34 percent of green plant and machine operators and assemblers report at least one year of work experience required, only nine percent of workers report the exact requirement in the SDS. This finding might imply that although skills required in green jobs are not all green and are complemented by other skills, relevant experience is important to tailor those transferable skills to perform the job well. This may also match the higher formality rate among green jobs; they may be better because individuals learn and deepen their experience.

Figure 26: Experience required for green jobs and top-growing occupations

Panel A: Top 20 green occupations



Panel B: Top 30 growing occupations



Source: SDS and World Bank staff calculation using GJS.
Note: The GJS question is, *"In your opinion, how many years of relevant work experience do you need to do this job?"* Share of workers reporting level of education required for their job over the total number of workers in each occupation.

5. Policies to prepare a greener workforce

Define green jobs following both the task-based and output-based approaches

Adopt the green jobs definition for the implementation of the green growth strategy. While the term "green jobs" has been used in the GGS, there is no consensus definition or baseline measurement of green jobs in Vietnam. A consensus on understanding green jobs would help policymakers identify what jobs are green and quantify the number of green jobs in Vietnam. From a skills development policy perspective, the task-based approach is much more informative than the output-based approach since it allows measuring the essential job-specific work activities needed to produce greener outputs. Such an approach also allows measuring the impacts of greening existing jobs. On the other hand, the output-based approach is useful to inform sectoral policies. The two approaches are complementary, but given the heavier focus on an output-based approach, we recommend balancing attention to the task-based approach, including the potential for greening across industries.

Monitor green jobs' growth and characteristics

Mainstream the reporting of green jobs statistics to assess the labor market effects of green transition, using as well as revising 5-digit classification codes for occupations or industries that are green or have green potential. For instance, to identify growing green occupations in renewable energy, the VSCO 2020 4-digit is not detailed enough, and there would be a need to revise VSCO 2020 5-digit to include such occupations. In addition, upon adopting definitions of green jobs, the GSO could publish statistical indicators on them using the LFS and the Economic Census. Such statistics on green jobs will provide the Government with a tool for (i) gaining a better understanding of the impact of "greening the economy" on the labor market and (ii) ensuring that effective policy measures and tools are formulated to respond to this shift to a greener economy.

Integrate information on green jobs and skills into the labor market information system (LMIS). At present, the Vietnam LMIS is at a nascent stage and needs to be improved to enhance the matching between workers and firms as well as to inform job seekers, students, and workers on growing and declining occupations and guide them, as well as the career and job counselors assisting them, in making their education, training, and job decisions. It is also needed to inform policymakers and training institutions on priority occupations and skills to train in. Furthermore, as green jobs are likely to grow, given Vietnam's commitments to a greener economy, the LMIS can help direct current and upcoming workforce toward green jobs and help them assess the skills that they need to develop to be suitable for these jobs. Many countries have incorporated information on green jobs in their LMIS to support their green transition. For instance, in line with its national strategy and a national pact to transition toward a green economy, France has established the National Observatory for Green Economy Jobs and Skills, which examines the impact of the green transition, with particular attention to its implications on the numbers of jobs and skills requirements (OECD 2017).

Upskill and reskill the population for green jobs

As Vietnam has plans for a green transition, this policy note shows that these have benefits in terms of being formal and upskilling the Vietnamese workforce. Our findings indicate that Vietnam could potentially increase the number of green jobs in renewable energy, agriculture, and forestry in the coming years based on its recent plans and commitments. In addition, this note indicates a higher skill profile of green jobs, consistent with the policy suggestion that higher skills allow an easier match to a more green-intensive job (IMF 2022). This indicates that increasing green jobs can contribute to upskilling Vietnam's workforce.

To meet increased local and global demand there is a need to increase the supply of green skills to meet local and global demand. Globally, green workers are being hired more than non-green workers. The share of green talent in the global workforce increased from 9.6 percent in 2015 to 13.3 percent in 2021 (LinkedIn 2022), and this is likely to continue and accelerate; globally but also in Vietnam, given recent commitments. However, the number of students registering in relevant post-secondary programs is insufficient to meet the demand for green skills. Training programs must be updated to overcome this challenge considering changing skill demands. While data on the provision of green skills are limited, the little evidence available indicates a minimal supply of green skills: A recent survey of higher education institutions found that less than one percent of university students were following environmental protection programs (a subset of green skills), with most of them at undergraduate levels (World Bank 2022c). Moreover, the number of master's degrees and doctorates in green skills decreased during 2016-2021. In TVET, several vocational training programs targeting green skills have been launched, including under the Vietnam-Germany Vocational Training Innovation Program framework. However, they remain limited in size (ASEAN and ILO 2021).[27]

Partnerships with the private sector can help identify skills needs for and improve training on green skills. For example, in the UK, the Skills Academy for Sustainable Manufacturing and Innovation (SASMI) is located in close proximity to a Nissan manufacturing plant in Northeast England. In Spain, the company Acciona operates the Acciona University program, which, in 2015, provided nearly 35 000 training hours to employees in green and environmental subjects in cooperation with the University of Alcalá (Madrid). Activities such as these can catalyze when they involve companies in the vanguard of green production processes and products and where they set ambitious standards in green skills for employees that can inspire other companies (CEDEFOD 2018).

The good news from a skills development perspective is that many non-green skills complement green skills and are used to perform green tasks, meaning that continued investments in cross-cutting transferable skills will present benefits for green jobs and are "no regret" policies. The expansion of clean energy, combined with the advancement of new technologies, will require new skills which need to be taught, for example, knowledge of sustainable materials and carbon footprint measurement skills, environmental impact assessment skills; and the education and training system needs to increase teaching in these areas. At the same time, the findings indicate a high correlation between green skills and other skills and that green skills are used much less frequently than green tasks are performed. This finding reflects what has been seen in digital skills (Cunningham et al. 2022): These are also complementary to other skills.

In the end, what is needed is combining environmental and climate issues in education and training, upskilling workers more broadly, and an efficient labor market that can help grow green clusters and green jobs. This news indicates that skills development can continue fostering a broad set of skills while building green skills. An interesting example is that of Denmark, which integrated environmental and climate issues into its educational and vocational training systems, thereby setting the foundation for further green skills development at more advanced education levels. At the same time, Denmark does not have an explicit green jobs program but focuses on ensuring that the labor market is well-functioning (OECD 2017).

Improve access to green jobs

Introduce policies to increase access to green jobs among female workers and vulnerable groups. The findings suggest that male workers dominate green jobs, while green jobs require more fields of study in the sciences. While there are some improvements, enrolments in universities and TVET still follow

traditional gender stereotypes, with more male students in technology-driven areas. Including women in apprenticeship and skills training for environmentally sustainable jobs is essential for overcoming disparities in the labor market and skill shortages in certain occupations.

6. Conclusion

The green growth transition, intertwining with other megatrends, will create new green jobs and make potential green jobs greener, requiring new skillsets or/and transferable skills that must be used at work. The transition to green growth will need to be managed alongside other megatrends, such as population aging, global integration, shifting toward a service- and knowledge-based economy, and increased digitalization and automation of production processes. These megatrends will affect future job skill requirements and how well they match the skills possessed by workers. Transitioning to a greener economy will intertwine with other megatrends likely to drive Vietnam's future jobs landscape. Shifting trade and consumption patterns will affect what Vietnam can export and in which value chains it will be engaged. The rise of knowledge-intensive industries will require new skill sets, production processes, and export models. An aging population will demand care services from a shrinking working-age population. Automation may take over some jobs and transform the nature of others (Cunningham et al., 2018).

A parallel transition of no less importance in Vietnam is the transition away from brown jobs. At a global scale, decarbonization of the energy sector is estimated to create 24 million new jobs while destroying 6 million jobs by 2030 (ILO 2018). The jobs destroyed will be mainly in fossil-related sectors, the so-called brown jobs. The transition from brown jobs entails complex issues related to skills development and the livelihood and well-being of workers, businesses, and communities adversely affected. Workers' skills might become irrelevant in a green economy and need to upgrade or retrained (Ruppert et al., 2021). Facilitating labor mobility from brown jobs to more neutral and/or green jobs could reduce the negative impacts the transition might incur on workers and ensure that the green transition is just. Nevertheless, the transition from brown to green jobs remains outside this report's scope.

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Appendix A: Methodology

A1. Task-based approach

We used GTI and potential GTI of ISCO-08 occupations in 425 out of total 501 VSCO 2020 occupations (85 percent).[28] We used the GTI and potential GTI of ISCO-08 occupations for VSCO 2020 occupations in cases where VSCO occupations have the same 4 digits, occupation titles, and task statements as in ISCO-08 4-digit or in cases where VSCO occupations can be crosswalked to ISCO-08. We further used the GTI and potential GTI of ISCO-08 in cases where there are no task statements in VSCO (but same digits and occupation titles).

For the 76 remaining occupations that have different task content in VSCO than in ISCO-08, we applied text analysis using the GTI toolkit to recalculate the GTI and potential GTI for these occupations. Details of the different cases for the ISCO-VSCO comparison and crosswalk is summarized in Table A 1. The 76 occupations are split in rows 2, 6, 9, and 10. We first translated from Vietnamese to English (using the built-in translation in MS Teams) and then applied the text analysis. An example of an occupation that was reclassified as green in VSCO is occupation 2145 Chemical engineers, which has an additional task statement that can be identified as green (row 2 in Table A 1): "Research on processes and methods of analysis of chemical compounds in environmental components, materials and products used in life and industrial activities". One occupation was reclassified from green to non-green, protective services workers except police (row 6 in Table A 1). Two occupations that are not in ISCO-08 and are classified as green are 2445 Rangers and green potential 3144 Aquaculture technicians (row 10 in Table A 1).

Table A 1: Different cases for the ISCO - VSCO comparison and crosswalk

	Comparison of VSCO 2020 to ISCO-08 (both 4-digit)	**Approach**	**Number of VSCO 2020 4-digit occupations**	**Percentage of workers in 2021 (among 15-64) (%)**	**Implication of deviation from applying the GTI (number of occupations reclassified)**
1	**Occupations that have the same 4 digits, occupation title**, and task content as in ISCO-08 4-digit.	Use the GTI and potential GTI of the ISCO-08 occupation	310	69.17	
2	Occupations that have the same 4 digits, and occupation title as in ISCO-08 4-digit but have different task content in VSCO.	Text analysis of task description	58	7.97	Out of these 58 occupations, 5 are green, 14 green potential, 39 non-green in ISCO-08. With text analysis, 2 occupations, chemical engineers and rangers (associate professionals) changes from non-green to green (see detail in Table A 3); 3 occupations, stonemasons, stone cutters, splitters and carvers; printers; and print finishing and binding workers change from green potential to non-green (detail in Table A 3).

[28] The GTI toolkit excludes 3 occupations in armed forces from ISCO-08; we exclude 8 occupations in armed forces from VSCO 2020.

3	**VSCO 4-digit occupations that do not have a correspondent occupation in ISCO-08 4-digit** and belong to the occupational group of senior government officers.[29]	Use the GTI and potential GTI of the ISCO-08 occupation "Senior Government Officials"	58	0.31	These occupations are non-green. We exclude them from the sample.
4	**Occupations that have different digits but the same occupation title as in ISCO-08 4-digit,** and task content as in ISCO-08 4-digit.[30]	Use the GTI and potential GTI of the matched ISCO-08 occupation	29	20.01	
5	Occupations that have different digits but the same occupation title as in ISCO-08 4-digit, but have no task content in VSCO.	Use the GTI and potential GTI of the ISCO-08 occupation	1	0.03	
6	Occupations that have different digits but the same occupation title as in ISCO-08 4-digit, but have different task content in VSCO.	Text analysis of task description	9	0.62	Out of these 9 occupations, 1 occupation is green, 1 green potential, 7 non-green. With text analysis, the green occupation changes to non-green (protective services workers except police). (detail in Table A 3)
7	**Occupations that have different digit numbers and occupational titles as in ISCO-08 4-digit but can be crosswalked from multiple VSCO 4-digit occupations to one ISCO-08 4-digit occupation.** And **task statements are *the same*** in the VSCO occupations and in the ISCO-08 occupation.	Use the GTI and potential GTI of the ISCO-08 occupation	1	0.14	
8	Occupations that have different digit numbers and occupational titles from ISCO-08 but can be crosswalked from multiple VSCO 4-digit occupations to one ISCO-08 4-digit occupation, ***but have no task content in VSCO***.	Use the GTI and potential GTI of the ISCO-08 occupation	26	0.67	
9	Occupations that have different digit numbers and occupational titles as in ISCO-08 4-digit but can be crosswalked from multiple VSCO 4-digit occupations	Text analysis of task description	5	1.02	These 5 occupations are non-green in ISCO-08 GTI and with text analysis, their GTI indexes do not change.

[29] There is no task content for occupations in the 1-digit occupational group of Legislators, Senior officials, Managers in VSCO.

[30] These occupations have the same titles and task content but different digits in VSCO and ISCO-08 because the ordering of digits in VSCO was adjusted to include more occupations in Vietnam. For example, the occupation education methods specialists is coded as 2391 in VSCO and 2351 in ISCO-08.

	to one ISCO-08 4-digit occupation. And **task statements are *different*** in the VSCO occupations and in the ISCO-08 occupation.				
10	**Occupations that do not have correspondence in ISCO-08 4-digit and have task content**	Text analysis of task description	4	0.06	1 additional occupation becomes green (Rangers, professionals) and 1 additional occupation becomes green potential (Aquaculture technician), (see Table A 4)
	Total excluding armed forces		**501**	**100%**	

Table A 2: Number of 4-digit occupations classified by the GTI toolkit in ISCO-08 and VSCO

	ISCO-08	VSCO 2008 (used in LFS up to 2020)	VSCO 2020
Total number of 4-digit codes	436	506	509
Identified occupations	433	503	501
GTI narrow > 0	36	37	39
GTI broad > 0	127	127	127
GTI broad = 0	306	376	374

Source: GTI toolkit, VSCO 2008 and VSCO 2020 manuals
Note: 4-digit occupations ISCO-08 in armed forces are not classified in the GTI toolkit

While Vietnam also has VSCO 2020 5-digit occupations for 786 occupations, the LFS only codes occupations at 4-digit and the 5-digit occupations do not have task descriptions. For example, occupation 2165 (cartographers and field surveyors) is further divided to five 5-digit level occupations: 21651 (general surveyor); 21652 (land surveyor); 21653 (hydrographic surveyor); 21654 (cartographer); and 21659 (other surveyors and cartographers). Furthermore, we applied text analysis to the occupation titles of both the 4-digit and 5-digit occupations and found only one VSCO 5-digit occupation that has a green term while its "parent" 4-digit occupation does not contain any green term.

Table A 3: VSCO 4-digit codes that change from green to non-green and from green potential to non-green (detail of row 2 and row 6 in Table A 1)

VSCO 4-digit	Occup. title	Tasks in ISCO-08	Green?	Tasks in VSCO	Green?
Detail of row 2 (change from non-green in ISCO-08 to green in VSCO)					
2145	Chemical engineers	conducting research and advising on, and developing, commercial-scale chemical processes to refine crude oil and other liquids or gases, and to produce substances and items such as petroleum derivatives, explosives, food and drink products, medicines, or synthetic materials;	Non-green	Conduct research, consultancy and development of commercial-scale chemical processes for refining crude oil, other liquids or gases and for the production of substances and articles such as petroleum derivatives, explosives, food, beverages, drugs or synthetic materials;	Non-green
		specifying chemical production methods, materials and quality standards and ensuring that they conform to specifications;	Non-green	Stipulate production methods of chemicals, supplies, quality standards and ensure they conform to specifications;	Non-green
		establishing control standards and procedures to ensure safety and	Non-green	Establish control standards and procedures to ensure the safety	Non-green

		efficiency of chemical production operations and safety of workers operating equipment or of those working in close proximity to ongoing chemical reactions;		and efficiency of chemical production operations and the safety of operating equipment of workers or persons working near ongoing chemical reactions;	
		designing chemical plant equipment and devising processes for manufacturing chemicals and products;	Non-green	Design chemical plant equipment and devise chemical and product production processes;	Non-green
		performing tests throughout stages of production to determine degree of control over variables, including temperature, density, specific gravity, and pressure;	Non-green	Perform tests throughout the production phases to determine the degree of control over variables including temperature, density, specific gravity and pressure;	Non-green
		developing safety procedures to be employed;	Non-green	Develop the safety procedures used;	Non-green
		preparing estimates of production costs and production progress reports for management;	Non-green	Prepare production cost estimates and report production progress to management;	Non-green
		performing laboratory studies of steps in the manufacture of new products and testing proposed processes in small-scale operations such as a pilot plant.	Non-green	Carry out laboratory studies of the steps in the production of new products and test proposed processes in small-scale operations such as pilot plants.	Non-green
				Research on processes and methods of analysis of chemical compounds in environmental components, materials and products used in life and industrial activities;	Green
3355	Rangers (associate professional)	establishing contacts and sources of information about crimes planned or committed, in order to prevent crimes or identify suspected offenders;	Non-green	Organize the performance of tasks of forest management and protection, forest fire prevention and fighting, ensure the observance of the law on forestry within the area under its management;	Green
		obtaining and verifying evidence by examining crime and accident scenes for clues and physical evidence, interviewing witnesses and suspects and analysing documents and computer files;	Non-green	Manage and direct the operation of forest ranger stations and forest rangers working in the locality to perform the tasks of advising and assisting the chairman of the commune-level People's Committee in organizing the implementation of legal documents, programs, plans and plans on forest management and protection, forest fire prevention and fighting, ensuring the observance of the law on forestry;	Green
		analysing evidence in order to solve crimes, identify criminal activity and gather information for court cases;	Non-green	Advising heads of provincial forest rangers and district-level People's Committees;	Green potential
		establishing contacts and sources of information not readily available or apparent concerning establishments or the circumstances and behaviour of persons, usually with the aim of preventing a crime;	Non-green	Perform other duties as prescribed by law and assigned by competent state agencies.	Non-green

		making arrests;	Non-green		
		testifying in courts of law or reporting to superiors about circumstances and results of investigations.	Non-green		
Detail of row 2 (change from green potential in ISCO-08 to non-green in VSCO)					
7113	Stonemasons, stone cutters, splitters and carvers	driving wedges into quarried stone to break it into slabs or blocks;	Non-green	Drive bulldozers into quarries to break it into blocks or sheets;	Non-green
		selecting and grading slabs and blocks of granite, marble and other stone;	Non-green	Selection and classification of panels and blocks of granite, marble and other stones;	Non-green
		cutting, shaping and finishing building and monumental stone such as granite or marble using hand tools or hand-held power tools;	Non-green	Cutting, shaping and finishing building stone blocks by hand or with portable power tools for granite or marble monument-related buildings, structures;	Non-green
		making patterns and marking shapes on stone for subsequent sawing, planing, drilling and other dressing and cutting operations;	Non-green	Pattern and mark shapes on rocks for sawing, drilling, chiseling, grinding and cutting stones;	Non-green
		cutting and carving characters, figures or designs on stone blocks used for monuments or memorials;	Non-green	Cutting and carving characters, drawings or designs on stone blocks used for monuments or memorials;	Non-green
		setting stone in the erection of monuments and memorials;	Non-green	Restoration, remodeling and replacement of stone structures of ancient buildings, churches and monuments;	Non-green
		repairing and replacing stonework on old buildings, churches and monuments.	Green potential	Arrangement of stones in the construction of monuments and memorials;	Non-green
				Perform related tasks;	Non-green
				Supervise other workers.	Non-green
7322	Printers	maintaining, adjusting, repairing and cleaning machines;	Green potential	Operation of functional parts of printing equipment including material supply system operation, printing system operation, printing product acquisition system, other auxiliary systems such as steam system, electrical system, cooling system,...	Non-green
		setting, adjusting and monitoring substrate-feed mechanisms, delivery mechanisms, inking systems and other printing machine functions;	Non-green	Control materials for the printing process including: Substrate materials (paper, thin film, ...), inks suitable for the above printing techniques, and auxiliary materials suitable for the above printing techniques;	Non-green
		mixing ink and solvents to standard, and regulating paper and ink supply during print runs;	Non-green	Establish technological parameters for the printing process in accordance with the above printing techniques to produce printed products that meet quality standards;	Non-green
		monitoring, evaluating and determining press to check print quality standards against proofs and detect malfunctions;	Non-green	Maintenance and servicing of functional parts of equipment for the above printing techniques.	Non-green

		producing a variety of printed products using digital, relief, lithographic, flexographic and gravure printing presses, and in-line finishing systems;	Non-green		
		preparing plates, blankets and impression cylinders on small offset lithographic printing presses;	Non-green		
		loading paper into feeding mechanisms;	Non-green		
		monitoring machine operations and quality of printing;	Non-green		
		producing digital print images, and transferring and outputting images.	Non-green		
7323	Print finishing and binding workers	binding full, half and limp-bound books, and repairing bindings;	Green potential	Craftsmen perform several stages in the process of completing publications and packaging;	Non-green
		setting up and supervising the operation of automatic binding and finishing equipment;	Non-green	Operate functional parts of finishing equipment and decoration of publications, packaging including operation of material supply system, operation of main finishing stage, operation of product acquisition system, other auxiliary systems such as steam system, electrical system, ...	Non-green
		folding, collating and sewing signatures by machine and hand;	Non-green	Control materials for the printing process including: Substrate materials (paper, thin film, ...), suitable adhesives, other decorative materials,...	Non-green
		operating paper guillotines for pre-press and post-press paper cutting and trimming, and programming electronically operated units;	Non-green	Establish finishing and decoration processes in accordance with product characteristics to produce printed products that meet quality standards;	Non-green
		operating systems to insert printed material into newspapers, magazines and envelopes;	Non-green	Maintenance and maintenance of functional parts of equipment in the publication and packaging finishing system.	Non-green
		embellishing printed products automatically and manually;	Non-green		
		operating photographic and electronic reproduction devices.	Non-green		
Detail of row 6 (change from green in ISCO-08 to non-green in VSCO)					
5401	Protective service workers (except police)	controlling and extinguishing fires using manual and power equipment and firefighting chemicals;	Green	Patrol a specific area to maintain public order, respond to emergencies, protect people and property, enforce laws and regulations;	Non-green
		informing the public about fire prevention.	Green	Identify and arrest suspects and perpetrators of criminal acts;	Non-green
		responding to fire alarms and other calls for assistance, such as automobile and industrial accidents, bomb threats and other emergencies;	Non-green	Guide traffic and protect the scene in case of an accident;	Non-green

	fighting special types of fires and using special equipment in industrial establishments;	Non-green	Emergency assistance to victims of accidents, crime and natural disasters.	Non-green
	rescuing people from burning buildings and accident sites and those trapped in dangerous situations;	Non-green		
	preventing or limiting the spread of dangerous substances in case of fires or accidents;	Non-green		

Source: World Bank staff's calculation based on GTI toolkit and VSCO Handbook (with translation from Vietnamese to English using MSOffice)

Table A 4: VSCO 4-digit codes that do not have correspondence in ISCO-08 and results of the text analysis of their task statements (row 10 in Table A 1)

VSCO 4-digit	Occupation title	Task statement	Green/Non-green
2445	Rangers	Advising heads of agencies to assist the Minister of Agriculture and Rural Development in performing the state management of forestry: elaborating legal documents, programs, plans, plans and schemes on forest management and protection, forest fire prevention and fighting, ensuring the observance of the law on forestry.	Green
		Directing, guiding and inspecting the management and protection of forests, forest fire prevention and fighting, ensuring the observance of the law on forestry nationwide;	Green
		Organizing the implementation of tasks on forest management and protection, forest fire prevention and fighting; ensuring the observance of the law on forestry nationwide;	Green
		Managing and directing regional forest rangers to perform tasks and powers of the Central Forest Rangers in forest management and protection; ensuring the observance of the law on forestry and organize specialized forces on forest fire prevention and fighting within the assigned areas;	Green
		Performing other duties as prescribed by law and assigned by competent state agencies;	Non-green
		Advising heads of specialized agencies to assist provincial-level People's Committees in performing the state management of forestry within the province in formulating programs, plans, plans and schemes on forest management and protection, forest fire prevention and fighting; ensuring the observance of the law on forestry;	Green
		Organizing the implementation of tasks on forest management and protection, forest fire prevention and fighting, ensuring the observance of the law on forestry within the province;	Green

		Performing other duties as prescribed by law and assigned by competent state agencies.	Non-green
3144	Aquaculture technician	Providing technical assistance for aquaculture and aquaculture care;	Green potential
		Protection of aquatic resources, diagnosis of aquatic pathology;	Green potential
		Manage fishing-related activities;	Non-green
		Monitor the growth and development of each individual aquatic animal, thereby helping to detect infected individuals for timely treatment;	Green potential
		Environmental management of ponds, aquaculture facilities, nutrition and feed in aquaculture;	Green potential
		Implementation of technical measures for breeding production.	Non-green

Source: World Bank staff's calculation based on GTI toolkit and VSCO Handbook (with translation from Vietnamese to English using MSOffice)

A2. Output-based approach

Following Posadas et al. 2023, we apply the output-based approach to classify industries in Vietnam. The classification is based on the BLS categorization of industries in the United States, using the NAICS2007. NAICS 6-digit codes are crosswalk to ISIC Revision 4 4-digit codes, similarly to what have been done in (Posadas et al. 2023). We then crosswalk from ISIC 4-digit codes to the Vietnam Standard Industrial Classification (VSIC) 4-digit codes and apply a manual reclassification of green industries to accommodate the local content in Vietnam.

This section documents the step-by-step procedure of crosswalk from NAICS 2007 codes to ISIC Rev. 4 codes, from ISIC Rev. 4th codes to VSIC (level 4 and level5), and the manual reclassification of VSIC codes.

1.1. Crosswalk from NAICS 2007 6-digit codes to ISIC Rev. 4 4-digit codes:

In 2010, the U.S. BLS classified 333 industries out of the 1192 6-digit NAICS 2007 codes as green industries.[31, 32] To estimate green jobs in the United States, the BLS first categorized "potential green" industries, and then conducted a survey of firms in these industries to estimate the number of green jobs as per their definition, meaning jobs "producing goods and services that benefit the environment or conserve natural resources across the country". Jobs are estimated from the reported percentage of revenue derived from green products from sampled firms that responded to the survey and the overall employment of the firm. The firm-level survey forms the Green Goods and Services database and includes about 120,000 firms. It was estimated that there were 3.4 million green jobs in the United States in 2011, accounting for 2.6 percent of all jobs.

We crosswalk from NAICS 2007 6-digit codes to ISIC Rev.4th 4-digit codes using the official crosswalk file from the BLS website, with some adjustments.[33] There is a discrepancy between the total number of NAICS 2007 6-digit codes in the green identification file (1192 6-digit NAICS industries) and the crosswalk file (1176 6-digit NAICS industries). There are 38 codes in the green identification file (BLS green) that are not listed in the crosswalk file, and 22 codes in the crosswalk file that are not included

[31] Bureau of Labor Statistics. n.d. "Green Jobs: Defining and Measuring the Green Economy." https://www.bls.gov/green/final_green_def_8242010_pub.pdf.

[32] These 333 industries represent 23 percent of all establishments and 20 percent of employment in the U.S. economy in 2010.

[33] North American Industry Classification System (NAICS). 2023. https://www.census.gov/naics/?68967

in the BLS green file. The 38 codes in the green identification file are comparable to 19 6-digit NAICS industries in the crosswalk file. These codes are related to construction, further split into residential and nonresidential construction contractor categories in the BLS green file. All these 38 industries are classified as green. We hence identify the 19 equivalent 6-digit NAICS codes in the crosswalk file as green. The other three unmatched industries in the crosswalk file are manually identified as green/non-green based on other similar industries in the BLS green file. These are *Dual-Purpose Cattle Ranching and Farming*, identified as green; *Offices of Notaries*, identified as non-green, and missing value (to be matched with ISIC4 codes 9810 & 9820-Undifferentiated service & goods-producing activities of private households for own use), identified as non-green. We manage to identify 1176 6-digit NAICS in the crosswalk file as green/non-green classification based on the BLS green file.

The next step involved crosswalk from 1176 6-digit NAICS2007 codes to 419 4-digit ISIC Rev.4 codes. Three possible situations may arise:

a. One NAICS 6-digit code corresponds to one ISIC 4-digit code. In this case, the ISIC is classified according to the matched NAICS. There are 62 out of the 419 ISIC codes of this type.

b. Multiple NAICS 6-digit codes correspond to one ISIC 4-digit code:

   a. If all NAICS are green (respectively non-green), then the ISIC 4-digit code is green (respectively non-green). There are 206 out of the 419 ISIC codes of this type.

   b. If the 6-digit NAICS codes corresponding to one 4-digit ISIC codes are a mix of green and non-green, we then create weights proportional to the number of green and non-green 6-digit NAICS for each 4-digit ISIC code (see example in Table A 5). There are 122 out of the 419 cases of this type.

c. One NAICS 6-digit code corresponds to many 4-digit ISIC codes. In this case, the multiple ISIC-codes take green/non-green values of the single NAICS 6-digit codes. There are 29 out of 419 cases of this type.

Table A 5: An example of how weights are assigned for mixed ISIC codes

NAICS 2007 6-digit	NAICS industry title	Green= 1, Non-green=0	ISIC Rev. 4 4-digit	ISIC Industry title	Green ISIC type	Weight (=Share of green industry)
332313	Plate Work Manufacturing	0	2512	Manufacture of tanks, reservoirs and containers of metal	Mixed	25%
332420	Metal Tank (Heavy Gauge) Manufacturing	0				
332439	Other Metal Container Manufacturing	0				
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1				

Source: Adapted from (Posadas et al. 2023).

The crosswalk from ISIC Rev.4th 4-digit to NAICS 2007 6-digit results in the classification of 419 ISIC codes into green, non-green, and mixed. In particular, 77 industries are coded as green, 220 industries as non-green, and 122 industries as mixed.

1.2. Crosswalk from ISIC4 4-digit code to VSIC2007 and VSIC2018 4-digit code:

We crosswalk ISIC Rev. 4 4-digit codes to VSIC 4-digit codes. There are more VSIC codes than ISIC codes at 4-digit level:

- There are cases in which a VSIC code matches only one ISIC code, then the VSIC 4-digit code takes green/non-green values of the matched (unique) ISIC4 code
- There are cases where multiple VSIC 4-digit codes match one ISIC 4-digit code, then these VSIC 4-digit codes take green/non-green values of the matched (unique) ISIC4 code.
- There is no case where VSIC 4-digit cannot be matched with any ISIC4 code and no case of multiple matches from 1 VSIC to multiple ISIC.

This crosswalk from VSIC2007 and VSIC2018 to ISIC4 results in the classification of industries in Vietnam into green, non-green, and mixed categories. 88 industries in VSIC 2018 as green, 243 as non-green, and 133 as mixed (Table A 6 also includes the figures for VSIC 2007, which is used when examining changes in jobs in green industries over time).

Table A 6: Green classification of VSIC 2007 and VSIC 2018 from crosswalk NAICS-ISIC-VSIC

VSIC 4-digit	Green	Non-green	Mixed	Total
VSIC 2007	80	232	125	437
VSIC 2018	88	243	133	464

Source: BLS green classification, VSIC 2007 and VSIC 2018 manuals

1.3. Manually revise the classification to adapt to the local context in Vietnam

To ensure the information on green industries from the U.S. is relevant to Vietnam, we revise the green classification for each VSIC 4-digit using VSIC documentation available at 5-digit level and weights for a crosswalk from 5-digit to 4-digit. The documentation of industry is available at 5-digit level, the lowest level that is available for VSIC 2018. The documentation contains detailed description and examples of VSIC 5-digit and is provided by the GSO.

Most of the reclassification is from green to non-green. For example, most agriculture industries in NAICS are coded as green because the BLS assumed that the United State Department of Agriculture (USDA) could certify organic produce. Since most of the agricultural production in Vietnam is not organic certified, we revise the classification from green to non-green. Similar reasoning applied to the fishery industries. Wood logging, extraction and gathering of non-wood forest products are recoded to non-green in Vietnam, since the outputs are not used for biomass as in the U.S. case. Sugarcane plantation and sugarcane manufacturing is reclassified as non-green since sugarcane is not yet used for ethanol production in Vietnam. Similarly, most manufacturing industries classified as green in NAICS because the output materials might be eligible for green certifications that are not yet available in Vietnam; hence, we have reclassified them as non-green**.** The certifications that green manufacturing industries can benefit from are specific to the U.S. context (i.e., the WaterSense certificates for efficient use of water, Energy Star for energy saving products), or globally recognized certifications not yet widespread in Vietnam (i.e., the Leadership in Energy and Environmental Design (LEED) certificates) or use recycled inputs. Some other manufacturing industries are classified as green in NAICS because materials might be inputs for renewables (i.e., iron and steel, non-ferrous metals) or for solar cells (electronic components and boards) are also recoded as non-green in Vietnam, given that the VSIC documentation does not mention such purpose.

On the other hand, we have reclassified 8 industries from non-green to green and mixed. Industries of repair services are reclassified from non-green to green in Vietnam, using the industry titles and descriptions when available. These industries are maintenance and repair of motorcycles; repair of footwear and leather goods; repair of furniture and home furnishings; repair of bicycles, watches, clocks and other

personal and household goods not elsewhere.classified. Industries of motion picture, video and television programme activities are reclassified from non-green to mixed with the assumption that part of these industries contribute to raising awareness about the environment. These industries are post-production activities and motion picture projection activities. Another industry is reclassified from non-green to mixed is research and experimental development on social sciences, which includes fields of economics, political science and social geography that can partly contribute to researching on the social dimension of environmental impacts.

And, finally, some other industries have been reclassified from green to mixed and from non-green to mixed. "Mixed" industries are industries that partly contribute to protecting the environment and/or conserving natural resources. The "mixed" category is assigned a weight to reflect the partial green component of industries. For example, Architectural and engineering activities and related technical consultancy has four 5-digit VSIC codes, two of them can be considered green "Geodetic surveying and mapping service activities" and "Geologic and hydrologic surveying activities". Hence the 4-digit VSIC code is classified as mixed with weight 0.5 (Table A 7). Information and communication activities are coded as mixed, because their content can partly contribute to the dissemination of environmental awareness and better understanding of environmental issues. This is the assumption in the U.S., and we accept this assumption in Vietnam. The weight of mix is adjusted to reflect the local documentation in Vietnam.

Table A 7: Example of revised green classification of industry with weight (from 5-digit to 4-digit)

VSIC 4-digit	VSIC 5-digit	Green category	Green category (1/0)	Weight
Architectural and engineering activities and related technical consultancy	Architectural and engineering activities	Non-green	0	0.5
	Geodetic surveying and mapping service activities	Green	1	
	Geologic and hydrologic surveying activities	Green	1	
	Other related technical consultancy	Non-green	0	

Source: VSIC manuals.

The crosswalk exercise from NAICS to VSIC with manual reclassification results in 41 industries as green, 59 industries as mixed, and 364 industries as non-green out of total 464 4-digit VSIC industries. The manual reclassification exercise results in the revision of category for 243 out of total 734 5-digit VSIC 2018 codes. Aggregation into 4-digit VSIC yields 169 out of total 464 4-digit VSIC are revised, of which 17 industries become green, 23 mix, and 129 non-green (Table A 8 and Table A 9 for the detail of mixed industries).

Table A 8: Manual revision of industry classification in VSIC (4-digit)

Initial VSIC classification using NAICS2007 and ISIC cros-waled	Revised classification based on VSIC handbook		
	Revised green	Revised mixed	Revised non-green
Green	0	11	52
Mixed	13	8	77
Non-green	4	4	0
Total	17	23	129

Source: VSIC manuals and BLS green industry classification crosswalk to VSIC.

Table A 9: List of mixed industries in Vietnam identified by the output-based approach

VSIC	Industry title	Mixed weight	Share in employment in 2021
1709	Manufacture of other articles of paper and paperboard n.e.c	0.1	0.117
2211	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber	0.5	0.038
2610	Manufacture of electronic components and boards	0.1	1.324
2651	Manufacture of measuring, testing, navigating and control equipment	0.8	0.001
2652	Manufacture of watches and clocks	0.5	0.004
2670	Manufacture of optical instruments and photographic equipment	0.1	0.002
2710	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus	0.4	0.035
2720	Manufacture of batteries and accumulators	0.8	0.032
2740	Manufacture of electric lighting equipment	0.8	0.022
2818	Manufacture of hand tools with electric motor or pneumatic drive	0.2	0.002
2819	Manufacture of other general-purpose machinery	0.3	0.011
2821	Manufacture of agricultural and forestry machinery	0.2	0.018
2822	Manufacture of metal-forming machinery and machine tools	0.1	0.005
2825	Manufacture of machinery for food, beverage and tobacco processing	0.3	0.006
2826	Manufacture of machinery for textile, apparel and leather production	0.2	0.013
2829	Manufacture of other special-purpose machinery	0.1	0.020
2910	Manufacture of motor vehicles and other motor vehicles	0.5	0.075
3030	Manufacture of air and spacecraft and related machinery	0.2	0.005
3100	Manufacture of furniture	0.2	1.785
3290	Other manufacturing n.e.c.	0.1	0.183
3511	Electric power generation	0.3	0.091
3520	Production of gas; distribution of gaseous fuels through mains	0.3	0.005
3530	Manufacture and supply of steam, hot water, air conditioning and ice	0.5	0.039
4211	Construction of railways	0.7	0.008
4221	Construction of electrical works	0.3	0.032
4229	Construction of other utility projects	0.5	0.025
4291	Construction of hydraulic structures	0.8	0.017
4312	Site preparation	0.3	0.122
4322	Plumbing, heat and air-conditioning installation	0.5	0.040
4329	Other construction installation	0.2	0.027
5011	Sea and coastal passenger water transport	0.3	0.002
5811	Book publishing	0.5	0.005
5812	Publishing of directories and mailing lists	0.5	0.001
5813	Publishing of newspapers, journals and periodicals	0.5	0.045
5819	Other publishing activities	0.5	0.003

5911	Motion picture, video and television programme production activities	0.1	0.018
5913	Motion picture, video and television programme distribution activities	0.1	0.004
5914	Motion picture projection activities	0.1	0.001
5920	Sound recording and music publishing activities	0.1	0.001
6010	Radio broadcasting	0.1	0.008
6021	Television broadcasting	0.1	0.036
6022	Cable, satellite and other subscription programming	0.1	0.011
6312	Web portals	0.1	0.003
6391	News agency activities	0.1	0.009
6910	Legal activities	0.2	0.065
7020	Management consultancy activities	0.4	0.026
7110	Architectural and engineering activities and related technical consultancy	0.5	0.164
7120	Technical testing and analysis	0.5	0.019
7221	Research and experimental development on social sciences	0.1	0.003
7310	Advertising	0.1	0.110
7420	Photographic activities	0.2	0.069
7490	Other professional, scientific and technical activities n.e.c.	0.5	0.016
8129	Industrial cleaning activities and specialized cleaning activities for buildings	0.2	0.042
8531	Basic-level training	0.3	0.079
8532	Intermediate-level training	0.3	0.030
8533	College-level training	0.3	0.073
8559	Other education n.e.c.	0.1	0.227
9102	Conservation activities and museums	0.5	0.015

Source: World Bank staff estimation based on BLS green classification and LFS 2021.
Note: The share in employment is the share of occupational employment to total national employment in 2021, weighted by population weight. The sample includes working age population aged 15-64 and excludes observations in high-level officials, military, and occupations that are not identified in VSCO 2020. The excluded observations account for 0.9 percent of the national employment (15-64) in 2021, both weighted by population weight.

Appendix B. Additional tables

Table A 10: Aggregation of industry

VSIC section	VSIC 1-digit industry group	Aggregated classification
A	Agriculture	Agriculture
B	Mining and quarrying	Mining and quarrying
C	Manufacturing	Manufacturing
D	Electricity	Electricity, gas and water supply
E	Water supply, sewerage	
F	Construction	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	Market services
H	Transportation and storage	
I	Accommodation and food service activities	
	Information and communication	
K	Financial and insurance activities	
L	Real estate activities	
M	Professional	
N	Administrative and support service activities	
O	Public administration and defense; compulsory social security	Non-market services
P	Education	
Q	Human health and social work activities	
R	Arts	
S	Other service activities	
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	
U	Activities of extraterritorial organizations and bodies	

Source: VSIC Handbook and ILO.

Table A 11: Classification of skill level

VSCO 1-digit	VSCO 1-digit occupational group	Skill level per VSCO	Skill level per ISCO	WB task team's classification
1	Legislators, Senior officials, Managers	2,3,4,5	3,4	High-skilled
2	Professionals	4,5	4	
3	Technicians and associate professionals	3	3	
4	Clerical support workers	2	2	Medium-skilled
5	Service and sales workers			
6	Skilled-agricultural, forestry and fishery workers			
7	Craft and related trades workers			
8	Plant and machine operators, and assemblers			
9	Elementary occupations	1	1	Low-skilled

Source: VSIC Handbook.

Table A 12: Green jobs and wage premium – Panel A GTI

	2021			2019		
	GTI (binary, green versus non-green)		GTI (continuous)	GTI (binary, green versus non-green)		GTI (continuous)
	(1)	(2)	(3)	(4)	(5)	(6)
	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)
GTI	-0.088**	0.034	-0.002*	-0.079	0.046*	-0.002
	(0.042)	(0.028)	(0.001)	(0.052)	(0.026)	(0.001)
Managers	0.613***	0.621***	0.608***	0.642***	0.650***	0.638***
	(0.039)	(0.041)	(0.039)	(0.032)	(0.033)	(0.033)
Professionals	0.320***	0.317***	0.315***	0.306***	0.307***	0.302***
	(0.038)	(0.037)	(0.037)	(0.043)	(0.042)	(0.042)
Technicians and associate professionals	0.241***	0.242***	0.238***	0.224***	0.227***	0.221***
	(0.027)	(0.027)	(0.027)	(0.030)	(0.030)	(0.030)
Clerical support workers	0.107**	0.109**	0.105**	0.079*	0.082*	0.078*
	(0.043)	(0.044)	(0.042)	(0.043)	(0.044)	(0.043)
Services and sales workers	0.002	0.041	-0.008	-0.012	0.023	-0.020
	(0.030)	(0.030)	(0.035)	(0.032)	(0.028)	(0.038)
Skilled-agricultural, forestry and fishery workers	0.140**	0.140**	0.136**	0.119**	0.114*	0.114*
	(0.067)	(0.071)	(0.067)	(0.059)	(0.063)	(0.059)
Craft and related trades workers	0.092***	0.088***	0.090***	0.094***	0.090***	0.092***
	(0.019)	(0.020)	(0.019)	(0.018)	(0.018)	(0.018)
Plant and machine operators, and assemblers	0.175***	0.174***	0.173***	0.142***	0.142***	0.141***
	(0.023)	(0.023)	(0.023)	(0.019)	(0.020)	(0.020)
Managers* GTI		-0.269***			-0.331***	
		(0.052)			(0.081)	
Professionals* GTI		-0.042			-0.050	
		(0.039)			(0.048)	
Technicians and associate professionals* GTI		-0.075			-0.095**	
		(0.054)			(0.043)	
Clerical support workers*GTI		0.000			0.000	
		(0.000)			(0.000)	
Services and sales workers*GTI		-0.287***			-0.313***	
		(0.048)			(0.038)	
Skilled-agricultural, forestry and fishery workers*GTI		-0.139			-0.077	
		(0.134)			(0.077)	
Craft and related trades workers*GTI		-0.005			-0.012	
		(0.031)			(0.033)	
Plant and machine operators, and assemblers*GTI		-0.064*			-0.048	
		(0.033)			(0.030)	
Male = 1	0.155***	0.158***	0.152***	0.138***	0.141***	0.135***
	(0.012)	(0.012)	(0.012)	(0.010)	(0.010)	(0.011)
Education: Secondary school	0.046***	0.047***	0.046***	0.042***	0.043***	0.042***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)
Education: High school	0.112***	0.112***	0.112***	0.104***	0.104***	0.104***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)

Education: Vocational school + college	0.205***	0.202***	0.204***	0.177***	0.174***	0.177***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Education: University or higher	0.380***	0.376***	0.380***	0.361***	0.354***	0.362***
	(0.032)	(0.033)	(0.032)	(0.028)	(0.027)	(0.028)
Observations	181,962	181,962	181,962	187,919	187,919	187,919
R-squared	0.352	0.354	0.352	0.324	0.326	0.324
Province FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Age	YES	YES	YES	YES	YES	YES

Green jobs and wage premium – Panel B Potential GTI

	2021				2019		
	GTI (binary, green versus non-green)			GTI Index (continuous)	GTI (binary, green versus non-green)		GTI Index (continuous)
	Not excluding agriculture		Excluding agriculture	Not excluding agriculture	Not excluding agriculture		
	(1)	(2)	(3)	(4)	(5)	(6)	(1)
	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)	ln (hourly wage)
Potential GTI	-0.007	-0.080*	0.010	-0.001*	-0.029	-0.081*	-0.001
	(0.026)	(0.042)	(0.028)	(0.000)	(0.025)	(0.047)	(0.000)
Managers	0.610***	0.617***	0.616***	0.609***	0.635***	0.645***	0.637***
	(0.040)	(0.042)	(0.040)	(0.039)	(0.033)	(0.033)	(0.032)
Professionals	0.314***	0.312***	0.311***	0.313***	0.299***	0.303***	0.298***
	(0.036)	(0.038)	(0.037)	(0.036)	(0.042)	(0.043)	(0.042)
Technicians and associate professionals	0.239***	0.238***	0.233***	0.237***	0.220***	0.225***	0.218***
	(0.027)	(0.030)	(0.028)	(0.026)	(0.030)	(0.033)	(0.029)
Clerical support workers	0.108**	0.102**	0.105**	0.104**	0.076*	0.076*	0.076*
	(0.042)	(0.044)	(0.041)	(0.042)	(0.044)	(0.045)	(0.043)
Services and sales workers	-0.013	0.057***	-0.020	-0.014	-0.020	0.035	-0.025
	(0.038)	(0.020)	(0.039)	(0.039)	(0.039)	(0.022)	(0.042)
Skilled-agricultural, forestry and fishery workers	0.137**	0.137**	-0.026	0.150***	0.122**	-0.184***	0.120**
	(0.067)	(0.054)	(0.047)	(0.057)	(0.056)	(0.067)	(0.053)
Craft and related trades workers	0.097***	0.015	0.083***	0.103***	0.114***	0.042	0.100***
	(0.030)	(0.051)	(0.032)	(0.021)	(0.027)	(0.037)	(0.019)
Plant and machine operators, and assemblers	0.176***	0.142***	0.168***	0.175***	0.146***	0.130***	0.141***
	(0.024)	(0.022)	(0.024)	(0.023)	(0.021)	(0.021)	(0.019)
Managers*GTI		-0.181***				-0.244***	
		(0.047)				(0.079)	
Professionals*GTI		0.072				0.085	
		(0.050)				(0.058)	
Technicians and associate professionals*GTI		0.055				0.054	
		(0.051)				(0.056)	
Clerical support workers*GTI		-0.082				0.055	
		(0.053)				(0.061)	
Services and sales workers*GTI		-0.197***				-0.203***	
		(0.048)				(0.051)	
Skilled-agricultural, forestry and fishery workers*GTI		0.018				0.322***	
		(0.082)				(0.086)	
Craft and related trades workers*GTI		0.158**				0.136**	
		(0.065)				(0.060)	
Plant and machine operators, and assemblers*GTI		0.162***				0.097*	
		(0.050)				(0.050)	
Male = 1	0.151***	0.155***	0.141***	0.152***	0.138***	0.142***	0.135***
	(0.012)	(0.012)	(0.011)	(0.012)	(0.010)	(0.010)	(0.011)

Education: Secondary school	0.045***	0.044***	0.044***	0.046***	0.042***	0.042***	0.042***
	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)
Education: High school	0.112***	0.109***	0.112***	0.113***	0.104***	0.101***	0.104***
	(0.014)	(0.013)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)
Education: Vocational school + college	0.204***	0.198***	0.205***	0.205***	0.183***	0.167***	0.181***
	(0.017)	(0.017)	(0.018)	(0.017)	(0.019)	(0.016)	(0.018)
Education: University or higher	0.380***	0.370***	0.380***	0.381***	0.365***	0.347***	0.364***
	(0.032)	(0.033)	(0.032)	(0.032)	(0.029)	(0.027)	(0.029)
Province FE	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES
Age FE	YES	YES	YES	YES	YES	YES	YES
Observations	181,962	181,962	167,589	181,962	187,919	187,919	187,919
R-squared	0.351	0.357	0.347	0.351	0.324	0.328	0.324

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: World Bank staff estimation using LFS 2019 and 2021.

Note: The sample includes working-age population aged 15-64 and having status of employment as employees. It excludes observations in high-level officials, military (0.83 percent of the sample), and occupations that seem to have a wrong code not in VSCO 2020 (less than 0.01 percent of the sample. The outcome variable is log of hourly wage of main job. The hourly wage is calculated as the monthly income of wage earners (employees) divided by the number of usual weekly hours times 4 (weeks). The standard errors are clustered at 4-digit occupational level.

Table A 13: Field of studies requirement for green jobs in Vietnam

Occupation	1st field of study	2nd field of study	3rd field of study
Chemists	Engineering, manufacturing, and construction	Natural science, mathematics, and computing	Health and welfare
Geologists and geophysicists	Engineering, manufacturing, and construction	Natural science, mathematics, and computing	Life science and environmental knowledge
Biologists, botanists, zoologists and related professionals	Life science and environmental knowledge	Natural science, mathematics, and computing	No training needed
Farming, forestry and fisheries advisers	Agriculture and veterinary	Life science and environmental knowledge	Natural science, mathematics, and computing
Environmental protection professionals	Life science and environmental knowledge	Social science, business, and law	Natural science, mathematics, and computing
Civil engineers	Engineering, manufacturing, and construction	Natural science, mathematics, and computing	Health and welfare
Environmental engineer	Life science and environmental knowledge	Engineering, manufacturing, and construction	Social science, business, and law
Town and traffic planners	Engineering, manufacturing, and construction	Social science, business, and law	Life science and environmental knowledge
Chemical and physical science technicians	Natural science, mathematics, and computing	Life science and environmental knowledge	Social science, business, and law
Civil engineering technicians	Engineering, manufacturing, and construction	Natural science, mathematics, and computing	Social science, business, and law
Power production plant operators	Engineering, manufacturing, and construction	Natural science, mathematics, and computing	Natural science, mathematics, and computing
Incinerator and water treatment plant operators	Life science and environmental knowledge	Engineering, manufacturing, and construction	Natural science, mathematics, and computing
Forestry technicians	Agriculture and veterinary	Life science and environmental knowledge	Natural science, mathematics, and computing
Forestry and related workers	Agriculture and veterinary	Life science and environmental knowledge	Social science, business, and law
Aquaculture workers	Agriculture and veterinary	Life science and environmental knowledge	Other
Floor layers and tile setters	Engineering, manufacturing, and construction	Other	Social science, business, and law
Insulation workers	Engineering, manufacturing, and construction	Health and welfare	Social science, business, and law
Motor vehicle mechanics and repairers	Engineering, manufacturing, and construction	Services	Natural science, mathematics, and computing
Plastic products machine operators	Engineering, manufacturing, and construction	Life science and environmental knowledge	Health and welfare
Steam engine and boiler operators	Engineering, manufacturing, and construction	Other	Life science and environmental knowledge

Source: World Bank staff calculation using GSS and GTI toolkit.
Note: Field of study is classified at 1-digit International Standard Classification of Education (ISCED). The field of studies reported for each occupation is the most frequent field reported among respondents of that occupation.

Appendix C: The Vietnam Green Jobs Survey

The Vietnam Green Jobs Survey (GJS) collects detailed information about tasks, skills, and educational requirements of green jobs in Vietnam. It was administered by the GSO with close supervision from the World Bank. The GJS uses the identification of green occupations from the GTI toolkit. The GJS includes the top 20 green occupations in Vietnam and could be further integrated into the Labor Force Survey to systematically collect information about green jobs in Vietnam. The survey was carried out in five provinces Ho Chi Minh City, Hai Duong, Hai Phong, Nghe An, and Khanh Hoa and has a sample size of 500 observations.

The GJS builds on previous efforts aimed at profiling tasks and skills of occupations in Vietnam. The questionnaire was developed based on the Survey of Detailed Skills (SDS) that interviews workers in the top growing occupations in Vietnam about their tasks, skills, and educational requirement (World Bank forthcoming). The SDS selects 30 occupations that are in-demand and/or relevant for the growth of strategic industries of Vietnam's economy. The GJS uses the questionnaire developed in the SDS while making some adjustments. The main adjustment adapted in the GJS is to include questions on ranking the importance of different types of environmental knowledge.

Targeted green occupations

The GJS includes the top 20 medium- and high-skilled occupations in Vietnam with the highest GTI score identified by the GTI toolkit. The selection of these green occupations is based on their GTI score, from the list of 37 green occupations in Vietnam (Table 1), with some adjustments. Two low-skilled occupations, refuse sorters and garbage and recycling collectors, have been excluded as it was deemed that their task-content may be rather simple and not the best use of survey resources. Furthermore, the medium-skilled occupation bicycle and related repairers because this occupation is close to another green occupation with higher share in employment, namely motor vehicle mechanics and repairers. Table A14 gives a full list of occupations included in the GJS survey.

Table A 14: List of selected green occupations in the Vietnam Green Jobs Survey

VSCO 2020	Occupation title (English)	GTI (green)	Share (%) in employment in 2021
2113	Chemists	25.0	0.007
2114	Geologists and geophysicists	25.0	0.012
2131	Biologists, botanists, zoologists, and related professionals	37.5	0.007
2132	Farming, forestry, and fisheries advisers	25.0	0.046
2133	Environmental protection professionals	85.7	0.010
2142	Civil engineers	28.6	0.266
2143	Environmental engineer	88.9	0.028
2164	Town and traffic planners	12.5	0.018
3111	Chemical and physical science technicians	16.7	0.009
3112	Civil engineering technicians	22.2	0.056
3131	Power production plant operators	16.7	0.006
3132	Incinerator and water treatment plant operators	50.0	0.009
3143	Forestry technicians	20.0	0.004
6210	Forestry and related workers	20.0	0.184
6221	Aquaculture workers	11.1	0.613
7122	Floor layers and tile setters	25.0	0.017
7124	Insulation workers	33.3	0.032
7231	Motor vehicle mechanics and repairers	12.5	0.756

8142	Plastic products machine operators	14.3	0.284
8182	Steam engine and boiler operators	16.7	0.012
Total			**2.377**

Source: World Bank staff calculation based on GTI toolkit and LFS 2021.
Note: The share in employment is the share (%) of occupational employment to total national employment in 2021, weighted by population weight. The sample includes working age population aged 15-64 and excludes observations in high-level officials, military, and occupations that are not identified in VSCO 2020. The excluded observations account for 0.9 percent of the national employment (15-64) in 2021, both weighted by population weight.

Sampling strategy and final sample distribution

The GJS uses snow-balling sampling method with rigorous selection criteria to ensure robust coverage and diversity across various key characteristics, including gender, age group, firm type, and geographics (urban/rural and region). The survey covers five provinces, including one large economic center and four smaller provinces in Vietnam's three main regions: Hai Duong and Hai Phong (Red River Delta region), Nghe An (North Central Coast region), Khanh Hoa (South Central Coast region) and Ho Chi Minh City (Southeast region) (Table A 15). In addition to ensuring geographical diversity, these provinces were selected because they have large numbers of green jobs based on LFS data. The sample is evenly distributed across locations and occupations: 5 observations per occupation per province, resulting in 25 observations per occupation and 100 observations per province, or a total sample size of 500 observations.

Table A 15: Five provinces selected for the Vietnam Green Jobs Survey

Province	Share of green jobs	Intensity of green jobs	Share of total jobs
Hai Duong	1.83	3.56	1.89
Hai Phong	2.23	3.97	2.06
Nghe An	1.87	2.13	3.22
Khanh Hoa	1.11	3.35	1.22
Ho Chi Minh City	11.86	4.79	9.09

Source: World Bank staff calculation using LFS 2021.
Note: The sample includes working age population aged 15-64 and excludes occupations in high-level officials, military, and occupations that are not identified in VSCO 2020. The excluded observations account for 0.9 percent of the national employment (15-64) in 2021, both weighted by population weight. The share of green jobs is the share of green jobs in the province to the total number of green jobs in the country. The intensity of green jobs is the share of green jobs to the total number of jobs in that province. The share of total jobs is the share of total number of jobs in the province to the share of total jobs in the country.

Sampling strategy. The GSO provided the five Provincial Statistics Office (PSO) with the list of the selected 20 green occupations, as well as required sample size and selection criteria. Each PSO then identified the first group of respondents (one worker per occupation, i.e., 20 workers per province) and requested their consent to participate in the survey. They identified these workers based on their own database and network, the annual Vietnam Enterprise Survey (VES) database and request for information from other relevant local government agencies. Each PSO then asked the first group to introduce them to other workers in the same occupations until they reached the target of 5 workers per occupation, 100 workers per province. The respondents in each province were selected based on the following criteria: urban/rural distribution, firm diversity, and oversampling female workers to avoid female underrepresentation given the small sample size. Once the identification of the 100 potential respondents and their contact details was completed, enumerators started conducting interviews. During fieldwork, if a pre-identified worker could not be contacted, the snow-balling method was again used to reach other workers in the same occupation while maintaining the selection criteria.

The GJS survey was conducted in-person and the interviews were conducted between February and March 2023. The final sample has the following attributes:

Rural/urban area: The sample includes respondents in both urban and rural areas. In the final sample, 66 percent of respondents are in urban area.

Firm: Each occupation has observations working in at least 9 different firms. For occupation 2142, Civil engineers, 25 respondents were interviewed in 25 different firms (where we also count a self-employed individual as a firm).

Gender: From the LFS 2021, female workers account for 18 percent of workers engaging in these 20 occupations. In the final sample, female respondents account for 23.2 percent.

Questionnaire Outline

The questionnaire comprises of four sections, including demographic and other general information of respondents, tasks, skills, and educational requirement for the jobs. The following section details the content that each section covers.

Section A. The General Information module collects demographic information on respondents, including age, gender, education, working experience, and type of business establishment.

Section B. The Tasks module is specific to each occupation. A task is defined as an action or a set of actions taken together to accomplish a goal. The questionnaire includes all tasks listed in the VSCO handbook for each specific 4-digit VSCO occupation, and their task statements. Each occupation included has between 6 to 12 tasks, and the majority have 7 tasks or more. Similar to the SDS, the task module of the GJS asks respondents to rate each of the tasks according to the frequency with which they are performed. The frequency options are (1) Never; (2) Once every few months/years; (3) Monthly; (4) Weekly; (5) Daily; (6) Several time per day; (7) Hourly or continuously.

Section C. The Skills module includes detailed questions about 10 types of skills: reading (5 items), writing (3 items), math (4 items), social (6 items), physical (3 items), problem-solving (6 items), technical (6 items), resource management (5 items), digital (12 items), and green (4 items).

Within each skill type, multiple skill levels are asked with examples to better illustrate the skill to the respondents. For example, reading includes different levels, ranging from simple (Read letters, memos, e-mails, newspapers or magazines) to advance (read books, professional journals, or academic publications). Another example is math, which includes different levels, ranging from simple (Use simple math, such as addition, subtraction, multiplication, or division) to intermediate (Use or calculate fractions, decimals, or percentages) and advance (used advanced math, such as algebraic, trigonometric, or regression techniques). The questionnaire requests that respondents rate each of the skills according to the frequency with which they are used, similar to the scale asked in the Tasks module. The scale ranges from (1) Never; (2) Once every few months/years; (3) Monthly; (4) Weekly; (5) Daily; (6) Several time per day; to (7) Hourly or continuously. The GJS questionnaire includes 49 skills. Some additional information is added for certain skills, for example the usual length of documents in pages (reading and writing), the use of computer (yes/no) and smartphone (yes/no) at work. The list of green skills is in Table A 16.

Table A 16: List of green skills in the Vietnam Green Jobs Survey

	In your job, do you perform […]? If yes, what is the level of performance?
A	Monitoring and optimizing the use of energy such as electricity, heat and fuel
B	Minimizing waste and waste generation and/or conserving natural resources (for example, by recycling or reusing waste/waste, optimizing the use of inputs, monitoring water use and protecting ecosystems)

C	Research, apply, or impart knowledge, plans or technologies about the environment (e.g., by developing a process or technology that reduces environmental impact or teaching, raising awareness of community on environmental issues)
D	Producing renewable energy or environmentally friendly outputs (e.g., making renewable energy equipment, operating renewable energy production vehicles, or engaging in agricultural sectors). agriculture, forestry or aquaculture using sustainable production methods)

Source: GJS questionnaire

One additional element of the GJS is asking respondents to rank the importance of nine types of environmental knowledge in their work. The scale of ranking ranges from (1) Very unimportant; (2) Unimportant; (3) Neutral; (4) Important; (5) Very important. The types of environmental knowledge are listed in Table A 17.

Table A 17: List of environmental knowledge types in the Vietnam Green Jobs Survey

How do you rate the importance of […] in the work you are doing?	
1	Environmental awareness (for example: awareness of human influence on the natural environment, the importance of protecting the natural environment, the harmful effects of environmental destruction)
2	Environmental laws and regulations
3	Knowledge of environmental certifications , such as ISO 14001, LEED Certification
4	Knowledge of renewable energy, natural resource management, recycling, waste management or environmental management
5	Knowledge of practical *processes to improve* energy, water , and resource efficiency or reduce emissions , reduce pollution
6	Knowledge of environmental science or sustainable development
7	Knowledge of Corporate social responsibility
8	Knowledge of sustainable or eco-friendly designs or techniques, such as green building techniques, organic farming, green cleaning
9	Sustainable business strategy

Source: GJS questionnaire

Section D. The Education and Experience Requirement module asks respondents about the qualifications needed to perform the job, including the level and fields of education, related work experience, and on-the-job training.