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KEY POINTS

- Green jobs can be defined in different ways. The key for public policy is to be aware of nuances and apply definitions with the use case in mind.

- Technical and medium-skilled occupations are expected to be in high demand in the green economy.

- Green jobs require more technical skills than other jobs, and a sustainability mindset.

- Green jobs are diverse, and particular roles require specific skills.

- Green workforce planning and development needs to include (i) country-specific green labor market forecasts, (ii) sector-specific workforce planning, (iii) a tailored approach to updating qualifications, (iv) capacity to deliver technical education, and (v) teaching sustainability as a mindset across education subsectors.

Preparing the Workforce for the Low-Carbon Economy: A Closer Look at Green Jobs and Green Skills

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The Asia and Pacific region is highly exposed to the effects of climate change. Six out of the top ten countries in the world most affected by weather-related loss (i.e., storms, floods, landslides, and heatwaves) in 2000–2019 are in developing Asia (Eckstein et al. 2021). Climate change under a high emissions scenario could impose gross domestic product losses of 24% in the whole of developing Asia, including 35% in India and 32% in Southeast Asia by 2100 (ADB 2023). The region is increasingly a contributor to the global climate crisis with its share of global greenhouse gas (GHG) emissions doubling from 22% in 1990 to 44% in 2019 (ADB 2023). Thus, decisive action is needed.

Governments in the region face a major policy challenge in leading the transition to a low-carbon economy. This policy challenge spans across multiple sectors and includes the transition to renewable energy, electrified transport, energy-efficient construction, nature-based solutions, and a circular economy.[1] It requires a concerted policy effort that includes the development of conducive policy frameworks, access to green finance, and the promotion of sustainable technologies (ADB 2017, OECD 2023).

The introduction of sustainable technologies will impact labor markets and companies' workforce requirements. New green jobs will emerge, and skill requirements of many existing jobs are set to change (Van der Ree 2019) with skills playing an important role in green technology adoption (Hötte 2019). It is estimated that 43% of the workforce in Asia and the Pacific is employed in industries that are either vulnerable[2] to climate extremes or the transition to a low-carbon economy (Deloitte 2023). Thus, green workforce development is a central pillar of the transition to a low-carbon economy, and education systems need to be prepared to meet emerging green skill needs.

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Governments recognize the need for action and green workforce development initiatives are taking shape across Asia and the Pacific. The Green Jobs Act in the Philippines (TESDA 2023), the Skill Council for Green Jobs in India and Green Technology Master Plan in Malaysia (KeTTHA 2017) are just some examples. However, the current speed of green workforce development has been deemed too slow to meet climate targets (Linkedin 2022). Climate education and skills development policies are scarcely mentioned in nationally determined contributions of many countries (ILO 2019, Kwauk 2021, UNESCO 2021). Policies on green skills and jobs are also often at a nascent stage. As such, low levels of knowledge among stakeholders as well as the lack of clearly delineated taxonomies of green jobs and skills are potential barriers for effective green workforce development (Kwauk and Casey 2022, Stanef-Puică et al. 2022, World Bank 2023).

The brief presents five recommendations for building a skilled green workforce for the transition to low-carbon economies across Asia and the Pacific. By outlining different definitions of green jobs, it will help define what constitutes a green job forming the basis for targeted policy actions. In addition, based on data of green labor market forecasts and skills needs comparisons, the brief points to the specific jobs and skills that are anticipated to be in demand in the green economy. The brief can help policymakers and administrators from the Asian Development Bank (ADB) developing member countries in taking their green workforce development initiatives further forward.

WHAT ARE GREEN JOBS?

There are various approaches to defining green jobs. While there is broad agreement that green jobs are jobs that contribute to preserving or restoring the environment and reducing the negative environmental impact of human activity (BLS 2013, ILO 2019, Stanef-Puică et al. 2022), there is no agreement on which specific jobs should be viewed as green. This section introduces four different ways of defining green jobs that are referred to as (i) sustainability, (ii) green industry, (iii) task profile, and (iv) green task definition (Table 1). The first definition sees sustainability as a guiding principle in all jobs, therefore all jobs are green. The second

definition identifies green jobs by their affiliation with specific green economic activities. The last two definitions identify green jobs by assessing characteristics of job task profiles.

The **sustainability definition** views all jobs as green jobs based on the premise that every occupation, if not already green, has a work process that can and should be made more sustainable. For example, bakers may become more sustainable by using organic flour, eco-friendly packaging, and energy-efficient ovens. This position has been adopted by the German technical and vocational education and training (TVET) sector, which has mandated the inclusion of minimum standard training requirements for environmental protection and sustainability in all apprenticeship occupations (BWP 2021). The sustainability definition is a normative approach to green jobs reflecting the broader goal that all jobs should follow sustainable practices. This creates the rationale for mainstreaming green skills into all qualifications. Its key drawback is that it does not strategically identify green jobs that are critical to the green transition or have specific green skilling needs. Therefore, it is too broad for strategic green workforce development.

The **green industry definition** takes a more targeted approach by viewing green jobs as those that are affiliated with outputs as well as economic activities in the economy that are deemed green. The definition therefore requires a clear green taxonomy defining what constitutes a green economic activity (Box 1). The United States (US) Bureau of Labor Statistics (BLS) takes this approach outlining five groups of goods and services that it regards as green: (i) energy from renewable sources; (ii) energy efficiency; (iii) pollution reduction and removal, GHG reduction, and recycling and reuse; (iv) natural resource conservation; and (v) environmental compliance, education and training, and public awareness. The five

Table 1: Four Definitions on Green Jobs

Definition	Understanding of Green Jobs
Sustainability	Jobs in which the work process can be made more sustainable. All jobs are green jobs.
Green Industry	Jobs affiliated with economic activities that are deemed green by virtue of contributing to reducing carbon emissions.
Task Profile	Jobs that are affected by the green transition either by an increase in demand or change in task profile.
Green Task	Jobs that have a high green skills intensity.

Source: Author.

Box 1: Green Taxonomies in Asia and the Pacific

The application of the green industry definition requires a green taxonomy that classifies economic activities and outputs of an economy as green as illustrated by the five groups of the United States Bureau of Labor Statistics. National green taxonomies have been emerging across Asia and the Pacific, such as the Green Taxonomy Edition 1.0 in Indonesia (Otoritas Jasa Keuangan 2022), the Sri Lanka Green Finance Taxonomy (Central Bank of Sri Lanka 2022), the Fijian Sustainable Bond Framework (Ministry of Economy 2022) and the Sustainable Finance Policy for Banks and Financial Institutions in Bangladesh (Bangladesh Bank 2020). The original purpose of those taxonomies is to guide investments into green economic activities for effective investment steering. In principle, they can also be applied in context of the green industry definition by identifying jobs in the economic activities that are outlined in the green taxonomies. This has been indicatively done for the European Union Taxonomy for Sustainable Activities (Wendland 2022). Future green job analyses in Asia and the Pacific may build upon existing national green taxonomies.

Source: Author.

groups encompass 333 industry subsectors out of the 1,192 total industry subsectors listed in the national industry classification system (BLS 2013). Green jobs are identified through an industry survey in the 333 green industry subsectors. The green industry definition identifies all jobs that are required in green production and service activities. This also includes indirect green jobs, which are jobs needed in those processes but may not require any green skills.

The underlying methodology—affiliating jobs with green production and service processes and outputs—has the advantage of showing which specific jobs are important for which specific green economic activities. This information creates the basis for strategic sectoral workforce planning. The drawback is while it shows which jobs are needed, it does not provide information about green skill needs of jobs, leaving open which of the identified jobs in green industries also require green skills.

The **task profile definition** regards green jobs as only those jobs that are affected by the green transition. The O*NET occupational database of the US labor market takes this approach by assessing how each job task profile in the database is affected by the green transition (Bowen et al. 2018, Dierdorff et al. 2009). It is therefore considered a task-based approach compared to the affiliation approach of the green industry definition (Vona et al. 2021).

The task profile definition identifies three different ways jobs are affected by the green transition resulting in three distinct green job categories:

(i)   Green increased demand: jobs with no changes in their task profile but are affected in terms of a higher demand due to the green transition. They are considered indirect green jobs.
(ii)   Green enhanced skills: jobs with significant changes to their task profile, considered direct green jobs.
(iii)   Green new emerging: jobs that are unique to the green economy require a new task profile, also considered direct green jobs.

The O*NET occupational database maps green jobs in the US labor market along the three categories (Table 2). For example, electricians in the energy sector are in higher demand in the green economy but do not face changes to their task profile and hence skill needs (green increased demand). Heating, air conditioning, and refrigeration mechanics and installers experience a significant

Table 2: The Three Green Jobs Categories Under the Task Profile Definition

	Green Increased Demand	Green Enhanced Skills	Green New Emerging
Agriculture	• Forest and conservation workers (M) • First-line supervisors of agricultural crop and horticultural workers (M)	• Soil and plant scientist (AH) • Farm and ranch managers (H) • Agricultural technician (M)	• Environmental restoration planners (AH) • Remote sensing technologist (AH) • Environmental economist (AH)
Construction and Installation	• Construction carpenters (ML) • Cement masons (L) • Welders (ML)	• Construction managers (H) • Construction laborer (ML) • Plumbers (M) • Civil engineers (H)	
Energy	• Electrical power line installers (ML) • Power distributors and Dispatchers (M) • Electrician (M)	• Heating, air conditioning, and refrigeration mechanics and installers (M) • Power plant operators (ML)	• Energy auditors (M) • Solar photovoltaic installers (ML) • Biomass plant technician (ML) • Wind turbine service technician (M)
Transport	• Rail track laying and Maintenance operators (ML) • Bus drivers (ML)	• Heavy truck drivers (ML) • Transportation vehicle and equipment inspectors (ML)	• Logistics managers (H) • Logistics engineers (H) • Automotive engineering technician (M)
Water	• Fish and game wardens (H) • Hydrologist (AH)	• Hydrologic technician (M)	• Water resource specialists (H) • Water/Wastewater engineers (H
Manufacturing	• Industrial production managers (H) • Electronic equipment assemblers (ML) • Punching and press machine setters and operators (ML)	• Sheet metal worker (ML)	• Robotics technician (M) • Electrical engineering technologists (M)
Other (e.g., services)	• Software developers (H) • Supply chain manager (H)	• Marketing managers (H) • Wholesale and retailer buyers (M) • Training specialist (H)	• Compliance manager (H) • Solar sales representatives (M)

Note: Training requirements are indicated in parenthesis based on O*NET five job zones: Low (L) = up to 3 months training; Medium-Low (ML) = 3 months – 1 year education typically requires a high school diploma; Medium (M) = 1-2 years, typically vocational training; High (H) = 2-4 years, typically bachelor's degree; Advanced High (AH) = 4+ years typically post-graduate degree.

Source: Author based on data from O*NET occupational database, https://www.onetonline.org/.

change to their task profile (green enhanced skills) and hence face substantial re-skilling needs. Wind turbine service technicians are new emerging jobs that are unique to the green economy (green new emerging). The task profile definition identifies all jobs that are relevant for green workforce development either due to higher demand or changes to task profiles.

The underlying methodology—assessing changes to job task profiles and demand—has the advantage of providing job-specific insights creating the basis for differentiating between green jobs and counting them more precisely. For example, in 2014, 10.3% of jobs in the US labor market were green increasing demand jobs that have no re-skilling needs, 7.9% were green emerging skills jobs that generally have significant changes to task profile and hence re-skilling needs, and 1.2% were green new emerging jobs with entirely new skilling needs (Bowen et al. 2018). The drawbacks of the task profile definition are: (i) its green job categories only provide an implicit and rough indication about green skilling needs of jobs, (ii) it does not affiliate jobs with green production processes for the sectoral identification of green jobs, and (iii) it is based on the analysis of existing job task profiles in the economy and therefore does not capture jobs that may become green in the future.

Finally, the **green task definition** put forward in academic literature (Bowen et al. 2018, Vona et al. 2019)**,** regards green jobs as jobs with a significant share of green tasks. As with the task profile definition, it is a task-based approach that analyzes job task profiles. It focuses exclusively on identifying green tasks in job profiles instead of assessing if tasks have changed more broadly. The "greenness" of a job is determined by dividing

the number of green tasks of a job by its total number of tasks. The level of greenness can then be shown on a greenness spectrum (Figure 1) starting from 0 (no green tasks) to 1 (all tasks are green). For example, the greenness score of an energy auditor is 1 as all tasks are green whereas the greenness score of a roofer is 0.3 indicating that around 30% of tasks in a roofer's profile are green. The green task definition thereby identifies all jobs that have green tasks in their job task profile.

Its underlying methodology—assessing green tasks in job task profiles—provides clear indications about the greenness of individual jobs, which also allows for counting green jobs more precisely. For example, when jobs with a greenness score of 1 are counted as green then 2%–3% of jobs in the current labor market are green jobs, compared to around 19% when all levels of greenness are counted (Bowen et al. 2018, Vona et al. 2021). Its drawback is that it provides a limited view of jobs needed in the green economy as it excludes indirect green jobs. In addition, as a task-based approach, it does not affiliate jobs with green production processes for the sectoral identification of green jobs, and greenness scores are based on the analysis of existing job task profile in the economy and therefore do not capture jobs that may become green in the future.

Applying green job definitions depends on the use case and methodological considerations.[3] The different definitions highlight that green jobs can be looked at in various ways. Broadly, the **green industry definition** enables policy makers to identify all jobs affiliated with green industries and link them with specific green economic activities. This provides the basis for a sectoral approach to workforce development and identifying potential labor

Figure 1: Green Jobs on a Greenness Spectrum Measured by Share of Green Tasks
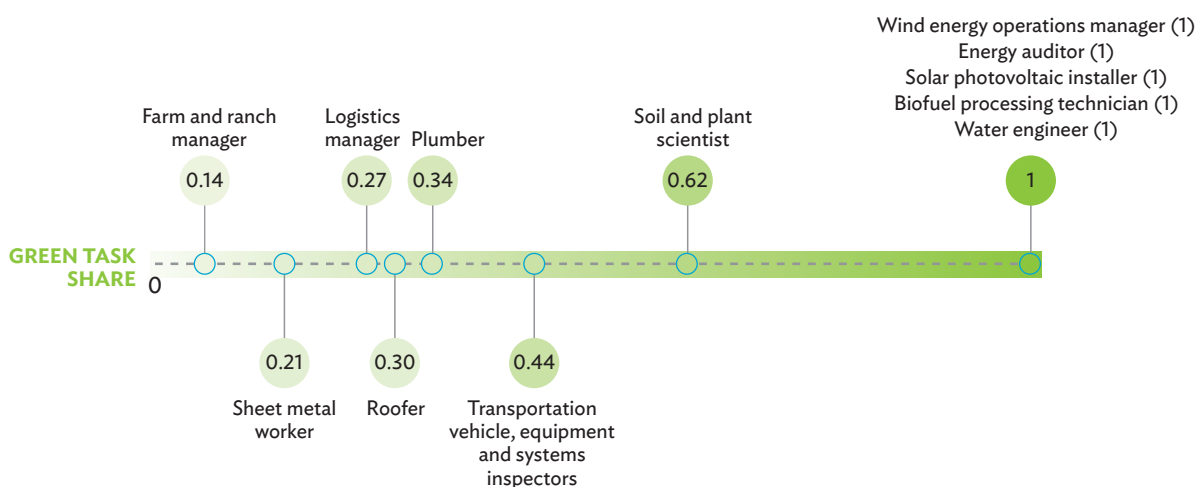
Source: Author based on data from F. Vona, G. Marin, and D. Consoli, 2019. Measures, Drivers and Effects of Green Employment: Evidence from US Local Labor Markets, 2006–2014. *Journal of Economic Geography*. 19(5).

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[3] See OECD 2023 and Vona et al. 2021 for an in-depth methodological discussion.

Box 2: Green Industry and Green Task Definition Applied to Viet Nam's Labor Market

The green industry and green task definition have been applied in an analysis of Viet Nam's labor market (World Bank 2023). The analysis contextualizes the green industry definition by matching the green industry categories of the United States Bureau of Labor Statistics with Viet Nam's Standard Classification of Industry. The green task definition is contextualized by applying jobs that have been classified as green in an international index to the Viet Nam Standard Classification Occupations and the national labor force survey. The analysis is an example of how green job definitions can be applied in practice to generate insights into the green labor market of Viet Nam:

- Following the green task definition, 3.6% of jobs may be currently considered green jobs in Viet Nam's economy, while it is 4.8% following the green industry definition.
- More than 80% of green jobs are currently held by men.
- Provinces with the greatest share of green jobs are Ho Chi Minh City (11.9%), Ha Noi City (10%) and Binh Duong (3.9%).
- Provinces with the highest reliance on green jobs as a share of total local jobs are Yen Bai (13.1%), Bac Lieu (12.2%) and Soc Trang (8.5%).
- Occupational groups with the highest share of green jobs are currently skilled agricultural, forestry and fishery workers, professional occupations, and craft and related trade workers.

Source: World Bank 2023.

shortages across all jobs needed in the green economy. Countries that have an industry classification framework and green taxonomy in place have an entry point to apply the underlying affiliation methodology. The green industry definition has been applied in a labor market analysis for Viet Nam (Box 2). The **green task definition** provides policymakers with an opportunity to pinpoint those jobs that have a high green task share and require significant green up-skilling. The definition has been also applied in a labor market analysis for Viet Nam. The **task profile definition** sits in the middle of the mentioned approaches. Policymakers may use it to identify all jobs affected by the green transition and to determine the extent to which they are affected. To apply the **green task or task profile definitions**, countries require either an occupational database that accounts for green tasks or need to cross between green job profile data from external occupational classifications to national occupational classification frameworks. Finally, the **sustainability definition** of green jobs is too broad for identifying or counting green jobs. It instead highlights the need for education planners to include basic green skills in all qualifications. For public policy, it is key that green jobs definitions are applied with use case in mind and can be operationalized in policy programs.

WHICH JOBS WILL BE IN DEMAND IN THE GREEN ECONOMY?

This section explores which specific jobs are anticipated to be in demand in the future green economy according to one global and one selected national labor market forecasts. The forecasts focus exclusively on green employment based on green transition

scenarios that assume that needed green investments (e.g., in renewable energy) will be made in the future as compared to a business-as-usual scenario.

There is a lack of green labor market forecasts in Asia and the Pacific that provide job level data across multiple green sectors.[4] The brief therefore references first a global green labor market forecast for 2030 that includes 38 economies,[5] 12 of which are in Asia and the Pacific and forecasts green jobs in a renewable energy transition scenario only (ILO 2019). The second is a national green labor market forecast for Germany that models a comprehensive green transition scenario including the renewable energy transition, energy-efficient construction and industry, and electrification of transport (Blazejczak and Edler 2021). The results of the German forecast may also apply to developing countries in Asia and the Pacific, as countries may broadly adopt the same green technologies (e.g., solar panels, wind turbines, electric vehicles) and hence will have similar workforce needs. At the same time, differences in the speed of technology adoption, green growth strategies, and priority sectors for greening are expected between all countries. Therefore, the German example should be treated with these differences in mind. Ultimately, each country would benefit from its own country-specific green labor market forecast.
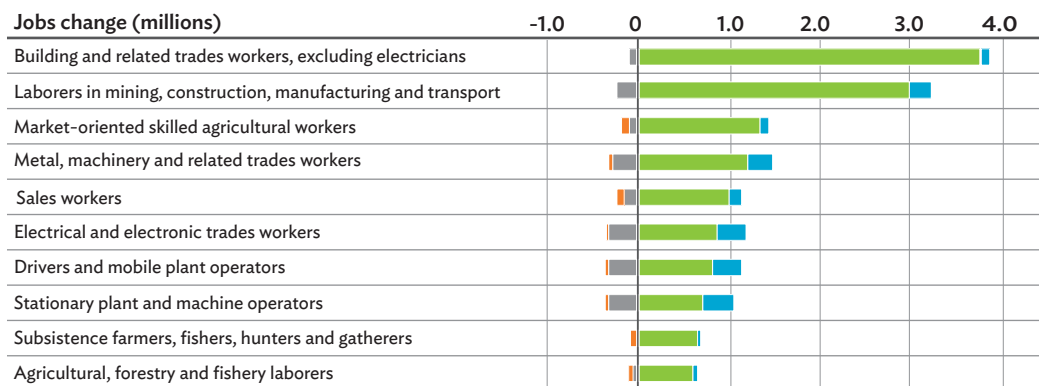
Both forecasts take the **green industry perspective** to green jobs, identifying all jobs that are in demand in (affiliated with) the economic activities of the given green transition scenarios.[6] It does not differentiate forecasted jobs by their level of greenness, which would require additional job task profile analyses.

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[4] Existing forecasts tend to focus on the energy transition only and provide aggregated employment forecasts for high level economic sectors, such as Abrigo et al. 2021 for Philippines; GGGI 2019 for Fiji; IASS, TERI, CEEW, and SCGJ 2019 for India; and World Bank 2022 for Pakistan.

[5] Bosnia and Herzegovina, Brunei Darussalam, Cambodia, Ecuador, Eswatini, Ethiopia, Fiji, Ghana, Greece, Guatemala, Guyana, Lao People's Democratic Republic, Liberia, Madagascar, Mauritius, Mexico, Mongolia, Myanmar, Nepal, Pakistan, Panama, Peru, Rwanda, Samoa, Serbia, Seychelles, Sierra Leone, Sri Lanka, Switzerland, Thailand, Timor-Leste, Turkey, Uganda, United Arab Emirates, United Kingdom, United States, Uruguay, Zimbabwe.

[6] See detailed description of methodology for International Labour Organization (ILO) study in ILO 2018.

Figure 2: Job Groups with the Highest Number of New Net Jobs Created in a Renewable Energy Transition Scenario for Various Countries by 2030

Jobs change (millions)	-1.0	0	1.0	2.0	3.0	4.0
Building and related trades workers, excluding electricians						
Laborers in mining, construction, manufacturing and transport						
Market-oriented skilled agricultural workers						
Metal, machinery and related trades workers						
Sales workers						
Electrical and electronic trades workers						
Drivers and mobile plant operators						
Stationary plant and machine operators						
Subsistence farmers, fishers, hunters and gatherers						
Agricultural, forestry and fishery laborers						

Note: Occupations measured at the ISCO-08 two-digit level. Green bar (new jobs), blue (new jobs absorbing laid-off workers), grey (jobs destroyed, transferable) and orange (jobs destroyed, not transferable).

Source: Author based on International Labour Organization. 2019. *Skills for a Greener Future: a Global View*. Geneva.

Technical and middle-skilled jobs are in high demand in the renewable energy sector. In the global labor market forecast for the renewable energy transition (Figure 2), the top three job groups in demand by 2030 are building and related trade workers,[7] elementary laborers in manufacturing, construction, and transport, and third, skilled agricultural workers. Of the top 10 job groups, five are blue-collar jobs (such as metal, machinery, and electronic trade workers), three are agricultural jobs, and the remaining two are laborer and sales jobs (ILO 2019). Other studies also find that construction and manufacturing jobs make up the majority of jobs in demand in the renewable energy transition (IEA 2022, OECD 2023).

The forecast also highlights that most jobs are anticipated to be in middle-skilled jobs (64%); with a small share in low-skilled (20%) and highly skilled (16%) jobs (ILO 2019).[8] Country-specific analyses for Pakistan (World Bank 2022), Viet Nam (IASS and Green ID 2019) and India (IASS, TERI, CEEW, and SCGJ 2019) also project the predominance of low- and middle-skilled jobs in the renewable energy sector.

Technical and middle-skilled jobs are also in high demand in other green sectors. The green labor market forecast for Germany by 2035 (including the renewable energy transition, energy-efficient construction and industry, and the electrification of transport) (Figure 3), confirms the results of the global forecast. The top three job groups in demand in the green transition scenario for Germany are construction, machines and mechanics, and electrical equipment. The high demand for construction and installation

workers is driven by infrastructure development such as installation of electrical vehicle charging infrastructure, installation of solar and wind farms, and retrofitting of energy-efficient housing. With an increasing number of green infrastructure completed over time, the demand for operations and maintenance technicians is anticipated to gradually increase including jobs in machines, mechanics and electrical equipment (Accenture 2023).There is also a smaller but noticeable demand for engineering services as well as business administration white-collar jobs that cut across sectors (Blazejczak and Edler 2021). Jobs in agriculture, fisheries, and mining are less in demand compared to the global forecast, reflecting their lesser quantitative significance in the German economy. These sectors are anticipated to play a more significant role in the green transition in Asia and the Pacific (Vivid Economics 2021) as also indicated in country-specific analyses for Indonesia (PAGE 2023) and Viet Nam (World Bank 2023).

In line with the results of the global forecast, most jobs in the green economy in Germany by 2035 are anticipated to be middle-skilled (58%, corresponding to vocational education) with a smaller share in low-skilled (19%, corresponding to short-term vocational education or less), and highly skilled jobs (23%, corresponding to advanced vocational education and higher education).[9] It has been suggested that the role of middle-skilled jobs becomes greater over time and initially highly skilled jobs are in greater demand (OECD 2023). Thus, the employment trends forecasted may not develop linearly.

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[7]   Related trade workers include building frame, building finisher, painters, and building structure cleaners.
[8]   High-skilled occupations are those listed under ISCO-08 codes 1, 2 or 3; medium-skill occupations are those listed under ISCO-08 codes 4, 5, 6, 7 or 8; and low-skill occupations are those listed under ISCO-08 code 1.
[9]   Some studies conclude that green jobs are most highly skilled jobs (Broome et al. 2022, Vona et al. 2019). Those studies only focus on jobs that have a high level of greenness excluding jobs needed in the green economy with little to no green skill needs.

Figure 3: Ten Sectors with Highest Number of Jobs Created in a Climate-Neutral Investment Scenario for Germany by 2035 (in thousands)

Jobs change (thousands)	0	50	100	150	200
Contruction and installation					203
Machines and mechanics		84			
Electrical equipment		54			
Metal products		43			
Services in architecture and engineering		37			
Services in legal, tax, or business		28			
Services in human resource management		28			
Building construction and engineering		27			
Security services		24			
Retail trading		24			
Wholesale trading		23			

Source: Author based on data from Blazejczak, J. and Edler, D. 2021. *Arbeitskräftebedarf nach Sektoren, Qualifikationen und Berufen zur Umsetzung der Investitionen für ein klimaneutrales Deutschland.* Berlin.

While the two labor market forecasts are based on different countries and green transition scenarios, they provide a similar overall outlook about jobs in future green labor markets. The key takeaways are: (i) blue-collar jobs are in greatest demand in the green economy, with a notable number in construction and manufacturing jobs; (ii) middle-skilled jobs make up the majority of jobs in the green economy in the medium- to long-run; (iii) green labor markets include a range of jobs that reflects the various sectors affected (e.g., energy, transport, agriculture) and related enabling services. Which of those identified green jobs require green skills is not shown by the forecasts, requiring additional analyses on the job profile level.

Country-specific green labor market forecasts are needed. The two forecasts provide a general direction of where labor markets are heading when economies embark on a green transition. Developing countries need to conduct their own green labor market forecasts that build on country-specific green transition scenarios as well as other country-specific factors that affect labor markets such as demographic change, digitalization, and structural change. The purpose of such forecasts is to provide education policy makers with foresight about future job trends to inform future-oriented education and workforce planning (Box 3).

WHAT ARE GREEN SKILLS?

For the development of a green workforce, identifying the skills that are needed in the jobs of the green economy, often referred to as green skills, is key. Green skills are broadly defined as knowledge, abilities, values, and attitudes needed to live, work and act in resource-efficient and sustainable economies and societies (CEDEFOP et al. 2022, European Commission 2022). A distinction is commonly made between green technical and transversal skills (CEDEFOP et al. 2022, ETF 2023, Pavlova 2022).

Box 3: Mapping the Skills Landscape for Green Jobs in India

Based on the projection that India has the potential to create 35 million green jobs by 2047 the Sector Council for Green Jobs (SCGJ) in India has outlined green jobs and skills development trends (Sattva Consulting and Skill Council for Green Jobs 2023). The report identifies key emerging green jobs in nine green industries and maps the current green education supply against it. The education supply analysis takes stock of existing qualification packages, active skill councils, and public and private training providers that provide related training, highlighting progress as well as gaps in the green skills ecosystem. The report notes the need to establish a scalable skill infrastructure for green jobs and to address challenges in training delivery such as limited depth of green skilling courses and a lack of expert trainers and equipment. It is an example of how labor market projections and an education supply analysis can be combined.

Source: Sattva Consulting and Skill Council for Green Jobs 2023.

Green technical skills are technology-specific. Green skills as technical skills are associated with green technologies. They are required to adapt or implement standards, processes, services, products, and technologies to protect ecosystems and biodiversity, and to reduce energy, materials, and water consumption (CEDEFOP et al. 2022). For example, the skill of equipment maintenance is a green skill when applied to solar panels as compared to an internal combustion engine.

Green transversal skills need to be approached as a competence. Green skills as transversal skills are more ambiguous. Transversal skills are not specific to green technologies and are already required in many other jobs in today's economy. What makes them "green" transversal
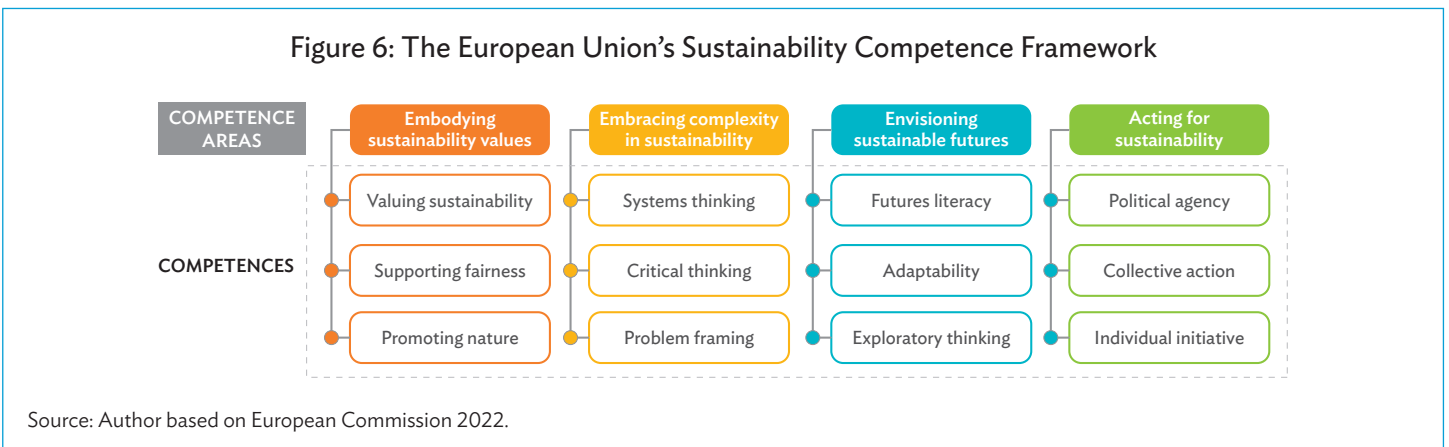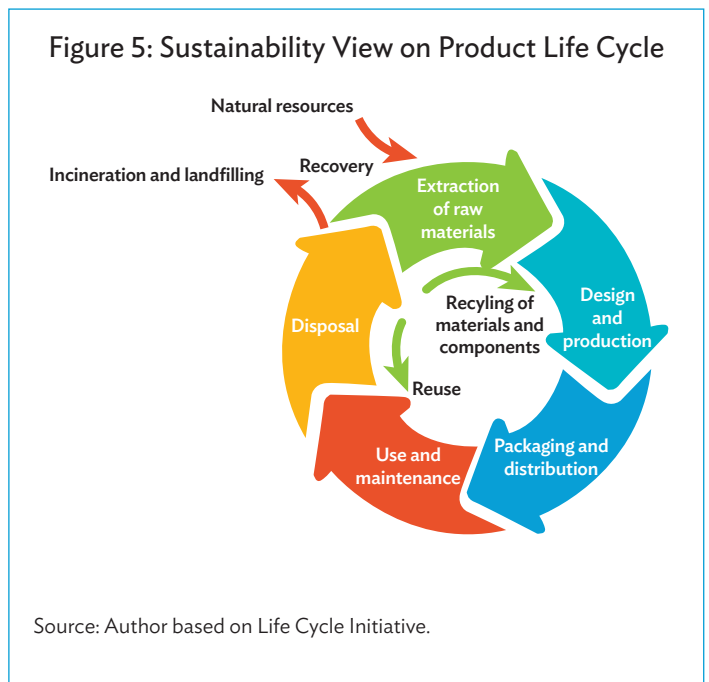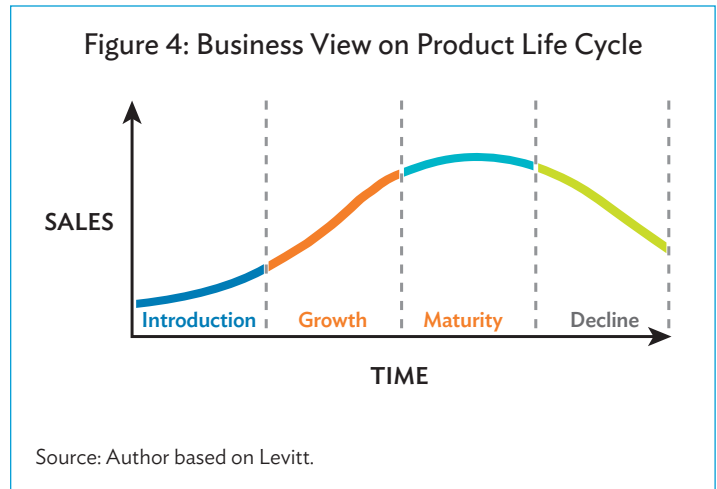
skills is when they are applied in a green context and informed by a sustainability mindset (European Commission 2022, Kwauk and Casey 2022, Pavlova 2022). For example, a product life cycle is a way to view a product as a system which requires system thinking skills. If system thinking is informed by a business mindset, a product life cycle may be defined by sales (Figure 4). If system thinking is informed by a sustainability mindset, the product life cycle may be defined by resource use and efficiency, resulting in a different green view of the same product (Figure 5). Thereby, learners apply system thinking as a green skill (Figure 5).

The European sustainability competence framework captures the idea of transversal skills being informed by a sustainability mindset (European Commission 2022). The framework is built around key transversal skills such as system thinking, future literacy, and critical thinking (Figure 6). It emphasizes that these skills need to be approached as a competence that combine skills, knowledge, abilities, values, and attitudes that together empower learners to think, plan, and act with sustainability in mind (European Commission 2022). Thus, transversal skills as a green skill need to be viewed in context with other sustainability skills, knowledge, and values and taught as a competence.

Green transversal skills are conceived as job and life skills.
As life skills green transversal skills have been referred to as green life and transformative skills (Kwauk and Casey 2022), with the underlying education goal to foster behavioral change preparing people to live and act in sustainable societies (European Commission 2022, UNESCO 2020). It is often viewed as part of citizen education (UNESCO 2020). Green transversal skills as a job skill have been referred to as generic green skills in contrast to green technical skills (Pavlova 2022). The education goal is to prepare people to apply sustainable behaviors also at the workplace in any work task (Gut et al. 2023). Green transversal skills as job and life skills considerably overlap, while in teaching they may be differently contextualized in general or job-specific learning scenarios.

Key observations on green skills are: (i) green skills can be functionally described as technical and transversal skills that are contextualized in green technologies and a sustainability mindset, (ii) teaching transversal skills as a green skill may build upon

Figure 4: Business View on Product Life Cycle

Source: Author based on Levitt.

Figure 5: Sustainability View on Product Life Cycle

Source: Author based on Life Cycle Initiative.

Figure 6: The European Union's Sustainability Competence Framework

Source: Author based on European Commission 2022.

existing teaching practices for transversal skills but must be taught as a competence in combination with sustainability knowledge and values, and (iii) green transversal skills are a life and job skill.

WHAT SKILLS ARE NEEDED IN GREEN JOBS?

While the previous section highlights the importance of teaching green skills as a competence, skills remain a useful metric to assess different skill needs of jobs. Table 3 compares the skills intensity between green[10] and all jobs in the economy for 14 selected social; cognitive; science, technology, engineering, and mathematics (STEM); and technical skills (Teller and Habans 2022). The skill differential percentage in the last column shows how much the skill needs of green jobs differs from other jobs in the economy resulting in the following observations:

- **Technical skills.** Green jobs have, on average, a significantly higher demand for technical skills such as equipment maintenance, repairing, and operation monitoring than other jobs as shown by the higher score differential in Table 3 (Teller and Habans 2022).

- **Social skills.** Green jobs require slightly lower social skills than other jobs. The scores for social skills in green jobs are however generally higher than the score for technical skills

underlining their importance as foundational skills in any job (Pew Research Center 2022).

- **Cognitive skills.** Green jobs require similar cognitive skills (transversal skills) as other jobs, including problem solving, systems thinking and critical thinking skills. The scores for cognitive skills in green jobs are generally higher than the score for technical skills underlining their importance in most jobs.

- **STEM skills.** The demand for STEM skills in the green economy is slightly lower but similar to jobs in the rest of the economy with the exception of science which is more needed in green jobs.

Technical skills are a key characteristic of green jobs. The comparison shows that technical skills play a greater role in green jobs than in other jobs. The need for social, cognitive, and STEM skills, except for science, is not markedly different in green jobs than in others. Some authors conclude therefore that green jobs do not require a radical departure from the skill sets already needed in the labor force (Bowen et al. 2018, Vivid Economics 2021). However, as noted earlier, existing transversal skills in the current labor force may not be perfectly transferable to green jobs. Instead, they need to be at least partially retaught as a sustainability competence. Thus, green jobs may face greater retraining needs than the functional skill intensity comparison above indicates.

Table 3: Skills Intensity Between Green and Non-Green Jobs for Selected Social, Cognitive, STEM, and Technical Skills

Skills	Score for All Jobs in Economy	Score for Green Jobs	Score Differential (%)
Social skills			
Active listening	3.54	3.35	(5%)
Speaking	3.49	3.34	(4%)
Writing	2.95	2.84	(4%)
Cognitive skills			
Critical thinking	3.3	3.31	0%
Judgment and decision-making	3.06	3.06	0%
Complex problem solving	2.93	3.02	3%
System analysis	2.43	2.51	3%
STEM skills			
Mathematics	2.41	2.39	(1%)
Programming	1.37	1.36	(1%)
Science	1.52	1.68	11%
Technical skills			
Equipment maintenance	1.51	2.24	48%
Repairing	1.48	2.19	48%
Operation monitoring	2.38	2.93	23%
Installation	1.18	1.56	32%

( ) = negative, STEM = science, technology, engineering, and mathematics.

Note: Number rates importance of a given skill 0 (not important) and 5 (highly important). In the last column, colors indicate if green jobs require more (green), similar (yellow), or less (orange) of a given skill.

Source: Author based on data from Teller, A. and Habans, R. 2022. *Toward an equitable blue-green economy in Southeast Louisiana.* Coast Brief. The Data Center.

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[10] Green jobs are based on the O*NET occupational database and include all three green job categories, green increased demand, green enhanced skills, and green new emerging job.

Different green jobs need different green skills. An additional caveat of green skills is that not all green jobs require the same green skills. When comparing different types of green jobs different skills appear to be important for different green jobs (Pew Research Center 2022). It has been shown that in **green new emerging jobs** (jobs unique to the green economy) science, mathematics and system thinking skills have a greater significance compared to other jobs[11] (Pew Research Center 2022, Saussary et al. 2022). However, in **green increased demand jobs** (jobs with no changes in task profiles but in higher demand in the green economy) technical skills such as repairing, and equipment maintenance are most significant when compared to other jobs (Pew Research Center 2022). These findings underline that green skills manifest themselves differently in different jobs as they are ultimately job- and technology-specific (Saussary et al. 2022).

The key takeaway for skills needs in green jobs are, (i) green jobs require on average more technical skills than other jobs, (ii) transversal and social skills are needed to a similar extent in green jobs as in other jobs but may still require retraining for their specific application in the sustainability context, and (iii)green skills manifest themselves differently in different green jobs resulting in different re- and up-skilling needs.

IMPLICATIONS FOR GREEN WORKFORCE DEVELOPMENT

The brief shows that green jobs have different levels of greenness, vary in labor market demand, are often technical jobs, and require different green skills. These findings have implications for green workforce development. Education planners need to engage in diagnostic work, sector-specific workforce planning (recommendation 1 and 2) and a tailored approach to updating qualifications (recommendation 3) to account for the different skilling needs between green jobs. In addition, given the importance of technical and green transversal skills in many green jobs, the promotion of technical education and sustainability competences are central to green workforce development (recommendations 4 and 5):

1. **Conduct green labor market forecasts and analyses.**
    The green transition will impact countries and labor markets differently depending on country-specific factors and green transition plans. Therefore, green labor market forecasts based on country-specific green development scenarios need to be conducted. They provide an orientation for education and workforce planners about future job trends and create the basis for more detailed skill needs and education gap analyses in those forecasted jobs.

    Such labor market forecasts need to be conducted with the green economy in mind. This includes outlining country-specific green economic development scenarios, following an agreed definition of green jobs, and focusing on specific green

industries or regions that are anticipated to be most affected by the green transition (OECD 2023). In addition, forecasted green jobs may also be assessed in terms of the quality of jobs, such as working conditions. Addressing issues in work quality ensures that green jobs are decent jobs and an attractive career choice including for women and youth.

2. **Promote strategic and sector-specific green workforce planning.** The speed of green technology adoption will differ between sectors and consequently so will the demand for green workers. Therefore sector-specific workforce and education planning is critical to develop demand-driven and timely green qualification programs.

    Effective green workforce and education planning requires structured dialog with industry as well as sector line ministries. Key cooperation partners may include green economic cluster organizations, technology center of excellence, lead companies, existing sector skill councils, business associations as well as sector line ministries that oversee state-owned enterprises such as utilities. Governments need to provide these actors with resources to become active in green workforce planning (ADB 2022). This includes providing grants to support the formation of sector workforce councils and fund their activities such as green occupational mapping, curricula reviews, and green education supply and demand analysis. Examples of this are the Skills Council for Green Jobs in India (Bishnoi and Rai 2022) and the TESDA Green Technology Center in the Philippines (TESDA 2023).

3. **Update green qualifications in line with different green skilling needs of green jobs.** The brief has shown that green skill needs differ between jobs. Correspondingly, greening curricula is not a uniform process for each qualification. Some green jobs change moderately and have low or moderate levels of greenness requiring some degree of updating in qualifications. This can range from making changes to existing curricula, introducing new modules to rolling out short-term continuous education programs for re- and up-skilling. Other jobs are fundamentally new to the green economy and have a high level of greenness requiring fundamental changes to qualifications. This can range from introducing specialized tracks within existing qualifications to developing completely new ones.

    Governments may lead the updating of qualifications in a top-down approach but may also support and incentivize actors in the broader skills ecosystem to become active. An example of this is the European Union's BUILD UP Skills initiative that strategically funds consortia of industry sector associations, training providers, and universities to develop and deliver new qualifications and up-skilling programs in energy building efficiency aimed at construction workers.[12]

4. **Improve capacities to deliver technical education for green jobs.** The brief underlines the central role of technical skills and

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[11]   Older jobs are jobs that are not unique to the green economy and include green increased demand and green enhanced skills jobs.
[12]   BUILD UP Skills. https://build-up.ec.europa.eu/en/bup-skills .

jobs in the green economy such as construction trade jobs and electricians. Technical training is therefore central to meeting the skill requirements of the green economy and avoiding future workforce shortages. It is recommended to improve the capacity of TVET and skills systems to deliver technical education with a focus on jobs in high demand in the green economy. Key actions can include establishing green centers of excellence, technical training for teachers, promoting work-based training, and developing greened qualification standards, curricula, and training and assessment materials.

5. **Teach sustainability as a mindset and competence in primary and secondary education as well as TVET.** The analysis of green skills underlines the importance of a sustainability mindset to inform transversal skills combining into a sustainability competence. Therefore, sustainability needs to be taught as a mindset, value, and knowledge in primary and secondary education to become a foundational skill. It may also be taught in technical education to contextualize it in work processes of different jobs (Gut et al. 2023). This requires among others updating of curricula to teach sustainability competences and corresponding teacher capacity building.

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