Preparing a Green ---- Blue Workforce

Building a Workforce for the Future: Sustainability, Green, and Blue Jobs

A white paper prepared for the EDC Convening: Preparing a Green and Blue Workforce

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Skills for a Green Future



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Introduction: The Rapidly Growing Sustainability Jobs Sector

The scale and magnitude of human imprints on the environment have reached levels that are leaving a permanent geological record in Earth's history. Evidence of this record marks the beginning of the Anthropocene—a testament to human ingenuity and adaptation but also a confirmation of environmental impacts that threaten the viability of people and ecosystems (Steffen et al. 2018). Climate change, biodiversity loss, land use change, deforestation, water diversion, disrupted nutrient cycles, pollution, avoidable poverty, and rising inequalities are among the environmental and sustainability challenges that human choices have precipitated. These challenges threaten biodiversity, undermine a stable climate system, and affect the viability of ecosystems and nature. They also threaten the people and societies that depend on well-functioning ecosystems for their health, safety, and livelihoods. Increased awareness of how human activities are causing environmental harms has led to responses from government, nonprofit and private sectors, individuals, and communities to reduce environmental impacts while meeting the needs and desires of present and future populations. Incorporating equity, well-being, and equality principles within and between generations while stewarding the environment on which all life depends is the essence of sustainability.

Policies, regulation, and compliance are critical levers for achieving sustainable development. However, an important recent shift is the recognition that sustainability is not simply a regulatory burden—it is also a driver of innovation and is financially profitable (Jones 2017; Whelan & Fink, 2016). Sustainability as opportunity has created a rising demand for professionals to work in this field.

Related to this need, sustainability jobs, careers, and opportunities are undergoing a transformation. This transformation is unfolding at a pace and in ways that were unexpected even a decade ago. It is increasingly evident that the ongoing shifts are necessary to achieve the transformative changes called for by corporate leaders, governments, international agencies, and civil society members.

100 million

new jobs will be created by the renewable energy and circular economy transitions

The number, diversity, and expectations for jobs and careers are rising faster than the available qualified professionals who can meet the challenges of sustainability. According to an analysis conducted by LinkedIn (2023), between 2022 and 2023, the number of jobs requiring at least one green skill rose by 22% while the share of green talent in the workforce rose by only 12%. Similarly, between 2018 and 2023, the number of jobs posted on LinkedIn requiring at least one green skill increased by 9.2%, while the share of LinkedIn users with green talent increased by 5.4% per year.

The International Labour Organization (2022) estimates that 100 million new jobs will be created by the renewable energy and circular economy transitions and that upskilling will be required to fill those positions. The World Economic Forum predicts that 40% of new green jobs will require new skills (Masterson, 2021). Preparing the next generation workforce to fill the green, blue, and sustainability skills gap is a major challenge and opportunity (Boone & Seto, 2023).

A number of factors are driving the rapid increase in sustainability-related jobs. These include a growing awareness of the scale and complexity of sustainability challenges and opportunities, changing consumer preferences, investor demands, new government regulations and investments, and technological innovation (e.g., plummeting costs for renewable energy hardware) (Boone et al., 2023).

In this white paper, we have three primary goals: (i) define sustainability jobs, including blue and green jobs; (ii) identify the skills and dispositions needed for these jobs; and (iii) outline the kinds of preparation, training, and education needed for these jobs. We draw on peer-reviewed literature, authoritative reports, and an extensive jobs database (Lightcast) to inform our findings and recommendations.

Defining Sustainability, Green, and Blue Jobs

Broad job categories are challenging to define, especially for new and emerging fields. Take green jobs, for example. Most definitions recognize that green jobs are related to environmental protection and improvement, but some call out specific tasks (e.g., research and development), skills (e.g., project management), and sectors (e.g., renewable energy) to define the category. (See Table 1.) Examples of green jobs (as well as blue and sustainability jobs) are certainly helpful for defining the category, and we provide those in the latter part of the paper. As a general starting point, we define three types of jobs related to the environment: sustainability jobs, green jobs, and blue jobs.

- + **Sustainability jobs:** Jobs that improve human well-being and improve social equity, while reducing environmental harms and strengthening environmentally positive outcomes.
- Green jobs: Jobs that reduce negative environmental impacts or advance environmental goals primarily in terrestrial ecosystems and contexts. (Note that, in many contexts, "green" is the overarching term used to describe all jobs related to environment and sustainability.)
- Blue jobs: Jobs that reduce negative environmental impacts or advance environmental goals primarily in marine, coastal, and aquatic ecosystems and contexts. (Note that blue jobs are often treated as a subset of green jobs, but with a specific focus on employment related to water issues. In many definitions, blue jobs focus on the marine rather than freshwater environments.)

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Green and Blue Jobs Definitions			
Source	Green Jobs Definition		
U.S. Bureau of Labor Statistics	"Green jobs are either (a) jobs in businesses that produce goods or provide,,, services that benefit the environment or conserve natural resources and (b) jobs in which workers' duties involve making their establishment's production process more environmentally friendly or use fewer natural resources." (U.S. Bureau of Labor Statistics [U.S. BLS] n.d., https://www.bls.gov/green/green_definition.pdf)		

United Nations Environment Programme	"Work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; decarbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution" (United Nations Environment Programme et al., 2008, p. 3).
LinkedIn Global Green Skills Report	"Green skills: are those that enable the environmental sustainability of economic activities; Green jobs: are those that cannot be performed without extensive knowledge of green skills; Greening jobs: can be performed without green skills, but typically require some green skills; Greening potential jobs: can be performed without green skills, but occasionally require some level of green skills" (LinkedIn 2022, p. 6)
U.S. Department of Labor's Occupational Information Network (O*NET)	New and emerging: "unique jobs (as defined by worker requirements) created to meet the new needs of the green economy" Green enhanced: "existing jobs that require significant changes in tasks, skills, and knowledge as a result of greening" Green increasing 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" (Bowen et al., 2018, p. 264)
Lightcast and WorkingNation	Core green jobs: "developed as a result of the transition into the green economy, and the job plays a direct role in conserving the environment" Green enabled jobs: "separate or tangent to the green economy, but are recently seeing a demand for more green skills" Green enabling jobs: "do not necessarily require green-related skills, but are housed at firms associated with the green economy" Potential Green jobs: "currently have little relation to the green economy (Beckett, 2023; Schindelheim, 2023)
Bezdek, 2020	"Green jobs include those created both directly and indirectly by renewable energy, energy efficiency, and environmental protection expenditures" (Bezdek, 2020, p. 1024)
Taylor et al. 2017	Green-blue jobs: "Production of goods, services and research that seeks to reduce environmental damage to primarily marine environments; production of goods, services and research that seeks to exploit the marine environment for economic growth, whilst limiting environmental risk and damage; regulatory activities to minimize or correct environmental damage and risks to the marine environment" (Taylor et al., 2017 p. iv)

World Bank	Jobs that support the blue economy: "the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystems" (World Bank & United Nations Department of Economic and Social Affairs, 2017, p. vi)
Middlebury Institute of International Studies at Monterey	Blue economy jobs are those that relate to "the overall contribution of the oceans to economies, the need to address the environmental and ecological sustainability of the oceans, and the ocean economy as a growth opportunity for both developed and developing countries" (Middlebury Institute of International Studies at Monterey, n.d.)

Defining "Green" Jobs by Job Skills, Content, and Intensity

The required expertise and responsibilities of sustainability, green, and blue jobs can vary in intensity. An employee who works as an environmental impact assessment specialist, for example, will likely require advanced training in environmental science and environmental regulation, and the majority of their work responsibilities would fall under the green/blue category (jobs that reduce negative environmental impacts or advance environmental goals primarily in terrestrial/marine/coastal/aquatic ecosystems and contexts). For an electrician, by contrast, they likely would not require advanced training in environmental science and very few hours may be dedicated to reducing environmental harm or reaching environmental goals (although this would likely vary based on the employer's or employee's priorities).

For its green jobs reports, LinkedIn (2022) divides green jobs into the following three categories. The most intensive are titled green jobs, defined as "those that cannot be performed without extensive knowledge of green skills." Green skills are those that "enable the environmental sustainability of economic activities." The second level is greening jobs, defined as jobs that "can be performed without green skills, but typically require some green skills." The least intense green jobs are called greening potential jobs, described as jobs that "can be performed without green skills, but occasionally require some level of green skills." LinkedIn offers example jobs for each category: green job (solar technician), greening job (civil engineer), and greening potential (data analyst). Using these categories, LinkedIn finds that 1% of all hires in 2021 fall under the green jobs category, 9% under greening, and 40% under greening potential. It also finds that hiring for green jobs is growing faster than all other categories, including "not green" jobs (LinkedIn, 2022).

The U.S. Department of Labor's (n.d.) Occupational Information Network (O*NET) addresses the issue of jobs intensity by dividing green jobs into three categories. The first is new and emerging green jobs, described as "unique jobs (as defined by worker requirements) created to meet the new needs of the green economy." The second is green enhanced jobs, defined as "existing jobs that require significant changes in tasks, skills, and knowledge as a result of greening." The third is green increasing demand jobs, or "existing jobs that are expected to be in high demand due to greening, but do not require significant changes in tasks, skills, or knowledge." The O*NET classification for green jobs is broad and includes all jobs that will be impacted or can contribute to the green economy. Using these categories and data collected from O*NET, Bowen et al. (2018) estimate that 19.4% of jobs in the United States are green jobs, with 10.3% of all jobs requiring specific green tasks and 1.2% in jobs (new and emerging green jobs) that are unique to the green economy.

Lightcast is a labor analytics company that collects and analyzes data from 65,000 sources amounting to over 1 billion job postings annually. We use data from that organization for our jobs analysis of blue, green, and sustainability jobs. (See next section.) Similar to LinkedIn, Lightcast identifies green jobs along an intensity spectrum, from core to potential green jobs. (See Table 1 for definitions.) For the United States, its analysis shows a greater than 50% growth in green jobs between 2019 and 2023, rising to 2.8% of all job postings. The number of

postings for solar sales representatives grew by 70% and 56% for solar installers between 2019 and 2020, and neither of these positions typically require a college degree (Beckett, 2023). In this regard, green jobs can provide a pathway for professional development and skills development for workers who lack access or choose not to pursue higher education credentials.

We concur with Bowen et al. (2018) that "green jobs vary in 'greenness', with very few jobs only consisting of green tasks" and that "the term 'green' should be considered a continuum rather than a binary characteristic" (p. 263). The idea of a continuum or jobs intensity should also be applied to blue jobs and sustainability jobs. A wastewater treatment operator is part of the blue economy because they are treating water to make it safer for the environment and human health. However, a wastewater treatment operator who is managing an artificial wetland for tertiary treatment would be further along the blue skills continuum. They would require more training in environmental sciences and nature-based services than an operator who is using standard chemical and biological wastewater treatment. For sustainability, an IT specialist may know something about the overall goals of the company that person works for and so considers the purchasing and operation of IT equipment based on sustainability principles (e.g., energy consumption, toxicity of materials, fair labor). If the company has a Chief Sustainability Officer, that individual would require deeper training in sustainability, including how to develop and ingrain sustainability as a company strategy.

As is true for most economic sectors, tremendous diversity exists in the types of jobs, hard- and soft-skill job requirements, and aptitudes and educational qualifications for sustainability jobs in the blue and green sectors as well as more generally. In all these categories, jobs fall along an intensity spectrum. For some positions, specialized education and training are required to prepare individuals to fill specific roles with particular green, blue, or sustainability knowledge and competencies. For others, the knowledge and competencies may be more generalized, preparing people for a range of positions, within or outside of the sustainability workforce. Even a cursory review of descriptions that employers have used to solicit applications for prospective workers and recruit talent demonstrates the mix and range of desired attributes that employers seek.

Defining "Green" Jobs by Job Output and Areas of Focus

Although there are many ways to define sustainability, green, and blue jobs (Boone et al., 2023; Urban et al., 2023), much of the work in this area has adopted a definition based on output (Bohnenberger, 2022a, 2022b; Urban et al., 2023). The output-focused approach labels a job as "green" or "not-green" based on the end product or service associated with the job. For example, as part of their definition of green jobs, the U.S. BLS (U.S. BLS, 2010, p. 57511) includes "jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources." The BLS goes on to describe these green goods and services as products that are sold to customers and associated with one or more of the following categories: energy from renewable sources; energy efficiency; pollution reduction and removal, greenhouse gas reduction, and recycling and reuse; natural resources conservation; and environmental compliance, education and training, and public awareness (U.S. BLS, n.d.). Rather than considering jobs at the level of the individual position, green jobs defined using an output approach are often identified at the company or sectoral level (Bohnenberger, 2022b; Janser, 2019). In this way, all jobs in the renewable energy sector, for example, are seen as green jobs as the end product is renewable energy. Examples of green jobs based on output may include a green building architect (based on end product) or a recycling coordinator or environmental educator (both based on services provide).

Classifying jobs as green based on the end product raises some challenges. Janser (2019) details the "multipurpose" and "multi-product" problems of the output approach when defining green jobs. Many companies do not exclusively produce goods or services that benefit the environment, often having a mix of environmentally friendly products and products that may harm the environment (multi-product problem). Similarly, in certain instances, a product or service might be used in a way that helps the environment, but in another scenario, that same product or service might be used in a way that harms the environment (multi-purpose problem). As an example, Janser (2019) describes how a pump made for and installed in a biogas plant might also be installed in a coal-fired plant. These blurred lines make it challenging to decide whether the workers making these products hold a green job. Bohnenberger (2022b) suggests other limitations of an output-oriented approach to green jobs, including a product-centric bias, a gender bias, and inclusion of greenwashed products. Finally, Urban et al. (2023) discuss how the output approach can exclude jobs in certain fields (e.g., the arts, health care) traditionally not considered green and disregard how a product or service is produced.

As the limitations of the common output approach to defining green jobs are recognized, researchers and organizations are broadening definitions of green jobs. In their two-pronged definition of green jobs, the U.S. BLS combines the output approach with a process-focused approach, resulting in the following: "Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources" (U.S. BLS, 2010, p. 57511). By shifting the focus from the end product (outcome) to the process, this conceptualization of green jobs expands to include jobs that involve environmental knowledge, skills, values, and goals but may not be directly tied to an environmental product or service. For example, according to the Climate Designer website (https://www.climatedesigners.org), a climate designer is someone who designs with "the explicit goal of implementing a sustainable future" (Climate Designers, n.d.). A climate designer can work in many fields, not just traditional green industries, and can work at any type of company, regardless of the product or service offered. Under the output model of green jobs, a climate designer who works in the retail industry for a company that is not focused exclusively on selling sustainable products would not be counted as a green job even if their work involves bringing sustainability practices to the company's day-to-day design; by contrast, a processfocused definition of green jobs would recognize this climate designer position as a green job. The International Labour Organization similarly recognizes green jobs as either output or process informed, but it also requires that green jobs demonstrate principles of decent work, adding a required component of social justice in support of fair wages and workers' rights (International Labour Organization, 2016).

Trends in Sustainability, Blue, and Green Jobs

We report data on sustainability, green, and blue jobs drawn from the Lightcast platform and its underlying jobs database. Lightcast aggregates economic, labor market, demographic, education, and job posting information from both government and private sector sources. It provides a comprehensive database of posted jobs by scraping information from more than 65,000 websites. It has full U.S. coverage and enables disaggregated reporting of available jobs along multiple dimensions, such as education, skills, demographics, location, or salary levels, and includes additional information about specific job postings.

We used the full Lightcast database for U.S. jobs on sustainability, green, and blue jobs. We narrowed our search by the sustainability, green, and blue jobs that Lightcast identifies through its listed job titles. (See the Appendix for the full list of job titles uncovered in our search.) We further refined the relevant set for sustainability, blue, and green jobs by using keywords. The keyword strings we used are as follows: "sustainability" {sustainability OR Environment}; "blue jobs" {marine OR water OR aquatic}, and "green jobs" {(sustainability OR environment) AND NOT (marine OR water OR aquatic)}.

All keyword-based searches approximate the underlying information on real-world information the databases represent. It is therefore likely that our searches missed some sustainability/green/blue jobs advertised in the United States; the search likely also includes others that are not, in fact, such jobs. In the absence of accurate job market data reporting by U.S. government or private sector agencies on sustainability, we believe the Lightcast database provides the next-best approximation on the sustainability job market. Tables 2–9 include data concerning all sustainability, green, and blue job postings from December 2022 to November 2023, as well as over

the last decade (December 2013 to November 2023). In the tables below, year-on-year changes in reported job market numbers are more reliable as indicators of how sustainability, green, and blue job markets are changing.

Lightcast scours approximately 60,000 job posting sites in the United States to build its database of all advertised employment positions. While it includes temporary job postings and those for internships, we excluded those categories in our keyword searches on the platform.

Sustainability Sectors and Jobs

Table 2 below shows how employment opportunities are increasing for sustainability, green, and blue job categories. In each case, the number of positions advertised in the year ending in October 2023 are between 65% to 88% higher than the average for the previous ten years.

Table 2.

Total Number of Sustainability, Green, and Blue Jobs Posted in the U.S. (2013-23)

Job category	2022-2023	2013-2023
Sustainability jobs	184,200	1,120,000
Green jobs	87,700	487,400
Blue jobs	55,200	294,800

Source: Lightcast

Table 3 shows that these increases are across the board for different educational qualifications. Whether job postings mention high school, BA/BS, MA/MS, or PhD as expected qualification, the number of advertised positions is between 60% to 90% greater for the most recent year compared to the average for the previous 10 years.

Table 3.

Educational Expectations for Sustainability, Green, and Blue Jobs Posted in the U.S.

Education level	2022-2023	2013-2023
High School/GED	43K	294К
BA/BS	90К	501K
MA/MS	27К	145K
PhD	4К	23К
Not specified	51К	402К

Source: Lightcast

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"Engineering, healthcare, food, water, waste treatment, and energy/electricity services are the sectors representing the majority of advertised jobs."

Table 4 indicates the main industry/sector for the advertised sustainability, green, and blue jobs. Engineering, health care, food, water, waste treatment, and energy/electricity services are the sectors representing the majority of advertised jobs. Their dominance has persisted over the past decade. As programs and schools of sustainability consider the key areas in which the training they provide their graduates will serve those graduates well in their pursuit of sustainability careers, curricular gaps in relation to training for blue and green jobs related to health care and waste treatment seem particularly important to consider.

Table 4.

Top rive industries/sectors for sustainability, dreen, and blue sobs in the o.s.				
Job category	2022-2023	2013-2023		
Sustainability jobs	Engineering services, government services, general government support, healthcare, environmental consulting	Engineering services, food services, healthcare, general government support, electrical services		
Green jobs	Healthcare services, engineering services, food services, hazardous waste, general government support	Engineering services, food services, electrical and installation contractors, hazardous waste treatment and disposal		
Blue jobs	Engineering services, environmental consulting, general government support, environmental consulting, research and development, water supply and irrigation	Engineering services, environmental consulting services, executive offices, hazardous waste treatment and disposal, water supply and irrigation		

Top Five Industries/Sectors for Sustainability, Green, and Blue Jobs in the U.S.

Table 5 shows the top employers posting jobs for sustainability, green, and blue positions. Some employers appear for all the three categories of jobs—Sodexo, Amazon, CDM Smith among them. The presence of these employers among those listed highlights two key features of the sustainability job market: (i) sustainability is increasingly mainstream, and (ii) many of the jobs for which large companies are seeking personnel are ones that have sustainability as a component of advertised skills/knowledge area. It is worth noting that the listed employers are seeking workers at all levels of educational qualifications and that the listed positions will be different for high school diploma versus BS versus MS versus PhDs.

Table 5.

Top Companies Posting Sustainability, Green, and Blue Jobs				
Job category	2022-2023	2013-2023		
Sustainability jobs	CDM Smith, AEPAC Aramark, Clean Harbors, Sodexo, Amazon	Sodexo, Clean Harbors, Healthcare Services Group, AECOM, Aerotek, Sunrun, Compass Group, Solar City		
Green jobs	Sodexo, Aramark, Amazon, Clean Harbors, CDM Smith, Next Era Energy	Sunrun, Amazon, Healthcare Services Group, Aramark, Solarcity		
Blue jobs	AECOM, CDM Smith, Jacobs Engineering, WSP Global, TetraTech, Montrose Environment Group,	AECOM, CDM Smith, Clean Harbors, TetraTech, Jacobs Engineering		

Top sustainability, green, and blue jobs titles have tended to be stable over the past decade as Table 6 reports. Many job titles are related to environmental training, qualifications, and responsibilities of hired personnel.

Table 6.

Top Ten Sustainability, Green, and Blue Job Titles*				
Job category	2022-2023	2013-23		
Sustainability jobs	Environmental health and safety specialists, environmental engineers, solar installers, environmental engineers, water and wastewater managers/engineers Environmental health and safety managers, environmental	Environmental health and safety managers, Environmental engineers and specialists, solar installers, water/wastewater engineers Environmental health and safety managers, environmental services		
Green jobs	technicians, environmental project managers, solar installers, sustainability managers	technicians, Solar installers, Environmental services managers		
Blue jobs	Water/Wastewater engineers, environmental engineers, environmental scientists, environmental specialists, environmental health and safety managers, wastewater operators	Waste/wastewater engineers, environmental engineers, environmental health and safety managers, environmental scientists, environmental technicians		

Source: Lightcast

*See Appendix for a more comprehensive list of titles.

To hone in on skills that employers expect sustainability, green, and blue professionals to possess, we looked at common and specialized skills (Table 7, below). Expertise in project management, environmental compliance, and risk analysis are commonly listed expectations. Additionally, depending on the class of jobs, more sector-specific expectations include skills related to wastewater, health and safety, storm water, and sewage management.

Table 7.

Top Five Skills in Sustainability, Green, and Blue Job Postings					
Job category/Year	2022-2023 (Specialized)	2022-2023 (Common)	2013-2023 (Specialized)	2013-2023 (Common)	
Sustainability jobs	Project management, environment health and safety, environmental science, wastewater management, environmental compliance	Communication leadership, management, coordination, planning, presentation and verbal skills	Environmental health and safety, project management, environmental science, wastewater management, environmental engineering, environmental laws, regulatory compliance, stormwater management	Communication, management, leadership, planning, coordination, verbal skills and presentations, self-motivation	
Green jobs	Project management, environmental health and safety, auditing, environmental science, data collection, risk analysis, environmental compliance	Communication, management planning, coordination, verbal skills, presentation, problem solving, written communication	Environmental health and safety, project management, Environmental science, Regulatory compliance, risk analysis	Communication, management, initiative and leadership, operations, problem solving, detail orientation, coordination	
Blue jobs	Wastewater management, project management, environmental science, environmental engineering, stormwater management, sewage treatment, environmental laws and compliance, sampling	Communication, management, operations, planning management, leadership, coordination, verbal communication presentation	Wastewater management, project manage- ment, environmental science, environ- mental engineering, environmental health and safety, stormwater management, sewage treatment, environmental laws, environmental compliance	Communication, management, operations, planning, leadership, writing, coordination	

Source: Lightcast

Table 8 highlights the importance of urban locations for sustainability, green, and blue jobs. The main urban locations (and states) have tended to remain consistent over the past decade for the field, and closely related to the overall size of the cities and the states.

Table 8.

Top Five Locations (City and State) for Sustainability, Green, and Blue Jobs w/Associated Job Numbers*				
Job category/Year	2022-23 City	2022-23 (State)	2013-23 (City)	2013-23 (State)
Sustainability jobs	Houston (3), New York (2.2), Los Angeles (1.9), Chicago, (1.9), Phoenix (1.6)	California (22), Texas (16), Florida (11), Pennsylvania (7), Illinois (7)	Houston (17.8), New York (16.5), Los Angeles (14.4), Chicago (11.7), San Diego (11.0)	California (163), Texas (14), Florida (61), New York (47), Pennsylvania (41),
Green jobs	Houston (1.4), New York (1.3), Los Angeles (1), Chicago (0.9), Phoenix (0.7)	California (10.5), Texas (7.8), Florida (4.6), Pennsylvania (4.0), Ohio (3.6)	New York (8.7), Houston (7.5), Los Angeles (6.7), Chicago (5.5), Atlanta (4.8)	California (73.7), Texas (39.6), Florida (25.0), New York (21.4), Illinois (19.4)
Blue jobs	Houston (.9), Atlanta (.6), Phoenix (.5), New York (.5), Chicago (.5)	California (6), Texas (4.9), Florida (3.4), N. Carolina (2.1), Pennsylvania (2)	Houston (5.5), New York (3.4), Atlanta (3.3), Denver (3.2), Los Angeles (3.1)	California (38.8), Texas (25.7), Florida (17.7), Pennsylvania (11), New York (10.8)

Source: Lightcast

*Nore: Numbers in parentheses are in thousands.

Table 9 includes brief descriptions of some of the more commonly advertised sustainability, green, and blue jobs. Broadly speaking, these descriptions document that employers expect sustainability professionals to possess jobspecific, in-depth technical expertise, but also some broader sense of sustainability as a field.

Table 9.

Illustrative Examples of Sustainability, Green, and Blue Job Descriptions		
Job Title	Description	
Sustainability job, example 1	Sustainability Analyst, Interface: Responsible for collecting, analyzing, synthesizing, and reporting on ecometrics data across the global enterprise. The global Sustainability Analyst works closely with other functions to track energy and water usage at all Interface facilities globally and generates greenhouse gas (GhG) calculations based on these measures. The global Sustainability Analyst also measures results of the Interface approach to environmental responsibility with the goal to minimize the company's environmental impact.	
Sustainability job, example 2	Senior Sustainability Analyst, City of San Carlos (CA): Responsible for the oversight and management of the city's sustainability program, including developing, planning, and	

	implementing activities to assist municipal operations and the community-at-large in reducing greenhouse gas emissions and water use and to communicate sustainability principles and programs to a wide variety of city staff, community leaders, business executives, and residents. Salary range is \$9,972.00–\$12,120.00 per month.	
Sustainability job, example 3	Solar Installer: Residential Solar Installer (Biddeford) compensation: \$20.00-\$33.00 per hour plus bonus. Employment type: full-time job. Title: Residential Solar Installer. Venture Solar is hiring a Residential Solar Installer. As a Residential Solar Installer, you will be responsible for assembly, installation, or maintenance of solar modules/array and mounting hardware; mechanical/structural mounting of racking, modules, and electrical equipment; electrical wiring of solar array/system (AC and DC); and other duties as assigned.	
Sustainability job, example 4	Environmental Education Director: This is a highly independent position requiring a mature, self-motivated individual capable of completing multi-faceted responsibilities. The position reports directly to the SVP North Division. The Director is responsible for the overall quality of all assigned deliverables. Effective communication skills are required in the regular conduct of project activities with contractors, regulators, and external/internal business associates. The ideal candidate has experience working within a regulatory framework, knowledge of EPA 503 regulations for biosolids land application, and knowledge of agronomy or environmental sciences and has management experience or leadership potential.	
Green job, example 1	Environmental Scientist: APTIM is seeking a full time Engineer or Environmental Scientist with expertise in the development and implementation of environmental site investigations and remedial actions. The successful candidate will possess two to four years' experience participating in various scopes associated with environmental site assessment and technical report preparation and demonstrates a willingness to contribute to a collaborative team environment. Experience may include, but is not limited to, preparation of Phase I and II Environmental Site Assessments (ESAs), installation of environmental soil borings and monitoring wells, and collection and documentation of soil and groundwater samples for laboratory analysis. This position requires the ability to conduct field work, desktop analysis and reporting, occasional overnight travel, and application of knowledge and skills to a wide range of standard and nonstandard situations.	
Green job, example 2	Safety Manager: Inspects the facility to identify safety, health, and environmental risks. Develops and implements inspection policies and procedures and a schedule of routine inspections. Develops health and safety procedures for all areas of the company. Prepares and schedules training to cover emergency procedures, workplace safety, and other relevant topics. Monitors compliance with safety procedures. Drafts inspection reports to document inspection findings. Ensures that material safety data sheets are maintained and readily accessible when needed. Maintains records of discharge of or employee exposure to hazardous waste and/or pollutants, as required. Performs other related duties as assigned.	
Blue job, example 1	Environmental Manager: This Environmental Manager position performs advanced professional work under the direction of the Program Administrator for the Division of Waste Management, Waste Cleanup Program located in Tallahassee, Florida. The ideal candidate will possess discipline-specific knowledge, leadership, and technical skills to advance site assessment and cleanup under the Brownfields and CERCLA Site Screening Section. The Manager will lead a team of five direct reports and will also work closely with district staff and delegated county brownfield coordinators.	
Blue job, example 2	Environmental Program Analyst: Cadmus seeks a highly motivated environmental/engineering analyst to support U.S. EPA, states, and nonprofit organizations as they address critical public health issues related to drinking water and water quality. Our work is on diverse topics such as reducing lead in drinking water;	

addressing harmful per- and poly-fluoroalkyl substances (PFAS); ensuring environmental justice; building water utility resilience to climate change; and ensuring healthy watersheds. Cadmus emphasizes working effectively in a team environment with a commitment to the highest standards of excellence. At Cadmus, we recognize that solving the world's most challenging problems can't be accomplished alone or with cookie-cutter solutions. That's why we look for team players and problem solvers who are driven to use their unique perspectives and intellectual curiosity to help deliver breakthrough solutions that achieve transformative goals. On the Cadmus team, you'll collaborate with leading experts to help our clients across the globe. Cadmus's mission is to deploy industry-leading expertise to help our clients achieve extraordinary results that strengthen society and the natural world. We offer competitive compensation, outstanding health care and retirement benefits, a vibrant and collaborative work environment, and opportunities for professional growth. We are committed to advancing diversity and fostering a culture of equity in the workplace and across society, and we strive to maintain an inclusive environment where all employees feel connected, respected, and valued. Join Cadmus. Let's solve the world's most challenging problems together.

Source: LinkedIn for first two row entries, Lightcast for subsequent entries

"Neither periodic swings in the job market nor stochastic shocks such as COVID have affected the overall rapid growth in sustainability jobs."

The above tables, based on keyword searches in LinkedIn, and Lightcast - the most comprehensive, individually searchable jobs database for the United States, highlight four key features of sustainability, green, and blue jobs in the country. One, employer interest in the field, and therefore employment opportunities or sustainability professionals, is growing. The number of jobs in the most recent years are substantially greater than the average for the previous decade. Neither periodic swings in the job market nor stochastic shocks such as the COVID-19 pandemic have affected the overall story of rapid growth in sustainability jobs. Two, the field of sustainability, instead of being a specialized and niche area of work, is now part of the mainstream of advertised jobs, with main industries and employers representing the larger domains of the economy such as health care, energy, engineering, food, and water. That being the case, training for sustainability professionals needs to become mainstream, moving from a focus on environment, conservation, or natural systems to a broader concern with the economy and its major sectors such as health care and energy, in particular. Three, the location of a large proportion of sustainability, green, and blue jobs is urban and the main cities and states where sustainability graduates can expect to find employment have remained consistent over the past decade. These are the large states and urban centers in the country, another indication of sustainability going mainstream. It also suggests that we need to pay attention to growing sustainability, green, and blue jobs in rural areas. Finally, employers want sustainability professionals to possess both field-specific technical knowledge and a broad sensibility about sustainability to meet job expectations.

Changing Skills within the Workforce

The supply of qualified individuals has not kept up with the demand for green, blue, and sustainability workers (Boone & Seto, 2023). Nevertheless, individuals are seeking and acquiring new green, blue, and sustainability skills in response to growing demand for workers in this sector. In an analysis undertaken by LinkedIn, the organization

found a rapid increase in year-over-year growth for LinkedIn members listing green skills. Skills related to climate, in particular, are growing rapidly. For LinkedIn members from the European Union, the number of people listing carbon accounting as a skill increased by 130% between 2021 and 2022. In the United States, that figure was 240%. Skills in water quality (192%) and energy engineering (173%) top out the fastest growing green skills for U.S. LinkedIn members. For the European Union, climate action planning (153%), sustainability education (140%), and carbon emissions (131%) join carbon accounting in the top-four fastest-growing green skills.

The International Labour Organization envisions new green skills required based on three transformations. The first is green restructuring or "a shift of activities and employment in the economy from a polluting sector to a low-carbon emission sector" (International Labour Organization, 2022, p. 28). An example is a shift from transportation on roads to transportation on rails, which requires different sets of skills for building and operating rail-based transportation. The second is the creation of new professions, where "development of new technologies leads to the emergence of entirely new professions" (ILO, 2022, p. 28). Solar energy or wind energy technicians are an example. The third is the greening of existing jobs. Examples are mechanics needing to know how to maintain electric vehicles or farmers needing to know how to adapt to and help mitigate climate change. At the most basic level, the ILO recommends that green economy workers have skills in environmental awareness, waste reduction and management, and energy and water efficiency.

Education and Training: Developing a Sustainable Workforce

The critical first step in designing, implementing, and supporting education and training for sustainability jobs is identifying the knowledge and skills needed to be successful in acquiring and carrying out these jobs. Given the tremendous diversity (Boone et al., 2023) and relative novelty of sustainability jobs (Strietska-Ilina et al., 2011), providing a definitive and concise list of such skills is challenging (Pavlova, 2018). Further complicating this effort is the fact that sustainability jobs, as is the case in many other modern industries and fields (World Economic Forum, 2020), require a mix of skills and the ability of workers to be flexible in light of the rapidly evolving, dynamic nature of environmentally related issues, policies, and technologies.

What is clear, from various studies of the green workforce—including employers, as well as current and future employees—is that green jobs require greater levels of problem-solving, more nonroutine activities, and on-the-job training than non-green jobs (Gamlath, 2022). In part, this reflects the novelty of some green jobs, where knowledge from non-green jobs cannot be easily passed on from one worker to another. Also, because of the rapidly evolving nature of green, blue, and sustainability jobs, workers will require more continuous learning and training than in long-standing established job categories. Important to many green jobs are also technical job-specific skills as well as transversal soft skills (e.g., skills in communication, collaboration, time management, problem-solving, critical thinking, leadership, and creativity; Marin-Zapata et al., 2022). Discussions of the skills required for sustainability jobs have referenced STEM skills (Kwauk & Casey, 2022) and digital skills (Santoalha et al., 2021), among others, highlighting the range of skills required for sustainability jobs and emphasizing the need for educational programs and policies that aim to create well-rounded students and trainees.

The idea and cataloging of green skills have received substantial attention in research and discussions of the green economy (e.g., Dierdorff et al., 2011). This attention appears warranted as the skills needed for green jobs may be distinct in some ways from those for non-green jobs. Based on an analysis of skills associated with green and non-green jobs in the United States, Consoli et al., (2016) concluded that green jobs required "higher levels of non-routine (e.g., creative problem solving) analytical skills as well as higher intensity of standard human capital indicators of formal education, work experience and on-the-job training" (pp. 1055–1056).

Sustainability Competencies and Capacities

The lack of consensus on sustainability-related skills, knowledge, and outcomes, along with the rapid expansion of sustainability-labeled programs in the United States (see subsequent section), prompted the U.S. National Academies of Sciences, Engineering, and Medicine (NASEM) to commission a study on how to strengthen and support sustainability curricula (Kapucinscki et al., 2020). Given the breadth of sustainability concerns—improving the well- being of present and future generations while stewarding Earth's life-supporting ecosystems—and sustainability's solutions orientation, the NASEM committee recommended a competency-based approach. Competencies, which link knowledge to action, can be defined as a "constellation of abilities, attitudes, knowledge, understanding, skills, and habits of mind that are functionally linked to support both problem-posing and problem-solving and evoke purposeful behavior toward particular goals" (Glasser & Hirsch, 2016, p. 126).

Competency-based approaches to learning are seen as effective for sustainability-related challenges and professions as they embed problem-solving and solutions. An added advantage is that competency-based frameworks do not privilege one form of knowledge over another, inviting engagement with multiple knowledges, disciplines, and ways of knowing. The NASEM report references Wiek et al.'s (2011) foundational paper on sustainability core competencies. This paper outlines five core competencies as elemental for sustainability programs: systems thinking, futures thinking, values thinking, strategic thinking, and collaborative thinking. (See Table 10.) The framework is discipline agnostic, but is most powerful when the learning is interdisciplinary and solutions oriented.

Sustainability Core Competencies		
Competency	Meaning	
Systems thinking	Analyzing how integrated social, ecological, and technical systems relate to and affect one another in a holistic way	
Futures thinking	Envisioning desirable and possible futures while anticipating the positive and negative consequences of human activity in ways that lead to sustainable futures	
Values thinking	Understanding how culture, tradition and values influence decisions; embracing principles of intra- and inter-generational justice as a motivational force	
Strategic thinking	Developing plans to achieve desirable present and future states that align with sustainability goals	
Collaborative thinking	Communicating, engaging, and working effectively with diverse groups to achieve a sustainability goal	

Table 10.

Source: Wiek et al., 2011

Others (e.g., Brundiers et al., 2021) have built on Wiek et al.'s (2011) framework to include two other sustainability core competencies: intrapersonal or self-awareness competency and implementation competency. The self-awareness or intrapersonal competency is defined as "the ability to be aware of one's own emotions, desires, thoughts, behaviors, and personality, as well as to regulate, motivate, and continually improve one-self drawing on competencies related to emotional intelligence" (p. 20). The implementation competency is defined as "the collective ability to realize a planned solution toward sustainability-informed vision, to monitor and evaluate the realization process, and to address emerging challenges (adjustments), recognizing that sustainability problem-

solving is a long-term, iterative process between planning, realization, and evaluation" (p. 21). Brundiers et al. (2021) added these competencies to recognize that implementation is a skill in itself and one that can be taught and encouraged in curricular design. The self-awareness competency is intended for students to reflect and act on how their own desires, thoughts, values, or biases can interfere with or motivate achieving sustainability goals.

A related idea to competencies are capacities: the demonstrated intent or ability to establish an outcome or task. Sustainability capacities refer to action-oriented learning, undertaken with the necessary understanding of complex (and uncertain) human-environmental dynamics. For effective sustainability inventions, Clark and Harley (2020) identify six capacities: "(a) measure sustainable development, (b) promote equity, (c) adapt to shocks and surprises, (d) transform the system into more sustainable development pathways, (e) link knowledge with action, and (f) devise governance arrangements that allow people to work together in exercising the other capacities" (p. 364). They note that these capacities can and should be developed through all stages of the educational process, including formal and informal learning, as well as on-the-job training. Kwauk and Casey (2022), in their framing of a New Green Learning Agenda, argue for developing sustainability capacities—or knowledge, skills, and attitudes across the range of specific, generic, and transformative dimensions.

Sustainability Education

High schools, colleges, and universities have responded to the growing demand for green, blue, and sustainability workers by expanding the number of courses, certificates, minors, and degree programs in appropriate and related fields. In 1997, U.S. high schools first offered the Environmental Science Advanced Placement courses and exams. The emphasis on sustainability is growing rapidly in U.S. colleges and universities as well. Although environmental sciences and studies programs have existed in colleges and universities since the mid-20th century, in the last 15 years, such programs have proliferated. As of 2023, there are nearly 700 sustainability programs (up from only 13 in 2008) and 1,350 programs in environmental studies and sciences (Association for the Advancement of Sustainability in Higher Education, n.d.).

Sustainability programs, however, are relatively new and evolving rapidly, with arguably less consensus than environmental studies and science about what should be taught and how.

K–12 Education

In the United States, K–12 education—with an enrollment of more than 50 million young people—provides an impactful avenue for developing sustainability competencies and capacities among a large number of students. Sustainability education is an approach, along with the related fields of environmental education and education for sustainable development (Braus et al., 2022; Pavlova, 2018), that offers educators and administrators guidelines, programs, and curricula to help students become sustainability literate (Potter-Nelson & Meyers, 2022). With a goal of a sustainability-literate populace, sustainability education is not limited to students interested in sustainability careers but rather, as noted previously, is a useful endeavor as part of creating a society knowledgeable about and engaged in a range of sustainability-related issues.

Despite the potential value of sustainability education in preparing students for the future workforce, the inclusion of elements of sustainability education (e.g., addressing climate change, environmental literacy) in education standards and policies varies among countries and, in the United States, from state to state (Kwauk & Kane, 2021; Myhre et al., 2020). At the international level, in response to an Organisation for Economic Co-operation and Development (OECD) survey identifying the need for more emphasis on sustainability knowledge and skills (Schleicher, 2021), a recent effort through the OECD's Programme for International Student Assessment (PISA) aims to include more environmental science and climate change knowledge and skills in science education teaching and learning (White et al., 2023). This effort foregrounds knowledge, but also highlights the importance

of building young people's sense of agency to act on challenging social-environmental issues (Monroe et al., 2023). In the United States, the North American Association for Environmental Education undertook a landscape analysis of climate change education policy, finding inconsistent quantity and quality across the country. It found that although all states had some policies that mentioned climate change, the opportunity for enhancing the quality, cohesion, and effectiveness of educational offerings is immense (Monitoring and Evaluating Climate Communication and Education & North American Association for Environmental Education, 2022).

In addition to bolstering state education standards and policy with an eye toward sustainability, supporters of preparing the green workforce need to address issues of teacher preparation. While studies have shown that U.S. teachers share a belief in the importance of teaching about sustainability similar to their global peers, a 2023 survey indicated that U.S. teachers report spending less time on sustainability-related topics in the classroom as they feel unprepared to teach about it and lack the needed support and time (Smithsonian Institute, 2023). In the same survey, U.S. teachers expressed a preference for field trips and hands-on materials to enhance their teaching of sustainability-related topics. In response to such gaps, nonprofit organizations, government agencies, and researchers have developed and evaluated a number of programs and strategies to provide U.S. teachers with the necessary pre-service and in-service training to address this shortfall in preparation and development (Fischer et al., 2022; Tomas et al., 2017). Redman et al. (2018), for example, designed and evaluated a continuing development program for current K–12 teachers across the United States, with a goal of teaching educators about sustainability education and encouraging them to become role models in sustainability. Brandt et al. (2021) describe how all K–8 pre-service teachers at Arizona State University take a Sustainability Science for Teachers course, and the research team documented how over 100 pre-service teachers gained sustainability skills and knowledge through personal, professional, social, and structural connections.



Photo Credit: iStock.com/SolStock

Another important area of focus and an opportunity in sustainability education, beyond competencies and capacities, is sector-specific training. Kwauk and Casey (2022) propose a green skills framework calling for a combination of skills for a green transformation (e.g., systems thinking and environmental stewardship), green life skills (e.g., communication and problem-solving), and skills for green jobs (e.g., science skills and

Building a Workforce for the Future: Sustainability, Blue, and Green Jobs entrepreneurship). Sustainability education addresses many of the skills for a green transformation and green life skills. The skills for green jobs, which also include sector-specific skills, represent an ideal place for K–12 education to help prepare students for sustainability careers. This is also an area in need of additional research. Vocational and technical education in the United States, rather than furthering study at a postsecondary institution, has a long history of preparing students for technical careers; training in such areas may, therefore, offer opportunities to train students for sustainability careers and increase interest in such jobs.

Certificates and Short Courses

Although the number of secondary and postsecondary programs related to sustainability is growing rapidly, not all individuals who are interested in pursuing a sustainability job have the time, resources, or inclination to attend a two- or four-year diploma or degree program. Another pathway to gain the needed knowledge and skills is through short courses, workshops, or credentialing programs that may or may not lead to a certificate.

Some credentialing programs are well-established and recognized within their respective industries, while others are newer and are being developed in response to the growing need for green knowledge and skills. An example of a well-established program is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification, which requires passing an exam in order to join the more than 200,000 people who hold the certification (Keniry, 2020). LEED certification is often a desired or required qualification for jobs in the building industry, especially in firms with a strong sustainability focus. The Sustainability Analyst Fundamental Specialization, a partnership between Google, Arizona State University, and Coursera, is a newer certification. It includes three courses—Careers in Sustainability, Sustainability Challenges for the Planet and Employers, and Foundational Sustainability analysts (Coursera, n.d.). Similar to other Google certificates, this offering's primary goal is to provide pathways to jobs in quickly growing sectors. Another recent effort is the launching of a Sustainability School by Schneider Electric, a multinational energy management company based in France. The stated benefits for learners are to "build sustainability expertise," "design for decarbonization," and "advance net-zero readiness" (Schneider Electric, n.d.). Learners in Schneider's Sustainability School receive a certificate for completing each course.

In addition to these formal credentialing programs, YouTube represents an important resource for learning. The platform includes a plethora of short and medium-length videos that define sustainability and green jobs, model green skills, provide guidance on entering the green workforce, and so on. YouTube has partnered with Crash Course and Arizona State University (ASU) to create Study Hall (<u>https://www.youtube.com/@studyhall</u>), which creates brief videos designed to demystify college and address a variety of subjects. The ASU School of Sustainability is currently working with Crash Course and Study Hall to build a broadly appealing and accessible introductory course on sustainability; this course includes modules on sustainability jobs and careers. Although the videos may be viewed free of charge, learners may choose to complete assignments and earn college credit at a reduced rate. For the Study Hall series on college degrees, a 13-minute video outlines what a sustainability degree is and the types of careers sustainability graduates can pursue (see <u>https://www.youtube.com/watch?v=Mh-TWaJzHRU&list=PLvv6BB9Mw3BT5vgm-u3nA4tsqNH8HWLHH</u>).

On-the-Job Training

The rapid growth in green, blue, and sustainability jobs and the insufficient number of qualified people to fill those positions have prompted companies and organizations to develop and enhance their own in-house training. Corporate training in sustainability reporting, sustainable finance, climate science, and other skills have been developed by companies such as KPMG, BNP PARIBAS, Deloitte, Schneider Electric, and other firms. Companies such as Microsoft, Salesforce, HSBC, and Starbucks have created internal training as a means of integrating sustainability knowledge and practice throughout their organizations rather than only in sustainability units.

Microsoft, for example, is working to generate sustainability "fluency" across the organization by creating highquality, in-person, and online training opportunities. To achieve the company's sustainability goals, the recommendation begins with four core competencies: systems thinking, futures thinking, circular thinking, and design thinking. These core competencies frame skills and knowledge in sustainability science, digital skills, transdisciplinarity, and change management. The advantage of starting with ways of thinking over specific skills development is that ways of thinking are adaptive and can be applied to acquire new and evolving skills that will likely emerge as critical for green, blue, and sustainability jobs in the near future.

Prioritizing a Just Transition in the Sustainability Workforce

The transition to a sustainable economy, including the blue and green sectors, means the creation of new jobs concurrent with the elimination of others. Over the last ten years, for example, the number of coal mining jobs has dropped by 46% to around 40,000 (U.S. Bureau of Labor Statistics, 2023). On the other hand, the number of solar voltaic installers and wind turbine service technicians in the United States is projected to grow by 51% and 61%, respectively, between 2019 and 2029, employing 29,000 people by the end of this decade. Globally, the number of clean energy jobs (36 million) surpasses the number of fossil fuels jobs (32 million), and jobs in the clean-energy sector are growing at a faster pace than those in the fossil-fuel sector (International Energy Agency, 2023).

The renewable energy transition will have uneven impacts and consequences. In the United States, the declining number of coal mining jobs will have harmful impacts in Appalachian communities, which are already suffering from high rates of unemployment and poverty (Santopietro & Zipper, 2021). In India, the goal of generating 100 GW of solar energy will bring employment to the western and southern regions of the country while the coal mining regions in the eastern part of the country will lose jobs (Sharma & Baterjee, 2021). Although coal is the dirtiest of the fossil fuels, coal miners' hard and dangerous work provided inexpensive and reliable energy that fueled the prosperity of individuals and communities far and wide. Clearly, climate change goals necessitate a transition to renewable fuel sources, but it would be unethical to abandon unemployed coal workers. It would also be deeply unpopular. In the United States, more than 8 out of 10 people favor the creation of programs that provide support for individuals who will lose their jobs in fossil fuel industries (Carman et al., 2022).

A just transition to the sustainability economy will require education, training, reskilling, and other forms of support for the most vulnerable populations. One study (Pollin & Callaci, 2019) estimated that the cost of transitioning fossil fuel-dependent communities in the United States would be a relatively modest \$600 million per year over the next two decades. This would include pension guarantees for fossil fuel workers, along with resources for education, (re)training, and relocation (if desired). For the United Kingdom, one solution for addressing the uneven geographic consequences of the renewable energy transition is to train and employ unemployed fossil fuel workers in Northern England, Wales, the Southwest, and the Midlands to improve the energy efficiency of homes; in those regions, existing buildings are less energy efficient, and unemployment rates are high (Unsworth et al., 2020).

The transition to the sustainability economy also provides an opportunity to address long-standing gender and racial disparities in employment. The renewable energy sector employs more women globally (32%) than the energy sector at large (19%). Although the number of women in renewables is larger, it is still limited by gender bias in a male-dominated energy industry (MacArthur et al., 2020). For jobs in the U.S. energy efficiency sector, women represent only 24% and African Americans 8% of the workforce (Carley & Konisky, 2020). Yet, women and minoritized communities are disproportionately harmed by the climate impacts these kinds of jobs aim to address. In recognition of these historical disparities and injustices, the White House's Justice40 Initiative, for example, includes support for training and workforce development focused on "disadvantaged communities" (Young et al., 2021). Organizations such as Jobs for the Future are working to provide green jobs to communities on the front lines of climate and other environmental challenges (Domeika et al., 2023). Diversifying the green jobs labor force

will require training, but also wraparound services—such as childcare, affordable and reliable transportation, and health care access—that otherwise limit full participation in the workforce (Environmental Justice Leadership Forum, 2020).

The Internal Labour Organization stipulates that, in addition to protecting, preserving, or restoring the environment, green jobs must also be decent jobs, defined as "productive work for women and men in conditions of freedom, equity, security and human dignity" (Poschen, 2017). The European Commission (2023) defines decent work as that which pays a fair income, guarantees secure employment and safe working conditions, includes social protection for workers and their families, ensures equal opportunity and treatment, offers opportunities for personal and social development, and gives workers freedom of expression and rights to organize. Strategies for, and evaluations of, just transitions should incorporate not only the number of people who manage to successfully find green, blue, and sustainability jobs, but also the quality and dignity of that work.



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Conclusion

The rapid growth of green, blue, and sustainability jobs is a positive trend. Growth in these jobs increases opportunities for people searching for meaningful work and for building the critical mass of workers needed to meet urgent environmental and sustainability challenges. Achieving the sustainability transition that the planet, its people, and its ecosystems need is contingent on a trained and aware workforce that can meet and lead sustainability expectations of employers. While the growth of green, blue, and sustainability jobs is positive, a troubling issue is the lack of qualified professionals to fill those roles.

Filling the skills gap will require a multi-pronged approach that includes many ways of learning and training. The capacity of colleges and universities to fill the skills gap is currently insufficient. At the same time, not all jobs require a college degree. Our analysis found that more than 1 out of 5 sustainability jobs required only a high school degree, and nearly 30 percent listed no educational requirements. This underscores the importance of learning and training in K–12, including problem-based learning framed by green and sustainability challenges, and

the need for on-the-job training. Lifelong learning for green and sustainability jobs can be facilitated through expanding opportunities offered in short courses, workshops, and certificates. The needs for training and retraining for green and sustainability jobs will be especially acute in regions of the country (and world) that are undergoing economic transitions to sustainable economies, most notably in the energy sector but also in agriculture and industry.

Filling the skills gap must recognize that green, blue, and sustainability jobs fall along a continuum of skills and knowledge intensity. Some jobs will require advanced training while others will require more basic green and sustainability skills, as well as an understanding of sustainability-related issues. Matching the skills intensity to the necessary training will require adaptive and flexible ways for employees and students to learn. This is a complex challenge, but the benefits and upsides of an educated workforce dedicated fully to putting green and sustainability principles into action are enormous.

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Appendix: Commonly Used Job Titles in Advertised Positions for Sustainability, Green, and Blue Jobs

Assistant Directors of Environmental Services **Bioenvironmental Engineering Technicians Bioenvironmental Engineers** Civil/Environmental Engineers **Commercial Housekeeping/Environmental Services Conservation Associates Conservation Agents Conservation and Land Management Interns Conservation Assistants Conservation Biologists Conservation Coordinators Conservation Educators Conservation Education Interns Conservation Interns Conservation Managers Conservation Officers Conservation Planners Conservation Program Coordinators Conservation Program Managers Conservation Scientists Conservation Specialists Conservation Technicians Conservation Workers** Conservationists **Corporate Environmental Engineers** Corporate Environmental Health and Safety Managers **Corporate Environmental Managers Directors of Conservation Directors of Corporate Environmental Health Directors of Environment Directors of Environmental Affairs Directors of Environmental Compliance** Directors of Environmental Health and Safety **Directors of Environmental Programs Directors of Environmental Services** Directors of Sustainability **District Conservationists Emissions Technicians Energy and Sustainability Managers Energy Conservation Engineers Energy Conservation Specialists Energy Efficiency Analysts Energy Efficiency Consultants Energy Efficiency Coordinators Energy Efficiency Engineers Energy Efficiency Interns Energy Efficiency Program Managers Energy Efficiency Specialists**

Energy Management Consultants Energy Management Engineers Energy Management Interns Energy Management Specialists Energy Managers Environment Engineers Environment Health and Safety Specialists Environmental Administrators Environmental Advisors Environmental Affairs Managers Environmental Aides Environmental Analysts Environmental and Quality Managers Environmental Assistants Environmental Auditors Environmental Attendants Environmental Attorneys Environmental Biologists Environmental Chemists Environmental Compliance Coordinators Environmental Compliance Engineers Environmental Compliance Inspectors Environmental Compliance Interns Environmental Compliance Managers Environmental Compliance Officers Environmental Compliance Specialists Environmental Compliance Supervisors Environmental Compliance Technicians Environmental Consultants Environmental Coordinators Environmental Counsels Environmental Data Analysts Environmental Designers Environmental Division Managers Environmental Economists Environmental Education Coordinators Environmental Educators Environmental Education Assistants Environmental Education Directors Environmental Education Instructors Environmental Education Interns Environmental Education Specialists Environmental Education Volunteers Environmental Engineer Assistants Environmental Engineering Consultants Environmental Engineering Interns Environmental Engineering Managers Environmental Engineering Specialists Environmental Engineering Technicians Environmental Engineers Environmental Engineers Specialist Environmental Engineers/Geologists **Environmental Engineers/Project Managers** **Environmental Engineers/Scientists** Environmental Engineers/Scientists/Geologists **Environmental Field Chemists Environmental Field Laborers Environmental Field Scientist Environmental Field Specialists Environmental Field Technicians Environmental Geologists Environmental Graphic Designers Environmental Group Managers Environmental Health and Safety Administrators** Environmental Health and Safety Administrative **Environmental Health and Safety Advisors Environmental Health and Safety Analysts Environmental Health and Safety Assistants Environmental Health and Safety Associates Environmental Health and Safety Compliance Environmental Health and Safety Consultants Environmental Health and Safety Coordinators Environmental Health and Safety Engineers Environmental Health and Safety Generalists Environmental Health and Safety Interns Environmental Health and Safety Leaders Environmental Health and Safety Managers Environmental Health and Safety Officers Environmental Health and Safety Professionals Environmental Health and Safety Program Managers Environmental Health and Safety Project Managers Environmental Health and Safety Representatives Environmental Health and Safety Specialists Environmental Health and Safety Supervisors Environmental Health and Safety Teachers Environmental Health and Safety Technicians Environmental Health Inspectors Environmental Health Interns Environmental Health Managers Environmental Health Officers Environmental Health Scientists Environmental Health Specialists Environmental Health Supervisors Environmental Health Technicians Environmental Inspectors Environmental Interns Environmental Investigators Environmental Laboratory Analysts Environmental Laboratory Technicians Environmental Laborers Environmental Managers Environmental Monitoring Technicians Environmental Monitors Environmental Officers Environmental Operations Managers Environmental Permitting Specialists**

Environmental Planners Environmental Planners/Project Managers Environmental Planners/Scientists **Environmental Planning Interns Environmental Policy Analysts Environmental Process Engineers Environmental Professionals Environmental Program Managers Environmental Program Specialists Environmental Program Supervisors Environmental Programs Managers Environmental Project Engineers Environmental Project Managers Environmental Project Specialists Environmental Projects Coordinators Environmental Protection Assistants Environmental Protection Managers Environmental Protection Specialists Environmental Quality Analysts Environmental Quality Specialists Environmental Regulatory Specialists Environmental Remediation Engineers Environmental Reporters Environmental Research Assistants Environmental Resources Specialists Environmental Sanitarians Environmental Science Instructors Environmental Science Interns Environmental Science Teachers Environmental Scientist Supervisors Environmental Scientists** Environmental Scientists/Biologists Environmental Scientists/Geologists **Environmental Scientists/Project Managers Environmental Scientists/Specialists Environmental Service Aides Environmental Services Aides Environmental Services Assistant Managers Environmental Services Assistants Environmental Services Associates Environmental Services Attendants Environmental Services Coordinators Environmental Services Floor Technicians Environmental Services Housekeepers Environmental Services Interns Environmental Services Leads Environmental Services Managers Environmental Services Operators Environmental Services Operations Managers Environmental Services Professionals Environmental Services Representatives Environmental Services Specialists Environmental Services Supervisors**

Environmental Services Team Leaders Environmental Services Technical Leads Environmental Services Technicians Environmental Services Workers Environmental Services Workers/Housekeepers **Environmental Specialists Environmental Superintendents Environmental Supervisors Environmental Technicians Environmental Technologists Environmental Techs Environmental Test Engineers Environmental Test Technicians Environmental Toxicologists Environmental Underwriters** Environmentalists **Environments Designers** Facilities Environmental Health and Safety Managers Field Solar Consultants **Field Solar Specialists** Global Environmental Health and Safety Managers **Guest Environment Experts** Hazardous Waste Specialists Hazardous Waste Technicians Health and Environmental Managers Healthcare Sustainability Specialists Home Energy Auditors Housekeepers/Environmental Services Technicians Housekeepers/Guest Environment Experts Housekeeping Environmental Services Aides Housekeeping/Environmental Services Associates Housekeeping/Environmental Services Technicians Housekeeping/Environmental Services Workers Housekeeping/Guest Environment Experts Interdisciplinary Environmental Engineers/Physical Janitors/Environmental Services Associates Land Use/Environmental Planners Lead Environmental Engineers Lead Environmental Inspectors Lead Environmental Specialists Lead Solar Installers **Outside Solar Sales Consultants** Outside Solar Sales Representatives **Project Environmental Scientists** Recyclers **Recycling Assistants Recycling Associates Recycling Coordinators Recycling Interns Recycling Managers Recycling Services Representatives Recycling Sorters Recycling Specialists**

Building a Workforce for the Future: Sustainability, Blue, and Green Jobs **Recycling Technicians Recycling Workers** Regional Directors of Environmental Health and Safety Regional Environmental Health and Safety Managers **Regional Environmental Managers Registered Environmental Health Specialists Renewable Energy Analysts Renewable Energy Consultants Renewable Energy Engineers Renewable Energy Interns Renewable Energy Specialists Residential Energy Auditors Residential Solar Consultants Resource Conservationists Resource Efficiency Managers Retail Solar Advisors** Retail Solar Consultants **Retail Solar Specialists** Safety Specialists Safety and Environment Advisors Safety and Environmental Coordinators Safety and Environmental Directors Safety and Environmental Managers Safety and Environmental Specialists Safety/Environmental Engineers Scientists/Natural Resources Specialists Site Environmental Health and Safety Managers Soil Conservation Technicians Soil Conservationists Solar Advisors Solar Ambassadors Solar Analysts Solar Concierges Solar Consultants Solar Design Engineers Solar Designers Solar Electricians Solar Energy Consultants Solar Energy Sales Consultants Solar Engineers Solar Installers Solar Journeyman Electricians Solar Marketing Specialists Solar Panel Installers Solar Power Sales Consultants Solar Project Managers Solar PV Installers Solar Sales Consultants Solar Sales Energy Specialists Solar Sales Managers Solar Sales Representatives Solar Sales Specialists Solar Service Technicians

Solar Specialists Solar Technicians Solid Waste Coordinators Solid Waste Directors Solid Waste Equipment Operators Solid Waste Managers Solid Waste Operators Solid Waste Supervisors Specialists Staff Environmental Engineers State Conservationists Supervisory Environmental Engineers Supervisory Environmental Protection Specialists Sustainability Advisors Sustainability Analysts Sustainability Assistants Sustainability Associates Sustainability Consultants Sustainability Coordinators Sustainability Engineers Sustainability Interns Sustainability Managers Sustainability Officers Sustainability Program Coordinators Sustainability Program Managers Sustainability Project Managers Sustainability Specialists Sustainable Agriculture Interns Sustainable Process Solutions Managers Technicians Waste Management Specialists Wastewater Engineers Wastewater Managers Wastewater Operators Wastewater Plant Operators Wastewater Process Engineers Wastewater Project Managers Wastewater Superintendents Wastewater Supervisors Wastewater Technicians Wastewater Treatment Operators Wastewater Treatment Plant Operators Water Conservation Coordinators Water Conservation Managers Water Conservation Specialists Water/Wastewater Engineers Water/Wastewater Operators Water/Wastewater Project Engineers Water/Wastewater Project Managers Wind Energy Lead Technicians Wind Site Managers Wind Technicians Wind Turbine Blade Composite Technicians

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