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Is the Global Workforce Ready for the Energy Transition?

By Romina Bandura and Clara Bonin

Introduction

International commitments on climate change imply bold actions to reduce global greenhouse gas emissions by 2050. Among them, switching energy production and industrial processes to cleaner sources will require massive investments in infrastructure and workforce training. Because of the myriad levels of fossil-fuel dependence, the path to net-zero emissions will have disproportionate effects on some countries, industries, and workers.[1] Regardless of the industry or country, the transition to a low-carbon economy will significantly affect the global workforce in the type of jobs available and the skills demanded.

Whether the energy transition happens fast or slow, what is clear is that the global workforce is not ready for the changes to come. Unfortunately, governments are not doing enough to guarantee a just, or even smooth, shift. Building on the **CSIS Just Transition Initiative**, this white paper analyzes the workforce implications of the energy transition and presents broad actions that governments, labor, businesses, and civil society actors can take to better prepare workers for the future.

POTENTIAL WINNERS AND LOSERS OF THE ENERGY TRANSITION: COUNTRIES AND SECTORS

Despite international commitments to reduce carbon emissions, the world still heavily relies on fossil fuels for its energy needs (Figure 1). Many of the top producers of fossil fuels are countries in the Global South, and these countries have the potential to lose tax revenues, exports, and jobs if they **phase down** fossil fuel production. In the Global North, even the most vocal advocates of addressing climate change are

1 Net zero "means cutting carbon emissions to a small amount of residual emissions that can be absorbed and durably stored by nature and other carbon dioxide removal measures, leaving zero in the atmosphere." In practical terms, this means that to keep global warming to no more than 1.5°C, emissions need to be reduced by 45 percent by 2030 and reach net zero by 2050. "For a livable climate: Net-zero commitments must be backed by credible action," United Nations, https://www.un.org/en/climatechange/net-zero-coalition.

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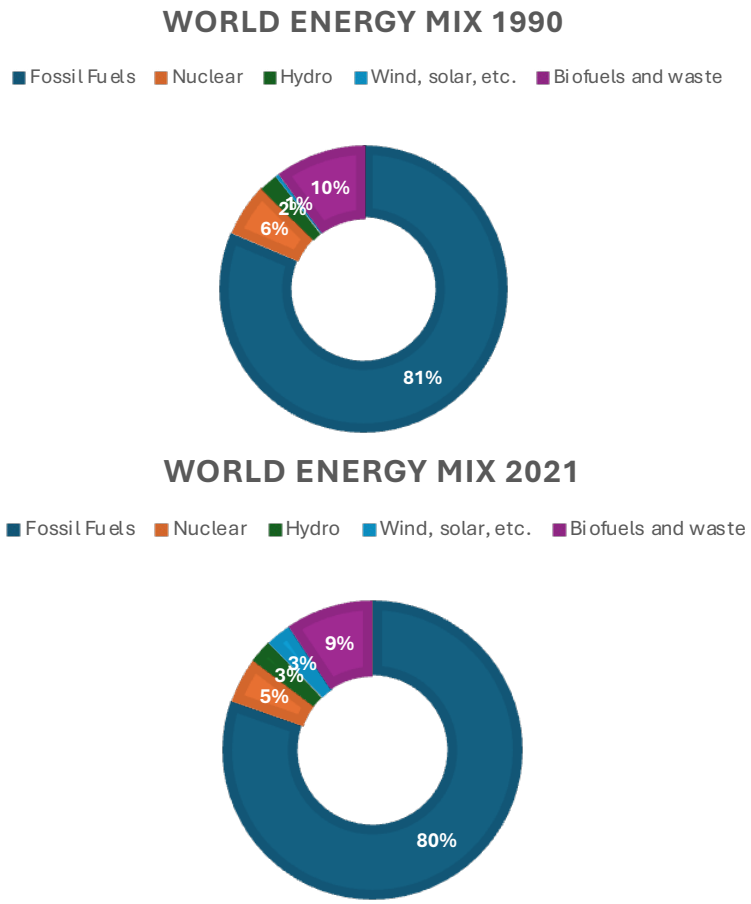
dependent on fossil fuels. For example, fossil fuels accounted for 45.5 percent of **France's** totally energy supply in 2023, whereas solar and wind accounted for just 3 percent. The same year, **Germany** relied on fossil fuels for 77.9 percent of its energy demands, with only 7 percent generated by solar and wind.

Yet, countries that hold large fossil fuel reserves are not automatically losers in this process. Their loss or gain depends, at least partially, on their potential for renewable energy, carbon capture, mining, and minerals deposits, as well as their control of inputs, manufacturing supply chains, and capacity-building efforts. Some countries have more capability than others to rebalance their energy and industrial mixes and may thus be able to leverage their resources to lead the low-carbon transition.

Figure 1: Global Total Energy Supply (TES) by Source, 1990 & 2021



Source: "World Energy Statistics and Balances," International Energy Agency (IEA), https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances.

In the Global South, there are opportunities to develop clean energy. Although some African countries have fossil fuel reserves, the continent is also home to **60 percent of renewable energy resources worldwide**. The 10 countries with the **most practical photovoltaic (PV) power potential** are also mainly located in the Global South, especially in Africa and the Middle East. Beyond renewables, hydropower also holds great potential. Growing electricity demand and export opportunities will drive fast hydropower expansion in Southeast Asia and Africa; Sub-Saharan Africa is expected to record the **third-largest growth** in hydropower capacity over the next decade. Looking at Latin America,

Colombia and Argentina are set to lead hydropower growth. If these countries are able to unlock their clean energy potential, they will have the opportunity to emerge as winners in the coming transition.

Countries with large fossil fuel production capabilities may also have an edge when it comes to the expanding carbon capture, utilization, and storage (CCUS) industry. The **CCUS chain** begins with the capture of CO_2 from large point sources (e.g., power generation or industrial facilities) that use fossil fuels or biomass. The carbon is then compressed and transported to be used as an input or feedstock to create products or services or to be stored in underground geological formations. CCUS's role in greening industries is potentially significant due to its ability to remove CO_2 from the air and help reduce emissions from energy-heavy industries, and it offers some complementarity with existing infrastructure, as it can be retrofitted into some existing power and industrial plants, for example.

In addition, countries that hold reserves of critical minerals, including rare-earth elements (REEs) such as cobalt, lithium, and niobium, could be leaders in the climate transition and help drive a **net-zero future**. These minerals are essential to make clean energy technologies work, and many such deposits are in the Global South. In fact, reaching the Paris Agreement's goal of a "well below 2°C global temperature rise" would require a quadrupling of REE requirements for clean energy technologies by 2040. REEs are used for making permanent magnets for wind turbines and electric vehicle motors. **Africa** holds the greatest opportunities in this regard, as over 40 percent of global reserves of cobalt, manganese, and platinum—key minerals for batteries and hydrogen technologies—are found there. The "lithium triangle"—Argentina, Bolivia, and Chile—hosts **two-thirds** of the world's known lithium reserves. The Democratic Republic of the Congo has the largest cobalt reserves, and Brazil, Guinea, Indonesia, and Jamaica have a high concentration of bauxite reserves.

Whether countries can develop their **renewable** energy sectors will not only depend on the supply of critical minerals but also on their capacity to process these minerals, their workforce readiness, access to equipment, and ability to provide the services needed along the whole value chain. To cite an example, although Africa is home to the **best solar resources** globally, China and other Asian countries are the world's largest manufacturers of clean energy equipment. Thus, unless Africa starts manufacturing these essentials, it will have to rely on Asia to develop its renewable energy.

WORKFORCE IMPACTS OF THE ENERGY TRANSITION

Taken together, to realize all of these opportunities and prepare economies for the energy transition, countries will have to spend money to build new infrastructure, transform industrial processes to new forms of energy, and train their workforce. Estimates show that investments will need to quadruple between 2024 and 2030 to align with international climate commitments, amounting to a staggering **$4.5 trillion** (or 5 percent of global GDP). More specifically, Global South countries will need to triple their annual investments in clean energy, increasing from $770 **billion** today to $2.2–$2.8 trillion by early 2030.

Although many countries of the Global South have publicly committed to international agreements regarding climate change, to navigate the energy transition they will have to make tough choices. If they choose to phase down their fossil fuel industries without viable options, they will lose fiscal revenues and face labor market disruptions. In parallel, many of the same countries do not have access to reliable and affordable energy and have deep socioeconomic challenges to address, such as low-quality

education, lack of decent work, and pervasive poverty.[2] These competing priorities require fiscal resources and private investments that many countries may not have.

Tax revenues provide a case in point. If a country's tax system and income rely heavily on fossil fuel proceeds, the government will need to find fiscal alternatives. This is the case in **many countries** in the Global South, where the fossil fuel industry contributes significantly to the fiscal coffers. In turn, this money finances public services (such as education and training), social programs, and public employment. In **South Africa,** for example, fossil fuels made up 5.5 percent of total government revenue and 1.6 percent of the country's GDP in 2019. Likewise, in the same year in **India**, fossil fuels made up 18 percent of total government revenue and 3.4 percent of the country's GDP. Saudi Arabia's main income source is the export of oil, which accounts for nearly **90 percent** of government revenue, although its **Vision 2030 Strategy** aims to diversify the economy. Fossil fuel royalties also finance social investments. For instance, **royalties** derived from the exploitation of nonrenewable natural resources, especially oil, are one of the main sources of financing for Colombia's public school system.

These trends raise important questions about the financing of the energy transition and what will happen when countries that house fossil fuel companies become the "losers" in that transition. Predictably, there is pushback from developing countries on their roles in the green transition and what the change implies in terms of tax revenues, financing, and workforce development. In a 2021 article, Yemi Osinbajo, Nigeria's vice president, **argued** that banning fossil fuel investments in Africa would hurt the continent's economic prospects much more than limiting global carbon emissions. Even though Osinbajo recognized that every country should play a role in addressing climate change, he also pointed to significant economic differences between countries.

These different socioeconomic realities should be considered when thinking about the pathway to net zero. The transition presents challenges to Global South countries, especially to their workforces. As countries are compelled to tackle climate change, they must also address the socioeconomic challenges that workers might face. This notion is captured by the principle of a "**just transition,**" which embodies meeting climate goals through a fair process for workers, ensuring that no workers become "losers" along the way.

Job Creation and Destruction

Like the labor market disruptions caused by globalization and technological change, the energy transition will both destroy and create jobs while also transforming occupations and the types of skills demanded. If the fossil fuel industry is significantly downsized, workers in these and related industries will lose their jobs. At the same time, as clean energy is developed, new jobs will be created. The effects of the transition will be seen throughout industries, even those not clearly linked to power production, storage, and use. In fact, most occupations will be affected in terms of skills and education requirements for the circular economy. For example, a car company shifting its manufacturing process from internal combustion engine (ICE) vehicles to electric vehicles (EVs) demands distinct sets of knowledge and skills for workers.

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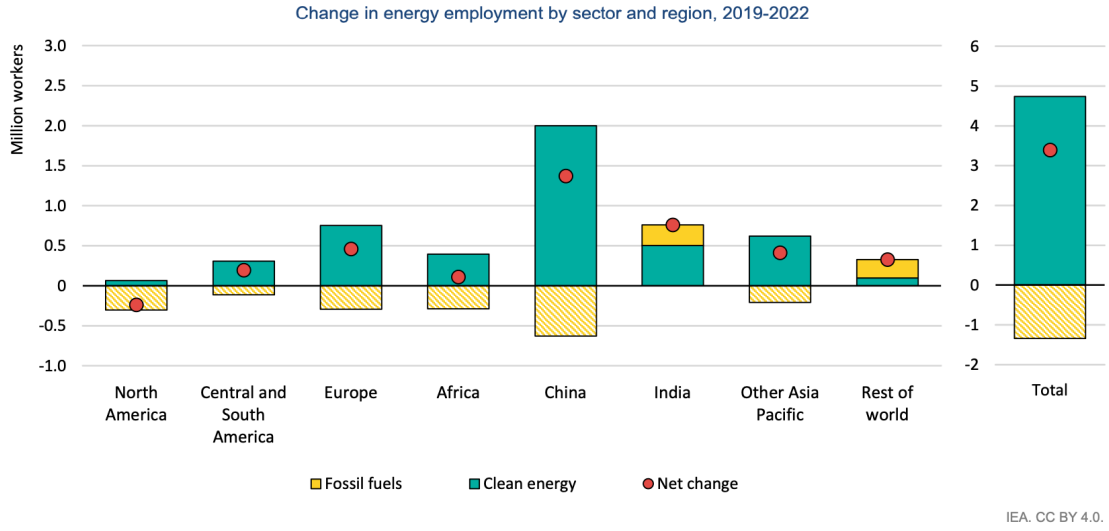
2 Close to 760 million people still lack access to electricity and 2.6 billion people lack access to clean cooking solutions. António Guterres, "Opening remarks to High-level Dialogue on Energy," (speech, United Nations, September 24, 2021), https://www.un.org/sg/en/content/sg/speeches/2021-09-24/opening-remarks-high-level-dialogue-energy.

While the qualitative effects can be described, quantifying how the energy transition will play out in the labor market is not straightforward. Will there be global net job creation or job destruction as a result? **Early estimates** paint an optimistic picture, broadly agreeing that by 2030 and 2050, the low-carbon energy transition will result in net job creation. According to the **International Labor Organization** (ILO), decarbonization is expected to generate up to 24 million green jobs by 2030, the majority in Asia. At the same time, some 6 million jobs are expected to be lost, particularly in carbon-intensive industries. These estimates thus provide a net increase of 18 million jobs.

Many of the "losers" of the energy transition will involve redundancies within the fossil fuel sector in developing countries. With regards to coal, for example, the **International Energy Agency** (IEA) predicts that miners will suffer disproportionately. There have already been 225,000 layoffs in the coal supply industry between 2019 and 2022, and an additional 1.4 million jobs could be lost by 2030 mainly in Asia (e.g., China and India). Within the manufacturing sector, workers in the car industry producing ICE vehicles will also experience **big losses**.

On the other hand, experts expect numerous job opportunities in renewable energy (including solar and wind), electric vehicles and batteries, heat pumps, and critical minerals. According to the **IEA,** the global energy sector employed 67 million workers in 2022, with clean energy representing over half of all energy sector jobs (35 million workers).[3] In most regions, clean energy jobs have grown more than fossil fuel jobs, particularly since the start of the Covid-19 pandemic (Figure 2). **China** leads in such energy employment, with about 60 percent of China's energy jobs in clean energy. Besides renewable energy, research conducted by the **Education Development Center** (EDC) highlights more than 270 different occupations in the fastest-growing green and blue sectors in developing countries: renewable energy, green construction, waste management, tourism and hospitality, and sustainable agriculture and forestry.

Figure 2: Global Energy Employment, 2019–2022



Source: IEA, *World Energy Employment 2023* (Paris: IEA, November 2023), 19, https://www.iea.org/reports/world-energy-employment-2023.

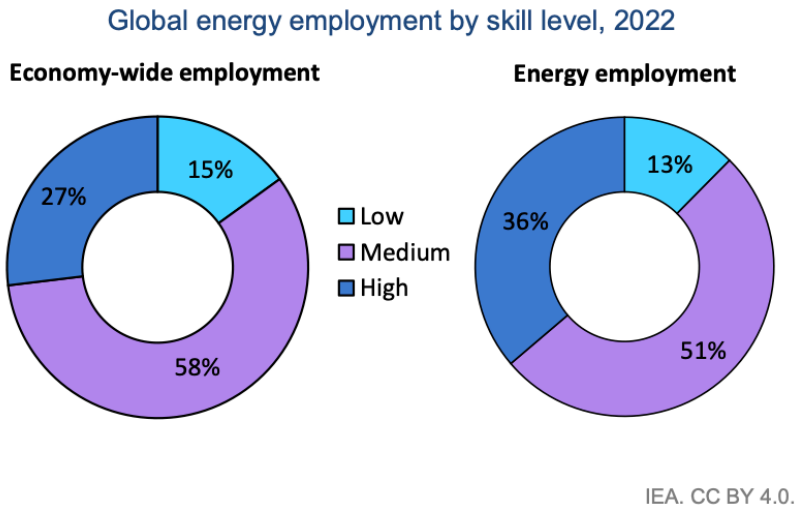
3 Clean energy jobs consist of low-emissions fuel sources, low-emissions power generation, power grids and battery storage, end-use efficiency, critical minerals extraction, and manufacturing of electric vehicles and their batteries. Fossil fuel sectors include the supply of oil, gas, and coal, as well as unabated fossil fuel-fired power generation and internal combustion engine vehicle manufacturing. "Total employment by sector, 2019-2023," IEA, November 13, 2023, https://www.iea.org/data-and-statistics/charts/total-employment-by-sector-2019-2023.

Education and Skills for the Energy Transition

These positive employment projections hinge upon a crucial condition: that workers will have the required education and training to take on the new jobs emerging from the energy transition. According to the **IEA**, 30 million clean energy jobs will have to be created in order to achieve net zero by 2050, and 60 percent of those will require some training. Similarly, the ILO report ***Skills for a Greener Future*** predicts net job creation, provided that there are massive investments in retraining and other measures. Successful transition requires further education and training for workers.

Since the carbon transition will impact energy production the most, it is worth analyzing the changing skill set in this sector. Specifically, what is the current skill set and what will be needed in the future? Currently, the energy sector employs more highly skilled workers than other sectors of the economy; the **IEA** contends that 36 percent of energy workers require higher education, whereas only 27 percent of economy-wide jobs require the same (Figure 3).

Figure 3: Skills Level in the Global Energy Workforce, 2022



Source: IEA, World Energy Employment 2023, 34.

In the growing renewable energy sector, the required level of skills is mixed. Studies suggest that the energy transition will create a wide range of jobs for workers with a variety of educational backgrounds and skills. The **International Renewable Energy Agency** (IRENA) predicts that by 2050 half of energy jobs will require only primary or lower secondary education, 37 percent will need secondary education, and 13 percent will require a tertiary education at the bachelor's, master's, or doctoral level. The **Asian Development Bank** (ADB) estimates that 20 percent of most new jobs will fall in the low-skilled range, 64 percent in middle-skilled, and 16 percent in high-skilled. According to a World Bank study, in sub-Saharan Africa, most of the workforce for **new power-generation projects**, and the largest job category for infrastructure upgrades needed to support increased energy access, consists of skilled and semi-skilled workers.

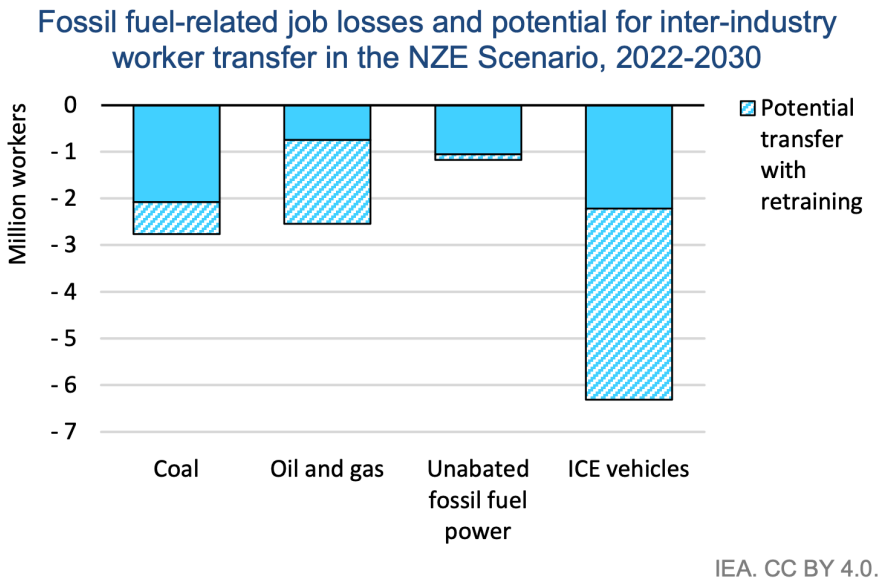
Workers will require new technical skills, such as equipment maintenance, safety procedures, and machine inspection, all of which could be acquired through on-the-job training. Required soft skills, such as ingenuity, creativity, problem-solving, and teamwork, are not easily taught in academic settings

but can be fostered in the workforce. Similarly, **green entrepreneurship skills** will be in high demand, likely encouraging the development of start-ups focused on green technology—products, services, and processes that prevent environmental damage and pollution.

What happens to workers in declining industries? Can they transfer their skills and be absorbed within the emerging workforce? Can they transition to a job with similar quality in the clean energy sector? Whether workers are transferable among carbon-intensive industries and green jobs remains debated. For now, there is only **limited** international evidence on job quality and transferability of skills of the carbon transition. For example, a **recent working paper** from the National Bureau of Economic Research (NBER) analyzed a **database** of 130 million worker profiles and 300 million job transitions globally and found that "less than 1 percent of employees leaving the carbon-intensive sector end[ed] up with a green job" between 2005 and 2021.

A more positive outlook offered by IEA**'s net zero models** show that half of the workers that risk layoffs in fossil fuel–dependent sectors have skills that can be applied to clean energy sectors. However, even those workers will require on-the-job training (Figure 4). Among fossil fuel workers, the IEA considers that petroleum engineering skills are **transferable** to geothermal activities, chemical engineering skills used in oil refineries apply to the production of clean fuels and hydrogen, and offshore petroleum skills can be used for offshore renewable energy production. For other occupations, including the CCUS sector, more structured retraining will be required. To return to the case of coal miners, such workers would face significant challenges in switching occupations into the critical minerals sector due to the mechanization and technological skills needed. Many coal miners in developing countries are low-skilled and thus would face extreme difficulties transitioning to the critical minerals sector.

Figure 4: Worker Transferability Potential, 2022–2030



Source: IEA, World Energy Employment 2023, 40.

These scenarios assume that policymakers and business leaders make significant investments in the skilling and upskilling of workers, along with funding social programs meant to help workers

weather the transition. Currently, this is not the case. Although many countries publicly recognize the importance of skill development for a green future, few have done anything about it. Less than **40 percent** of Paris Agreement signatories include any skills training in their policies aimed at supporting the implementation of their climate action plans; over 20 percent do not even envision any human capital–related activities. In the United States, for example, a **study** of climate action plans for 50 cities shows that workforce planning for the green transition is still in its infancy. Moreover, workforce development is not directly referred to as such in the plans but in the context of "**just transition,**" which involves ensuring that the shift to a low-carbon economy creates new jobs while providing social protections for workers in industries affected by decarbonization.

Within the reskilling challenge, technical and vocational training must play an important role. Such training includes upper secondary vocational education in fields such as clean energy, manufacturing, and petroleum and chemicals for China, as well as in fields such as engineering, manufacturing, construction, and architecture in the European Union. In the United States, vocational training targets construction trades, engineering technologies and related fields, and mechanics and repair. Despite the clear importance of these fields, data show that enrollment in these types of **programs** has either stagnated or fallen in China, the United States, and the European Union.

Curricula in higher education have not yet fully adapted to green skills either. **Green skills** entail "technical knowledge, expertise and abilities that enable the effective use of green technologies and processes in professional settings." A **study** of nearly 200 countries demonstrated that universities still prioritize coal and petroleum studies. In 2019, 68 percent of the energy-focused educational degrees worldwide were oriented toward fossil fuels, while only 32 percent focused on renewable energy. Even assuming demand for green skills is **particularly high** in the Global South, the universities in these regions offer only a few degrees in clean energy.

Beyond higher education, there are also deep, unresolved issues in basic education. In some regions, such as sub-Saharan Africa, **almost a third** of school-age children do not attend school. The literacy rate for individuals aged 15–24 in the region is only 75 percent, versus 90 percent in other developing economies. Since sub-Saharan Africa's population is estimated to double to **2 billion** by 2050, with the **working-age population** (15–64 years old) leading this increase, it is crucial to offer quality education so that future generations will be ready to deal with the energy transition. Green skills will be part of the future, but many countries have not yet integrated the realities of climate change into their educational institutions.

Is Reskilling Enough to Guarantee No Worker Is Left Behind?

In addition, reskilling might not be sufficient to enable workers to weather the carbon transition. Beyond necessary (and lacking) skills, there are other issues that need to be factored into policy responses, including the ability of workers to retrain, geographic distribution of jobs and desire for workers to relocate, loss of earnings, and wider community and social impacts:

- **Re-trainability:** Workers might be at a stage in their careers where it is harder to retrain. For example, a senior or even mid-career oil engineer or coal miner might not find it easy to acquire the skills necessary to switch to another occupation.

- **Relocation:** Even if workers obtain the requisite skills, there may be **mismatches** between regions where displaced workers currently live and where new job opportunities emerge. Energy and energy-intensive industries, for example, are naturally concentrated in specific geographies, with their workers necessarily situated nearby. In the global energy sector, **60 percent** of the jobs are not offshorable; in other words, they cannot be relocated from one country to another.
- **Loss of Earnings:** Though workers may find new jobs in another town, there are no guarantees of higher, or even equal, earnings. Within the **energy sector** specifically, wages for workers in fossil fuel industries tend to be higher than in the renewable sector.
- **Community Impacts:** Local economies that depend on declining industries will also be impacted, even driving families to relocate. **Lessons** from past transitions away from coal in the United States, Canada, Poland, and, to a lesser extent degree, India show how local economies that depend on these industries can be severely affected. A negative shock spreads though the community via multiple direct and indirect channels. Closing a coal mine, for example, means that employees throughout the supply chain lose their jobs. This, in turn, reduces labor demands in many associated sectors. Within **communities** where energy firms have shut down, companies outside of the fossil fuel industry may be forced to relocate, creating even larger socioeconomic impacts in local economies. Families in such communities also see their **purchasing power** decrease, causing local businesses to lose earnings, further impacting the local community.

Recommendations

One way to guide policymakers about future workforce disruptions is to look at lessons from past experiences. To avoid mistakes made in the past, policymakers can also learn from programs that have not been successful. In this regard, the results of the various policy measures taken to address the social impacts of the coal phase-out can help steer workforce policies during the climate transition. These country cases show that a wide range of other measures are needed beyond training and reskilling (see Box 1).

Box 1: Sample Programs for Coal Phaseouts

Alberta, Canada: The city of Alberta, Canada, offers an optimistic case study. Operational since **January 2018,** the **Coal Workforce Transition Program** offers career counselling services and retraining opportunities, including publicly funded retraining programs. Workers are also eligible to receive the Coal and Electricity Transition Tuition (CETT) Voucher, which **provides** up to CAD 12,000 for post-secondary education. Additional financial aid is available based on workers' ages. Younger workers may receive a bridge to re-employment relief grant, offering financial support during their job search. When combined with employment insurance benefits, such workers can receive **up to 75 percent** of their previous weekly earnings for up to 45 weeks. Additionally, Alberta provides **relocation assistance** (up to CAD 5,000) for workers who relocate at least 40 kilometers for a new job. Workers aged 53 and above are also eligible for the relief grant, but are eligible for longer, up to 72 weeks, or until they start receiving a pension. The phase out of coal in Alberta, coupled with an increase in renewable energy

jobs and the conversion of coal facilities to gas, is estimated to create between **1,970 and 3,570** annual full-time jobs by 2030, largely helping to offset the estimated 2,890 job losses in the coal industry.

Poland: The case of the coal-mining industry in Poland offers mixed results. Since the early 1990s, **Poland** has been transitioning away from coal, with the coal labor force shrinking by 80 percent (from around 390,000 jobs to 80,000 jobs) as of 2022. The government's **Mining Social Package** (1998–2002) enacted a series of policies meant to help coal miners deal with the transition. Measures included encouraging mine workers to voluntarily accept layoffs through early retirement, severance payments, welfare allowances, loans to start new businesses, and incentives for training in another profession. However, new economic opportunities for laid-off workers were lacking, and retraining failed to sufficiently help former mine workers land new jobs. The Polish example demonstrates that phasing out fossil fuel employment requires an integrated approach to successfully transition the workforce, including with parallel efforts to pursue economic diversification.

Given these competing factors, governments should implement policies and social measures with a holistic approach in order to ensure a just transition for all workers and communities. Going forward, there are four broad actions that governments—working with companies, civil society, and labor unions—need to take to successfully prepare the workforce for the upcoming disruption:

- **Incorporate workforce development into climate action plans and ensure the inclusion of green skills in basic education.** More countries and cities need to include workforce programs in their climate action plans. Generally, workforce development initiatives within climate action plans typically focus on several key areas including training and reskilling programs, formal and informal environmental education, sector-specific training, and inclusive policies focused on youth, gender, age, and ethnic groups to close gaps in green industries. These plans need to include issues such as identifying the sectors that will produce new jobs, developing needed policy reforms, and deploying funding mechanisms along with the goals and timelines to achieve these objectives. Antigua and Barbuda, Australia, Cambodia, Canada, Egypt, Gambia, and Liberia are among countries that have structured workforce development frameworks.

  Within the education system, green skills must be better incorporated into classroom settings. In this regard, primary and secondary schools could integrate knowledge on environmental issues and climate into the science curricula and across subjects (e.g., reading, history, and geography). Schools can also promote more awareness among students about environmental challenges, for example, by inviting expert guest speakers, organizing environmental fairs and workshops, and building out recycling programs. They can also teach more sustainable practices and lifestyles through specific activities such as outdoor environmental **education**. Educators also need professional training on these issues so that they can better incorporate green literacy into the classroom.

- **Partner with the private sector and labor unions in the design, funding, and implementation of training programs.** To better prepare workers for the energy transition

requires a mix of actions, and companies can help identify what those are. The private sector must work with governments, unions, and educational institutions on the required skills and fiscal incentives before policies and programs are put into place.

In terms of identifying the skills in demand, companies can use roundtables, employer surveys, and focus groups to gather valuable information and trends from the labor market. In addition, **trade associations** and skills councils could also set up working groups to exchange ideas, training approaches, best practices, and key lessons learned from their programs. These insights can be transmitted back to governments and educational institutions to help them in the design of school curricula and technical and vocational education and training (TVET) programs.

For example, the **European Skills Agenda** aims to reskill 120 million adults in the European Union between 2020 and 2025 so that they may successfully enter the digital age and green the economy. With more than €80 billion in investments, it is composed of 12 broad pillars and numerous interventions involving governments, companies, and educational institutions, including data analysis and skills certification. The skilling objectives are captured in four main indicators (Table 1). The European Union monitors **progress** on a regular basis and results are published in the bloc's annual Joint Employment Report. The latest data shows that more progress is needed on this front. Within the European Skills Agenda, the **Pact for Skills** is a multistakeholder community of practice (i.e., local governments, companies, unions, chambers of commerce, education and training providers, and employment services) set up to help public institutions and companies to reskill and upskill workers by sharing best practices, providing advice, forming partnerships, and identifying funding mechanisms.

Table 1: European Skills Agenda Objectives for 2025

Indicators	Objectives for 2025	Current level (latest year available)
1. Participation of adults aged 25-64 in learning during the last 12 month (in %)	50%	47% (2022)
2. Participation of low-qualified adults 25-64 in learning during the last 12 months (in %)	30%	19.4% (2022)
3. Share of unemployed adults aged 25-64 with a recent learning experience (in %)	20%	14% (2023)
4. Share of adults aged 16-74 having at least basic digital skills (in %)	70%	56% (2023)

Source: "European Skills Agenda," European Commission, https://ec.europa.eu/social/main.jsp?catId=1223.

In turn, governments could provide companies with incentives to upskill and reskill workers but they need sufficient **fiscal** resources to fund these programs. For example, under the **Inflation Reduction Act** (IRA) in the United States, employers are eligible for a nonrefundable income or franchise tax credit equal to $1.25 for each hour of employment of an eligible apprentice (not to exceed 1,000 hours per apprentice).

- **Institute active and passive labor market policies.** Beyond the need for training and reskilling, displaced workers might require wider support measures, including programs to help them find new jobs (e.g., active labor market policies) and measures to help them weather layoffs (e.g., passive labor market programs, such as early retirement and unemployment insurance). These policies and programs include relocation packages to enable workers to switch jobs, assistance in job searches, and access to unemployment insurance. For these programs to be effective, unions and civil society need to have a seat at the table in order to ensure that the widespread effects of layoffs are accounted for.

  Policymakers will play an important role in providing incentives for companies and those workers willing to relocate. Because relocation packages tend to have **higher costs** than training new workers, companies may not be as receptive to such programs and incentives as workers, particularly with regard to low- and middle-skilled jobs. Traditional examples of **financial benefits** aimed at incentivizing workers to move include relocation reimbursement, housing cost assistance, support for workers' families, and compensation adjustments.

  Even with relocation incentives, not all workers may want to move. A 2023 **study** conducted in the United States found that fossil fuel workers are more sensitive to geographic distance than to skill differences, meaning that such workers would rather switch occupations and retrain than move far away for another job. For this type of worker, individual-based policies such as **unemployment insurance**, social protection, and subsidies may be the way to mitigate financial distress.

- **Design more holistic support measures targeting communities in decline.** Finally, for regions where their main economic engines have suffered a structural decline (such as coal or manufacturing industries), instituting place-based policies might be more suitable instead of policies targeting specific group of workers or sectors. In the United States, such **place-based policies** include tax incentives to recruit new companies or retain established ones, public investments in workforce retraining, financial and technical assistance to small businesses, infrastructure development, and other fiscal incentives to invest in low-income areas.

  The **World Bank's strategy** to manage coal mine closures also emphasizes stimulating alternative activities and diversifying local economies while continuing to support individual workers. Larger community effects will be felt, for example, by workers in energy supply chains or those in businesses that provide goods and services to the energy sector, along with the families of workers in both. Economic diversification can also be achieved through the repurposing of energy sector lands and assets. The **Appalachia case study** of mine closures shows how close coordination across different levels of government (i.e., local, regional, and national) is key to achieving economic diversification of resource-dependent economies.

However, these examples primarily reflect how countries from the Global North have handled the decline of certain industries. This does not mean that there is a one-size-fits-all model that can be applied everywhere. In fact, in the Global South, just transitions might be more difficult to achieve given the lower quality of education, reduced availability of vocational training, the lack of fiscal space, and the higher numbers of vulnerable populations.

Conclusion

The transition to a low-carbon economy will significantly affect the global workforce. Although international commitments and targets to get to net zero by 2050 are highly ambitious, there is a strong discrepancy between political statements and actions to address climate change. Analysis of the current energy mix, and the actions and investments taken by countries to date, reveals that switching to green energy may be a long way away. As of **2023**, "the world is not on track to meet the long-term goals of the Paris Agreement." However, if governments work with companies, unions, and civil society to design plans and strategies to safeguard workers against these disruptions, a just transition is achievable. It will require measures such as skilling and reskilling, relocation incentives, unemployment insurance, and other social assistance for workers who lose their jobs. As the world rebalances its energy mix, it needs to manage the workforce impacts to ensure no one is left behind. ■

Romina Bandura *is a senior fellow with the Project on Prosperity and Development at the Center for Strategic and International Studies (CSIS) in Washington, D.C.* ***Clara Bonin*** *is a former intern with the Project on Prosperity and Development at CSIS.*

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