WORKFORCE & POPULATION STRATEGIES FOR THE TRANSITION TO RENEWABLE ENERGY SYSTEMS

Labour as An Implementation Gap

MENTOR to IMPACT

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About Mentor to Impact: Mentor to Impact is a nonprofit organisation that strategically works to secure labour and skills for a just and green transition. This is achieved through thought leadership, research, projects and collaborations across the world.

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Executive Summary

The purpose of this report is to investigate whether we can reasonably support the premise that a lack of labour will become a significant obstacle to the transition to renewable energy systems – a so-called Implementation Gap. It is critically important to assess that the lack of labour will constitute a barrier to the energy transition.

This work has been done through extensive literary and data studies across various platforms, organisations and writers. Further, we have conducted expert interviews across Brazil, Europe, India, Kenya and Tanzania and talked to a range of experts to clarify or get a better understanding of our findings. As for all future studies and forecasts, it is impossible to predict the future, but the documentation gathered in this report paints a clear picture.

Shortage of skilled labour is bound to emerge as a big implementation gap to the transition to renewable energy systems

As the energy transition accelerates, the shortage of skilled labour and competencies is going to become a major implementation gap for the energy transition. Addressing this gap is crucial for an effective transition implementation, as we see both current and anticipated skill shortages in renewable energy projects and electrification pose investment risks, driving up costs and hindering effectiveness.

Projections on job changes vary widely, influenced by sectors assessed, policy assumptions, technological adoption, and methodology. Despite uncertainties, a net increase in employment is anticipated, but disparities across occupations and regions may exacerbate social inequalities.

We already see that the current demand for skilled workers exceeds supply, hindering progress in energy-related projects, particularly in installation and repair work, construction, battery storage, and electric vehicles. Shortages are expected to worsen with increased climate policies and investments. Construction and investments in renewable energy are expected to continue rising, sustaining demand for labour over an extended period. Although labour demand may taper off during the maintenance phase, ongoing reinvestment and technological development ensure a continuous cycle of employment opportunities, especially among subcontractors.

Various forecasts suggest an increase in jobs as the energy transition unfolds, supporting the argument for its role in driving job growth. However, addressing skill shortages, labour dynamics, and regional disparities is crucial for navigating the transition effectively and ensuring its benefits extend across societies.

Small and Medium-sized Enterprises (SMEs) face unique challenges in ensuring a skilled workforce due to limited resources, emphasising the need for reskilling and upskilling initiatives.

Also, the scarcity of STEM skills poses a notable challenge, creating a disparity between employer demands and workforce qualifications, especially crucial in the green sectors driven by technological advancements.

In conclusion we can see that the lack of qualified labour is already and will increasingly constitute an implementation gap in the years to come.

What are the major obstacles with regards to skills for the transition to renewable energy systems?

Lack of skills for the energy transition is a two-dimensional problem. One of them being the demographic development and the other lack and mismatch of skills.

When we look at demographic development, we see that both the Global South and the Global North are affected by this. In the global North the demographic development is characterised by a decreasing youth population, a decrease in the workforce and an increase in the median age. This means that the lack of skills is not only a problem regarding the quality of the availability of skills but also a quantitative problem. As the workforce is set to decline in the coming years it will become increasingly difficult for companies to recruit staff.

To overcome this, it is necessary to address the problem by implementing policies to increase the available workforce. One way this can be achieved is to secure a broader participation from the population, e.g. by increasing participation of women in critical sectors and including vulnerable groups or people in transition between jobs or due to migration in the workforce. Further, reports show that digitalisation is expected to create more jobs than it will replace, however concerns have been raised of the opposite.

In the Global South, we see large countries and regions such as India and Sub-Saharan Africa currently close to, or within a couple of decades of, becoming very likely to enter the demographic dividend, where the proportion of the working-age population exceeds the proportion of the non-working population (e.g., children and the elderly).

Whether or not the demographic shift results in a demographic dividend is however closely linked to governmental prioritisation in areas such as education, health, governance, and the economy. In India, there is an increasing demand for skills for the energy transition; however, at the same time, many people in the labour force lack employability, and this relates to both university students and vocational and unskilled labour.

Another major issue is accessibility to training. This issue covers both the lack of trainers and access to training for vocational workers, unskilled labour, and academia. There is a recognized need for support and guidance in training of trainers for the energy transition. Challenges include financing adequate training of trainers and tailoring programs to specific industry sectors.

To address the skills mismatch, larger companies create their own training programs to enhance their employees' skills and education. However, this approach does not seem to mitigate the general lack and mismatch of skills, nor does it expand the recruitment pool among vocational workers. Furthermore, this strategy does not positively impact the public school system; on the contrary, it appears to have the opposite effect, further entrenching silo thinking within the educational system across various sectors.

Moreover, the effectiveness of the educational system in supplying skilled workers is heavily reliant on government prioritisation and funding. Vital updates are required in VET (Vocational Education and

Training) programs to incorporate technological advancements and cater to the demands of the energy transition, while challenges persist in financing and tailoring programs for specific industry needs.

Further there is a need for universities to meet companies' escalating demand for green sector expertise, addressing discrepancies between taught academic skills and employer expectations to enhance graduates' employability. This problem is particularly, but not exclusively, pertinent to India.

Lastly, we see silo thinking at both the political level (horizontal level) and in the cooperation within the ecosystem (vertical level, including market creators, companies, educational institutions, and organisations). Hence, we see that national, institutional, and intergovernmental collaborations play a vital role in setting strategic guidelines for the energy transition, ensuring stability, predictability, and reducing scepticism towards future reduction paths. Further collaboration between educational institutions, industries, and governments is essential to align educational programs with industry needs and bridge the skills gap effectively.

Identifying six Bottlenecks

Through our work, we have identified six bottlenecks. They all carry weight in themselves, but they are also intertwined and carry synergies between them.

The six bottlenecks are:

- *1) Lack of labour as an implementation gap in the energy transition*: To ensure a successful transition to renewable energy systems, the Global North must address workforce shortages and demographic decline, while the Global South needs targeted education and skill development for its growing workforce.

- *2) Increased gender disparity in the green labour market*: Without addressing gender disparity, the energy transition risks perpetuating existing social and economic inequalities, thereby impeding its progress. Women's contributions and leadership in climate solutions are crucial for ensuring effective and inclusive climate action. Furthermore, females make up half of the workforce, and are therefore unavoidable when addressing skills and labour shortages.

- *3) People in transition from declining industries and migration*: Support for the energy transition is closely tied to ensuring economic security for workers from declining industries and developing skills for migrants, as socio-economic instability can undermine public support for climate initiatives.

- *4) Lack of skills posing as an implementation gap*: The successful implementation of the energy transition relies on addressing workforce challenges and reducing skills mismatch, as the lack of skills presents a significant barrier to realising the full potential of investments in renewable energy and other green technologies.

- *5) Shortage of trainers and green VET institutions*: A critical shortage of qualified trainers for the energy transition, particularly in vocational schools, poses a significant obstacle to effective training and upskilling required for the energy transition, further amplifying the growing demand for skilled workers.

- *6) Silos across administrations and sectors*: Breaking down silos in both horizontal cooperation (silo mentality in policymaking) and vertical cooperation (cross-sector collaboration) is vital

for the energy transition. These issues intertwine, as silo mentality can also exist within cross-sector efforts and vice versa, leading to fragmented strategies and inefficiencies. Overcoming these barriers ensures integrated environmental, economic, and social strategies to close mismatch gaps and develop a skilled, adaptable workforce fit for the energy transition.

Synergies and Negative Up-stream Effects

To illustrate the major obstacles within the implementation gap on labour for the energy transition, the role of the central stakeholders and the connection between the six bottlenecks, the synergy model has been developed.

The model specifies the role of the stakeholders in relation to each of the major obstacles, linking this model to the Quadrature of Competencies. The Quadrature defines the most important stakeholders in the development of the (green) labour market and systemizes the shared effort between workforce & population, educational institutions, companies and market creators.

The model demonstrates how "Lack of Qualified Workforce" is an issue closely linked to the population in general and the workforce specifically (Bottleneck 1, 2, 3 and 4). The educational institutions are the most important stakeholders for the "Limited Accessibility to Training", since the educational institutions main mission is to ensure quality training and education for the population through dedicated and competent teachers (Bottleneck 5). Market creators, such as government officials, and companies form the rules, regulation and general practices for the job market and educational system. It is therefore especially important to ensure good collaboration and prevent silo thinking for these stakeholders (Bottleneck 6).

Furthermore, we see that the cooperation between companies and educational institutions is one of the most fundamental prerequisites for a balanced labour market and closing mismatch gaps. Without continuous understanding and dialogue between these two stakeholders, it is simply not possible to equip the workforce with the skills needed to implement the necessary technologies. Additionally, we see that digital technologies are developing exponentially, making reskilling and up-qualification even more important. Also, the involvement of social partners in this dialogue and cooperation ensures a more sustainable and long-lasting dialogue.

As an example female participation in the green workforce is of vital importance for several reasons. One of the most dominant reasons is that women constitute approximately potentially 50% of the workforce. Increasing female participation in the green workforce requires a targeted approach, including training of trainers, ensuring accessibility to training, and providing clear signals from both the market and the government. Schools need to tailor their education to the demand side. If inclusive company and governmental gender policies are not clear, schools are less likely to adjust their curricula and teaching methods to accommodate females.

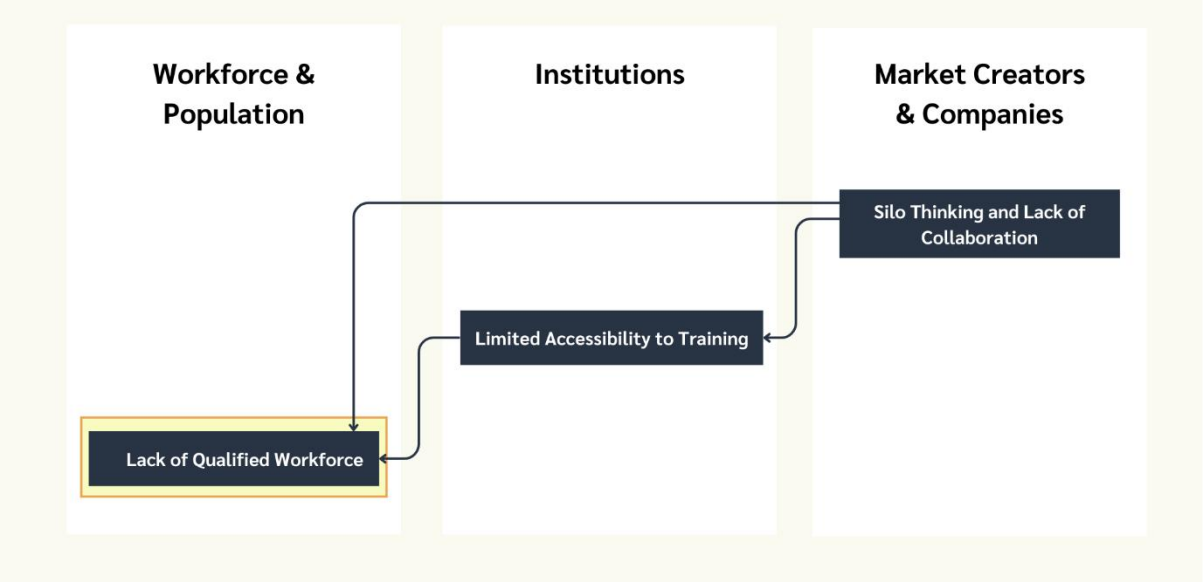
Additionally, underinvestment and lack of political prioritisation are gradually undermining the educational system. When companies do not cooperate with educational institutions and authorities, focus is lost in educational and employment policies.

On the other hand, we see a clear correlated effect when there is strong collaboration at both vertical and horizontal levels, and when policy and development steps are made with consideration of their probable long-term consequences.

We have identified a clear tendency, that when there is a linear effect between the supply of labour and market opportunities, companies are more likely to invest in labour. However, where the connection is not direct, such as in the case of women's roles, vulnerable groups, and technocrats' competencies, companies generally play a more passive role. Additionally, labour development has a long-time horizon, and if companies only act when the need directly arises, the development time can be very long. At the same time, the development time for teachers and trainers is even longer, as it is often people who have worked directly in the field who become vocational teachers. This must therefore be added to an already long-time horizon.

Furthermore, we can see that the lack of knowledge and competences among technocrats, civil servants, and government officials poses a problem with regard to creating clear pathways for the market to follow. This becomes especially apparent in licitation processes and at the vertical level, which then becomes a barrier further down the supply chain. Throughout our work, we have detected clear deficiencies at the implementation, educational, and policy levels.

Another important aspect of the Synergy model is the placement of the three main issues on a spectrum ranging from downstream to upstream. This means that issues relating to “Silo Thinking and Lack of Collaboration,” placed upstream on the Synergy model, have consequences for “Limited Accessibility to Training” and ultimately the “Lack of a Qualified Workforce.”



Simplified Synergy Model

Call for action

In conclusion, there is a clear role for macro level financing and strategic pathways in addressing the labour gap in the energy transition. Closing the mismatch and skills gap in the energy transition requires a multi-stakeholder approach. However, these stakeholders often have different priorities and bottom lines. Despite increasing recognition that the lack of skills for the energy transition is a major implementation gap, green skills development is not being prioritised at the centre of business strategy or policy development.

As mentioned above, if there is a linear effect between the supply of labour and market opportunities, companies are more likely to invest in skills development, especially among their own employees. However, when the connection is not direct, such as in the case of women's roles, vulnerable groups, and technocrats' competencies, companies generally play a more passive role. This is because the development paths are longer and more uncertain. Additionally, many companies have an economic bottom line as their primary success criteria, whereas what is needed is systemic impact and change, which requires macro level financing and strategy. Furthermore, in many countries, there is little to no action being taken to secure skills for the energy transition, largely due to a lack of prioritisation in the upstream supply chain.

In economic policy, there is often a focus on increasing labour supply in general, whereas ensuring that the workforce actually possesses the skills demanded by employers is often neglected. Imbalances in the labour market can have serious economic consequences, as structural imbalances will lead to lower employment and lower productivity. Nevertheless, the degree of match between the workforce's skills and employers' demand is not included in most conventional economic models.

The Quadrature of Competences model has been developed to systemise the necessary collaboration across sectors and stakeholders in the development of a balanced labour market. The model represents a structured approach to identify and implement strategic interventions. This approach leverages the collective expertise of stakeholders, ensuring that initiatives are not only effective but also scalable and widely adoptable, thereby maximising their impact.

Thus, we see a significant role for strategic interventions on a macro level to bridge silos and connect stakeholders across systems, leveraging systemic change to enhance skills and empowerment in the workforce, and disrupting unintentional negative upstream effects. A clear example on this would be partnerships to develop certified micro credentials and/or standards to secure efficient upskilling and inclusiveness policies.

To disrupt existing upstream deficiencies, it is necessary to step in where the market will not naturally go due to the lack of a direct linear effect. This could, for example, involve focusing on women, refugees, and other vulnerable groups, ensuring they have access to the necessary training and opportunities in the green workforce. Additionally, it is important to address areas where there is a general lack of skills, such as the competence to conduct green procurement processes among technocrats, disrupting silo thinking, and training of trainers.

There is a clear need for fostering collaboration between educational institutions, government bodies, and the private sector to understand the market development and demand as the market and technologies evolve. Establishing platforms for continuous learning and knowledge exchange can further enhance the capabilities of individuals and organisations involved in the energy transition. However, these

platforms need to be engaging, easily accessible, action oriented and directly implementable to be successful.

Methodology

Investigating the future role of the workforce in an effective energy transition is a comprehensive task, which requires a holistic worldview of the workforce domain before pointing to specific solution paths. This approach aligns with the Social Implication Design (SID) methodology developed by Nynke Tromp and Paul Hekkert[1], where the initial stage is to anticipate the future by gathering indications of how the domain is evolving and develop a structured worldview, which exposes where to intervene for the greater good of society.

Social Implication Design was developed at University of Technology Delft to give designers a methodological approach to structure complex societal problems and distil possible solution paths before settling on a design proposal[2]. This report focuses on the initial stage of the methodology, as we seek to create a structured worldview of the future within the green workforce domain and identify possible solution paths.

There are three steps within the stage of anticipating the future:

1. Describing the domain
2. Identifying context factors
3. Creating a context structure

The domain is the area of collective life or the aspect of society that is being examined. The following report will be based on observations within the green workforce domain.

Context factors

To anticipate the future of the workforce for the energy transition, it is necessary to gather information on what the workforce looks like now and which changes can be expected over time.

Tromp and Hekkert use the phase context factors as a description of different aspects of the domain, which combined can help form a holistic understanding of what the future might look like. There are four types of context factors:

Trends
Trends describe developments in shared experiences, beliefs and behaviours. An example from our research is the behavioural changes in the American workforce after the pandemic, where unemployed individuals are less eager to seek new employment after the pandemic (see page 31).

Developments
Developments are changes that do not describe human behaviour. The demographic developments in population growth, fertility rates and median age (see page 28) are good examples of developments.

States

[1] Tromp and Hekkert, Designing for Society - Products and Services for a Better World.
[2] Tromp and Hekkert, Social Implication Design (SID).

States are descriptions of the context as it is now and is not expected to change soon. An example is the use of a dual training approach to vocational training in Nothern Europe (as described by Jesper Friis from Danish Industry, see page 57).

Principles
Principles are laws that govern human life in the world. They can be anything from laws of physics to principles of psychology, as long as they help provide insight for the fundamental structure of our world. An example of a principle, which is relevant for this domain, could be "an uncertain future leads to increased anxiety", as is evident from the interview with Isabelle Barthes and Corinna Zierold from Industry All Europe (see page 45).

The context factors have been collected through literature studies, analysis of data (such as demographic data points) and interviews with a wide range of experts.

Context structure

Tromp and Hekkert describe[3] the context structure to organise all the gathered context factors, which can provide a relevant, coherent and original perspective on the domain. It is a way to communicate to others how the context factors fit together and point to how societal benefit can best be achieved.

The initial analysis of the context factors led to a formation of six bottlenecks for the workforce in the energy transition. These bottlenecks can be seen as a form of initial context structure. The bottlenecks each represent a cluster of context factors, which when combined shows an important challenge the energy transition will face when securing a qualified workforce in the future. All bottlenecks are described in the first part of this report, including a general introduction to each of the issues and regional perspectives, where relevant excerpts from our interview with experts are included as well.

The Synergy model (see page 68) is the final context structure, which shows the synergy between the six bottlenecks through three main issues. This model reveals opportunities for intervention and the potential role macro level interventions by placing the three issues on an upstream/downstream spectrum and thereby revealing the connection between them.

Quadrature of Competences

In addition to Social Implication Design, the Quadrature of Competences[4] has been used as a guideline throughout the project. The Quadrature of Competences framework has been developed to ensure the necessary collaboration across the development of a balanced labour market. By a balanced labour market, we mean a well-functioning and efficient labour market where the workforce possesses the skills demanded by companies and the public sector.

In economic policy, there is often a focus on increasing labour supply in general, whereas ensuring that the workforce possesses the skills demanded by employers is often neglected. Imbalances in the labour

[3] Tromp and Hekkert, Designing for Society - Products and Services for a Better World.
[4] Mentor to Impact - strategic modelling on skills development

market can have serious economic consequences, as structural imbalances will lead to lower employment and lower productivity. Nevertheless, the degree of match between the workforce's skills and employers' demand is not included in most conventional economic models. Thus, it is a necessary condition for a well-functioning and efficient labour market that the workforce possesses the skills demanded by companies and the public sector.

In the Quadrature, the four most important stakeholders are identified. These are 1) Market Creators, 2) Companies, 3) Institutions, and 4) Population and Workforce (see Figure 0 below).

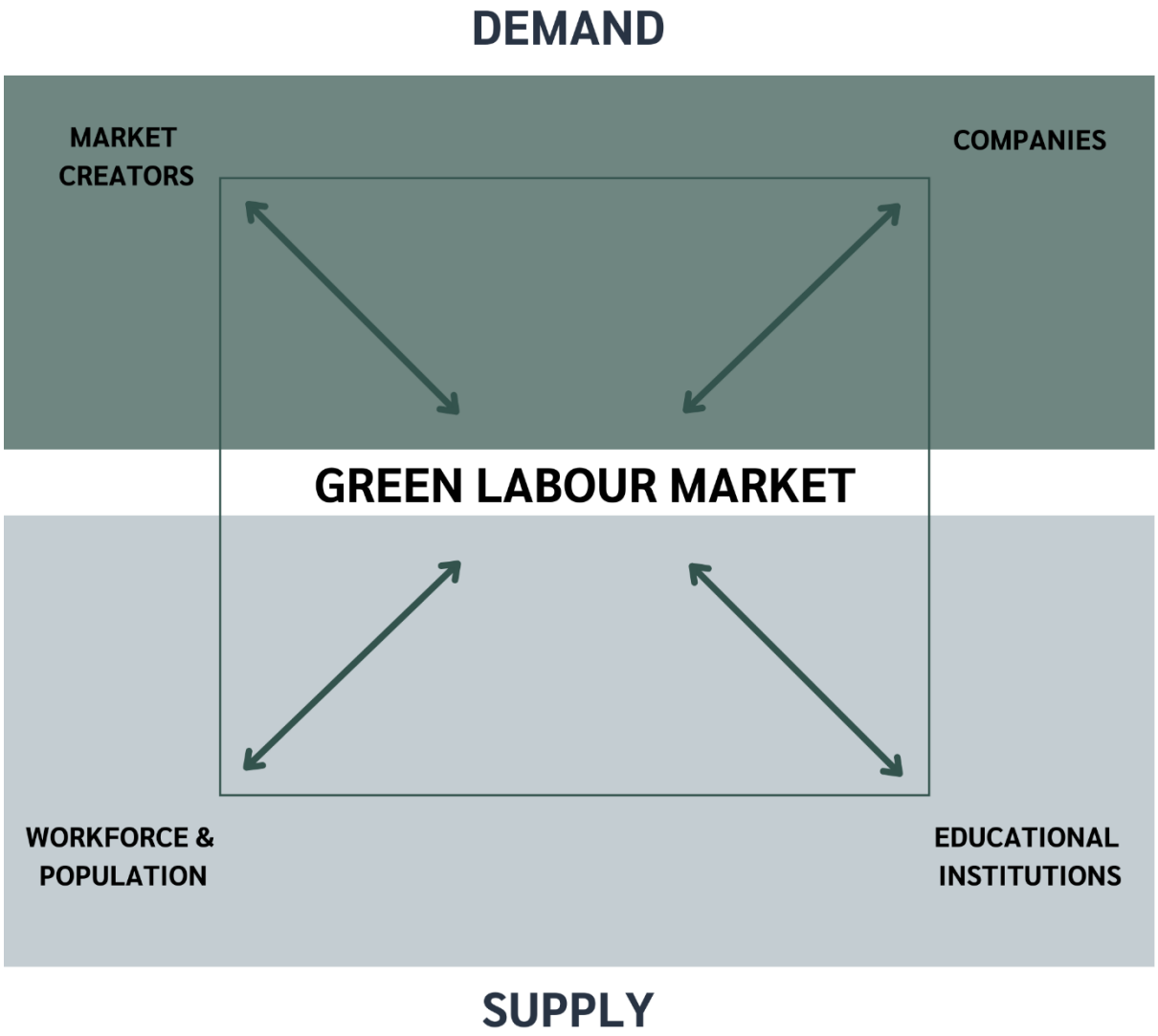


Figure 0. *Quadrature of Competences*

The Quadrature of Competences has been used throughout the research phase, as it has served as a framework for holistic stakeholder inclusion. The final context structure represented in the Synergy model (see page 70) includes all of the four main stakeholder groups and displays which issues are most relevant for each of the stakeholders.

Defining a Green Labour Market, Green Jobs and Green Competencies

For this report, the following definition of the Green Labour Market[5] was used.

The definition originates from the project *"The Green Labour Market of the Future"*[6], and builts opon previous work by the United Nations, ILO and OECD. The definition focuses specifically on classifying individual jobs and competencies, and the Green Labour Market. In this report focus is specifically on the Green Energy Labour Market, and emissions reductions.

[5] Damvad Analytics, Den grønne omstilling af arbejdsmarkedet.
[6] Concito, Fremtidens grønne arbejdsmarked

Overall Mapping and Identification of Bottlenecks

Lack of labour as an implementation gap in the energy transition

Introduction

As the energy transition accelerates, the shortage of skilled labour and competencies emerges as a major implementation gap. This gap encompasses labour dynamics, competencies among stakeholders like market creators, companies, educational institutions, and the workforce, considerations of a just transition, and gender-related aspects. Addressing this gap is crucial for effective transition implementation and garnering political support from global populations. Moreover, both current and anticipated skill shortages in renewable energy projects pose investment risks, driving up costs and hindering effectiveness.

Projections on job changes vary widely, influenced by sectors assessed, policy assumptions, technological adoption, and methodology. Despite uncertainties, a net increase in employment is anticipated, but disparities across occupations and regions may exacerbate social inequalities. Addressing skill mismatches and labour mobility challenges is crucial.

Current demand for skilled workers exceeds supply, hindering progress in energy-related projects, particularly in installation and repair work, construction, battery storage, and electric vehicles. Shortages are expected to worsen with increased climate policy and investment, leading to unsustainable workloads and slowed company growth.

Construction and investments in renewable energy are expected to continue rising, sustaining demand for labour over an extended period. Although labour demand may taper off during the maintenance phase, ongoing reinvestment and technological development ensure a continuous cycle of employment opportunities.

Various forecasts suggest an increase in jobs as the energy transition unfolds, supporting the argument for its role in driving job growth. However, addressing skill shortages, labour dynamics, and regional disparities is crucial for navigating the transition effectively and ensuring that the potential benefits of the transition extends across societies.

Overall findings

With the energy transition gaining momentum, a significant deficit in skilled labour and competencies shortage has surfaced as a critical challenge. This shortage encompasses several dimensions, including labour dynamics, and the competencies among stakeholders such as market creators, companies, educational institutions, and the workforce. Additionally, considerations of a just transition, and gender-related aspects, contribute to this complex yet crucial implementation gap in the energy transition.

It is imperative not only to ensure the availability of appropriate skills and competencies for an effective transition implementation but also to demonstrate the employment opportunities and potential inherent in the energy transition. Demonstrating these benefits is vital for garnering support to accelerate efforts within political systems. Furthermore, we can observe that both the current and anticipated lack of skills in several renewable energy projects is seen as an investment risk, driving up the price of investments and rendering them less effective.

The projected total number of jobs created and lost due to the energy transition exhibits significant variability across scholarly literature and reports. This variability stems from differences in the sectors assessed, underlying policy assumptions, the adoption of various technologies, and methodological considerations. While many sources anticipate a net increase in employment resulting from the transition, it is essential to recognize its concurrent creation and elimination of jobs across various occupations and regions. This disparity carries the potential for social backlash and exacerbation of inequality concerns.

Furthermore, job losses in one region may not necessarily be offset by job growth in the same location, potentially leading to skill mismatches and labour mobility challenges. Thus, addressing these dynamics is crucial for navigating the transition effectively.

Despite uncertainties in future projections, many sectors and employers are currently experiencing high demand for skilled workers in the low-carbon economy that cannot be met by the current supply. Employers in the Global North struggle with hiring skilled workers in a historically tight labour market. In many emerging and developing economies, vacancy levels are at record highs despite high unemployment due to lack of skills and skills mismatches.[7]

The shortage is hindering progress in various energy-related projects, as energy companies struggle to hire individuals with industry-specific knowledge, particularly in installation and repair work. Construction jobs, crucial for installing clean energy technologies and retrofitting buildings, are especially experiencing acute skill shortages. These positions are expected to make up around half of the new positions in the energy sector until 2030 on the path to net zero.[8] Talent shortages are also impeding progress in industries like battery storage and electric vehicles, leading to unsustainable workloads and slowed company growth. Further the lack of knowledge on relevant and necessary technologies among decision makers and technocrats is impeding effective implementation and the development of a “green” market demand.

When examining the various phases of renewable energy construction, a significant demand for labour is observed during the construction and preparation phases, which is expected to taper off as the transition into the maintenance phase occurs. However, recent data from the Danish wind sector shows the opposite. The numbers indicate that, despite of a decrease in investments in manufacturing and assembling windmills from 2021 to 2023, there has been a net increase in the number of people employed as subcontractors in the Danish wind industry during these years.[9] Further, it is crucial to recognize that the construction and implementation of renewable energy projects will be spread out over an extended period. With the expectation of adhering to a Paris-compatible scenario, it is essential to note that construction and investments in renewable energy sources are not expected to peak in the near future. Instead, a sustained increase in demand for many years is anticipated.

A study identified three labour market phases during the transition: 'scale-up', 'scale-down', and a long-term steady state, suggesting a net increase in jobs in the initial phase of the renewable electricity

[7] IEA, World Energy Employment 2023.
[8] IEA, World Energy Employment 2023.
[9] The mapping is based on a register analysis from Statistics Denmark's research server. 'Subcontractors' includes employment in companies manufacturing components, such as electrical parts, used in assembling wind turbines. The wind industry category excludes advisory and consulting services. Source: Green Power Denmark.

transition. The dynamics of the labour market change throughout the transition until a stable decarbonized energy system is established. Even when a stable decarbonized system is established ongoing reinvestment and technological development must be expected, creating a continuous cycle of initial investments, maintenance, reinvestments, and further maintenance.[10]

Long-term forecasts often present challenges in providing precise numbers and projections. Some figures may vary depending on methodologies, available data, and political considerations influencing specific assumptions. Nonetheless, given existing investment scenarios, a significant demand for labour within the renewable energy sector is anticipated. Current demands and short-term projections from employers align with these expectations, which are expected to persist as investments continue to rise.

Particularly challenging are the ageing demographics and the shrinking labour pool across the Global North. Additionally, the significant skills gap in the Global South suggests that these problems will persist across generations.

Uncertainties and methodology in assessing employment effects of the transition

Recent studies on the employment impact of renewable energy generally suggest a positive net effect.[11] They argue that the reported net employment effects of renewable energy are largely influenced by the chosen methodology. Estimates accounting for induced effects tend to be less optimistic. While direct and indirect employment effects are typically positive, induced effects can vary. Factors such as the decline of conventional energy sources and competition for capital are expected to decrease net employment, while the effects of changes in electricity prices, labour wages, and household income remain uncertain. The inclusion of induced effects is more computationally complex and requires employment data for all sectors of the economy. The limited inclusion of induced effects suggests that the current literature may be overly optimistic about the employment benefits of renewable energy and energy efficiency. Policy reports tend to report more positive outcomes compared to academic studies, primarily because they often overlook induced effects.[12]

Projections of job changes rely heavily on systemic assumptions, including future policy scenarios, technological advancements, and the geopolitical landscape driving emission reduction goals and transition costs.[13] Bücker et al. (2023) examined job creation in the U.S. and pointed out that most studies focus on the aggregate job numbers in the initial transition phase and their models overlook the heterogeneous impacts across workers, including their occupations, skills, and geographic locations. This oversight may lead to significant temporal labour market fluctuations and skill mismatches.

[10] Bucker et al., Employment dynamics in a rapid decarbonization of the power sector.
[11] Stavropoulos and Burger, Modelling Strategy and Net Employment Effects of Renewable Energy and Energy Efficiency.
[12] Stavropoulos and Burger, Modelling Strategy and Net Employment Effects of Renewable Energy and Energy Efficiency.
[13] Xie et al., Distributional Labour Challenges and Opportunities for Decarbonizing the US Power System.

Projections

Globally, IEA projects that under current policies, 8 million clean energy jobs will be created, while jobs in fossil fuels will decline by 2.5 million by 2030. From 2019 to 2022, clean energy jobs have outweighed job losses due to declining employment in fossil fuels across most regions, with exceptions noted in Russia and North Africa.[14]

Projections by subsector

The future labour demand in the oil and gas industry varies depending on the pace of the transition. While employment is expected to rise under current policies, a Net Zero Emission Scenario (NZE) by 2050 would lead to significant decreases in employment within oil and gas. Many oil and gas companies are expanding into other energy sectors which can help mitigate labour transition risks. Employment growth in hydrogen, CCUS, geothermal, biofuel, and biogas processing almost offset the decline in the oil and gas business by 2030 for an NZE scenario[15]. Up to two million new roles will be created in the hydrogen value chain by 2040.[16]

According to Manish Ram, Arman Aghahosseini and Christian Breyer in the post-pandemic period, over half of the energy sector's job growth is expected to be concentrated in five sectors: solar photovoltaic (PV), wind energy, electric vehicles (EVs) and battery manufacturing, heat pumps, and critical minerals mining, currently employing 9 million workers. Notably, EV manufacturing has experienced the largest employment growth, adding over 1 million jobs globally since 2019. The majority of these new jobs are in manufacturing and construction, comprising over half of total employment in the energy sector today.

The study assesses the changes in employment in the power sector by 2050 for the nine major regions: Europe, Eurasia, MENA, Sub-Saharan Africa, Northeast Asia, Southeast Asia, North America, South America, and globally. This assessment, however, is limited as it only includes job changes in the power sector and assumes an ambitious best-policy scenario with 100% renewable power production by 2050. It projects that construction and installation jobs, which are project-based, will constitute a substantial share of global employment, whereas operation and maintenance jobs will offer more stability. Total employment is expected to grow rapidly, with the power sector rising from 21 million in 2015 to 35 million in 2050, especially with the surge in new installations from 2020 to 2030. Although specific jobs in electricity generation may decline due to increased productivity and improving learning rates, the overall job creation in the renewable sector will more than compensate for the losses in the conventional energy sector [17].

The coal sector is anticipating substantial job losses in the coming years as coal production is set to peak soon. According to the International Energy Agency (IEA), global coal demand is projected to reach its peak by 2025, driven by a combination of slowing economic growth, energy transitions

[14] IEA, World Energy Employment 2023.
[15] IEA, World Energy Employment 2023.
[16] ManPowerGroup, A People-First Green Business Transformation.
[17] Ram et al., Job Creation during the Global Energy Transition towards 100% Renewable Power System by 2050.

towards renewables, and policy measures aimed at reducing carbon emissions. The decrease in coal has so far not been affected by the war between Russia and Ukraine[18]

From 2019 to 2022, approximately 225,000 jobs have already been lost in coal mining in emerging economies, and projections indicate that this number could rise to 1.4 million by 2030 as countries transition away from coal.[19] Nearly half a million workers are currently employed in mines that may cease operations before 2035, and by 2050, almost 1 million coal mine jobs are projected to be lost due to anticipated closures, representing a significant workforce reduction of over one-third without climate-related pledges or policies.[20]

Examples of job creation and losses by region

Forecasts in job development are numerous and often based on different assumptions. However, the principle of the law of large numbers and the numerous reports indicating an increase in jobs as investment in the energy transition unfolds support the argument that the energy transition will drive job growth.

In Europe, Cedefop estimates that the implementation of the European Green Deal could yield approximately 2.5 million additional jobs[21], while the growth and maintenance of electricity grids and storage facilities in the energy sector are forecasted to provide millions of additional jobs worldwide, with the ILO projecting up to 3,500 jobs per 100,000 in Europe.[22]

Further in the UK, a significant shortage of qualified heat pump engineers is evident, with only around 3,000 accredited engineers compared to the required 27,000 by 2028. Additionally, the offshore wind industry alone is anticipated to triple its workforce to over 104,000 by 2030, while the nuclear sector is expected to require about 250,000 workers, surpassing its current 77,000-strong workforce.[23]

In India, the ILO estimates that approximately 54 million green jobs will be created between 2021 and 2030, while the World Economic Forum suggests that India's transition to a net-zero economy could potentially generate 50 million jobs.[24]

In the United States, a plethora of literature and reports project various job changes due to the transition to clean energy, ranging from net increases of 1.6–3.6 million by 2050. Furthermore, the 2022 Inflation Reduction Act is estimated to generate more than 5 million job-years in the clean energy sector by 2030, with regional disparities in job opportunities becoming evident, particularly in states like Wyoming,

[18] Centre for Research on Energy and Clean Air, Russia-Ukraine war has not led to increased fossil fuel consumption in the EU.
[19] IEA World Energy Employment.
[20] Global Energy Monitor, Scraping By 2023: Global coal miners and the urgency of a just transition.
[21] Cedefop, From ‘greenovators’ to ‘green’ minds: key occupations for the green transition: the nuances of defining ‘green' occupations.
[22] Economist Impact, Green Skills: driving the transition to a more sustainable future.
[23] Ambrose, We’re facing a critical shortage.
[24] PAGE, Assessment of India’s Green Jobs and Just Transition Policy Readiness.

Montana, and West Virginia, which are projected to experience job losses due to the energy transition, primarily due to declines in coal supply.[25][26]

The impact in the coal sector is expected to be particularly severe in China and India, where substantial portions of the workforce are employed in the coal sector. In China's Shanxi province, the largest global decline is anticipated, with nearly a quarter of a million jobs expected to be lost by 2050. Similarly, in India, Coal India Ltd. is facing potential job cuts of up to 73,800 by mid-century. [27]

Research Gaps

Projection of job creation by sectors and regions

A research gap exists in enhancing the depth and scale of projected employment figures for the energy sector. Hanna et al. (2024) conducted a systematic review of 121 publications on job creation in a low carbon transition to renewables. They find that various methods for estimating low carbon energy job creation lack standardisation, impeding comparisons across regions. There is a notable gap in data on job quality, skills, and geographic distribution of employment impacts, highlighting these as priority areas for research. Investments in renewable energy and energy efficiency generally create more jobs than fossil fuels, but regional and sectoral disparities in job gains and losses necessitate coordinated transition plans and skills development.[28] Furthermore existing projections often rely on simplified methodologies, overlooking induced effects and the time dimension of the transition.[29] [30]

Women's participation in the energy workforce

This report identifies a knowledge gap in women's participation in the energy workforce. A lack of comprehensive data on the level and nature of women's employment in the energy sector hampers efforts to understand and address gender diversity within this field. Despite some emerging research on gender in renewable energy, overall, the focus has been limited, often concentrating on gendered energy usage in households rather than employment and decision-making within the industry.[31]

The scarcity of gender-disaggregated data exacerbates the problem, leading to incomplete sector analyses and hindering the integration of gender considerations into energy policies. Initiatives like Data2X and the UN's EDGE are working to close gender data gaps, but their focus rarely extends to the energy sector. For a more accurate understanding and effective policies, it is important to prioritise

[25] Xie et al., Distributional labour challenges and opportunities for decarbonizing the US power system.
[26] This number depends on who will be elected president in the coming elections.
[27] Global Energy Monitor, Scraping By 2023: Global coal miners and the urgency of a just transition.
[28] Hanna et al. Job creation in a low carbon transition to renewables and energy efficiency.
[29] Stavropoulos and Burger, Modelling Strategy and Net Employment Effects of Renewable Energy and Energy Efficiency.
[30] Bücker et al., Employment dynamics in a rapid decarbonization of the power sector.
[31] Pearl-Martinez and Stephens. Toward a gender diverse workforce in the renewable energy transition.

gender-focused research and data collection throughout the entire energy value chain, addressing the needs and contributions of women comprehensively.[32]

Training of trainers

Knowledge and analysis regarding training of trainers and securing the necessary skills for trainers in the energy transition is very scarce. Many projects discuss trainers as a natural part of the projects, but very few address the independent issue of training trainers and the shortage of trainers. This is particularly interesting since trainers often bring several years of experience into their teaching, which means that becoming a professional trainer or teacher has a longer lead time. Through many of our dialogues, the shortage of trainers and the long lead time have been discussed, but we have not found literature dealing or addressing this specific issue on a strategic or academic level.

Participation and access to green education and training programs

Research endeavours may be directed towards illustrating strategies aimed at increasing the visibility and accessibility of relevant education and training programs for the energy transition. Furthermore, research could focus on identifying barriers preventing marginalised communities from accessing green training programs. Understanding these factors can inform the development of more inclusive and accessible training initiatives.

Upskilling pathways

The transition to a green economy requires the development of new skills and the upskilling of existing workers, yet there is a noticeable gap in the literature regarding specific upskilling pathways tailored to this transition. Disparities in access to upskilling opportunities persist, particularly affecting disadvantaged regions and low-skilled workers. Research is needed to identify strategies that ensure equitable access to training programs in these contexts. Effective policy implementation and coordination among various stakeholders—government, industry, and educational institutions—are crucial for successful upskilling initiatives. However, the literature lacks adequate exploration of best practices and challenges in this area.

Regional road mapping for transition planning

Developing detailed regional roadmaps of job losses and skill demand is identified to be important for effective transition planning. This gap is evident in the need for sector-specific roadmaps associated with declining sectors such as the phasing out of coal. Adequate planning is essential to securing a just transition. For instance, in the context of India's coal transition, the Planning Commission Aayog emphasises the importance of analysing the coal ecosystem, understanding job dependencies, and identifying opportunities for economic diversification in coal-rich regions. Challenges in this process include insufficient data availability and the tendency to underestimate the contributions of informal labour.[33]

[32] Pearl-Martinez and Stephens. Toward a gender diverse workforce in the renewable energy transition.
[33] PAGE, Assessment of India’s Green Jobs and Just Transition Policy Readiness.

How to create an enabling environment

According to the UNDP[34], "*an enabling environment relates to things such as policies, legislation, institutional arrangements, leadership, political processes, power relations and social norms. These factors govern how different parts of society prioritise, operate, and engage each other. If favourable conditions are developed, it will allow effective capacity development*". We have not found literature addressing how to create an enabling environment for developing skills and reskilling to the energy transition. Several of our sources have pointed at the creation and development of enabling environments for training and skilling to the energy transition. This goes for an example with trainers, females and vulnerable groups.

Twin transition and Implications of AI on jobs in renewable energy

Diodato et al. (2023) points that the academic discourse on the twin transition—encompassing digitalization and environmental sustainability—is evolving but remains nascent in several crucial areas. One area needing further investigation is the synergies between digital and energy transitions, on how advancements in digital technologies can enhance the adoption and effectiveness of green technologies, and vice versa. Moreover, there is a need to study how the twin transition might exacerbate or alleviate existing economic inequalities. This involves analysing its impact on access to resources, job opportunities, and economic outcomes across different industries and demographic groups. Further research could investigate how organisations adapt to these dual challenges and evaluate the effectiveness of policies and regulations designed to promote the twin transition. This includes assessing how policies can balance digitalization and green goals.[35] AI is predicted to play a crucial role in the renewable energy sector by enhancing infrastructure maintenance, optimising energy generation, and integrating renewable sources into existing grids.[36] However, the impact of AI on job markets within the renewable energy sector, along with the necessary competencies required, remains a research gap.

[34] UNDP, Capacity Development.
[35] Diodato et al., Introduction to the Special Issue on 'the Twin (Digital and Green) Transition.
[36] Hamdan, AI in Renewable Energy: A Review of Predictive Maintenance and Energy Optimization.

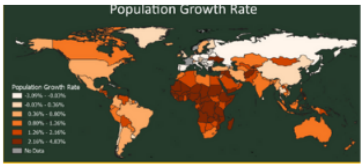
Bottleneck 1: AGEING GLOBAL NORTH AND NASCENT GLOBAL SOUTH

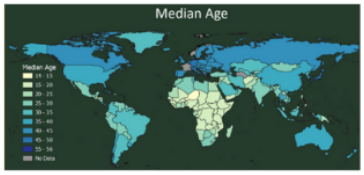
Short description:

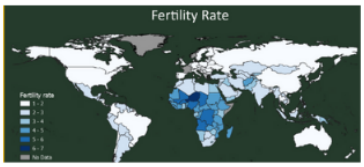
To ensure a successful energy transition, the Global North must address workforce shortages and demographic decline, while the Global South needs targeted education and skill development for its growing workforce.

General introduction to the issue

- The workforce is declining and the population is aging in the Global North:
  - The workforce in this part of the world is shrinking due to demographic developments
  - Some regions are suffering from demographic decline and brain drain
- Regions in the Global South are experiencing significant population growth, especially in India and sub-Saharan Africa
  - The primary challenge for the workforce in these regions is to obtain the necessary skills for the green transition







Regional perspectives

Global North

Ageing population in Europe: The median age in Europe is increasing. This is an issue, as the replacement rate results in labour shortage.

Demographic changes in the US: The population is getting older, but is still growing due to immigration.

Job vacancies in the US: Many people in the workforce choose to work less, retire or stay at home with children after the COVID pandemic.

ETUC (Europe): The rising median age is an obstacle for the green transition in Europe. Just transition policies are needed to overcome this challenge.

Global South

Indias demographic dividend: Indias growing working-age population requires sufficient job creation and enhanced education.

Interview perspective

Regional perspective based on litterary sources

Introduction

Demographic developments pose challenges for the energy transition in both the Global North and the Global South. The Global North must find ways to mitigate workforce shortages and manage demographic decline by investing in training, reskilling programs, and policies that encourage labour force participation. At the same time, the Global South needs to focus on building robust educational and training systems that can equip its large, young population with the skills required for the green economy.

The Global North: Declining Workforce and Aging Population

The Global North, which includes developed regions such as North America, Europe, and parts of East Asia, is confronting significant demographic and labour-related challenges that impact the energy transition. These regions are characterised by ageing populations, slower or negative population growth, and declining fertility rates (See Figure 1-3). These demographic trends lead to a shrinking workforce, which poses a substantial obstacle to maintaining economic productivity and achieving sustainable development goals.

The energy transition faces significant challenges due to a shortage of skilled labour. As older workers retire, there are fewer young workers available to replace them, particularly in specialised green industries. This labour shortage can hinder the ability to implement and scale up green initiatives effectively. Additionally, the competition for limited labour resources can lead to sectoral cannibalization, where different industries compete for the same pool of workers, driving up wages and causing instability in the labour markets. The ageing population also places increased pressure on social services and healthcare systems, diverting resources that could otherwise be invested in energy transition projects.

Retirements will absorb some of the lost jobs in declining sectors like fossil fuels. Some industries are collaborating with unions to offer early retirement packages to workers not suitable for reskilling.[37] On the contrary, the demand for skilled labour in green jobs is increasing. Retiring skilled workers in green sectors must be replaced, and the overall workforce needs expansion. The changing demographics pose significant challenges in fulfilling the demand for these skills.

Labour shortages, particularly for the energy transition, are already a significant problem across many countries in the Global North. The IEA has highlighted the increasing difficulty in recruiting qualified labour globally. Many surveyed companies express genuine concerns that the labour shortage will become a major barrier, exacerbated in the long run.[38]

The EU Commission has expressed concern about a "geography of discontent," which potentially can fuel extremist movements and anti-European sentiments in regions suffering from demographic decline

[37] IEA, World Energy Employment 2023.
[38] IEA, World Energy Employment 2023.

and brain drain.[39] This could lead to increased polarisation in the democratic system. Furthermore, the United States, New Zealand, Australia, and Canada[40] are all experiencing significant demographic shifts with ageing populations, presenting challenges such as increased demand for healthcare services, higher prevalence of chronic conditions, a growing need for long-term care, potential labour shortages impacting economic productivity, and pressure on social security and pension systems as the ratio of working-age individuals to retirees decreases.

The Global South: Population Growth and Skills Gap

In contrast, the Global South, particularly regions such as India and sub-Saharan Africa, is characterised by significant population growth. with a large proportion of the population being in the workforce[41]. At the same time the number of young people not in employment, education, or training remains high globally, particularly among women and rural youth in low- and lower-middle-income countries[42]. The combination of these two factors - the demographic dividend and a high youth unemployment emphasises the need for skills development and targeted national youth educational strategies.

The primary challenge for the Global South is to develop a workforce with the necessary skills for the energy transition. Many countries in these regions have educational systems that are under-resourced and may not be aligned with the demands of emerging green industries. There is a need for targeted educational strategies and vocational training programs that focus on green skills, and at the same time are accessible and affordable.

Moreover, there is often a lack of infrastructure and investment to support large-scale educational and training initiatives. Addressing these gaps is crucial to ensure that the growing workforce can contribute meaningfully to the energy transition and support sustainable economic development.

Regional perspectives

Regional population trends

Sub-Saharan Africa has some of the highest population growth rates in the world, especially due to very high fertility rates (Figure 1; Figure 2). Countries in South Asia, including India, Pakistan, and Bangladesh, continue to undergo significant population growth. Similarly, nations in Southeast Asia, such as Indonesia, the Philippines, and Vietnam, exhibit relatively high population growth rates. In the Middle East and North Africa, countries like Egypt, Iraq, and Saudi Arabia are also experiencing notable population growth (Figure 1).

China and Japan are notable for their low population growth rates, with Japan experiencing population decline due to very low fertility rates and an ageing population. China is also facing similar issues with a rapidly ageing population and low fertility rates despite recent policy changes (Figure 1; Figure 2). Many European countries, especially in Eastern and Southern Europe, are seeing either stagnant or declining populations due to low fertility rates and ageing populations (Figure 1; Figure 2; Figure 3).

[39] Rodríguez-Pose et al., The geography of EU discontent and the regional development trap.
[40] United Nations, Changing population age structures and sustainable development.
[41] Zhou et al., The Demographic Dividend or the Education Dividend? Evidence from China's Economic Growth.
[42] ILO, Global Employment Trends for Youth 2022.

The United States and Canada have relatively low population growth rates. The U.S. growth rate has slowed in recent years, and Canada relies heavily on immigration to sustain its population growth. Australia and New Zealand have moderate population growth rates, primarily driven by immigration, as fertility rates are relatively low (Figure 1; Figure 2).

These population trends are very interlinked with the median age. Generally, regions in the Global North with advanced industrial economies tend to have higher median ages due to lower fertility rates and longer life expectancy. This is particularly evident in countries across Europe, North America, and parts of East Asia, where median ages often exceed 40 years (Figure 2; Figure 3). In contrast, the Global South regions with younger populations and higher fertility rates typically have lower median ages. Sub-Saharan Africa, South Asia, and parts of Southeast Asia often exhibit lower median ages, typically below 30 years, reflecting higher birth rates and shorter life expectancies (Figure 2; Figure 3).

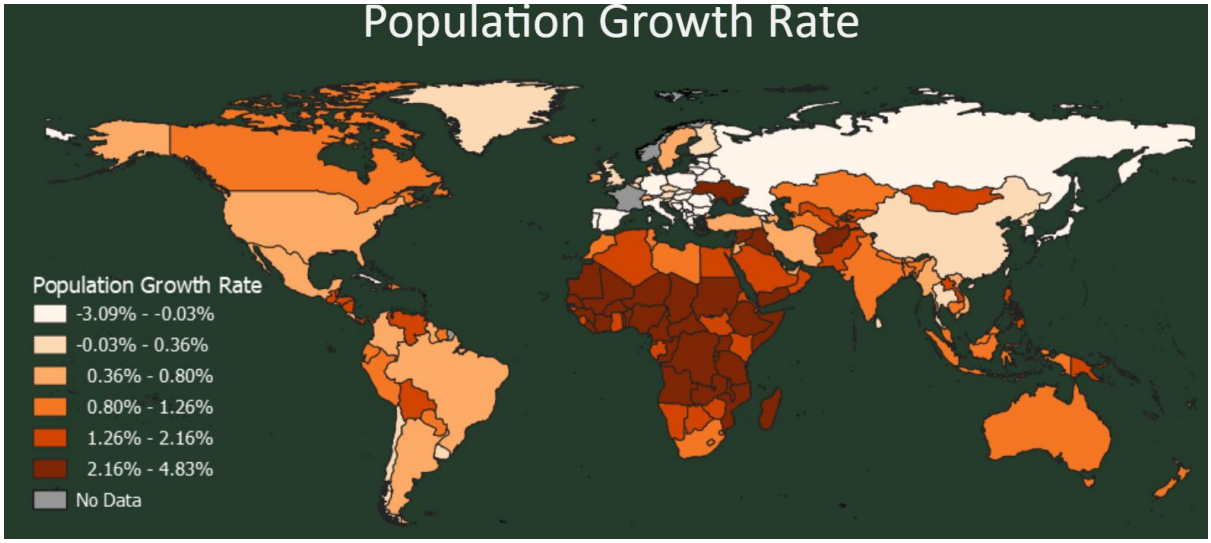


Figure 1. Population growth rate by country.[43]

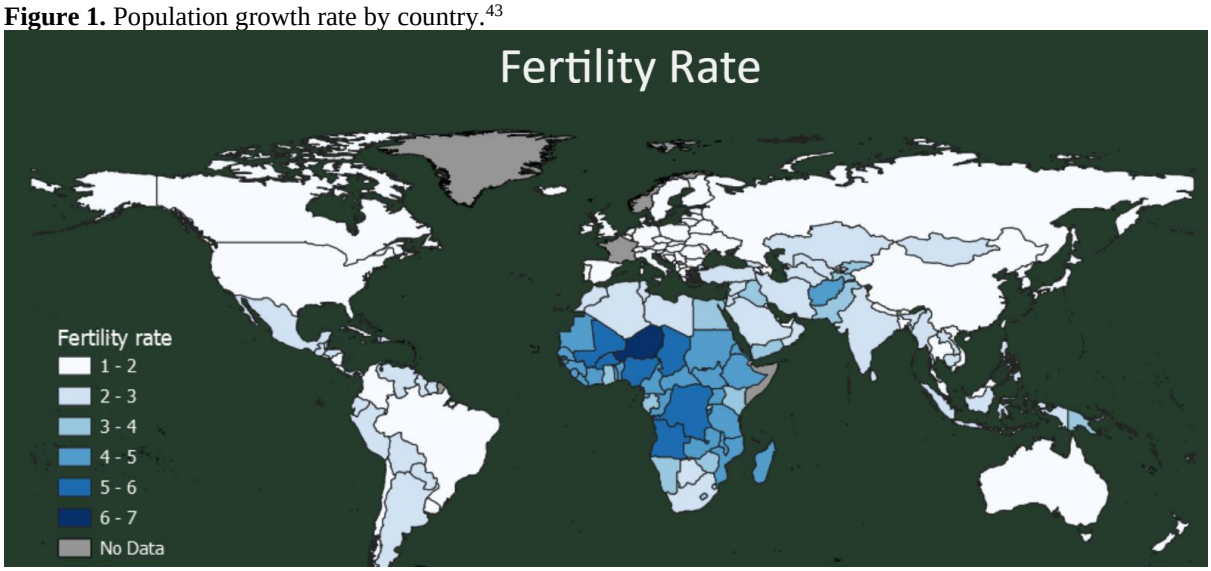


Figure 2. Fertility rate by country. The fertility rate is the average number of children that women of childbearing age give birth to.[44]

[43] Data Source: UN, World Population by Country 2024.
[44] Data Source: World Bank, Total fertility rate 2024.

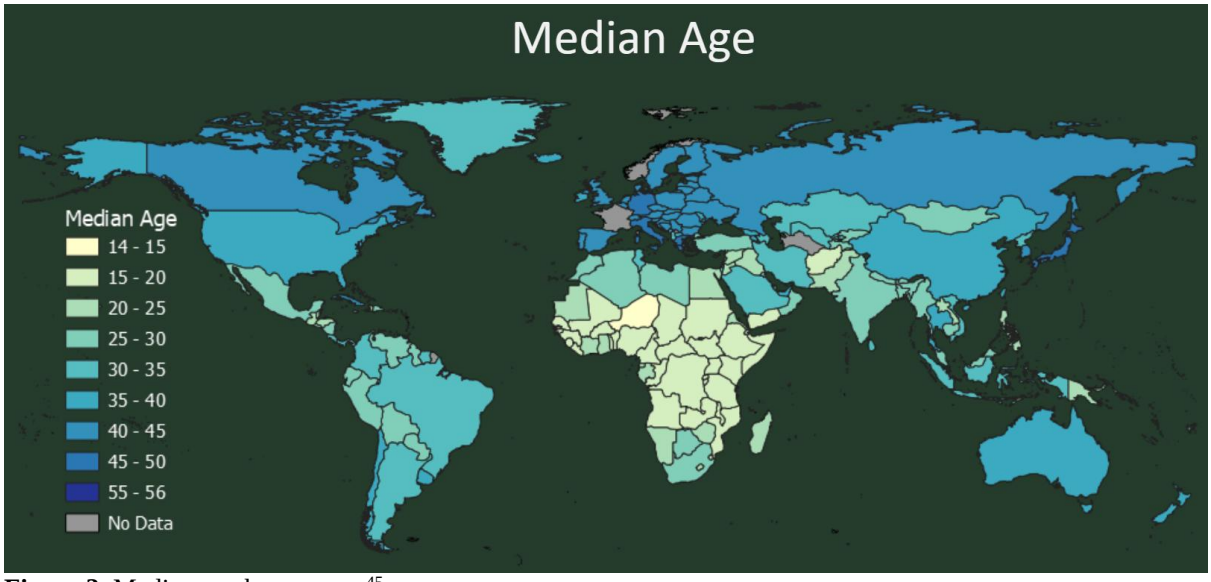


Figure 3. Median age by country.[45]

Labour shortages in EU caused by demographic challenges

In 2020[46], 199 (out of 1,166) Europe's regions were experiencing population decline. Europeans will only account for less than 4[47] percent of the world's population by 2070, and Europe's share of global GDP continues to decline. [48]

The projected decline in the working age population from 265 million in 2022 to 258 million by 2030 is expected to exacerbate labour shortages. Furthermore, employment rates reached a record high of 74.6%, with 213.7 million people employed in 2022, while unemployment rates fell to a historic low of 6.2%. Despite high employment rates, the lower labour market participation of certain groups—including women, lower-educated individuals, people with a migrant background, as well as older and younger people—contributes to current labour shortages.[49] Increasing the participation of these groups presents a significant opportunity to mitigate these shortages.

Some sectors in the EU relevant to the energy transition, such as water supply and waste management, have been particularly affected by population ageing. These sectors have a high proportion of older workers, which exacerbates labour shortages as the replacement rate for younger workers is low. Vacancy rates have doubled in key sectors between 2015 and 2021, indicating growing labour shortages. The construction sector, in particular, has seen a significant increase in vacancies, reflecting the rising demand for skilled labour. [50]

[45] Data Source: CIA, Median age by country.
[46] United Nations, World Population Prospects.
[47] European Commission, Eurostat, Demography of Europe.
[48] European Commission, Eurostat, Demography of Europe.
[49] European Commission, Employment and social developments in Europe 2023.
[50] European Commission, Employment and social developments in Europe 2023.

Challenges and Opportunities of India's Demographic Dividend

India stands on the brink of reaping the demographic dividend due to a growing working-age population, a result of declining fertility rates from over 4 in the 1990s to 2.3 by 2015. This shift has led to smaller family sizes and increased disposable incomes, boosting economic growth. The decreasing share of economically dependent children and a relatively small elderly population have allowed more resources for socio-economic development[51].

India's growing working-age population poses both challenges and opportunities. By 2041, the working-age population will make up about 63% of the total population. To harness this demographic dividend, sufficient job creation and enhanced education and training are essential. The current small formal employment sector and limited manufacturing base hinder this transition. Moreover, female employment remains low, and the informal sector dominates, influencing the demand for education and training.[52]

The expansion of education in the past two decades, driven by policies like Sarva Shiksha Abhiyan (SSA) and the Right to Education Act, has improved access to elementary education. However, challenges persist in terms of quality and dropout rates, particularly in northern states. Secondary education faces hurdles with low completion rates from elementary levels and socio-economic disparities affecting access. India’s demographic transition presents a window of opportunity to boost economic growth through a well-educated and skilled workforce. Addressing regional disparities, enhancing education quality, and creating adequate job opportunities will maximise the benefits of this demographic shift.[53]

Changing demographics in the US

By 2030, one in every five Americans will be of retirement age, and older adults will outnumber children by 2034 for the first time in U.S. history. Additionally, immigration is projected to surpass natural increase as the primary driver of population growth, as the ageing population leads to a slowing natural growth. Beyond 2030, the population will continue to grow slowly, age significantly, and become more racially and ethnically diverse. Despite slowing growth, the U.S. population is projected to reach over 400 million by 2058, distinguishing it from other developed countries.[54]

Many companies in the U.S. report unprecedented challenges in filling job vacancies, with 9.5 million openings but only 6.5 million unemployed individuals. During the peak of the pandemic, millions of workers were jobless. However, job openings have surged since then. Despite this, many positions remain vacant due to a shortage of skilled workers. Although more Americans are joining the workforce post-pandemic, the overall labour force participation rate has declined. If participation rates matched those of February 2020, there would be an additional two million workers. This decline in labour force

[51] IIEP, India. Challenges for education from the two-tier demographic transition and education policy responses.
[52] IIEP, India. Challenges for education from the two-tier demographic transition and education policy responses.
[53] IIEP, India. Challenges for education from the two-tier demographic transition and education policy responses.
[54] Vespa, Jonathan, Lauren Medina, and David M. Armstrong, Demographic Turning Points for the United States: Population Projections for 2020 to 2060.

participation is not new, persisting for decades and contributing to a shrinking workforce. Currently, the participation rate stands at 62.5%, down from 63.3% pre-pandemic and 67.2% in 2001[55]

Several factors have led to this ongoing shortage. A U.S. Chamber survey conducted in 2022 revealed insights into why unemployed individuals are not returning to work: 66% of those who lost full-time jobs during the pandemic are minimally active in job hunting, 49% are unwilling to accept positions without remote work options, and 26% believe returning to work is unnecessary. Changes in livelihoods include retirement (17%), transitioning to homemaking (19%), and part-time work (14%). Additionally, 24% attribute reduced job search activity to government aid during the pandemic. Younger respondents (25-34) prioritise personal growth, with 36% focusing on acquiring skills before re-entering the job market.[56]

Early retirements have increased, with over 3 million adults retiring prematurely due to the pandemic. The share of retirees aged 55 and older rose from 48.1% in 2019 to 50.3% in 2021. Additionally, the ageing U.S. population is a result of lower birth rates and reduced international migration. Net international migration to the U.S. has significantly declined, contributing only 247,000 individuals to the population between 2020 and 2021, compared to over a million in previous years. This decline in immigration impacts population growth and exacerbates the labour shortage.[57]

Interview perspective - Confederate Secretary Ester Lynch and Advisor Ben Lennon from the European Trade Union Confederation

We asked the European Trade Union Confederation whether the rising median age in the EU creates challenges related to ensuring a skilled workforce for the energy transition. They provided the following written statement:

The median age of the workforce in Europe is rising, posing some challenges to the prospects of the energy transition. However, these challenges can be overcome with proper planning, resourcing, and support.

The transition will cause some industries to decline while others grow. With the full implementation of just transition policies, in line with the ILO guidelines, we can rise to this challenge at the EU, national, and regional levels.

The fundamental requirements of this process are:

- rigorous socio-economic impact assessments and detailed just transition strategies
- the right to employee training, reskilling, and upskilling
- adult learning strategies and the financing of adult learning
- validation of skills workers have gained through everyday work
- effective social dialogue and collective bargaining
- well-funded and planned job-to-job transition support

[55] U.S. Chamber of Commerce, Understanding America's Labour Shortage.
[56] U.S. Chamber of Commerce, Understanding America's Labour Shortage.
[57] U.S. Chamber of Commerce, Understanding America's Labour Shortage.

The migration of workers to Europe will also play a role in the transition. The ETUC has called for the improvement of labour migration pathways for all migrant workers across sectors and skill levels and for an integration and inclusion policy based on equal treatment of all migrants in the labour market.

This will require greater monitoring of labour exploitation and human trafficking and an improvement of overall protection for all migrant workers. Trade unions must be supported to continue their activities to organise migrants and refugees and to collectively bargain to ensure all workers, no matter their immigration status or nationality, are treated equally and have their rights respected.

Bottleneck 2: INCREASED GENDER DISPARITY IN THE LABOUR MARKET

Short description:

Without addressing gender disparity, the energy transition risks perpetuating existing social and economic inequalities, thereby impeding its progress. Women's contributions and leadership in climate solutions are crucial for ensuring effective and inclusive climate action. Furthermore, females make up half of the workforce and are therefore unavoidable when addressing skills and labour shortages.

General introduction to the issue

- The entire population needs to be involved in ensuring effective climate action - including women!
- Women leadership has been linked to better climate outcomes, including less investments in high polluting industries and lower carbon emissions in companies.
- Women and girls bear a disproportionate burden from the climate crisis. Creating resiliant education systems and supporting women´s right to education are important interventions.
- Women are significantly underrepresented in green jobs. This disparity is reflected in the lack of female graduates within critical fields such as engineering, computing and electricians.

Regional perspectives

Global North

ETUC (Europe): The green transition is an opportunity to address the gender inequalities we see in the current labour market. Undervalued and underpaid work in sectors dominated by women must be avoided at all cost.

Global South

SEWA (India): Women workers in the informal sector are facing significant practical challenges and descrimination on the job market

Interview perspective

Introduction

The involvement of women is essential for effective climate action as it ensures the participation of the entire population, leads to improved climate solutions, enhances community resilience, addresses the unequal impacts of climate change, and is increasingly recognized in national and international climate planning.

A growing body of evidence indicates[58] that women's leadership results in better climate outcomes. For instance, when women constitute a significant proportion of boards of directors, banks are less inclined to lend to high-polluting industries. Moreover, increased representation of women in senior management is associated with lower carbon emissions in companies. Beyond these studies, it is evident that the energy transition necessitates large-scale transformation, which is unlikely to be achieved if half the population is not actively considered.

Furthermore, the UN emphasises that while climate change affects everyone, its impacts are not equally distributed.[59] Vulnerability to climate change is exacerbated by inequity and marginalisation related to gender, ethnicity, low income, and other social and economic factors. Addressing these disparities is crucial for the efficacy of climate solutions. Policies and initiatives that incorporate considerations of equity and inclusion tend to produce more robust and resilient outcomes. Therefore, the active participation of women is indispensable for advancing climate action and ensuring a just transition.

The position and vulnerability of women in the energy transition has two dimensions. Firstly, women are significantly more socially vulnerable. Moreover, existing inequalities in the labour market, particularly in sectors like the energy economy where substantial investments and job creation are expected, worsen this vulnerability. Women are underrepresented in these sectors compared to men, posing a real risk of widening the gender gap. Without systemic changes to advance women's participation, this gap could deepen further.

Inequalities in economies

As investments in the green energy system are expected to significantly increase in the coming years, there is a significant risk of deepening existing gender gaps in the energy labour market if this discrepancy remains unaddressed. If the energy industry does not prioritise gender diversity now, the renewable energy transition could perpetuate and deepen, rather than reduce, gender inequality.

Several studies[60] show that women are significantly underrepresented in green jobs, comprising 28% of the green workforce, and approximately 15% of the energy sector workforce. Furthermore, the IEA assesses that within the energy economy, gender diversity is most advanced in sectors like consumer services and consumer goods, and least advanced in sectors like power, utilities, and infrastructure. This disparity reflects women's lower presence in critical fields such as engineering (25% of graduates), computing (20% of graduates), and electricians (1-2% in Denmark, the US, and the UK).[61] [62] According to The world Economic Forum women accounted for 41.9% of the total workforce in 2023.[63]

[58] Deininger, F. & Gren, A., Green jobs for women can combat the climate crisis and boost equality.
[59] UN Women, Climate change and the environment.
[60] IEA, Gender and Energy Data Explorer.
[61] OECD, Job Creation and Local Economic Development 2023: Bridging the Great Green Divide.
[62] IEA, World Energy Employment 2023.
[63] World Economic Forum, Global Gender Gap Report 2023.

Transitioning to renewable energy holds promise for increasing job opportunities for women. The International Renewable Energy Agency (IRENA) reports that women constitute a larger share of the renewable energy workforce (32%) compared to the oil and gas industry (22%)[64]. In industrialised countries, female employment in the renewable energy sector is estimated to be 20–25%, predominantly in administrative and public relations roles.

With the expected substantial growth in the energy system and investments in renewable energy in the coming years, job opportunities are set to increase significantly. However, these opportunities are anticipated to primarily benefit male-dominated jobs and sectors, posing a risk of deepening inequality in the energy labour market if we fail to address these disparities. Additionally, women often encounter lower wages and poorer working conditions in these sectors[65]. Without prioritising gender diversity, the renewable energy transition could perpetuate and worsen gender inequality. Despite evidence that diversity enhances innovation and creativity, there is insufficient focus on promoting diversity within the energy workforce.

Policy interventions are crucial to enhance female involvement in green jobs. Addressing gender biases and investing in skills development can help mitigate disparities in the labour market.[66] In emerging and developing economies, targeted skill development programs for women can help expand the labour pool and support local businesses.[67]

Social vulnerability

Women and girls bear a disproportionate burden from the climate crisis. They are 14 times more likely to die in climate disasters than men[68]. When crises hit, they're often the last to eat and the first to be married off at a young age, potentially facing violence and abuse in the aftermath. Moreover, girls and women are frequently excluded from decision-making processes regarding climate solutions, exacerbating their vulnerability.

UNICEF[69] reports that 640 million girls and women are currently married before the age of 18, with 5% married before turning 15. Despite a decade-long global decline in child marriages, recent trends show a reversal, attributed to ongoing crises and intensified climate events weakening girls' rights.

Experts state that there is a clear correlation between the consequences of climate-driven disasters and the impact on child marriages. Families, facing limited resources post-disaster, often see child marriage as a survival strategy. For instance, devastating floods in Pakistan left families with few options, leading to increased child marriages.

Despite intending to protect girls, child marriages hinder their development and rights, often resulting in early pregnancies and dropping out of school. Longer-term solutions must stabilise economies post-disaster and invest in girls' education, vital for breaking the cycle of vulnerability.

[64] IRENA, Renewable Energy: A Gender Perspective.
[65] GWNET, The role of gender in the energy sector.
[66] IEA, World Energy Employment 2023.
[67] PAGE, Assessment of India’s Green Jobs and Just Transition Policy Readine.
[68] CARE, Kvinder rammes hårdest af klimakatastrofer.
[69] Girls Not Brides, Thematic brief: Child marriage in an humanitarian context.

Furthermore, girls and women often face societal norms and systems that exclude them from having influence and decision-making power. At local, national, and international levels, they are often excluded from participating in making important climate decisions and developing solutions.

A core strategy to prevent child marriages is to stabilise families' economies and ensure that climate disasters affect as few families as possible. The longer children stay in school, the lower the risk of child marriages. Therefore, supporting resilient education systems, addressing inequality, and supporting girls' access to education are important interventions.

Regional perspectives

Women occupy only 20% of oil and gas extraction jobs and 9% of coal mining jobs in the U.S. (2013). In Canada, employment by women corresponds to 27% in oil and gas and extraction and 12 % in coal mining. The energy industry in the U.S. had the lowest representation of women on boards of directors compared to other industries in 2012, with 61% of energy companies having no female representation on their boards. Renewable energy sectors have slightly higher female employment rates. In the United States, women's employment in solar jobs increased from 18.7% to 21.6% between 2013 and 2014. In a 2011 survey of 22 wind industry companies in the U.S., women comprised 25% of the workforce and 11% of senior management. Similarly, in the European Union, women constitute 22% of the wind-industry workforce[70].

In 2020, India's labour force participation rate was 51.1%, with a significant gender gap: male participation was 75.8%, while female participation was 26.2%. The inactivity rate was 48.9%, suggesting the potential for absorbing inactive population into green sectors.[71]

Interview perspective - National Secretary of Self Employed Women Association Manali Shah

SEWA is working with women in the informal sector, where discrimination against women is widespread. According to Manila Shah, employers in the construction sector in India often view women as liabilities in the workplace, as female employees might become pregnant and therefore require childcare facilities at the work site. This perception leads employers to resist hiring women, even when they have the required skills and experience. Shah provides an example:

"An employer we worked with had employed 200 women to help build a stadium. Afterward, another stadium construction project began, but the employer did not wish to hire any women workers, as they considered them a liability. This hesitation is so strong that they would refuse to hire the women even though they had the required skills and had been employed before on a similar building project".

Women who do secure employment face additional challenges in the workplace. The impact of climate change is severe, especially in the informal sector at construction sites, where workers are often working outdoors all day. Women are particularly vulnerable, as they are more susceptible to dehydration, and there are often no sanitary facilities available for them.

[70] Pearl-Martinez et al., Toward a gender diverse workforce in the renewable energy transition.
[71] PAGE, Assessment of India's Green Jobs and Just Transition Policy Readiness.

Another issue where women experience more severe consequences than men is the financial impact of missing payment while undergoing training. Both men and women face this issue, but the consequences are more severe for women workers due to their role in the family. Women typically carry most domestic chores, including childcare and cooking, and they use their income to support their family both in the present and future. According to Shah, women often prioritise their family's well-being and invest any additional income in their children's education. This differs from many male workers, who typically do not feel the same level of responsibility for their family. In some cases, the male workers spend their income on items like alcohol, leaving women with the responsibility of providing for the family.

Interview perspective - Confederate Secretary Ester Lynch and Advisor Ben Lennon from the European Trade Union Confederation

The ETUC is focusing on the energy transition as an opportunity to improve conditions for women in the labour market. Esther Lynch and Ben Lennon share their perspectives:

"*The just transition is an opportunity to address the gender inequities that have existed in employment for generations. The transition should be used as an avenue to break up horizontal segregation in the labour market, for which the energy sector is only one example."*

To build a more equitable system in the future, it is important to identify and address the shortcomings of the current economy.

"When we talk of a just transition, it is not just about direct job-to-job transition from one declining polluting industry to more sustainable industries but also looking at who was excluded from quality jobs in the first place. These were often women" Lynch and Lennon explain. They emphasise that quality training and employment are key to achieving a more equitable job market.

Currently, significant gender gaps exist in re- and upskilling and continuous education, which must be addressed in the future. Lynch and Lennon argue that inclusive training opportunities, which consider the practical barriers to reskilling, are essential. Better planning, such as classes and courses that accommodate single mothers and apprenticeship payment rates that support families, would be a good starting point for addressing these issues.

Lynch and Lennon stress that another dimension to keep in mind is occupational safety and health for women. *"Gender-responsive risk assessments are an important factor in ensuring women workers' safety at work. A just transition should cater for this, too".*

Lynch and Lennon conclude that it is essential to avoid repeating the mistakes of the past:

"*What must be avoided at all costs is the creation of undervalued and underpaid work in the sectors with jobs filled by women workers".*

Bottleneck 3: PEOPLE IN TRANSITION FROM DECLINING INDUSTRIES AND MIGRATION

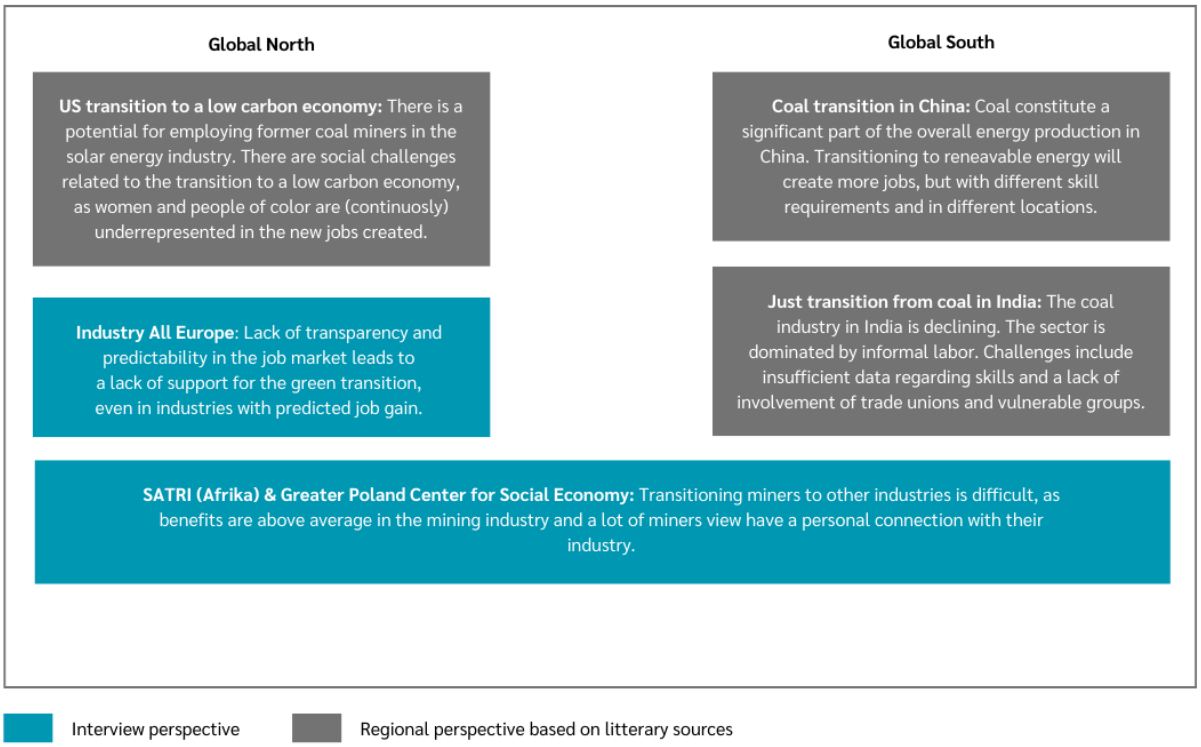
Short description:

Support for the energy transition is closely tied to ensuring economic security for workers from declining industries and developing skills for migrants, as socio-economic instability can undermine public support for climate initiatives.

General introduction to the issue

- Support for the green transition decreases if individuals feel that their position, job or livelihood is threatened by it.
- Migration processes further weakens individuals and creates instability, which puts the support for the green transition at risk.
- Workers with lower education levels and medium skilled occupations face heightened displacement risk in the green transition.
- Coal mining is an industry facing extensive transitioning risks. However, many fossil fuel workers have transferable skills that can be used in clean-energy roles with a minimum of additional training
- Refugees experience severe restrictions in employment opportunities. Jobs within green sectors could become available for refugees if their prior learnings and credentials are recognised.

Regional perspectives



Introduction

Studies indicate that support for the energy transition decreases if individuals feel that their position, job, or livelihood is threatened by it. This trend is evident even among those who generally favour the energy transition.[72]

The UNDP[73] supports this finding, emphasising that if governments can demonstrate the socio-economic benefits of a energy transition – such as economic growth and new green jobs – they can build a broad base of public support for higher climate ambition. When individuals recognise the tangible benefits, they are more likely to endorse associated policies and investments.

This shows the correlation between support for the energy transition and the security of having an economic livelihood within it. This is particularly evident in sectors that will be phased out during the energy transition. For instance, in the mining sector, it is crucial to ensure that the necessary transition occurs, and resistance is minimised by demonstrating that alternative employment is available as mines close.

Furthermore, individuals become particularly vulnerable during migration processes, especially when it involves forced displacement due to instability, disasters, and other crises. According to the UNHCR approximately 110 million people worldwide are displaced, with 6.6 million residing in refugee camps.[74][75] Reports suggest that the number of refugees will increase in the coming years, potentially fostering geopolitical instability. This instability is expected to weaken support for the energy transition unless it is effectively mitigated. Therefore, it is essential to focus on developing the skills of people in migration so they can actively contribute to local transitions or have competencies they can leverage when they eventually settle into more permanent circumstances.

To maximise the benefits of transitioning, states must anticipate and manage the costs of unemployment, retraining, and relocation resulting from the decline in the fossil fuel workforce, preventing a sustained decline in living standards.[76] Governments need to assess declining sector workforces to determine the most appropriate reskilling strategies. Some industries are working with unions offering early retirement packages to workers not suitable for reskilling. Effective training programs should align with industry needs and ensure accessibility and affordability. Social dialogue involving workers, employers, civil society, and government is essential in decision-making processes.[77]

[72] FH, En retfærdig grøn omstilling.
[73] UNDP, What is just transition? And why is it important?
[74] UNHCR, Mid-Year Trends 2023.
[75] UNHCR, Refugee Camps Explained.
[76] Xie et al., Distributional labour challenges and opportunities for decarbonizing the US power system.
[77] IEA, World Energy Employment 2023.

Inequality and Social Risk in the Energy transition

Workers in green jobs typically have higher education levels and higher wages, with 50% having completed higher education compared to one-third in non-green jobs. Workers in green jobs enjoy a wage premium of 20% compared to their counterparts in non-green jobs. This disparity may exacerbate existing workforce inequalities. Workers with lower education levels and medium-skilled occupations face heightened displacement risks in the energy transition.[78] Lower-skilled workers are far more likely to feel the threat of job transition than higher-skilled workers. Many believe the advances in green technology, AI, and the evolution of remote work mean diminished rather than enhanced opportunities for low-skilled workers.[79]

Lack of diversity in the climate workforce poses a serious challenge, limiting the talent pool, exacerbating talent shortages, and perpetuating economic inequality.[80] National governments should address gender, social, and geographic disparities in green jobs and support and empower vulnerable regions and workers to acquire necessary skills, with targeted aid for at-risk workers, services facilitating their transition to new local employment opportunities, and measures assisting firms in creating new green jobs.[81]

Coal Transition

The transition away from coal is expected to have a severe social backlash.[82] Coal miners in emerging economies are already facing acute transition risks, with 225,000 jobs lost (2019-2022) and an expected loss of 1.4 million jobs by 2030.[83] The majority of coal mines expected to close in the coming decades have no planning for extending their operations or facilitating a transition to a post-coal economy. Nearly half a million workers are currently employed in mines that may cease operations before 2035. By 2050, almost 1 million coal mine jobs will be lost due to anticipated closures, representing a significant workforce reduction of over one-third without climate-related pledges or policies.[84]

China and India are expected to be affected most: China's Shanxi province could see the largest global decline, with nearly a quarter of a million jobs lost by 2050. India's coal workforce officially accounts for around 337,400 miners at its active mines, but studies indicate that for every direct employee, there may be up to four "informal" workers in the local mining sector. Coal India faces the prospect of the largest job cuts, totaling 73,800 by mid-century.[85]

Targeted reskilling policies for coal mining can ease this transition, with successful examples from coal-producing regions providing valuable insights. Critical mineral mining offers job growth opportunities, with 40% of current coal miners near such deposits. However, challenges are significant, as coal mines in these economies are less mechanised and rely heavily on unskilled labour.[86]

[78] OECD, Job Creation and Local Economic Development 2023: Bridging the Great Green Divide.
[79] Prising, The green transition requires an upskilled workforce.
[80] Stehr et al., Advanced STEM Talent Challenges in Climate: Insights from Industry Leaders.
[81] OECD, Job Creation and Local Economic Development 2023: Bridging the Great Green Divide.
[82] Global Energy Monitor, Global coal miners and the urgency of a just transition.
[83] IEA, World Energy Employment 2023.
[84] Global Energy Monitor, Global coal miners and the urgency of a just transition.
[85] Global Energy Monitor, Global coal miners and the urgency of a just transition.
[86] IEA, World Energy Employment 2023.

In general, fossil fuel workers possess transferable skills for clean energy roles, with half of those facing redundancy having in-demand skills. With four weeks of additional training, many could transition. By 2030, 1.2 million could shift to heat pump installation and 4 million to EV manufacturing. Some may need extra training, especially for roles in offshore wind, hydrogen, and CCUS sectors, which could largely occur on the job.[87]

Skilling and Acknowledging Prior Learning of Refugees

Migration has increased due to climate change and geopolitical instability. Currently, UNHCR reports 110 million displaced people worldwide, and every year, weather-related sudden-onset hazards result in the forced displacement of 21.5 million people. [88] [89] As climate change accelerates, extreme weather events such as hurricanes, droughts, and sea-level rise displace communities, rendering their homes uninhabitable. Changes in temperature and precipitation patterns due to climate change, coupled with disruptions in water availability, can affect crop yields and agricultural productivity, undermining food security and livelihoods for millions of people, especially those in rural areas dependent on agriculture. This can create competition over resources, increase civil unrest, and force mass migration.

In parallel, geopolitical conflicts, caused by factors like resource scarcity, political unrest, and territorial disputes, force millions to flee their countries in search of safety and stability. The increased migration puts pressure on migration systems worldwide while exacerbating vulnerabilities for displaced populations. The International Think Tank Institute for Economics & Peace (IEP) projects that more than 1 billion people could be displaced by 2050 due to environmental change, conflict, and civil unrest. [90]

The majority of refugees live in urban areas, while many also live in refugee camps. Around 6.6 million people live in refugee camps worldwide, with Kenya, Jordan, Bangladesh, and Sudan hosting some of the largest camps.[91] These camps play a vital role in providing temporary and sometimes long-term support to displaced individuals, but refugees in camps face hunger, language barriers, unemployment, and limited medical access. For instance, Kutupalong, one of the largest camps in Bangladesh, comprises densely packed bamboo and tarpaulin shelters, increasing the risk of rapid fire spread and facing threats from cyclones and monsoon seasons, which annually endanger nearly 10% of the camp's tents. In Kakuma, housing 288.000 refugees in 2024[92], inhabitants endure challenges from dust storms, high temperatures, and malaria outbreaks. Due to Kenyan law, refugees are confined to the camp, often from childhood into adulthood. Due to their legal situation and local environmental conditions, refugees in Kakuma are unable to support themselves, where agriculture is not possible due to the climate, and employment limitations prevent refugees from finding work. Refugee Camp in Jordan accommodates 80,000 people, with over 80% of Syrian refugees in Jordan facing hunger or near hunger.[93]

[87] IEA, World Energy Employment 2023
[88] UNHCR, Mid-Year Trends 2023.
[89] UNHCR, Frequently asked questions on climate change and disaster displacement.
[90] Institute for Economic and Peace, Ecological Threat Register.
[91] UNHCR, 2021, Refugee Camps Explained.
[92] The UN Refugee Agency, Kenya – Registered refugees and asylum-seekers.
[93] UNHCR, 2021, Refugee Camps Explained.

UNHCR reports[94] that only 7% of refugees have access to tertiary education, whereas 68% have access to primary and 37% to secondary education. Refugee camps provide opportunities to host education and skill development programs, with numerous learning centres already established for children's education. The green sectors can create job opportunities that may be accessible to refugees. This could potentially address existing shortage of skilled workers in the energy transition and provide refugees with income and livelihood options. Integrating refugees into climate resilience and adaptation efforts can leverage their knowledge and experiences, contributing to more effective strategies for building resilience in vulnerable communities.

Initiatives can be launched to equip refugees and migrants with the skills necessary to participate in the energy transition. Many refugees have skills but lack opportunities. The organisation Talent Beyond Boundaries underscores[95] this challenge, noting that numerous refugees are in countries where they do not have the right to work locally and are locked out of the skilled migration system. Efforts can be made to combat barriers to the international employment of refugees and create pathways to ensure that displaced people have equitable access to skilled migration.

The lack of recognition of prior learning and credentials is a significant barrier for refugees to access education and employment. Implementing Recognition of Prior Learning (RPL) mechanisms can address this issue. RPL is a process that assesses and validates an individual's skills, knowledge, and competencies acquired through formal, non-formal, or informal learning experiences. RPL allows individuals to receive credit or recognition for their existing skills and knowledge, which may have been gained through work experience, volunteer activities, self-study, or other means. However effective RPL systems remain to be developed.

Regional Perspectives

Coal Transition in China

China's coal power sector contributes approximately to 40% of the nation's total CO^2 emissions. Achieving carbon neutrality by 2060 requires comprehensive decarbonisation, notably by phasing out existing coal plants by the mid-century mark. While transitioning away from coal is projected to create more jobs in renewables than those lost in coal, the shift may lead to spatial disparities in employment opportunities. The nature and skill sets required for jobs in solar and wind energy differ significantly from those in coal plants, limiting the transferability of employment between sectors and potentially causing structural job misalignment[96].

Despite pledges for carbon neutrality, China has initiated the construction of over 40.8 GW of new coal-fired power capacity in the first half of 2020 alone (more than installations for all of 2019), with 88 GW of coal-fired power capacity currently under construction and 159 GW approved and waiting to be realised. The expansion is driven by economic stimulus measures in response to the COVID-19

[94] UNHCHR, Briefing Notes: UNHCR reports progress in refugee education; tertiary enrolment rate hits 7 per cent.
[95] Talent Beyond Borders, Opening Skilled Migration Pathways for Refugees and Displaced Individuals.
[96] Zhang et al., Immediate Actions on Coal Phaseout Enable a Just Low-Carbon Transition in China's Power Sector.

pandemic. This expansion risks locking China into a high-carbon trajectory, complicating future emissions reduction efforts. Without careful management, abrupt coal plant closures to reach climate goals could result in mass layoffs and worsen the job imbalance, particularly in regions heavily reliant on coal and with limited renewables (Anhui, Henan, Hebei, Shandong, etc.). [97]

Prior job impact assessments of China's low-carbon transition have predominantly operated at the national level, neglecting the uneven distribution of job losses from coal plants and opportunities in renewables. This oversight results in a spatial mismatch of employment changes. While some studies have highlighted the consequences of delayed mitigation actions, such as increased costs and stranded assets, none have quantified the exacerbation of labour inequality resulting from these delays. Most modelling studies on China's electric power sector transition have focused on specific targets like NDCs or the 2°C goal, neglecting the cost-optimal evolution towards a zero-carbon electricity system.

Zhang et al. (2022) aimed to bridge these research gaps by employing a combination of power sector optimization modelling and detailed job assessment to analyse job losses and creations across various factors in China's power sector decarbonization from 2020 to 2050. Results show potential for 6.5 million additional job opportunities by 2050, but transition pathways vary significantly.

Gradual, managed transitions offer smoother evolution and reduce unemployment risks while continuing planned coal projects heightens unpredictability, potentially displacing over 90% of coal plant employment between 2030 and 2040. Although decarbonisation promises more jobs in renewables, there's a mismatch between job losses and creation, requiring attention for a fair transition. With the large coal fleet, phasing out coal not only affects workers but also local economies. While China has begun addressing worker displacement in heavy industries, a comprehensive policy framework for fossil fuel workers is lacking. To mitigate transition impacts, proactive planning, retraining programs, and supportive policies are crucial. As other carbon-intensive industries undergo similar transitions, sustained support and coordination are necessary to address potential labour supply shortages caused by expanding renewable capacity.

Just transition from coal in India

Government stakeholders in India acknowledge the urgent need for a just transition from coal while recognizing coal's continued importance for energy security over the next 20-30 years. The Planning Commission National Institution for Transforming India (NITI) Aayog emphasises the necessity of analysing the coal ecosystem, job dependencies, and economic diversification opportunities in coal-rich regions. India's coal sector is declining due to unproductive mines and the rise of renewable energy, potentially resulting in job losses. Skilling coal mining workers for renewable energy jobs is crucial, but uncertainties exist regarding their skills and aspirations. The coal industry in India directly employs 2.5 million, with 70% being informal workers, and indirectly supports 13 million jobs, with 700,000 jobs in coal mining regions at risk of being lost by 2030. [98]

Challenges in just transition planning include data inadequacies, underestimation of informal labour, lack of clear roadmaps for achieving net-zero targets, fiscal accountability, and insufficient involvement of trade unions and vulnerable groups. The monopoly of the state-owned Coal India in the coal sector

[97] Zhang et al., Immediate Actions on Coal Phaseout Enable a Just Low-Carbon Transition in China's Power Sector.
[98] PAGE, Assessment of India's Green Jobs and Just Transition Policy Readineness.

in India presents an additional challenge, due to the strong market position. India's Ministry of Coal has established a Just Transition Division and is collaborating with the World Bank on a mine closure framework. Trade unions and civil society organisations advocate for just transition planning, with initiatives such as The Energy Resources Institute's dialogue on transitioning away from coal and The India Just Transition Centre's efforts to enhance understanding from a Global South perspective. [99]

U.S. transition to a low carbon economy

The U.S. holds the most fossil fuel assets globally, imposing a high financial risk in relation to the transition to a low-carbon economy. Retraining coal workers for solar employment in coal mining regions is assessed as both feasible and financially manageable. Expanding wind energy in states that already have large wind energy capacities could generate local economic benefits, with potential spill-over effects to other states.[100]

States with higher dependency on fossil fuel, including the Appalachian regions, are expected to experience a smaller net increase in jobs. For example, Kentucky will experience job losses in the power sector as natural gas resources will be less utilised, but retirements are expected to outweigh the job losses.[101]

The construction and manufacturing jobs created during the low-carbon transition tend to be male-dominated, perpetuating existing gender imbalances in the energy workforce. Despite a global trend of renewable energy employing a higher share of women compared to fossil fuels, women are still underrepresented in administrative roles. People of colour are underrepresented in the clean-energy workforce, particularly in coal-fueled sectors. The construction industry shows disparities in racial representation, with Hispanic Americans overrepresented and African American and Asian Americans underrepresented [102].

The overrepresentation of certain racial groups, such as Hispanic Americans in construction, may introduce vulnerabilities due to job quality and stability concerns. African American students, especially women, are underrepresented in STEM fields, highlighting systemic challenges in workforce diversity. Intentional policy planning is necessary to address the challenges faced by underrepresented populations and ensure their inclusion in the low-carbon transition. Indigenous communities' lack of visibility in workforce demographic data underscores the importance of initiatives promoting Indigenous ownership of energy projects.[103]

Europe coal regions in transition

As the energy transition accelerates across the EU, and in the wake of the Russian aggression that led to the launch of the REPowerEU plan, it has become increasingly clear and accepted that the coal

[99] PAGE, Assessment of India's Green Jobs and Just Transition Policy Readiness.
[100] Xie et al., Distributional labour challenges and opportunities for decarbonizing the US power system.
[101] Xie et al., Distributional labour challenges and opportunities for decarbonizing the US power system.
[102] Xie et al., Distributional labour challenges and opportunities for decarbonizing the US power system.
[103] Xie et al., Distributional labour challenges and opportunities for decarbonizing the US power system.

sector is facing a comprehensive phase-out in the coming years and decades. This transition, which was already underway, has significantly accelerated in recent years. According to Eurostat, the supply of lignite fell by 24.2% from 2022 to 2023, down to 222.84 million tons, while the supply of hard coal decreased by 20.4% to 130.44 million tons[104].

Although the decline in coal consumption/extraction has resulted in the closure of mines and the decommissioning of power plants in several European regions, there were still about 208,000 people employed in the mining sector in 2021. The countries with the most jobs in the sector are Poland, Germany, Romania, the Czech Republic and Bulgaria[105].

To address the challenges of transitioning to a greener economy, the European Commission has established the Just Transition Fund and the Just Transition Mechanism. These initiatives are designed to support the transition from coal to alternative job opportunities and ensure that people employed in the coal sector receive the necessary retraining[106]. Support from the Just Transition Fund is provided to the regions that are facing the biggest challenges in undergoing the energy transition in terms of both social and economic effects[107]. The Just Transition Mechanism is intended to assist the just transition on both individual and regional level, as the intended beneficiaries are the people and citizens, the companies and sectors as well as the member states and regions. The initiative is ongoing, as the goal is to provide targeted help amounting to €55 billion from 2021 till 2027.

In particular, the decline in coal extraction in Poland, Germany, the Czech Republic, Romania, and Bulgaria will have a significant impact on employment. In Central and Eastern Europe, energy systems and the surrounding industries are still heavily dependent on fossil fuels. Here, the debate on the energy transition is often tense, as the future seems uncertain. Public perception in these regions has yet to see concrete improvements or strategies for the transition. The lack of visible progress is especially problematic in a time marked by an energy crisis, a cost-of-living crisis, and increasing efforts to reduce dependence on Russia.

There is a clear connection between support for the energy transition, the closure of mines, and uncertainty about future living conditions. Thus, an uncertain future creates a political climate that makes it more difficult to secure support for the energy transition. At the same time, the closure of plants requires that the people/coal miners who lose their jobs due to the energy transition have access to reskilling and retraining.

Interview Perspective - General Secretary Isabelle Barthes and Head of Just Transition Coordination Corinna Zierold from Industry All Europe

In Industry All Europe a just energy transition is at the top of the agenda. Through work with unions all over Europe, Corinna Zierold has experienced significant regional differences in the attitudes towards the energy transition. In Central Eastern Europe the energy system and surrounding industry are still heavily reliant on fossil fuel, and the debate surrounding the energy transition is strained, as the future seems uncertain. The public in these regions has not seen any improvements yet or any tangible

[104] Eurostat, Reneawables take the lead in power generation in 2023.
[105] European Commision, EU coal regions in transition
[106] European Commission, The Just Transition Mechnism: making sure no one is left behind.
[107] European Commission, Just Transition Platform

strategies for the transition. The lack of tangible progress is especially problematic in a time where energy crisis, cost of living crisis, and an increasing effort to cut off dependency on Russia.

The uncertain future fosters a political climate, which is making it harder for unions to get the support of their members for the energy transition.

"It is not that the unions cannot make a strategy (for the energy transition) but they are struggling with keeping their members on board. The far-right and populist parties are describing really easy concepts using very accessible language to the public, but they are not really presenting any solutions" Zierold explains.

Interview Perspective - Executive Research Director Martin Kaggwa from Sam Tambani Research Institute (SATRI) and chairman of the board Przemyslaw Piechocki from Greater Poland Center for Social Economy

Both interview participants from SATRI and the Greater Poland Center for Social Economy stressed the difficulty in ensuring a just transition for miners, as the benefits and salary in their current jobs are better than the industry average. Martin Kaggwa from SATRI explains the situation in South Africa:

"The mining sector has been highly unionised, so miners have over time secured a number of benefits within the sector. The wages in the mining sector are above normal compared to the economy average, so the mining workers are reluctant to move from e.g. mining to agriculture because in agriculture the minimum wages are too low."

Initially, the miner's trade unions had presented a solution where the hiring of miners would be slowed down to match the phasing out of the industry, allowing existing miners to exit the job market through retirement. However, it became apparent that the global transition to clean energy may not allow the long time span of natural attrition. Therefore the new suggestion was to train miners for alternative jobs, but the efforts have not yet been successful.

Prezemyslaw Piechocki from the Greater Poland Center for Social Economy paints a similar picture of the transition of miners in Poland. Here it is also the case that miners would almost certainly get a lower salary if they worked in other industries. An additional challenge is for the miners to find a job locally, as they do not want to move or travel for a new job. The strong unions for miners have also put pressure on the government and secured the miners working in publicly owned plants a job within the mining industry in the future. Piechocki explains that all miners who are working in publicly owned enterprises will have the right to work there until 2050. Some politicians do, however, admit that this agreement will be difficult to sustain, so it is plausible that a future government will not be able to secure the jobs in the mining industry that far into the future.

Piechocki is working on finding new solutions for the miners, which will not slow down the energy transition.

"We have to work together, not to stop the transition, but to find new job opportunities for people. We need to see this climate challenge as an opportunity."

Bottleneck 4: LACK OF SKILLS POSE AN IMPLEMENTATION GAP IN THE ENERGY TRANSITION

Short description:

The successful implementation of the energy transition relies on addressing workforce challenges, as the lack of skilled labour presents a significant barrier to realising the full potential of investments in renewable energy and other green technologies.

General introduction to the issue

- The gap between needs in the energy sector and people who are pursuing relevant degrees is widening.
- New clean industries requires advanced STEM workers but there are not enough workers with the needed profiles to fill the positions.
- R&D drive innovation and technology development in the green transition. R&D employment growth in Europe is expected.
- Skilled workers are an important key to succes for small and medium enterprises but it is difficult for SMEs to find the time for employee training.
- Green transition projects risk delays due to a lack of skilled labor. This can be a result of mismatch gaps, which happens when the skills of the individual worker does not correspond to the skills needed by the employers. Skill mismatch lead to less effective investments and have consequences for both companies and regions.

Regional perspectives

Global North

ETUC (Europe): Almost half of the adult population in Europe needs upskilling to ensure effective participation in the green transition. Continuosly evolving industries require training, reskilling and upskilling opportunities for workers.

Energinet (Denmark): A lack of highly skilled workers is proving a challenge for the establishment of a sustainable energy system. Skilled labor should be considered a part of the critical supply chain when establishing new, ambitious infrastructure.

EFBWW (Europe): Small and medium enterprises do not have the ressources to train their employees in new skills.

Global South

Danish Industry (Sub-Saharan): Lack of qualified workers is a challenge for international and local businesses in Kenya, Tanzania and Jordan.

Interview perspective

Introduction

Addressing the workforce challenges is essential for achieving the energy transition and meeting the demands of emerging clean industries. Investments in the energy transition are closely linked to the demand for labour. When we invest heavily in green technologies, we simultaneously need a skilled workforce to implement, manage, and maintain these initiatives. If we don't have the necessary workforce, we won't be able to fully realise the potential of these investments. This challenge is a global issue affecting the cost-effectiveness and success of green investments worldwide.

Current and future skill gap

The gap between the growing demand for energy sector jobs and the number of workers pursuing relevant degrees or certifications is widening. Degrees in STEM fields relevant to the energy sector are not increasing fast enough to meet demand. The gap is more severe for workers with vocational certificates, such as heat pump engineers, welders, electricians and electrical engineers .
Energy companies struggle to hire individuals with industry-specific knowledge, particularly in installation and repair work. Construction jobs, which are crucial for deploying clean energy technologies and retrofitting buildings, are experiencing massive shortages. [108]

Research from Economist Impact finds that more than 38% of business leader respondents in the energy sector prioritise smart grid implementation as a key aspect of their organisation's energy transition. Across sectors, key green skills include sustainability and disclosure reporting (39%), environmental impact assessment (35%), and sustainability compliance (32%). However, sourcing skills in compliance and reporting remain challenging. Soft skills are also vital, with the top ones sought including environmental awareness (45%), innovation and creativity (37%), and problem-solving (31%).[109]

Lack of employees with higher educational and academic background

There is a critical shortage of engineers necessary for the energy transition worldwide. The US needs approximately 400,000 new engineers annually, but lacks the necessary next-generation skill sets, potentially leaving one in three roles unfilled each year until at least 2030, risking economic and industrial progress. The Japanese Ministry of Economy forecasts a shortage of over 700,000 engineers in Japan by 2030, while the German Economic Institute reported a deficit of 320,000 STEM specialists in Germany as of April 2022.[110]

New clean industries require advanced STEM workers in various roles such as electrochemists and thermofluids engineers. In specific sectors like food systems, Precision Fermentation Engineers, Cell Membrane Engineers, Microbiologists, and Biochemists are essential for scaling alternatives to animal meat and curbing food waste. Similarly, energy efficiency technologies across various sectors rely on the expertise of Thermofluidics Engineers and Mechanical Engineers, pivotal for applications like heat recovery systems and energy-efficient structures. Energy generation and storage technologies necessitate the contributions of Thermofluidics Engineers, Mechanical Engineers, Electrochemists, and Materials Scientists. Electrochemistry is a fundamental skill, underpinning advancements in batteries, solar cells, and CO2 conversion, as highlighted by experts. Cleantech talent shortages reflect broader

[108] IEA, World Energy Employment 2023
[109] Economist Impact, Green Skills: driving the transition to a more sustainable future.
[110] Kodey et al., The US Needs More Engineers. What’s the Solution?

STEM issues, indicating an exacerbation of STEM shortages within the cleantech sector. These shortages are exacerbated by market pressures and competition from incumbent industry giants.[111]

Jobs in Engineering and R&D, essential for driving innovation and technical development in the energy transition, will increase in importance, even though these jobs may be relatively small in terms of employment. In the EU all Member States except Luxembourg will experience substantial employment growth in R&D due to Europe's crucial role in this sector.[112] Also digitalization is a major driver for skill and job changes in the energy transition (twin transition), with high growth expected in ICT-related occupations. Challenges in bridging this gap include insufficient reskilling and upskilling, limited diversity and inclusion, and inadequate coordination between industries and educational institutions. [113]

Lack of skill development in SMEs

Skilled workers are important for the success of small and medium enterprises (SMEs), but they can be hard to come by and retain. The importance of having skilled workers was clearly expressed in a recent survey conducted by the European Commission[114], where 95% of all SMEs stated that it is very (82%) or moderately (13%) important for their business model to have workers with the right skills.

One important parameter for ensuring that employees have the right skills is through employee training. According to the above-mentioned survey of SMEs in the European Union[115], one of the main challenges for completing employee training is to find the time for staff to participate in the training, with 24% of SMEs stating that finding time is "very difficult" and 26% stating that it is "moderately difficult". Another significant challenge for employee training is identifying appropriate training opportunities for the staff, with 9% finding it "very difficult" and 27% finding it "moderately difficult".

A survey conducted by the European Commission reported that 42% of SMEs with technicians in the EU report facing skills shortages for this role, making it the most commonly identified skill shortage in the EU.[116]

Lack of skills makes investments less efficient and transformation more difficult

Investments in the energy transition are closely linked to the demand for labour. When there is a heavy investment in renewable energy, energy efficiency, and other green technologies, there is a simultaneous need for a skilled workforce to implement, manage, and maintain these initiatives. Without the necessary workforce, the full potential of these investments cannot be realised, leading to several issues.

[111] Stehr et al., Advanced STEM Talent Challenges in Climate: Insights from Industry Leaders.
[112] Cedefop, Skills in transition: The way to 2035.
[113] Kodey et al., The US Needs More Engineers. What's the Solution?
[114] European Commission, SMEs and skills shortages.
[115] European Commission, SMEs and skills shortages.
[116] European Commission, SMEs and skills shortages.

Firstly, projects can face delays due to a lack of skilled labour. This means it will take longer to see the benefits and costs can increase due to prolonged timelines and potential penalties for delays[117]. Additionally, operational costs increase if less experienced workers who require additional training and supervision are hired, which reduces overall efficiency.

This is closely linked to the problematic regarding mismatch gaps. According to the ILO[118] skills mismatch is a discrepancy between the skills that are sought by employers and the skills that are possessed by individuals. This means that education and training are not providing the skills demanded in the labour market, or that the economy does not create jobs that correspond to the skills of individuals.

Skills mismatch can be put into four types of categories:

1) **Overskilling**: A person can be overqualified when their level of education exceeds the skills required for their job. At a macroeconomic level, this represents an economic loss, as significant time and resources may have been spent obtaining a degree that is underutilized in the workplace. Furthermore, overqualified individuals often tend to seek alternative employment that matches their skills-level, leading to potential losses for the company. Organizations that have invested time, effort, and resources in training and recruiting such employees may face challenges when those employees leave.
2) **Underskilling:** A person can be underqualified when their level of education falls below the skills required for their job. If the person's skill set is not adequately developed, there is a risk that the company may become dissatisfied with their performance. Additionally, tasks within the company may remain unresolved, leading to inefficiency and potential economic loss.
3) **Skills obsolescence** often accompanies digitalization and technological advancement but can also occur when skills are not being regularly practised and become obsolete after time. Both of these scenarios can be a result of changing demands in the labour market.
4) **Different types of mismatch may co-exis**t: For instance, a person can be simultaneously overqualified and underskilled. As with over/under skilling this often happens when the field of education does not correspond to the field of occupation.

According to the ILO the consequences of skills mismatch reach all levels of the labour market and have economic consequences, leaving investments more expensive and thus less efficient[119].

For companies, skills mismatch has negative consequences for productivity and competitiveness, which affects their ability to implement new products, services or technologies. What is more, skills mismatch causes higher staff turnover and sub-optimal work organisation. Eventually skills mismatch leads to the loss of profits and markets.

For countries and regions skills mismatch can increase unemployment, and affect competitiveness and attractiveness to investors, meaning lost opportunities on the pathway to productive transformation and job creation. Public or private resources are invested in training with the assumption that achieved qualifications will yield positive results in terms of employment insertion or wages. Yet, if skills mismatch is present, these expectations often do not materialise, leading to returns on investment that are lower than expected, and making investments less profitable.

[117] IEA. World Energy Employment 2023.
[118] ILO, What is skills mismatch and why should we care?
[119] Brigden and Thomas, What does economic theory tell us about labour market tightness?

Further, organizations identify skills gaps and an inability to attract talent as the key barriers preventing industry transformation, with 60% of surveyed companies highlighting the difficulty in bridging skills gaps locally and 53% identifying their inability to attract talent as the main barriers to transforming their business

Projects that don't have the skilled workforce they need might not perform as well as expected, leading to lower returns on investment and possibly deterring future investments in similar projects.[120]

Especially in the Global South we see that companies train their own staff to meet industry demands, but this often occurs within rather confined teams that are already employed at the company. However, there is often no systematic approach or positive spillover effect on the public educational system from these privately initiated training programs, widening the gap even more.

Regional perspectives

Interview perspective - Confederate Secretary Ester Lynch and Advisor Ben Lennon from the European Trade Union Confederation

The need for upskilling and reskilling of the workforce to ensure they can effectively participate in the energy transition is a central issue for the European Trade Union Confederation. Esther Lynch and Ben Lennon refer to a rapport from Cedefop, which states that 46% of the adult population, approximately 128 million adults in Europe, needs upskilling and reskilling. 74% of SMEs in the EU say they are facing skills shortages.

According to Lynch and Lennon, the most immediate need for skills in the energy transition is in the renewables sector. Meeting our EU renewable energy targets necessitates the creation of over 3.5 million jobs by 2030, with the solar sector alone requiring a doubling of its workforce to one million in less than six years.

In Germany, the largest solar market in Europe, a shortage of 5 million workers is predicted by 2030, with 60% of German electrical contractors in the sector currently having vacancies.

While the EU now has the makings of a green industrial strategy — via the Net Zero Industry Act — Lynch and Lennon explain it lacks a clear, Europe-wide pathway for delivering the workforce that is going to install the solar panels, build the wind turbines, and maintain the grid.

It is, however, not just the renewables sector that is facing a shortage of skilled workers and the shortage is not only present in Europe. Markets across the globe are already facing shortages of construction workers and other tradespeople, such as electricians, carpenters, concrete workers, welders, and pipefitters. According to the IEA, the European Union is facing particularly severe shortages of tradespeople, including electrical engineering technicians, roofers, vehicle mechanics, and truck drivers.

The ETUC believes that training, reskilling, and upskilling should be a part of the solution, as well as quality jobs with fair wages and collective bargain. "*Workers should always have the opportunity to gain additional skills throughout their careers. Industries are not static and are continually evolving.*

[120] World Economic Forum. Future of Jobs report 2023.

That is why we are committed to guaranteeing the right to all workers to training, reskilling, and upskilling" states Lynch.

Interview perspective - Director of International Electricity Market Development Johannes Brunn from Energinet (Denmark)

Johannes Brunn recognizes the need for more skilled labour. In Energinet specialists at the highest educational levels are needed to ensure the future development of the energy sector, but specialists are getting increasingly harder to come by:

"*It is reasonably easy for us to recruit more generally skilled people, such as economists and engineers, but if we for instance need a highly skilled candidate for high voltage DC (Direct current)lines projects, it is a rather fierce competition for that labour. When looking into future developments, we can see that the flagship of the European energy transition is expected to be offshore wind, which requires a meshed offshore high-voltage DC grid. It will be very, very demanding to secure those experts, as we are not just in need of generally skilled labour, we need a significant number of specialists with a PhD level educational background".*

According to Brunn, highly skilled labour and experts should be considered important elements of the supply line for realising the energy transition. Just as the right infrastructure such as factories needs to be in place, a sufficient capacity of skilled workers and experts needs to be available.

From Brunn's perspective, the lack of skilled experts is primarily due to shortcomings in the educational system. An underestimation of the extent and urgency of the energy transition could be the reason why the educational system has not yet been reformed to reflect the needs of the industry today. Ambitious plans to reform the energy systems have been made by all member states in the EU, resulting in enormous investments and demand for thousands of kilometres of high-voltage DC cables, converter stations, and DC breakers. The infrastructure that needs to be established is therefore very, very significant. As political ambition has been accelerated, so has the need for experts and specialists, who can help realise the transformation.

"*This is why it is so important to actively look into securing the educated people we need in the future"* concludes Bruun.

Interview perspective - Head of the Partnership and Policy Development team in Danish Industry Jesper Friis

Jesper Friis recognises the need for a workforce with the right educational competencies and skills as a significant bottleneck for the energy transition, not just in Denmark but in developing economies as well. This becomes apparent when talking to local African companies and Danish companies operating in Africa. There is an extensive labour shortage of professions such as carpenters and electricians across the entire industry. Friis has been a part of several development projects in Kenya, Tanzania, and Jordan and is therefore able to identify some of the reasons why there is a lack of skilled workers in Africa.

The issue starts with the general lack of investment in education. A lack of resources leads to inefficient primary schools, which fail to prepare the students for a technical secondary education later on. Another issue is the perception that a university degree will lead to a better life than vocational training.

"As in many other countries, there has been an increased search towards universities. The perception is that you need a university degree to succeed. The technical colleges have definitely been under-prioritized and suffered from insufficient funding. The lack of funding and lack of dialogue between the private sector and the educational system has led to a lack of qualified workers" Friis explains.

Interview perspective - Slavica Uzelac from the European Federation of Building and Wood Workers (EFBWW)

Policy officer Slavica Uzelac from EFBWW describes how companies struggle to train their employees in the construction and woodworking industry, where the majority of companies are small or medium enterprises.
Uzelac identifies the main challenge as limited resources within the companies. Sometimes smaller companies solve the issue of funding by building a joint training center in collaboration with other companies. This kind of solution can, however, not stand alone. Training should not be the sole responsibility of small companies, but rather a joint effort across many stakeholders.

*"(*The initiative of joint training centers*) needs to go hand in hand with public support and involvement of educational centers to provide the curriculum"* states Uzelac.

Uzelac underlines the important role of joint social partner efforts between trade unions/ workers' representatives and employer organisations/companies. Collective agreements on skills development and training strengthen the commitment on both sides – employees and management to engage in strategic planning and implementation of skills development schemes which profit the company but also the employee. It is challenging for smaller companies to predict the training they will need to prepare for the future, as it is highly dependent on the kind of technology they want to invest in.

Uzelac points out that *"The companies need to really engage in skills intelligence, which requires them to sit down and identify what will be the needs and future skills".*

This challenge is also highlighted in the European Commission survey (European Commission, 2023), where 26% of SMEs find it "moderately difficult" to assess the training needs of staff, while 9% find it "very difficult".

Bottleneck 5: SHORTAGE OF TRAINERS AND GREEN VET (Vocational Education and Training) INSTITUTIONS

Short description:

A critical shortage of qualified trainers for the energy transition, particularly in vocational schools, poses a significant obstacle to effective training and upskilling required for the energy transition, further amplifying the growing demand for skilled workers.

General introduction to the issue

- Vocational education and training is important for the green transition.
- VET training of trainers can be done using different approaches:
  - Trainers can collaborate with industry and learn from them
  - Trainers can seek the information themselves through conferences etc.
- Most teachers lack preperation and enthusiams for teaching green skills.
- VET initiatives lack financing for industry specific training.
- There are not enough VET trainers to meet the demand.

Regional perspectives

Global North

Greater Poland Center for Social Economy: Upskilling and training initiatives are important elements in transitioning miners into sustainable industries, but is very hard to find providers who can supply the kind of training needed.

Global South

Danish Industry (Sub-Sahara): Teachers often lack skills due to limited connection with industry. Short exchange periods where teachers can work in industry help them to understand the reality students will face once they graduate.

Brazil national bank: Lack of investments in educational system creates double burden, as investments are impeeded by the lack of skills.

Interview perspective

Introduction

Trainers and educators are essential for developing the skills needed for the energy transition. Without them, we cannot effectively train and upskill the workforce to participate actively in this critical change. Currently, there is a significant shortage of qualified trainers for the energy transition, particularly in vocational schools, and this shortage is even more pronounced within the public education system.

Moreover, this issue extends to problems with certification and the availability of instructors in general. The lack of trainers has a clear consequence: the necessary training and upskilling required for the energy transition cannot meet the growing demand.

Training of Trainers

Trainers and teachers are clear catalysts for skilling the workforce for the energy transition. Competent VET teachers and trainers in schools and companies are crucial to VET becoming innovative, relevant, and flexible. There's a recognized need for support and guidance for green teacher training. Further trainers and teachers need ongoing training as new technology is developed.

In effective systems there is close collaboration between VETs, industrial partners, and external training providers to identify and address the upskilling needs of educational staff, delivering effective training programs to integrate sustainable development practices into teaching. Another approach is to rely on teachers and trainers to engage in self-learning by seeking information on sustainability and green skills through conferences, workshops, literature, online communities, and networking. These approaches complement each other, with collaboration ensuring relevant training and self-learning fostering personalised professional development[121].

An ETF analysis indicates that in numerous countries, most teachers lack sufficient preparation or enthusiasm for instructing the competencies essential for the energy transition. This aligns with UNESCO's research, where a survey found that while 95% of primary and secondary teachers acknowledged the significance of teaching climate change, fewer than 30% felt adequately prepared to do so.

Current approaches are fragmented and rely on individual VET institution initiatives. Challenges include financing adequate teacher training and tailoring training to specific industry sectors. Some industries may have limited interest in developing more sustainable practices which increases VET providers' reliance on external partners for supporting green teacher training.[122]

Other national challenges identified also include the ageing VET teaching population, shortage of young VET teachers, low attractiveness of VET overall and VET teaching specifically, and inadequate alignment of VET programs with the labour market. National policy responses focus on enhancing the quality and flexibility of continuous professional development (CPD), improving apprenticeship and work-based learning, upgrading VET teachers' digital skills and pedagogical preparedness, and enhancing the appeal of the VET teaching profession.[123]

[121] European Training Foundation, GRETA: GREENING OF VOCATIONAL EDUCATION.
[122] European Training Foundation, GRETA: GREENING OF VOCATIONAL EDUCATION.
[123] European Training Foundation, SKILLS FOR THE GREEN TRANSITION.

An important aspect of the aging teaching population is that it takes longer to become a vocational teacher than a vocational worker. Becoming a vocational teacher typically requires vocational training, practical experience, and additional pedagogical training, which is often a prerequisite for becoming a successful trainer.

Regional perspectives

Interview perspective - Chairman of the board Przemyslaw Piechocki from Greater Poland Center for Social Economy

Przemyslaw Piechocki recognises the need for qualified trainers to ensure workers can acquire the skills they need to transition from jobs within the coal mining industry to emerging green industries. As chairman of the board of Greater Poland Center for Social Economy (WOES), Piechocki has worked together with trade unions, local government, and local organizations to ensure a just transition for workers whose jobs have been terminated due to industry developments caused by the energy transition. One of the main tasks in ensuring a just transition for the workers is to identify potential new employment opportunities and make sure the workers have the right skills.

One of the projects WOES has been involved in focuses on finding new jobs for former coal miners. The transition from the coal mining industry into e.g. the renewable energy sector requires a qualified worker, who has the skills needed for participating in complex tasks such as constructing farms for solar energy. Upskilling and training are therefore important parts of ensuring the energy transition.

A prerequisite for high-quality training is qualified educational institutions, which according to Piechocki are transforming at the moment.

"*If you ask me whether the educational market is ready for the energy transition, I would say that it is in a preparation process, just like the rest of the industry*," says Piechocki, who goes on to explain that there are a lot of institutions who can offer education in basic skills, but that high-quality vocational training is still hard to find.

One reason for this challenge might be a gap between educational institutions and companies, especially regarding the development of micro-credential courses. Piechocki explains

"*There is a high demand for vocational training right now. Good vocational training programs have a lot of work to do in the industry. There are few qualified trainers and they all have busy schedules because it is difficult to find people who have the right knowledge, skills, and experiences to train workers in the industry*".

Another challenge is to obtain vocational training, which is closely connected and tailored to new job opportunities. The miners expect more clear and concrete information about future job opportunities like salaries and work conditions before choosing vocational training. In the future, Piechocki sees a closer collaboration with educational institutions as an important step in securing more effective vocational training.

"*The educational institutions have a big task ahead of them in educating trainers and ensuring they have the right support*" Piechocki concludes.

Interview perspective - Head of the Partnership and Policy Development team in Danish Industry Jesper Friis

Jesper Friis has been working with several development projects focusing on education initiatives. Recent projects in Kenya, Tanzania, and Jordan focused on developing effective vocational training based on the competencies needed by local businesses. The need for more targeted education and reskilling of vocational teachers became apparent throughout the projects.

"It was suggested to us by the local companies that it would be a good idea to focus on further educating the teachers, as they often lack sufficient skills. In some cases, it is the basic skills that are insufficient, but another factor is the fact that the technology used in the labour market has changed while the teachers have been teaching at the institution. It is important that the teachers are preparing the students for the reality they will meet once they get a job" Friis explains.

It was decided that the teachers should partake in a short exchange period in the industry to learn about new technology and ensure that their skills are up to date. The short exchange period also helped the teachers understand the reality that their students will partake in after education.

According to Friis, the approach was inspired by the Danish (and in general Northern European) approach to vocational education, where the dual training system is the most common way to teach. Dual training means that students will complete some of their education while working in a company. Exposing teachers to dual training as well ensures that the curriculum stays up to date and that the teaching is in touch with the technical reality in the industry.

Interview perspective - Manager of Sustainability Marta Bandeira de Freitas from the National Development Bank of Brazil

The state of the educational system in Brazil causes concern, as the general skill level is not at all sufficient to accommodate large green investment projects from e.g. Europe or the US.

"Even if we got the kinds of big green investment projects that we are hoping for we would have a shortage of labour with the relevant skills to be able to fulfil all the job openings. We really have to go back to the basics and rethink the public schools and the investments we put into these schools" Marta Bandeira de Freitas explains.

Public universities have traditionally been the leading research and educational institutions, but due to a lack of investments from the last couple of governments, the universities are falling behind. This continuous neglect of the educational system means that it is difficult today to get a highly respected degree in Brazil. Bandeira de Freitas explains how seriously this development is affecting Brazil:

"We have a problem of capacity building and of educating top class professionals, which we need to e.g. compete with China. Brazil is falling behind in terms of skills development"

Having talented and dedicated educators is an important part of providing quality education, but since there is a general lack of funding in the educational system, teachers and professors are not earning very well. Bandeira de Freitas explains how the low salaries within education create systemic effects:

"The teachers and professors are not valued and that is part of a bigger, structural problem here in Brazil. The inequality in our country is huge, so when the educational system fails, the rich families will leave the country to secure other educational opportunities abroad."

Bandeira de Freitas notes that the above statements are based on her personal opinions. She is not speaking on behalf of the National Development Bank of Brazil.

Bottleneck 6: SILOS ACROSS ADMINISTRATIONS AND SECTORS

Short description:

Breaking down silos in both horizontal cooperation (silo mentality in policymaking) and vertical cooperation (cross-sector collaboration) is vital for the energy transition. These issues intertwine, as silo mentality can also exist within cross-sector efforts and vice versa, leading to fragmented strategies and inefficiencies. Overcoming these barriers ensures integrated environmental, economic, and social strategies to close mismatch gaps and develop a skilled, adaptable workforce fit for the energy transition.

General introduction to the issue

- Silo thinking hinders collaboration and holistic planning of the green transition.
- Breaking down silo thinking in policy making is important for mitigating the social backlash arising from e.g. a loss of jobs.
- Cooperation across industry sectors for skill development, knowledge and resources is essential for a successful green transition.
- Close collaboration between industry and universities is important for ensuring graduates have the skills needed by companies.
- Developing educational programs focusing on green skills will contribute to developing a workforce capable of driving the green transition.

Regional perspectives

Global North

ETUC (Europe): Difficulties in the EU legislative landscape represent a barrier for a just green transition.

EFBWW (Europe): Competition and trade secrets between companies can hinder collaboration.

Global South

Anonymous government official (Brazil): Challenges in collaboration within the green economy arena across administrations hinders consistency and budget for green development projects.

Danish Industry (Afrika): Skill development requires broad collaboration between centralized and decentralized structures.

SATRI (South Africa): Lack of solidarity within sectors leads to reluctance to let workers dedicate time to training.

Introduction

Cross-sector cooperation in skills development for the energy transition is crucial. By joining forces, educational institutions, businesses, and governments can create training programs that equip people with the skills needed for green jobs. This collaboration ensures that the workforce is prepared to meet the demands of the rapidly evolving green economy, closing skill gaps and encouraging innovation.

Additionally, it is essential to break down silo thinking within public administration. Employment, social, climate, and energy ministries need to work together across sectors to create clarity and transparency around reduction pathways. They should strategically align educational policies and reduction policies within national employment and education strategies to address competency mismatches.

Silo Mentality in Policymaking (horizontal cooperation)

Silo mentality refers to the organisational phenomenon where departments or teams operate in isolation, resulting in compartmentalization and a lack of collaboration.[124] This mentality can significantly hinder holistic planning for the energy transition, leading to fragmented efforts that fail to address interconnected challenges comprehensively. Overcoming these barriers allows administrations to integrate environmental, economic, and social considerations into comprehensive strategies. This integration is vital given the economic and employment opportunities presented by the energy transition, as well as the need to mitigate potential social backlash or negative discourse stemming from job losses in certain sectors. Ensuring an inclusive transition process is essential for addressing these issues effectively.

The IPCC Sixth[125] Assessment Report emphasises the necessity of cross cooperation in policymaking. Accelerating the transition depends on breaking down silos, leveraging sectoral synergies, and ensuring policy coherence across scales. This shift requires moving away from isolated policy instruments towards a combination of approaches that drive both social and technological change. Stakeholders must adopt a coherent strategy across local, national, regional, and international levels. This involves transcending sectoral boundaries and implementing integrated policies to promote cross-sectoral synergies and effectively manage trade-offs. By adopting this approach, the complexities of the energy transition can be navigated more effectively, ensuring that efforts are synergistic and comprehensive.

Cross-Sectoral Cooperation (vertical cooperation)

When we talk about breaking down silos in the vertical hierarchy, we refer to the need to promote collaboration across sectors and societal institutions. This collaboration is crucial for creating an effective and sustainable labour market that can support the energy transition. It requires close cooperation between businesses, educational institutions, authorities, and organisations, all of which play a central role in both the supply and demand of the green labour market.

To ensure an efficient labour market that can meet the demand for green skills, it is necessary to overcome silo thinking and promote dialogue across systems. Particularly in vocational areas, it is

[124] De Waal et al. Silo-Busting: Overcoming the Greatest Threat to Organizational Performance.
[125] Ipcc, National and sub-national policies and institutions.

important to maintain an ongoing dialogue about the development of businesses' demand for skills with the educational system. This is especially crucial to ensure that teaching and training are aligned with the needs of businesses. It is equally essential that universities stay in tune with industry needs and technological advancements.

Furthermore, it is vital to have transparency regarding market development and frameworks so that companies feel confident in making the investment decisions that support the long-term ambitions and reduction targets set by the government, which will naturally serve as strategic benchmarks for companies as they evolve.

An example of a silo challenge between businesses and educational institutions can be seen in India, where many university students lack "employability" – the ability to combine theory with practice – making it difficult for them to find employment. This illustrates the importance of creating a closer connection between education and the labour market to ensure that students are better equipped to enter the workforce and contribute to the energy transition.

The Importance of Aligning Educational and Climate Policies

ILO[126] emphasises the critical importance of aligning educational and climate policies to address the challenges and opportunities presented by the energy transition. This alignment is essential to ensure that the workforce is equipped with the necessary skills to support sustainable development and to mitigate the potential negative impacts of the transition on employment.

Educational institutions play a pivotal role by developing curricula that incorporate green skills and sustainable practices. By working closely with industries and government agencies, these institutions can create programs that respond to the evolving needs of the green economy. This collaboration ensures that students and workers are prepared for future jobs, which increasingly require knowledge and skills related to renewable energy, energy efficiency, and other green technologies.

Government agencies can support this alignment by providing funding and policy support for educational programs focusing on green skills. They can also promote policies that encourage the integration of sustainability into all levels of education, from primary schools to universities and vocational training centres. By establishing a coherent policy framework that supports both education and climate goals, governments can help develop a workforce capable of driving the energy transition.

Further The ILO highlights the need for social dialogue and collaboration among stakeholders to develop effective strategies for aligning educational and climate policies. This includes engaging employers, workers, educational institutions, and government agencies in discussions about the skills needed for the green economy and how to best provide those skills through education and training programs[127].

[126] ILO, Green jobs recovery through employment policies.
[127] ILO, Just Transition Policy Brief.

Regional perspectives

Interview perspective - High-level government official in Brazil

The following perspectives are based on an interview with a high-level official working in the Brazilian government, who wishes to remain anonymous. The government official has experienced how silo thinking and a lack of cooperation within the political system can slow down the progress of the energy transition.

According to the government official, the lack of cooperation might be due to the structure of the political system. Ministries are run by different parties and there is a fight for budget between them. The way the parliament works in Brazil results in a constant negotiation of the budget, which lacks consistency.

Therefore the mindset in policy-making needs to change:

"We need to change the mindset in the executive branch because right now parliament has the power to dominate how the budget is spent. It is a challenge for us to deliver policies and it is also a challenge of consistency".

Effective collaboration between different stakeholders within the government is complicated within the green economy arena, as a lot of areas of government are involved and they do not necessarily want to coordinate. The government official explains that it can be difficult to get an overview of all the different projects on the energy transition.

The lack of cooperation is a problem between the administrations as well:

"Policies can change dramatically from one electoral period to another. It is amazing to see how policies are discontinued. It is a schizophrenic problem here in Brazil (...) we end up using ideology to undo things that are on the state agenda and this results in important changes not happening" explains the government official.

The government official envisions a broader collaboration between a range of stakeholders, both governmental and civil, as the best way to drive the transition forward. It is important to engage the big political parties and key actors in the government, who will be able to validate the budget. It is, however, also important to take into account the perspectives of non-political actors, including the big coalitions (representing interests from industry), the civil society (e.g. relevant NGOs and grassroots movements), and the banks (as they are involved in the funding of initiatives).

Interview perspective - Confederate Secretary Ester Lynch and Advisor Ben Lennon from ETUC

Silo thinking can occur in the legislative landscape, where restrictions and policies in one area can create interconnected challenges in another one. ETUC reports on several restrictions in the EU legislative landscape, which must be overcome to reach a just energy transition.

Financial restrictions within the EU are a barrier to investments in the energy transition. Lynch and Lennon state that current EU restrictions on borrowing limit the ability of member states with higher debt and deficits to meet green spending needs. As a result, under current rules, only four countries (amounting to 10% of EU GDP) would be able to muster sufficient fiscal space to practically undertake a 1.5-degree Paris-aligned scenario within debt and deficit limits.

An example is the more ambitious interim carbon reduction target for 2040 that the EU recently announced. According to the European Court of Auditors, the EU has committed to less than 10% of the total investment required to achieve the 2030 aim. An estimated investment of €1.5 trillion annually is needed for a 90% emissions cut by 2040. Existing restrictions on borrowing within the EU limit the fiscal flexibility of Member States, hindering their ability to create new jobs and meet green spending needs.

Lynch also points to the lack of integration of social perspectives in EU policy. "*The relative lack of social conditionalities in EU policy is a huge barrier. When we give taxpayers money to industries we should be ensuring that there are some basic requirements attached that benefit us all and not just private profit, such as quality jobs and the hiring of appropriate numbers of apprentices. Also, we need a directive for just transition in the world of work through anticipation and management of change, based on the principles of trade union involvement and collective bargaining*" Lynch explains.

Interview perspective - Head of the Partnership and Policy Development team in Danish Industry Jesper Friis

Through several educational development projects in Kenya, Tanzania, and Jordan Jesper Friis has learned the importance of getting local business organisations to engage with the governments to build effective training programs and identify relevant policies. The local context and business environment are very important factors to consider, as there is no such thing as a "one fits all" when it comes to developing policy recommendations for the government.

"My experience tells me that effective policy crafting requires collaboration between centralised and decentralised structures. If you only work on the national level, e.g. by establishing a national skills sector council and bringing in some experts as has been supported by the World Bank, you risk very quickly getting away from the reality on the ground" explains Friis.

According to Friis, the solution is to establish a strong connection between the schools, the companies, and the communities in the local setting. Together these actors can support the development of the curricula and learning plans, which can then feed into the centralised system.

Interview perspective - National Secretary of Self Employed Women Association Manali Shah (India)

Through her work with SEWA, Manila Shah has witnessed government training initiatives that have been less than effective for the women working in the informal sector. Supporting training and upskilling of women workers is in the government's interest, but a lack of understanding of the workers' situation hinders the government's skilling initiatives in achieving its goals.

Shah explains that it is not a lack of will from the government's side, but rather a mindset that needs to change. The core issue is that the government institutions developing the initiatives are not aware of the reality of the workers:

"The government does not understand the ground realities before they design the scheme and implement it. Therefore, the real workers are not able to take advantage of the training initiatives".

Shah is requesting a more investigative way of developing training and certification initiatives, where the practical issues the women are facing are being taken into account from the very beginning.

SEWA is a part of a cooperative, which provides training for women in local training centres. When facilitating the training, they discovered that besides training the women needed tools and equipment as well, to secure better, more well-paid jobs. They therefore opened a tools library, which allows the women to rent the tools they need. The tools library is just one example of how grassroots organisations, that interact with the workers and see their struggles, are better able to design and implement effective initiatives that take the entire context of the workers into account.

The grassroots initiatives can, however, not stand alone. An important qualification for the workers is to have certification of their skills. According to Shah, this kind of certification is something only big employers or the government can provide, as the employer or government-driven training represents the state of the art. Therefore, the government must start to cooperate with grassroots organisations and unions to design effective training programs.

Interview perspective - Policy Officer Slavica Uzelac from the European Federation of Building and Wood Workers

According to Slavica Uzelac, there is a wide consensus within the industry for the need for skilled workers. Both employer organisations and trade unions are supporting initiatives on the European level to ensure a skilled workforce in the future.

There is, however, a potential issue when companies within the same sector (especially in energy intensive industries) need to work closely together on this agenda. Uzelac explains her perspective:

"It may be that companies within the same industry are not so keen to cooperate and share information, as sharing too much information with others may affect the business competitiveness."

This attitude can hinder closer collaboration between companies, e.g. explore what is the newest technology within this field that workers need to be educated in. The need for keeping trade secrets hidden can also make it difficult for companies to learn from best practice examples by visiting each other's sites.

Interview perspective - Executive Research Director Martin Kaggwa from the Sam Tambani Research Institute (SATRI)

According to Martin Kaggwa, employers will sometimes stand in the way of educating the workforce, as they are afraid that a skilled worker will be more likely to leave the company for another, better opportunity in the industry. The government is providing funds for skills development initiatives but the employers are reluctant to release the workers to spend time on training, as this is not considered a productive activity for the company. When asked why this is the case Kaggwa elaborates:

"I think the reluctance from the employer is based on the fact that some of the skills workers will receive in training are not only intended to be relevant for the current position of the worker but might be used to get a better opportunity elsewhere on the job market."

This example illustrates the lack of solidarity that exists some places within sectors, as the common goal should be to develop a highly skilled workforce that is prepared for the technology of tomorrow. Kaggwa brings up an additional obstacle within the industry, which makes it difficult for the local workforce to achieve the required competencies to work with new green technology:

"There is enough workforce available in South Africa, but they need the required skills to participate in the energy transition. Sometimes which skills are needed is not very clear. One example could be PV closed solar panels, where workers may need access to specific intellectual property, depending on who manufactured the solar panels. This kind of information is not easy to get."

Intellectual property protection means that only selected workers can achieve the required skills and be allowed to work with the interface of the intellectual property. This results in fewer opportunities for creating local jobs in developing countries when renewable energy projects are established.

"It is not something being highlighted in the debate about our future skills, but it is a part of the reality when you talk about technology and the energy transition. The intellectual property is connected to job creation and it is an important factor in preparing people to work in a particular sector" Kaggwa adds.

Synergy Model

Synergy Model

All of the six bottlenecks represent important obstacles securing skills and labour for the energy transition. When cross examining the bottlenecks we see some clear synergies between them, which not only point at clear overall transcending obstacles, but also show how they are interconnected, and most importantly how these obstacles can be broken down. The Synergy model (see Figure 4) illustrates the three main issues within the green workforce domain, the role of the central stakeholders and the connection between the six bottlenecks.

The three main issues identified are:

- Lack of qualified workforce
- Limited accessibility to training
- Silo thinking and lack of collaboration

The lack of qualified workforce has been supported throughout the quantitative and qualitative research. The two main themes that capture the lack of a qualified workforce are demographic challenges and mismatch of skills. Demographic challenges cover issues related to ensuring the quantity of the workforce. **Bottleneck 1** describes how the Global North is facing serious demographic challenges, which will only become worse, as the median age, fertility rate and population growth rate will lead to a decreased workforce in the future. It is therefore vital that all groups that can contribute to the workforce get a chance to, including women, who are currently underrepresented in the green workforce and the energy sector, as described in **Bottleneck 2.** It is also vital that vulnerable groups are included in the workforce. These groups could be workers from declining industries or migrants, as described in **Bottleneck 3**. The Global South is approaching a demographic dividend, which presents opportunities in terms of a larger workforce but also poses challenges, as adequate job opportunities and upskilling need to be developed to ensure stability. A pervasive issue concerning skills in the Global South is the general lack of them within the population and gaps in the educational system, leading to unemployability despite an increasing demand for labour.

Mismatch of skills focuses on the quality of the workforce (quality here referring to how qualified the workers are in terms of green skills). **Bottleneck 4** emphasises the skill gap between the current workforce and what we need for a successful energy transition.

The lack of accessibility to training is one of the main reasons for not having enough qualified workers. Educational institutions need to increase the emphasis on green skills in their curriculums and focus on the competencies that are needed in the future. Right now micro credential courses and recognition of prior learning would help build a qualified workforce faster. These efforts within the educational institutions would directly target the skill gap that is described in **Bottleneck 4**.

Furthermore, there is a need for more skilled and passionate trainers, as described in **Bottleneck 5,** who can help engage the future workforce in green skills and make sure groups that are currently outside the green job market can seek qualified guidance for reskilling.

Silo thinking and lack of collaboration within government and companies is a central issue that hinders effective access to training and is ultimately an obstacle for ensuring a skilled workforce for the energy transition. **Bottleneck 6** describes this central issue. Both horizontal and vertical silo thinking are important to tackle. Horizontal silos within government should be broken down to prevent inconsistent and ineffective policies for ensuring green skills. Vertical silos should be avoided across workforce and organisations, educational institutions, companies and market creators to allow actors to join forces to achieve skilling of employees.

The Synergy model specifies the role of the stakeholders in relation to each of the main issues, linking this model to the Quadrature of Competencies framework, which defines the potential for innovation as a shared effort between workforce & population, educational institutions, companies and market creators.

"Lack of Qualified Workforce" is an issue closely linked to the population in general and the workforce specifically. The educational institutions are the most important stakeholders for the "Limited Accessibility to Training", since the educational institutions main mission is to ensure quality training and education for the population through dedicated and competent teachers. Market creators, such as government officials, and companies form the rules, regulation and general practices for the job market and educational system. It is therefore especially important to ensure good collaboration and prevent silo thinking for these stakeholders.

Furthermore, we see that the cooperation between companies and educational institutions is one of the most fundamental prerequisites for a balanced labour market and closing mismatch gaps. Without continuous understanding and dialogue between these two stakeholders, it is simply not possible to equip the workforce with the skills needed to implement the necessary technologies. Additionally, we see that digital technologies are developing exponentially, making reskilling and up-qualification even more important. Also, the involvement of social partners in this dialogue and cooperation ensures a more sustainable and long-lasting dialogue.

Upstream and downstream effects

An important aspect of the Synergy model is the placement of the three main issues on a range going from downstream to upstream. The downstream/upstream terminology is often used when discussing e.g. supply chain issues, where upstream activities form the basis for downstream activities. In the case of a product, upstream activities would include sourcing the materials, while downstream activities would include delivering the finished product to the customer. Similarly, the "Silo thinking and lack of Collaboration" issue placed upstream on the Synergy model has consequences for "Limited Accessibility to Training" and ultimately the "Lack of a Qualified Workforce". This connection between the issues is best illustrated through the following three examples, which are visualised in Figure 5.

Lack of skilled workforce in Brazil

The interview perspective from Marta Bandeira de Freitas from the National Development Bank of Brazil (see page 57) provides a clear example of the synergies between the three main issues. First of all, there is clearly a **lack of qualified workforce**, as de Freitas explains that even if Brazil managed to acquire big, green investment projects they are hoping for, they would not be able to realise them, due to the lack of skills within the workforce.

De Freitas points to a failed educational system as the reason for why Brazil is falling behind in skills development. The **limited access to training** is thereby creating undesirable effects downstream, as it directly prevents capacity building of a skilled workforce.

When asked why the educational system is falling behind de Freitas points to a continued lack of investment from the government and a general undervaluing of teachers. There is a **lack of collaboration** between government and industry, as it is evident that the industry needs more skilled workers, but the government is not making the necessary investments in education to secure a qualified workforce in the future. This lack of collaboration is directly influencing the educational system, which is not aligned with industry demand, and is thereby contributing to the lack of qualified workforce.

Just transition of miners

Przemysław Piechocki´s experiences with just transitioning of miners in Poland (see page 46) is another good example of how the accessibility to training influences the workforce. Miners can transition into green jobs, and thereby contribute to a **qualified workforce** for the energy transition, but this transition requires upskilling and training for complex tasks.

The **accessibility to training** is dependent on qualified trainers, but according to Piechocki they are hard to come by. There are few qualified trainers, and the ones that fulfil the requirements have very busy schedules. The educational institutions are failing in delivering the trainers needed in order to upskill the miners.

In the future, this will become an issue for both government and industry, as a significant population of unemployed miners is unproductive and costly for society, but also a missed opportunity for companies, who could have benefitted from reskilled miners as a valuable workforce. The **lack of collaboration** for investments and alignment of the educational system between government and industry is causing issues downstream.

Women in green jobs

The lack of women in green jobs is a complex issue, which spans over all three major issues. As established previously, women are underrepresented in fields that are important for the energy transition, e.g. the energy sector, engineering, computing and electricians (see Inequality in economies, see page 35). The lack of women in these sectors is contributing to the **lack of qualified workforce**.

Blindsides and biases in the educational institutions are further upstream, as these institutions are supposed to supply the population with the needed skills, including women. However, the vocational education system has been designed with male students in mind and with physical settings that do not match the needs of female students, limiting their **accessibility to training**. Furthermore the (unconscious) attitude of teachers towards their students has an impact, as female students can risk discrimination. These biases have not been built into the educational system consciously, but are rather a consequence of the current workforce and the way the industry works, where men constitute the majority of workers.

To involve women in sectors that are important for the energy transition will require a conscious effort to change the status quo and should involve actors from government as well as social partners. In most cases the government is involved in educational initiatives, but **silo thinking and lack of collaboration** can hinder the effectiveness of such initiatives. Manali Shah from SEWA explains how government initiatives lack a coherent understanding of the context of the workers, resulting in ineffective educational programs. The lack of understanding of the workers' context is due to vertical silos within government, where important stakeholders such as NGOs and other representatives of the public are not being heard before developing the educational initiatives.

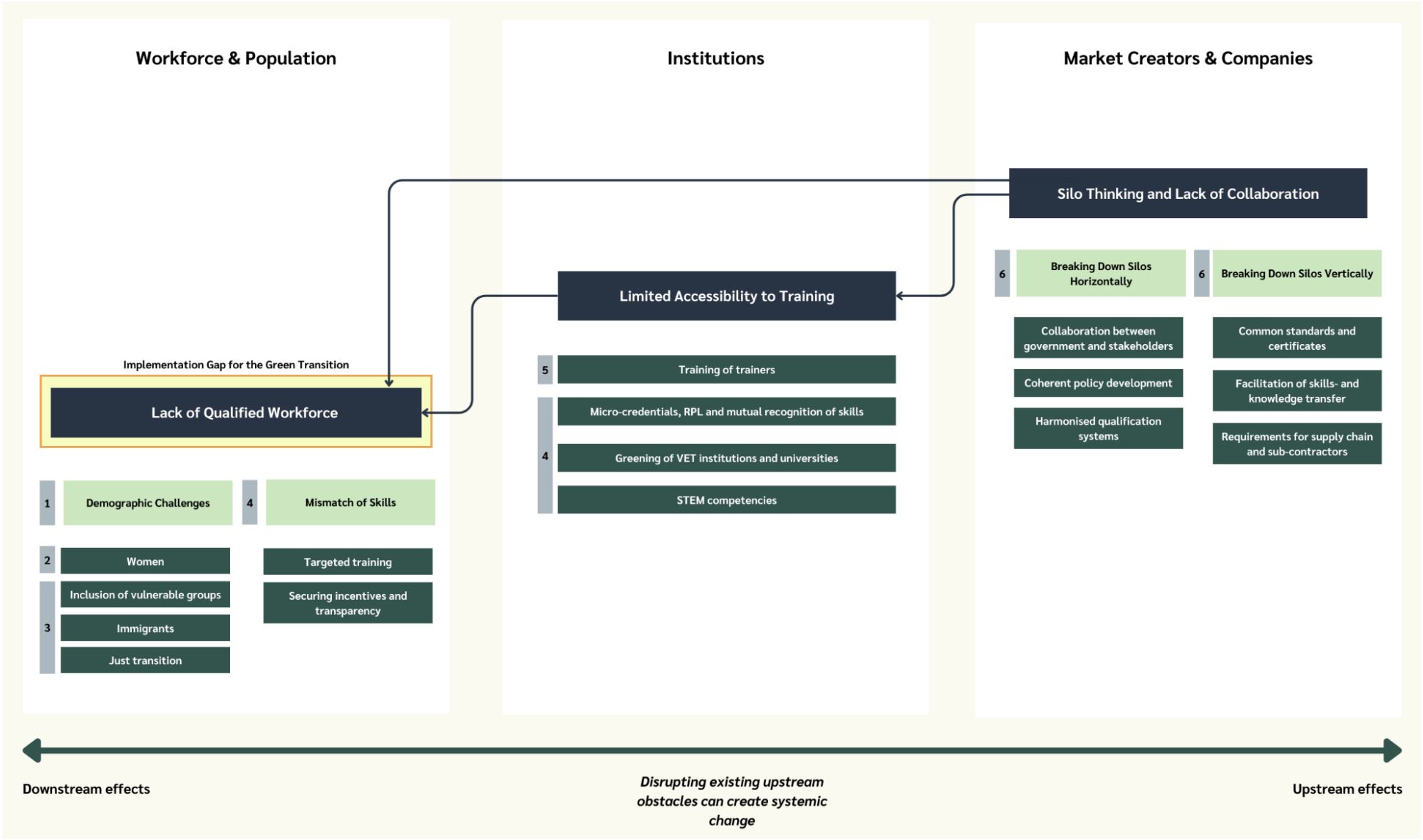


Figure 4. *Synergy model*

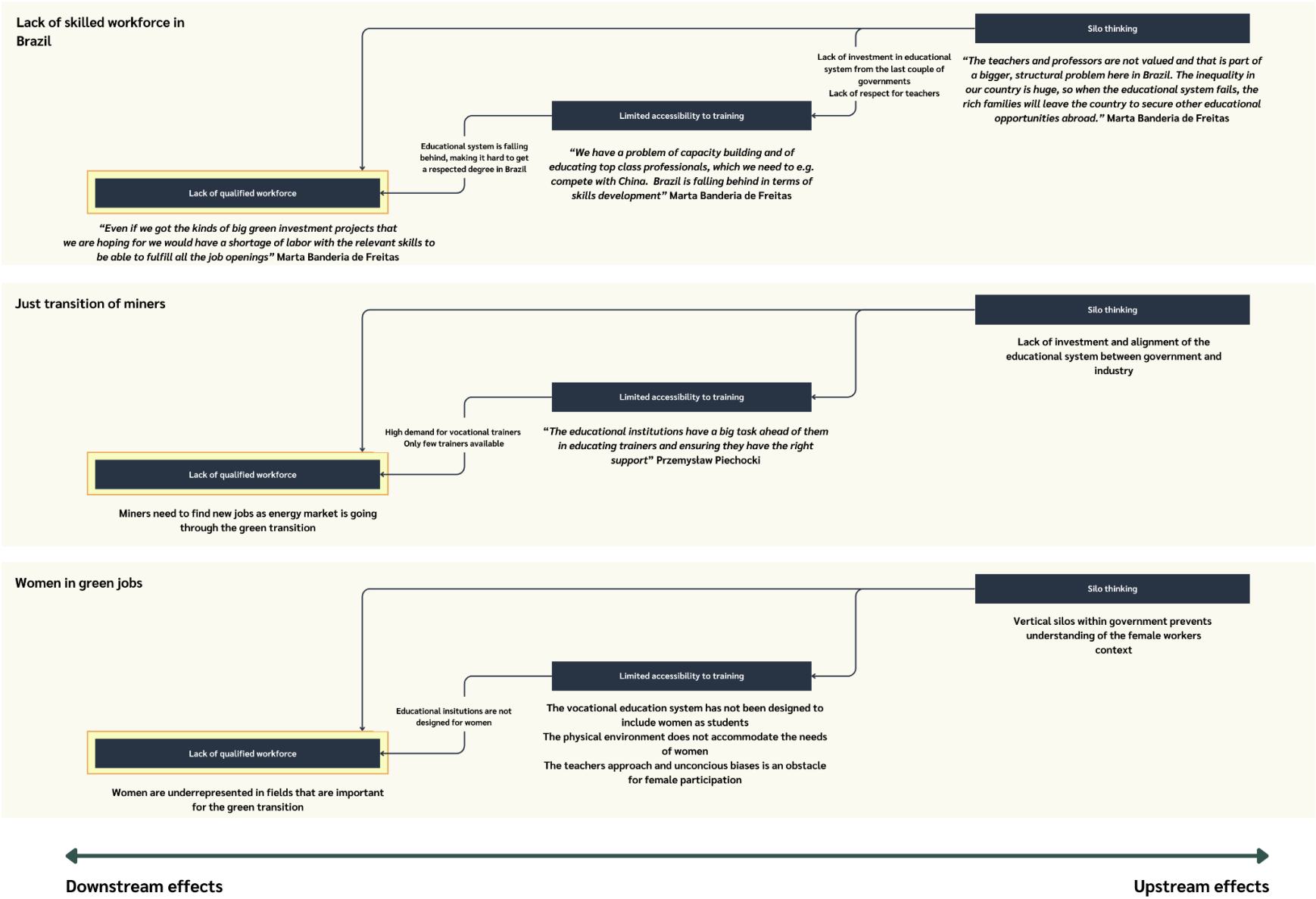


Figure 5. *Upstream and downstream effects - three examples.*

Need for macro level strategic interventions

Linking systemic change to the synergy model and the bottlenecks, we see that collaboration between government and industry has an effect on the educational institutions, which again have an impact on the qualifications of the population and workforce. When examining the drivers of systemic change, the literature offers various perspectives on what constitutes systemic change and its impact.

According to Robert F. Smith systemic change is defined as "*the full overhaul of a system to create a lasting difference. While approaches may vary, this form of change typically involves modifying policies, processes, relationships, mindsets, and power structures within a system to understand and fix underlying issues. Another way of thinking about it is working to fix deeply ingrained issues by addressing the root causes rather than zeroing in on symptoms. All in all, the goal of systemic change is to create a lasting impact by adjusting the core elements that form the system. This form of change is critical because it offers society a way to solve big, important problems—think social, economic, and environmental issues and systemic racism—by addressing their root causes. In other words, it offers government entities and organisations a way to understand and mitigate ingrained patterns within systems that create barriers for underrepresented communities.*"[128]

The New Philanthropy Capital's 2015 handbook[129] includes concepts of sustainability and the different components of a system, to define systemic change as"*…an intentional process designed to alter the status quo by shifting the function or structure of an identified system with purposeful interventions… Systems change aims to bring about lasting change by altering underlying structures and supporting mechanisms which make the system operate in a particular way. These can include policies, routines, relationships, resources, power structures, and values.*"

In other words, system change aims to bring about lasting change by altering underlying structures and supporting mechanisms that make the system operate in a particular way. These can include policies, routines, relationships, resources, power structures, and values.[130] For the energy transition stakeholder collaboration involving governments, businesses, civil society, and international organisations is pivotal for developing and implementing effective green skills transition strategies.

When looking into the Synergy model, any of these issues can be approached individually, but handling upstream issues leads to more beneficial downstream effects. The Synergy model also makes it clear that in order to achieve real systemic impact, it is crucial to include all the relevant stakeholders, as the population & workforce, the educational institutions, companies and market creators each have a determinant role to play in ensuring a qualified workforce for the energy transition.

Closing the mismatch and skills gap in the energy transition requires a multi-stakeholder approach. However, these stakeholders often have different priorities and bottom lines. Despite increased recognition that the lack of skills for the energy transition is a major implementation gap, it is not being prioritised at the centre of business strategy or policy development. This is also because there is no immediate effect on the financial bottom line, if a company invests in skilling initiatives that are not directly linked to the market it represents and its business.

[128] Smith, Systemic Change: Driving Meaningful Transformations.
[129] Abercrombie, et. al. System Change - A guide to what it is and how to do it
[130] Ripley, Systemic Change: walking the talk?

Especially in the Global South we see that companies train their own staff to meet industry demands, but this often occurs within rather confined teams that are already employed at the company. However, there is often no systematic approach or positive spillover effect on the public educational system from these privately initiated training programs, widening the gap even more.

We have identified a clear tendency, that when there is a linear effect between the supply of labour and market opportunities, companies are more likely to invest in labour. However, if the connection between skills development and financial bottom line is not direct, such as in the case of women's roles, vulnerable groups, and technocrats' competencies, companies generally play a more passive role. This is because the development paths of these groups are longer or more uncertain. This can be described as a direct linear effect between the supply of labour and market opportunities, where companies are more likely to invest in skills development with a clear direct linear effect.

At the national economic level, there is often a strong focus on increasing the general labour supply. However, ensuring that the workforce possesses the specific skills demanded by employers is frequently neglected. This neglect leads to structural imbalances in the labour market resulting in lower employment and productivity levels.

Conventional economic models typically do not look at mismatches between workforce skills and employer demand, and consequently, this mismatch is often overlooked in national policy-making. Consequently, there often exists a disparity between the labour demanded by companies and the labour supply policies implemented at the national level. This issue becomes more pronounced with the introduction of additional factors, such as the energy transition, which brings in new technologies and workforce demands. As a result, the existing skills gap is exacerbated by the need for new green jobs, adding complexity to the labour market.

Moreover, there have been few, if any, instances where governments, on their own initiative, have developed training programs to equip their staff with the skills necessary to meet reduction goals or other energy transition plans. This suggests a skills gap within governments themselves, which hinders the effective implementation of national reduction plans. We see a clear lack of skills among government officials, which, though not openly discussed, has significant implications for decision-making processes and the creation of clear and transparent reduction pathways.

To disrupt existing upstream deficiencies, it is crucial to develop macro level initiatives that step in where the market will not naturally go, due to the lack of a direct linear effect. This could, for example, involve focusing on women, refugees, and other vulnerable groups, ensuring they have access to the necessary training and opportunities in the green workforce. Additionally, it is important to address areas where there is a general lack of skills, such as the competence to conduct green procurement processes among technocrats, disrupting silo thinking, and training of trainers.

Another method is to focus on a regional or sectoral approach that could serve as inspiration for best practice examples. This involves not only developing the necessary implementation practices but also securing and sharing knowledge across different regions and sectors.

By creating platforms for knowledge sharing, best practices can be disseminated more widely, ensuring that successful strategies are replicated and adapted to local contexts. However, these platforms need to be engaging, easily accessible, action oriented and directly implementable to create an impact. We often see existing platforms falling short of gaining the right traction and engagement, and this could indicate a lack of transparency and not enough focus on the how to engage the end-user.

There is a clear need for fostering collaboration between educational institutions, government bodies, and the private sector to understand the market development and demand as the market and technologies evolve. Lastly, it is vital to close some of the existing research gaps, which are closely linked to the identified bottlenecks.

Ensuring qualified workers, who has the competences to work with implementing new technologies can be done by applying a stackable micro credential approach (see Figure 6). Here, workers will partake in short courses focusing on concrete, practical skills.

By completing additional courses, the worker will become more and more specialised over time and achieve proof of learning in a range of practical skills. Economically this is also an effective path, because it does not involve the employee being gone for a long time, and there is an immediate effect of the up skilling Breaking down the courses also makes the acquired skills more transparent, surmountable, and cheaper to follow. Commonly, a micro-credential can be as short as a couple of hours or days, depending on the content.

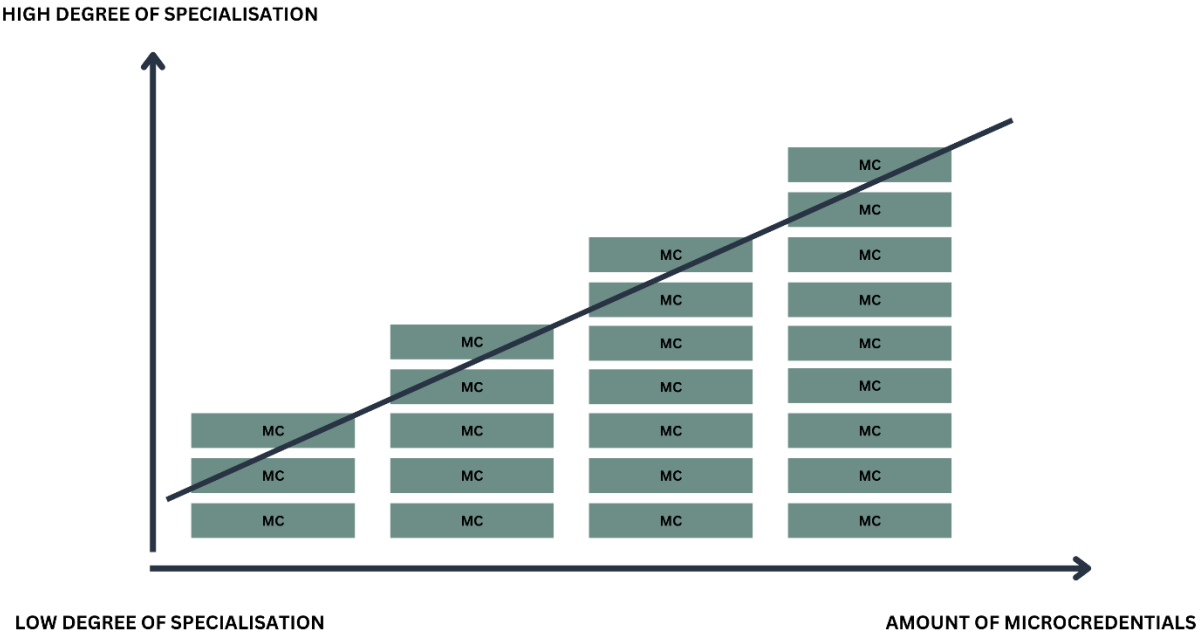


Figure 6: *Stackable micro credentials*

Lastly, it is vital to close the existing research gaps, which are closely linked to the identified bottlenecks. We have identified several areas where it has been difficult to conduct literature studies and where knowledge appears vague or scarce; conducting more studies or gathering experts to investigate these subjects more deeply would help in generating actionable knowledge and driving further progress towards a strategic approach to securing a population and workforce fit for the energy transition.

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Interview participants

A range of interviews have been conducted to supplement the quantitative findings gathered from literature and data. These interviews provide lived experiences within different areas related to ensuring a skilled workforce for the energy transition. There are representatives from unions, organisations, NGOs, industry and government among the participants, which provides different perspectives. Excerpts from some of the interviews have been included in the description of the six bottlenecks, while other interviews have provided more general background information.

Africa

Danish Industry
Jesper Friis
Head of the Partnership and Policy Development Team
(This interview focused on the education programs Jesper Friis has been developing in Kenya, Tanzania and Jordan)

Sam Tambani Research Institute (SATRI)
Dr Martin Kaggwa
Executive Research Director

Tanzania Union of Industrial and Commercial Workers (TUICO)
Lisungu Magnus Mapunda
Senior Education Secretary and Organiser

Brazil

Green Economy Secretariat of Brazil
Director of New Economies
Lucas Ramalho

High level government official (anonymous)

National Development Bank of Brazil
Marta Bandeira de Freitas
Manager of Sustainability

Qualifica PAC (Commission in Brazilian Government)
Rogerio de Veiga
Deputy Secretary for Public Policies Monitoring

Europe

European Federation of Building and Wood Workers (EFBWW)
Slavica Uzelac
Policy Officer

Elnet (Denmark)
Johannes Bruun
Director of International Electricity Market Development

Greater Poland Center for Social Economy
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Divers
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Project manager and international advisor

Arbejderbevægelsens Erhvervsråd
Sofie Holme Andersen
Chief economist

Global Wind Alliance
Ralph Savage
Chief Stakeholder Relations Officer

India

Self Employed Women Association (SEWA)
Manali Shah
National Secretary

TKTMS (construction workers union from South India)
Ponkumar Ponnuswamy
President