



Solar Hands-on training and
International Network of Exchange

Greening TVET for the solar energy sector in Ghana

Case illustration and roadmap



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Author

Siri Lijfering
Rikke van der Veen

Supervisor

Anika Altaf

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Executive summary

Ghana's developmental progress over recent decades has been exceptional. However, the country's impressive economic growth has not been matched by a corresponding rise in job opportunities, especially for its youth. Annually, only 20,000 out of 200,000 new job seekers secure formal employment and one in five young people between 15 and 35 are unemployed. Furthermore, with the informal economy comprising 75% of the workforce, inadequate working conditions continue to be a significant issue, compounding the challenges of youth unemployment and underemployment. A promising avenue for employment creation is the country's low carbon transition which is expected to create new, green job opportunities for youth. The solar sector, in particular, presents vast opportunities as the country holds significant solar potential, yet very limited installed solar PV capacity. However, a significant barrier to capitalise on these opportunities is the mismatch between the evolving needs of the labor market in the green economy and the current skills of young people.

Technical and Vocational Education and Training (TVET) holds a pivotal role in bridging this skills gap and supporting Ghana's transition to a green economy. Investing in Greening TVET in Ghana is crucial for aligning the workforce with the emerging demands of the solar energy sector, fostering innovation, and supporting sustainable development. Additionally, it equips young professionals with the skills needed to thrive in the green economy, enhancing their employability not only in the current labour market, but also in the future of work.

However, many challenges and obstacles still remain when it comes to greening TVET in Ghana and concerted effort is needed by key stakeholders in Ghana's solar industry and TVET ecosystem. This report provides insights into the opportunities and barriers for greening TVET in Ghana by examining the energy and TVET landscape and the labour market context. It also identifies skill gaps and showcases best practices. It draws on both existing research and empirical data collected during a study visit in June 2024. By highlighting the perspectives and experiences of key stakeholders in Ghana's TVET system and solar energy sector, the report outlines barriers and opportunities for greening TVET resulting in a roadmap with recommendations and pathways for change.

Ghana's energy and policy landscape

With an energy access rate of approximately 87%, Ghana is one of the highest performing countries in Sub-Saharan Africa when it comes to the ambition of universal energy access.¹ The country has made major strides over the last decades in increasing access to the grid; from a mere 61% electricity access rate in 2011 to 79% in 2016 and 87% today. Ghana relies on a diversified energy mix, dominated by hydropower, thermal energy and gas.² However, despite hosting the largest hydropower project of the Western African region, more than two thirds of Ghana's energy sources come from burning fossil fuels, which generates high Greenhouse Gas (GHG) emissions. Furthermore, although Ghana receives some of the highest levels of solar radiation globally,³ renewable energy sources like wind and solar contribute to less than 1% of its total energy supply.⁴

¹ International Energy Agency: <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>

² International Energy Agency (IEA): <https://www.iea.org/countries/ghana>

³ Asumadu-Sarkodie, S., Asantewaa Owusu, P (2016) A review of Ghana's solar energy potential, Aims Energy 4. <https://www.aimspress.com/article/10.3934/energy.2016.5.675>

⁴ <https://www.se4all-africa.org/seforall-in-africa/country-data/ghana/>

The increasing demand for reliable and affordable electricity in Ghana and the need to reduce greenhouse gas emissions has resulted in significant investments and policy engagement supporting renewable energy projects. In 2019, the government launched its Renewable Energy Master Plan and in 2023 this was supplemented by the Energy Transition and Investment Plan. Both these strategic documents set ambitious targets, including the achievement of net-zero energy-related carbon emissions by 2060 and achieving 10% renewable energy penetration by 2030. Additionally, the government has launched policies, partnerships and regulations supporting solar adoption, such as feed-in tariffs, net metering and public-private partnerships (PPPs) which have contributed to the growth of the industry. However, despite these efforts, Ghana's solar energy potential remains vastly untapped and the solar market is anticipated to grow and expand substantially over the next decade.

Labour market trends, challenges and opportunities

With the growth of the solar energy sector in Ghana, there is a rising need for a skilled workforce that can keep up with the industry's innovations and rapid advancements and is prepared for changing labour market needs in the future of work. As solar panels and equipment are primarily manufactured abroad and imported to Ghana by various national and international companies, the majority of professionals in the solar industry work in the installation and maintenance of solar PV technologies. As the market expands, however, other occupational profiles become increasingly more relevant and it is crucial to develop labour market intelligence through foresight analysis to understand where the new jobs will be created and what skills would need to be developed.

However, critical skills gaps remain:

- **Practical Installation Skills:** Basic practical skills in designing solar PV systems, covering aspects such as system sizing, site analysis and placement optimization for maximum energy generation are often only read about but not sufficiently practiced. Additionally, proper use of tools and adherence to health and safety standards are lacking. Knowledge of diverse system set-ups, including both on-grid and off-grid setups and net metering, is also missing.
- **Analytical and Problem-Solving Skills:** Maintenance and troubleshooting of solar systems to identify faults and inefficiencies require strong analytical abilities, which are often underdeveloped in current training programs.
- **Innovation and entrepreneurship skills:** There is also a skills gap in leveraging the Productive Use of Energy, particularly in optimizing the increased energy supply from solar power and using it to create tangible value, such as enhancing productivity, generating income, and creating employment opportunities. Application of solar in other industries such as heating and cooling systems, solar-powered irrigation and e-mobility is also not well-developed.
- **Transversal and soft Skills:** While technical skills are essential, the ability to manage projects, communicate effectively with clients, and innovate new solutions is equally important in the solar sector. While entrepreneurship is included in (most of) the TVET curricula, more real-life engagement and work-experience learning opportunities are needed.

- **Green life skills:** Environmental awareness, knowledge about sustainable practices, other renewable energy technologies, and energy efficiency is often missing.

TVET ecosystem: policies, perceptions and pathways

A key factor in addressing these skill gaps and fostering the growth of Ghana's solar sector is the development of a strong and supportive TVET system. This system should focus on developing green skills to prepare Ghana's youth for working in the expanding solar energy market.

Ghana's TVET system has undergone substantial reform in recent years, particularly through the 2019 Harmonization of TVET initiative, which centralized all 218 institutions under the Ministry of Education and appointed two agencies with the responsibility of managing the TVET system in Ghana: The Commission for TVET (CTVET), responsible to regulate, promote and administer TVET and the Ghana TVET Service (TVETS), responsible for management, oversight and implementation of approved national policies and programmes relating to pre-tertiary TVET.

Another relevant change has been the introduction of the Free Senior High School (SHS) policy in 2017 when president Nana Addo Dankwa Akufo-Addo declared that secondary education, including TVET, would be freely accessible to all students. The free element of the policy refers to free tuition, admission, library fees, facilities fees such as ICT, examination fees, boarding, and meals. As a result, the number of students for SHS including TVET drastically increased. However, despite the increasing enrolment rates, the TVET system in Ghana still suffers from a poor public image as a place 'for the academically weak' and most parents believe that students attending TVET institutions do so as a last resort after failing to secure a university placement. In addition, the chances of obtaining a job after TVET are deemed significantly lower than in tertiary education.

Another important development is the increased focus on competency-based training (CBT) in TVET, which is an outcome-based education and training where the learner is educated and assessed based on demonstrated ability (occupational standards) rather than on that of elapsed time. The CBT approach has helped align TVET programs better with labor market demands, which is particularly important in emerging sectors like renewable energy. However, solar energy TVET training remains in its nascent stages in Ghana. Currently, training in solar PV technology is scattered across public institutions, private providers and through informal apprenticeships. In TVET, solar courses are integrated into broader electrical engineering curricula, leaving a gap in specialized solar training.

Recent initiatives have attempted to address this. A comprehensive three-year competency-based solar PV curriculum has been piloted in selected TVET institutions, with plans for a nationwide rollout. In addition, short courses (1- 4 weeks) are offered by private sector-led initiatives that focus on basic technical skills. Despite these advances, much of the solar training remains theoretical, with insufficient opportunities for hands-on learning. This lack of practical exposure is a major barrier to young people entering the labour market.

Barriers & Pathways for change

As this paper shows, greening TVET in Ghana provides a promising avenue for generating green jobs for the country's expanding youth workforce and advancing towards a low-carbon economy. However, substantial barriers to fulfilling this potential remain. To overcome these challenges and unlock the power of solar energy and TVET in Ghana, the following recommendations outline potential pathways for driving meaningful change.

1. **Strengthen stakeholder engagement and coalition building.** In recent years, numerous solar trainings have emerged in Ghana. However, these efforts often lack alignment with existing programs, leading to issues with accreditation, and quality assurance. Collaboration among key players in the solar industry in Ghana is essential for greening TVET as it ensures that TVET programs align with industry needs, policies and opportunities in the green economy.
2. **Development of green curricula and green skills identification.** Despite the increased focus on competency based training and workplace experience and learning, the collaboration between TVET institutions and companies is still limited. Working closely with the sector skills bodies, the renewable energy association and other industry leaders to forecast labour market demands and systematically identify and address skills gaps. In addition, expanding TVET-industry partnerships can help in facilitating relevant attachments and practical experiences for students which is crucial to bridge the lack of practical experience.
3. **Capacity building for TVET trainers.** Many TVET teachers lack up-to-date knowledge and hands-on experience with solar PV systems, which impedes their ability to effectively teach the latest techniques and technologies. In addition, teacher retention is an issue, leaving TVET institutions struggling to maintain a knowledgeable teaching workforce. Invest in specific solar energy teacher training and encourage trainers to gain hands-on experience in the solar industry to better understand practical applications and current technologies. Providing incentives and opportunities for lifelong learning to increase attractiveness.
4. **Fostering inclusivity in TVET institutes.** Ensuring inclusivity within TVET is essential for fostering a diverse and equitable workforce in Ghana. This involves addressing several critical dimensions: gender responsive training opportunities, in particular access to TVET training by young women, support for individuals with disabilities, outreach to people from remote communities and engagement of youth in decision making processes around TVET policies.
5. **Facilitating green job creation and employment in the solar industry.** Creating a supportive business environment for solar companies and raising awareness among youth and the public about career opportunities in the sector is key to support employment in Ghana's solar sector. In-depth research on the labour market to understand job demands and trends, focusing on the decency of green jobs and advocating for stable employment and service contracts over temporary positions will

be instrumental in creating sustainable livelihoods.

6. **Enabling policy and funding environment for the solar industry.** Establishing a supportive policy and funding environment is crucial for advancing the solar industry and greening TVET in Ghana. Key steps include developing education and training policies and standards, as well as implementing policies that guide the transition to a green economy
7. **Green awareness building.** Building green awareness is essential for greening TVET programs to design and implement sustainable practices into curricula and TVET systems. In addition, broader green societal awareness will enhance the relevance of solar TVET education and promote a culture of sustainability in Ghana.

About SHINE

SHINE is a Capacity Building project funded by the EU Commission that seeks to drive the green transition and enhance energy Access in Africa. A European African consortium, involving VET providers and stakeholders from education, industry, and policy makers, is collaboratively redesigning a market-oriented VET program focused on solar panel technology.

Starting in January 2024 and for 36 months, the SHINE project gathers 10 organizations from Europe and Africa actives in the field of TVET and education and experts in the solar energy industry. It is constituted by VET providers and their networks (CIFP Usurbil LHII - ZubiGune Foundation in Spain, AKMI in Greece, Jobitech in Nigeria, Suame Technical Institute in Ghana, and Kiryandongo TI & Huys Link VTC in Uganda), Universities, research and business development centers (Start-up SMEs Centre, SSC, in Ghana, Pan-Atlantic University in Lagos, Nigeria and Universiteit Leiden with their Dutch-African knowledge platform of researchers, INCLUDE). All of them led by Mundus, an Spanish organization with a wide experience in the African continent and presence in more than 25 countries through capacity building initiatives.

The main objective is to deliver an innovative capacity building program in Solar Training in Africa and the specific objectives include:

1. To strengthen the evidence-base around green skills in the solar industry in Africa
2. To develop a hybrid capacity building program for VET teachers
3. To redesign and pilot Solar Panel technology program
4. To promote the employability and self- employment of learners
5. To encourage long- lasting international partnerships

To achieve this ambitious goal, the working methodology is divided into three distinct phases: The first phase is focused on research, during which study visits, interviews, and meetings with key stakeholders in TVET, employment, and the energy sector (schools, universities, government bodies, and the private sector) are conducted to map out the current state of solar energy and training, identifying the main challenges and opportunities.

Once the context is understood, capacity-building pathways are designed to upskill trainers in VET centres in Nigeria, Ghana, and Uganda, with specific training provided in centres of excellence in Europe.

Finally, based on the groundwork, the training for educators, and collaboration with key stakeholders, the curriculum is co-created and redesigned to align with market needs.

Below is one of the key outcomes of the project's first phase, where the solar energy landscape and the sector's needs in terms of skills, strategies, and policies were thoroughly analyzed.

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1. Introduction

Ghana's developmental progress over recent decades has been exceptional. However, the country's impressive economic growth has not been matched by a corresponding rise in job opportunities, especially for its youth. Annually, only 20,000 out of 200,000 new labour market entrants secure formal jobs⁵, highlighting an urgent need for more job creation. In this regard, a low-carbon transition offers a promising avenue, as the green economy is projected to generate vast new job opportunities across the continent. A key barrier to realizing this potential however, is the skills mismatch between the evolving needs of the labour market and the education and skill-set of young people. Bridging this skills gap is essential for preparing Africa's youth not only for today's economy but also for the future of work. Technical and Vocational Education and Training (TVET) can play a pivotal role in this transition, helping to bridge the skills gap and support the shift to more sustainable societies and green jobs.

A promising sector for green job creation is the solar industry as Africa holds 40 percent of the world's solar potential but only 1 percent of installed solar photovoltaic (PV) capacity so far.⁶ By integrating solar technology training programmes into TVET, Ghana can provide its youth with specialized skills in a rapidly expanding sector that holds promises both for job creation and environmental sustainability. Investing in solar energy training not only addresses the immediate need for skilled workers in a growing industry but also contributes to a greener economy. Strengthening and Greening TVET in Ghana can thereby support young Ghanaians to seize new opportunities, drive innovation, and build a more resilient workforce capable of meeting the labour market demands of the future.

This report provides insights into the opportunities and barriers for greening TVET in Ghana by examining the energy and TVET landscape and the labour market context. It also identifies skill gaps and showcases best practices. It draws on both existing research and empirical data collected during a study visit in June 2024. By highlighting the perspectives and experiences of key stakeholders in Ghana's TVET system and solar energy sector, the report outlines barriers and opportunities for greening TVET resulting in a roadmap with recommendations and pathways for change.

Ghana's energy landscape

With an energy access rate of approximately 87%, Ghana is one of the highest performing countries in Sub-Saharan Africa when it comes to the ambition of universal energy access.⁷ The country has made major strides over the last decades in increasing access to the grid; from a mere 61% electricity access rate in 2011 to 79% in 2016 and 87% today. Ghana relies on a diversified energy mix, dominated by hydropower, thermal energy and gas.⁸ However, despite hosting the largest hydropower project of the Western African region, more than two thirds of Ghana's energy sources come from burning fossil fuels, which generates high Greenhouse Gas (GHG) emissions. Moreover, despite receiving some of the highest amounts of radiation

⁵ African Center for Economic Transformation (ACET) (2022)

⁶ Ghantous, N. (2022).

⁷ International Energy Agency (2022)

⁸ International Energy Agency (2024)

globally,⁹ still less than 1% of Ghana's energy is supplied by renewable energy (RNE) sources such as wind and solar.¹⁰

In addition, despite its good performance, the country still faces challenges in the provision of universal energy access. The first is the high cost and technical difficulty in the last mile distribution of electricity to remote communities such as the island communities in the Volta region. Addressing the spatial inequality whereby almost 94% of urban zones have access opposed to 74% access in rural areas, is therefore a key concern of the Ministry of Energy.¹¹ A related challenge is the reliability of energy access. In recent years energy users have been plagued by power cuts, colloquially called “dumsor”. This has led to many households, businesses and public institutions resorting to the use of diesel-powered generators for backup energy usage to avoid dependence on the national grid, which is leading to increased carbon emissions. Thirdly, the high cost of electricity, which is the result of long-term and expensive power purchase agreements (PPAs) that the state concluded with private operators combined with the recent inflation rates, provides a barrier to energy usage for many low-income households.¹²

In order to secure political support in this pivotal election year, the Ghanaian government increased its energy efforts as the general adage in Ghana states: “No lights, no votes.” In this respect, an ambitious policy target was formulated stating that by 2025, 90% of the country should have access to reliable energy. To meet this target, there is an increased need for intensification of renewable energy deployment programs with an emphasis on solar energy as it constitutes about 90% of Ghana's installed renewable energy generation capacity.¹³ This requires targeted policy and programme interventions to support the solar energy sector in Ghana.

Energy transition: policy & practice

The increasing demand for reliable and affordable electricity in Ghana and the need to reduce greenhouse gas emissions has resulted in significant investments in renewable energy projects. In the solar industry these investments primarily take shape as feeding tariffs, public private partnerships and SME support. Additionally, the government offers an implementation of tax incentives and importation fee exemptions for some renewable energy components.¹⁴ With investments from the Swiss government and the African Development Bank, the Ministry of Energy is currently working on scaling the solar energy production and consumption by investing in net metering,¹⁵ which allows utility customers to generate their own electricity cleanly and efficiently. During the day, most solar customers produce more electricity than they consume; net metering allows households to export that power to the grid and reduce their future electric bills.

⁹ Asumadu-Sarkodie, S., Asantewaa Owusu, P (2016)

¹⁰ Irena (2021)

¹¹ Interview with the Deputy Director of the Renewable Energy Regulation department of the Renewable energy commission.

¹² GIZ (2022)

¹³ Amo-Aidoo, A., Kumi, E. M., Hensel, O., Korese, J.K. Sturm, B. (2022)

¹⁴ Ibid.

¹⁵ Interview with the Deputy Director of the Renewable Energy Regulation department of the Renewable energy commission.

Ghana's increased ambition to transition to a more sustainable energy mix, has also resulted in an update of its policy and regulatory frameworks. In this respect, the country updated its nationally determined contribution under the Paris Agreement from 2020 to 2030 and published the "Renewable Energy Master Plan" in 2019 which puts forward the target of achieving 10% renewable energy penetration (excluding hydropower) by 2030. In September 2023, the government also launched the Ghana Energy Transition and Investment Plan, which stipulates strategies and regulations for the achievement of net-zero energy-related carbon emissions by 2060.

Youth (un)employment - statistics and trends

Although internationally commended for its proactive energy policies, critics warn that policy implementation and prioritisation of green economic growth is lacking and the focus on *justice* in the just transition process risks getting lost.¹⁶ This is particularly salient for Ghana's youth as 57% of the population is below 25 years, and 35% is aged between 15 and 35 years.¹⁷ According to the 2021 Population and Housing Census,¹⁸ one in five (19.7%) young persons is unemployed in the country. The unemployment rate for young people between 15 and 24 is even higher, at an estimated 32.8%.¹⁹ Only 10 percent of the 200,000 people entering the labour force each year find formal sector jobs.²⁰ Furthermore, unemployment is more prevalent among women compared to men. In addition, a lack of decent working conditions and health and safety are major concerns as the informal sector in Ghana employs around 90 percent of the total workforce, a majority of them being women. The informal sector is characterized by lack of access to credit, high financial risk, income insecurity and unsafe working conditions.²¹

Young people are often faced with a unique set of challenges as they transition from school to work, making them more susceptible to unemployment.²² As Avura and Ulzen-Appiah (2016) noted, young people are more likely to remain unemployed because of their lack of job-relevant soft and hard skills, job-search experience, and skills mismatch. Technical and Vocational Education and Training (TVET) is in this regard positioned as crucial to equip a new generation of Ghanaian workers with the skills they need for the future of work. As incumbent President Nana Addo Dankwa Akufo-Addo stated, "*the development of TVET is key to building a prosperous future*".

Ghana's 5-year Strategic Plan for TVET (2018-2022) highlighted Greening TVET as a priority for the enhancement of the TVET system. Following the Strategic plan, the National Green Jobs Strategy Implementation Plan (2021-2025), focused heavily on skills development to address the lack of professionals such as engineers, technicians, and technologists and the skills mismatch and equip young Ghanaians with 21st century skills for the future of work in the green economy.

¹⁶ Sefa-Nyarko, C. (2024)

¹⁷ Baah-Boateng W. (2021).

¹⁸ Ghana Statistical Services (2022)

¹⁹ Ghana Statistical Service, 2021

²⁰ African Center for Economic Transformation (ACET) (2022)

²¹ Ibid.

²² Oosterom & Yeboah, 2022; Nilsson, 2019

2. An overview of the TVET ecosystem in Ghana

This section first describes the structure of the TVET system, with a specific focus on solar energy, and discusses relevant policies, regulations, and key system players. Next, it outlines the various types of TVET programmes available. Finally, the third part reflects on the public perception of TVET in Ghana, highlighting potential shortcomings as seen by the public.

Stakeholders and Policies regulating TVET

Following the heightened political attention and importance placed on secondary education in Ghana, the country has made giant strides in TVET education through some specific policy- and delivery reforms. Before the reforms, Ghana had one of the weakest TVET systems in the region,²³ due to a highly fragmented system that resulted in a lack of coordination and oversight that made it difficult for quality assurance management. In 2019, the Government of Ghana initiated a transformation of the TVET sector, better known as the “Harmonization of TVET”. In this context, all 218 TVET institutions, which were previously spread over 19 different ministries, were organized under the umbrella of the Ministry of Education (MoE). Guided by the *Education Regulatory Bodies Act 2020* and the *Pre-Tertiary Education Act, 2020*, two agencies were newly established and tasked with the responsibility of managing the TVET system in Ghana: The Commission for TVET (CTVET) responsible to regulate, promote and administer TVET and the TVET Service (TVETS) responsible for management, oversight and implementation of approved national policies and programmes relating to pre-tertiary TVET.

In addition to regulation and management, these two agencies are responsible for the expansion of competency-based training (CBT) approaches in Ghana. CBT is an outcome-based education and training where the learner is educated and assessed based on demonstrated ability (occupational standards) rather than on that of elapsed time. The main objective of the CBT approach is to strengthen the competencies of learners in the national skills development agenda in order to increase the employability of students and address the shortage of skilled and competent workforce needed in the country. Within CBT education, learning materials and curricula are designed and developed with input from industry. In this regard, various Sector Skills Bodies were established in Ghana with key industry leaders in a particular trade to ensure that the skills and knowledge obtained through education and training are relevant to the needs of industry, commerce, and the community at large.

The CBT model is integrated in the National TVET Qualification Framework (NTVETQF) which offers TVET learners an opportunity to progress along eight qualification levels, starting from National Proficiency I (NP I) to Doctor of Technology (D.Tech). Technical training at a TVET centre is situated at the first four levels after which students can decide to go to university to continue their education and pursue a higher degree. The National TVET Qualifications Committee is responsible for the pre-qualification and inclusion of new TVET programmes. Out of a total of 575 pre-tertiary TVET institutions, 25% have been accredited by CTVET and are entitled to run CBT-based programmes.

²³ African Center for Economic Transformation (ACET) (2022)

The CBT assessment system has also been used to facilitate the recognition of prior learning (RPL) which entails the evaluation of prior skills and knowledge acquired through formal and non-formal learning (skills acquired in earlier study or through work experience) against predetermined qualification standards to formally recognize them. If learners pass assessment, they are able to skip a number of modules in a training course or acquire certification.

CTVET is also expanding access to TVET in the informal sector through the Ghana TVET Voucher Project (GTVP). The Voucher project is implemented in collaboration with the German Government and its development organization KfW. This project provides training vouchers to CTVET registered master craft persons, their apprentices, and workers. Target groups are owners of small and medium scale enterprises of the informal sector as well as their workers and apprentices with the mandate to manage, oversee and implement approved National policies and programmes relating to Pre-tertiary Technical and Vocational Education and Training. Currently, the project is implemented in nine trade areas, one of which is electrical installation. However, no specific solar programmes are recognised.

In this way the commission tries to align its coordination efforts with the country's traditional informal sector apprenticeship training which is very well established and common in West Africa. According to Breyer (2006), informal apprenticeship training accounts for about 80-90% of all skills training in urban areas in Ghana. Private TVET institutions in Ghana make up one-third of all TVET institutions, however they account for only eight percent of enrolment²⁴.

Free education

Finally, one of the most radical reforms affecting the TVET system was the Free Senior High School (SHS) policy launched in 2017 when president Nana Addo Dankwa Akufo-Addo declared that secondary education, including TVET, would be freely accessible to all students. The free element of the policy refers to free tuition, admission, library fees, facilities fees such as ICT, examination fees, boarding, and meals. Out of the 261 formal TVET institutions, 222 are currently implementing the Free TVET programme²⁵. As a result of the introduction of free SHS, the number of students for SHS including TVET drastically increased. The TVET enrolment almost doubled between 2019 and 2024, from 30,486 to 60,481²⁶. While the Free TVET policy has increased the access to vocational training for Ghanaian youth, it also has its drawbacks. As only 3 percent of public funding for education is allocated to TVET²⁷ any additional investment in education support such as career guidance and counselling have lagged in implementation.

TVET policies and programmes for the solar energy sector

The Solar Technology training offer in Ghana is highly dispersed. Until recently, solar PV training was only available as a public, formal training course that was part of the curriculum (a

²⁴ Ghana Ministry of Education (2018)

²⁵ Presentation by Ghana TVET service

²⁶ Ibid.

²⁷ Ghana Ministry of Education (2018)

module) of the general electrical engineering course or informally through apprenticeship and on the job training provided to (prospective) workers by solar companies. In recent years, a number of solar specific courses have been developed and put on offer by various private training providers and a comprehensive three-year competency-based Solar PV curriculum is currently piloted in a number of selected TVET institutions and is scheduled to be implemented nation-wide. Within this training offer there is a clear distinction to be made by the short, practical courses and the formal CBT training.

Short courses

In the last ten years there has been an expansion of the solar training offer by universities and private training providers. These entail mostly short courses ranging from one week to one month. Some notable training providers include the following.

The Regional Centre for Energy and Environmental Sustainability (RCEES)

Situated on the campus of the University of Energy and Natural Resources in Sunyani, 120 km North of Kumasi, RCEES, was established in 2019 with support from the World Bank, the Association of African Universities and the Government of Ghana as a Centre of Excellence (CoE) in Africa. The centre provides four short, internationally accredited courses relevant to the solar sector; 1). Design and Installation of Standalone Solar PV Systems, 2) Solar-Powered Irrigation Systems, 3). Energy Audit and Energy Management and 4). Energy Management and Efficiency Training. The duration of the courses is one week and is targeting professional who are just entering the job market, students completing their studies in electrical or mechanical engineering and looking to obtain more practical skills or students who wish to diversify their knowledge into diverse solar applications²⁸.

The Energy Center of the Kwame Nkrumah University of Science and Technology (KNUST)

The KNUST Energy centre, based in Kumasi was one of the first university-based centres offering a MSc Programme in Renewable Energy Technologies by e-Learning. This master program targets students wanting to work in the solar sector and energy policy makers and small/medium scale entrepreneurs aiming to get a deeper understanding of the renewable energy landscape in Ghana. In 2011, advanced courses were introduced which targets engineers and other practitioners in the energy sector (with a minimum of a University Degree in Science or Engineering) who require more sophisticated analytical tools for design and decision-making²⁹. These advanced courses take one week and are focused on hands-on and practical training, including System Design (Load Assessment, PV array sizing, charge regulators, battery bank, cabling, etc); Installation, System maintenance and Management; Economic Assessment of PV projects³⁰.

Applied Technology Institute, Accra Technical Training Centre, and Prefos Electrical Training Centre Emerging from a public-private partnership between the German government through UWZ, an environmental Centre in Germany and the Ghana TVET Service under the guidance of the Partner Africa project, this hands-on training workshop in Solar Photovoltaic Technology was developed to train TVET trainers in practical solar skills. Modules for the

²⁸ Focus group discussion with the staff of The Regional Centre for Energy and Environmental Sustainability

²⁹ Brochure provided by the director of KNUST

³⁰ Interview with the director of the KNUST energy centre

training comprised Solar System Installation and Design, Sales, and Marketing. The training offer is now institutionalised at four training centres in the country.

Business-led training offers: example Solar taxi

In addition to technical training institutes, there are also increasingly courses offered by industry leaders to upskill students with technical knowhow and hands-on skills. One of these companies is solar taxi, that started as a project funded by the MasterCard Foundation to create employment opportunities for young people through the use of solar energy to power solar-powered electric vehicles (EV). Solar taxi offers a 4-week intensive practice-based training course for young women in EV technologies and EV operation. Although the company works together with TVET institutes, there is still a gap that the private training needs to fill which is the hands-on experience with solar applications in auto mechanics as this is often not part of the formal TVET training.³¹

3 year programme: CBT Solar Photovoltaic Technology Course

In 2021, CTVET and GIZ joined forces to co-develop a standalone TVET course on solar PV technology. This course, focused primarily on solar systems installation and maintenance is a three year formal TVET course for proficiency level I and II certification. Within this training, students will be required to cover the whole value chain from the installation of Solar PV systems, to project development skills for PV system design, resource assessments, and business plan development. The contents of the course include basic electrical and electronics principles, health & safety, Solar PV components, site assessment and Solar PV troubleshooting and Solar PV design and installation³².

To develop the curriculum, GIZ and CTVET engaged the Renewable Energy Sector Skills Body to formulate occupational standards and skill requirements. GIZ initially piloted the programme at 6 selected TVET institutes in 2022/2023 and this year selected 6 more technical institutes for further piloting. After the completion of the pilots, plans are in the works for nation-wide rollout.

Perception of TVET for the solar sector

Despite the increasing enrolment rates, the TVET system in Ghana still suffers from a poor public image as a place 'for the academically weak'.³³ Most parents believe that students attending TVET institutions do so as a last resort after failing to secure a university placement. In addition, the chances of obtaining a job after TVET are deemed significantly lower than in tertiary education,³⁴ even though the data does not support this claim. In a comprehensive survey of companies in Ghana, 61.5 percent indicated that the minimum qualification level they hire is secondary, which includes TVET graduates.³⁵ To address this poor perception and

³¹ Interview with Chief Operating Officer Solar Taxi

³² Information leaflet on the CBT Solar PV training shared by the Suame Technical Institute

³³ Baffour Gyau, M., Osei, M., Baffour Gyau, N. (2024)

³⁴ Ibid.

³⁵ African Center for Economic Transformation (ACET) (2022)

promote TVET as a worthwhile pursuit, the Council for TVET (the predecessor of CTET) launched a national campaign in 2019 called “MyTVET” to showcase different TVET career paths. In addition, the Ministry of Education has co-organised TVET campaigns such as the WorldSkills Ghana Competitions, STEMNOVATION, and TVET Sports.

Talking to students participating in a solar PV installation course at the Don Bosco Technical and Vocational Institute in Sunyani, it seems that TVET for the solar sector has a better reputation. Most students shared the perception that ‘solar energy is the future in Ghana’. When asked what their motivation was for participating in this course, the majority said it was to be able to get the right skills to get a job. As one student expressed: *“I wanted to go to TVET and not to a university, because TVET prepares you better for a job and that’s what we need here in this community.”*³⁶ When asked if they considered environmental sustainability considerations in their decision for this course, they unanimously said those considerations didn’t play a factor. It was the market growth potential that was the deciding factor. They also saw the solar PV training as a great way to set them apart from other electrical engineering students as this ‘gives them an edge on the job market’, while still enabling them to perform the same work as the electrical engineering students. Finally, opting for a certified course was also a reason for enrolment as the certificate *“proves the skills you have developed”*. Overall, students felt that the TVET solar training would provide them a solid foundation for their future job search.

³⁶ Focus group with learners at the Don Bosco Technical and Vocational Institute in Sunyani

3. Labour market trends, challenges and opportunities

Although solar energy is still a very limited part of the energy mix in Ghana, the solar sector has experienced rapid growth in recent years and is expected to grow substantially over the next decade³⁷. This growth is driven by several factors. Firstly, a number of favourable government policies and regulations aimed at reducing reliance on fossil fuels and supporting a transition to clean energy sources. Many large-scale solar projects are driven by public-private partnerships with the Ghanaian government providing funding and support. One such project is a floating solar power plant in the Bui reservoir. This 5-megawatt facility, part of a hybrid plant combining solar and hydro, installed earlier this year is now the continent's largest floating solar photovoltaic (PV) project.

Secondly, the declining solar installation costs, including the cost of solar panels and inverters and the increased public awareness of the benefits of solar energy³⁸ provides a conducive environment for business growth. Thirdly, technological advancements in solar panel and storage efficiency are expected to convince people to switch to renewable energy as electricity prices from non renewables keep rising. Rooftop solar installations have particularly gained popularity due to declining costs and increasing panel efficiencies. The agricultural sector is also a growth market in Ghana, where solar powered irrigation is increasingly used to improve agricultural productivity, reduce the reliance on traditional fuel powered pumps and enable efficient water management³⁹.

However, there are also still factors holding back market growth such as the limited access to finance for solar energy projects and the high costs for batteries needed for energy storage, making it often too costly for private households and small businesses⁴⁰. In addition, the government's insistence on supporting projects for on-grid energy solutions hinders the development of off-grid solutions and mini-grids operating independently from the national transmission grid⁴¹. The recent push by the Ministry of Energy for net metering may provide additional opportunities for solar engineers as 12.000 net metering systems will be installed in the coming year⁴². However, there is also an active lobby of utility companies to maintain the status quo as they have important government contracts they do not want to lose, which is hampering the public investment in solar energy sector and the instalment of the net metering systems⁴³.

Finally, there was also the risk of solar systems getting a bad reputation as most people imported the systems from China which were often of low quality and would stop working after a few months or cause incidents. In the media solar systems were sometimes portrayed as fire hazards which dampened enthusiasm of households to invest in their own solar system and slowed market growth.

³⁷ Mordor Intelligence (2021)

³⁸ MarkWide Research Report (2024)

³⁹ Ibid.

⁴⁰ Interview with the Deputy Director of the Renewable Energy Regulation department of the Renewable energy commission

⁴¹ Reflection shared by a private partner at the multi-stakeholder meeting in Accra

⁴² Interview with the Deputy Director of the RE Regulation department of the Renewable energy commission

⁴³ Interview with GIZ Ghana Director

The ecosystem: private sector players and sectors

A variety of companies are active in the solar sector in Ghana, operating in several business segments, from retailers to wholesalers and importers. Most of the larger companies are foreign-owned that have local subsidiaries or offices within Ghana and domestic companies.⁴⁴ Most solar retailers are located around Accra and Kumasi and focus on selling or leasing solar PV systems to households or to actors operating on a commercial and industrial scale.

In addition to these solar retailers there are also other companies using solar energy as part of their business model. One of the biggest electrical engineering companies in Ghana, Prefos limited recently engaged in a Public-Private Partnership with the Ghanaian government to install solar LED street lighting in urban centres. The company also hosts a private TVET institution; the Prefos Electrical Training Centre (PETC) which offers a hands-on training workshop for youth in Solar Photovoltaic Technology supported by the German government. The PETC focuses specifically on school dropouts, pre-tertiary graduates and the unemployed youths in electrical installation with a special interest in street lighting and Solar PV as these youths would be potential future employees⁴⁵. As the centre is sponsored by both national and international partners, including the German Government, the World Bank, The Energy Commission and the Ghana TVET service, the centre is kitted out with modern equipment, including Solar panels, inverters, and solar accessories.

Another example is Solar taxi. The company provides an e-hailing service and assembles and sells solar-electric powered vehicles (bikes, tricycle, and cars) and solar-powered charging stations. The primary aim of the station is to charge electric cars using solar energy, providing a cost-effective and environmentally friendly option.

Some businesses also utilize solar thermal energy to provide heating and cooling for applications. Solar heating is applied mainly to water heating and crop drying in agriculture and the hospitality and food processing industries are the main users of solar water heaters. Solar cooling is almost non-existent in Ghana but some companies do use solar energy for powering refrigeration. One example is Amponsah Efah Pharmaceuticals, a Ghanaian-owned pharmaceutical company in the Ashanti Region of Ghana who recently installed a 1.140 MWp solar plant to control the climate inside its factory in Kumasi. As the manager explained, the main reason for the grid-led solar plant was to save costs and, in the future, reduce the reliance on the not reliable electricity provided by the grid. Although the company boasts a large solar plant which would provide opportunities for local employment, the company entered a contract with German-based company Redavia, that provides installation and maintenance services exclusively for which it sends staff from its Accra offices.

Solar powered irrigation systems are another upcoming business avenue where farmers are looking to adopt more sustainable and cost-effective irrigation methods. In Ghana, about 40% of the population is employed in the agricultural sector and slightly over 70% of these workers are smallholders living in rural areas.⁴⁶ Extensive rain-fed agriculture under unpredictable and erratic rainfall patterns is a leading cause of low productivity and food insecurity, together with

⁴⁴ SmartSolar Ghana (2019)

⁴⁵ Visit to the Prefos factory and training centre in Kumasi.

⁴⁶ World Bank (2018)

a low degree of mechanization. A recent study,⁴⁷ found that standalone solar PV irrigation systems have the potential to meet more than a third of the water needs for crops in small-scale farms and thereby provide a business opportunity in this field.

Finally, still the most common private sector actors in Ghana are the small and medium enterprises (SME's) and the informal economy. As the solar sector is still not well developed, most graduates end up self-employed, being hired for installation (mainly) or maintenance jobs of solar home systems or solar systems for small businesses or government buildings. Many start-up firms struggle with gaining access to capital which hampers their scalability and thereby also their employment potential. The bigger companies are mostly foreign-owned or funded by international donors such as the World Bank or foreign loans.

Aligning occupations with emerging labour market needs

With the growth of the solar energy sector in Ghana, there is a rising need for a skilled workforce that can keep up with the industry's innovations and rapid advancements and is prepared for changing labour market needs in the future of work. As solar panels and equipment are primarily manufactured abroad and imported to Ghana by various national and international companies, the majority of professionals in the solar industry work in the installation and maintenance of solar PV technologies. As the market expands, however, other occupational profiles become increasingly more relevant and it is crucial to develop labour market intelligence through foresight analysis; i.e. to ability to understand where the new jobs will be created and what skills will then be missing?⁴⁸

This section provides an overview of key occupations required across the solar energy value chain in Ghana, focusing on the emerging labour market opportunities and the critical skills necessary to support this growth. As aggregated data is still largely missing, this section is based on the available information online and from the interviews with key system players during the study visit.

Installation: Installation involves mounting the solar panels, positioning the inverters and batteries, and connecting the system according to the wiring diagram supplied by the designer of the system. This includes the installation of grid-tied, off-grid and hybrid systems. In Ghana, by far the most jobs are currently available in the installation of solar PV systems and this is expected to grow even further with the increased home solar installations and other developments such as net-metering. To support the nation-wide rollout of net metering, there is a high demand for solar technicians who can install bi-directional meters, which can record the energy the solar panels export to the grid and the energy the customer takes from the grid when the solar panels aren't making enough power to run the home's appliances.⁴⁹ While basic technical skills and hand-on experience are needed for the simpler installations, higher skill levels are required for more complex systems.

Maintenance: To ensure solar systems are operating at maximum capacity and efficiency, there is a need for people who can service and maintain the solar systems. On the most basic level, this involves regularly clearing the solar panels of dust and debris, especially when there is little

⁴⁷ Falchetta, G., Semeria, F., Tuninetti, M., Giordano, V., Pachauri, S., Byers, E. (2023).

⁴⁸ Interview with the chairman of the Renewable Energy Sector Skill Body in Ghana

⁴⁹ Interview RE commission lead Ministry of Energy

to no rainfall. On a more advanced level, this includes problem identification and fixing of faulty systems. Although modern inverters come with software that allows the system owner to monitor energy production and energy usage, it often takes a seasoned eye to spot trends that could indicate potential problems with the system, that includes system monitoring as well as regular site visits. In addition, as most Photovoltaic modules were designed and tested in a cooler climates (max 25°C), extreme heat such as in Ghana's Northern provinces can reduce output efficiency by 25%⁵⁰. Smart placing of solar panels and regular checks are key to solar system maintenance and are in high demand by especially larger businesses and public projects such as the Bui floating power plant.

Energy audits: On an even more advanced level, there is a need for energy auditors, who are responsible for assessing the energy usage of a building or facility, identifying areas of improvement, and recommending changes to improve efficiency. Although there is limited demand yet, this is expected to grow with the expansion of Ghana's solar sector.

Project management & marketing: On the business side of the solar value chain, there is also a need for marketeers and project managers who can oversee the design, construction, and installation of solar PV systems to ensure projects are completed on time and within budget. This also includes health and safety checks and stakeholder management.

Entrepreneurs: Another upcoming career path is solar entrepreneurs. These, mostly young Ghanaians use their imagination to turn a societal problem into a business opportunity. One business owner created a business to recycle old laptop batteries to provide reliable and affordable power for electric bikes, power banks, solar lights, businesses and homes.⁵¹ Especially innovation for off-grid solar solutions to enable last-mile distribution in remote areas is a potential growth sector.

Job decency in the formal and informal sphere

As the solar market is not yet well-established, most young people end up self-employed working in the informal sector as freelance installers or retailers of smaller solar systems. Without safeguards, there are concerns about health and safety and decent working conditions in this sector. Moreover, as most of the work is concentrated at the start of a project, with few or no follow-up contracts, most of the work is highly temporary and often lacks the stability and sustainability. Informal traineeships or apprenticeships, which are still the majority of work experience opportunities, often do not pay a living wage as placement is quite competitive. The extent of these issues is hard to tell however, as there is a lack of research and reliable data on decent work and sustainable livelihoods in Ghana's solar sector, highlighting the need for more in-depth studies in this area.⁵²

For women, the challenges of employment in a male-dominated sector such as the solar industry are even more pronounced. The workplace culture or environment is often unwelcome or sometimes even unsafe for women⁵³. In addition, with fewer women in leadership or technical positions, there are also limited role models and mentors for aspiring

⁵⁰ Interview RCEES

⁵¹ Interview with solar entrepreneur that is part of the Ghana Start-up SME Centres network

⁵² Interview researcher at CREES

⁵³ Discussion with the director general of the Ghana TVET service

women in the industry. This lack of representation can make it harder for women to envision themselves in these roles or to find support and guidance. Moreover, in technical fields like solar energy, where there's a prevalent stereotype of these roles being "male" jobs, women may struggle against ingrained assumptions about their abilities and fit for the role. As one female mechanic working on solar-powered electric vehicles shared, finding a job was challenging, as most shops were reluctant to hire her, believing she couldn't be a good mechanic because she was a woman and due to the widely held belief that working as a car mechanic wasn't suitable for women⁵⁴. She ultimately found a job through an NGO funded training and apprenticeship in electrical engineering and is now a trainer and mentor in the female engineering academy.

Identifying skills gaps

As the sections above highlight, the solar sector in Ghana holds great potential for Ghana's youth in a variety of different business sectors and occupations, ranging from technical roles in solar panel installation and maintenance to strategic positions in project management and entrepreneurship. However, the shortage of qualified professionals with the necessary skills poses a substantial barrier.

This section investigates the evolving demands of the labor market within Ghana's solar energy sector and the corresponding skills deficiencies among the youth. It aims to identify the specific skills gaps that need to be addressed through TVET programs.

Practical skills and hands-on experience

"Students come with knowledge, but without any practical skills." This quote from the director of the Renewable Energy Association reflects the perspective shared by many respondents of the study visit that students graduating from TVET or University have some good basic theoretical knowledge, but lack hands-on experience and practical skills. Because of this skills gap, businesses often rely on foreign expertise for bigger projects, rather than local engineers⁵⁵.

Basic practical skills in designing solar PV systems, covering aspects such as system sizing, site analysis, shading analysis, and placement optimization for maximum energy generation are often only read about but not sufficiently practiced. There is a lot of energy wastage by the wrong placement of solar panels, degradation because of wear and tear or overheating. Additionally, proper use of tools and adherence to health and safety standards are not always ensured. Knowledge of various systems and applications, including both on-grid and off-grid setups and net metering, is also lacking. Many students and teachers we interviewed were unfamiliar with how to work with emerging opportunities like net metering.

Analytical skills and problem solving

Another skills gap was identified in the maintenance of solar systems and pertains to the analytical skills and problem analysis needed to understand the behavioural aspect of a system. This is critical for the performance of the system but very underrepresented and

⁵⁴ Interview female car mechanic at solar taxi.

⁵⁵ Interview with Director at KNUST

underappreciated⁵⁶. In addition, knowledge on how to deal with e-waste is often not considered but a very important element to ensuring sustainability. When a solar plant is decommissioned, batteries cannot simply be discarded; they must be dismantled with care. Unfortunately, not everyone is trained for this task, and there is a shortage of skilled professionals to manage it properly.

Innovation and entrepreneurship skills

There is also a skills gap in leveraging the Productive Use of Energy (PUE), particularly in optimizing the increased energy supply from solar power and using it to create tangible value, such as enhancing productivity, generating income, and creating employment opportunities. Skills are also lacking in implementing solar-powered irrigation and other solar-driven solutions that can boost revenue for rural communities and stimulate demand for clean electricity.

Soft and transversal skills

On the other side of the spectrum, there is a lack of soft skills, which include interpersonal, communication and behavioral skills. A survey conducted among business professionals in Ghana showed that communication skills are among the skills most desired by Ghanaian employers, but graduates are often found lacking in this regard⁵⁷. As the opportunities for employment in the Ghanaian solar sector are still limited, these transversal skills are incredibly valuable⁵⁸. Project management skills and customer service were also mentioned as skills that often need further development post-TVET education. And while entrepreneurship is included in (most of) the TVET curricula, there is potential for further enhancement through more real-life engagement and work-experience learning opportunities. Providing opportunities for life-long learning ensures that individuals remain up-to-date with industry advancements and enhance their skill sets over time.

Green life skills

Finally, when it comes to finding opportunities in the green economy, there is also a need for green life skills, which includes environmental awareness, knowledge about sustainable practices, other renewable energy technologies, and energy efficiency.

4. Challenges and systemic barriers for greening TVET

This section explores the various challenges and systemic barriers that impede the greening of TVET. From limited technical expertise of trainers, limited resources for teaching materials and equipment, to weak coordination among stakeholders and poor linkages with industry. Understanding these issues is crucial for developing targeted strategies to advance greening TVET systems for the solar industry in Ghana.

⁵⁶ RCEES interview.

⁵⁷ African Center for Economic Transformation (ACET) (2022)

⁵⁸ Interview Country Director GIZ

Insufficient coordination and cohesion between different stakeholders and programmes

In recent years, numerous new solar training programs have emerged in Ghana, aimed at addressing the skills mismatch in the industry. Many of these programmes are foreign-funded and led by international development organisations and institutions like the World Bank or the German government. The DG of CTVET⁵⁹ expressed concern that many of these efforts are not well-aligned with existing programs and structures managed by the Commission. This lack of integration can result in new programs not complementing established and standardised frameworks, and a lack of accreditation. In addition, non-accredited programmes may lack proper quality assurance which can add to the negative perception of TVET in the country.

Additionally, young people participating in non-formal training programs frequently find themselves without formally recognized certifications, which limits their job prospects and hinders their ability to showcase their qualifications to employers. There is also a need to match supply-side interventions such as funding of training programs to demand-side interventions targeting employment creation in the labour market to avoid leaving graduates unemployed or feeling discouraged.

Weak linkages between TVET and industry

A third barrier relates to the weak linkages between TVET institutions and the labour market which hampers the ability of the workforce to meet the evolving demands of the job market. Despite the increased focus on competency-based training (CBT) and workplace experience and learning (WEL) in TVET education in Ghana, the collaboration between TVET institutions and companies is still limited and securing quality placements for students is often challenging as companies are not always willing to take on students. In addition, there is still insufficient engagement of industry leaders in defining training needs. This leads to outdated curricula which compels companies to either provide their own training for employees or turn to short, specialized courses offered by non-formal TVET providers. The establishment of sector skills bodies has been a step in the right direction, but as the Renewable Energy Association acknowledges; “There is still a long way to go in terms of knowledge management, especially in the documentation of occupational profiles and skills gaps in the solar industry”.⁶⁰

Limited technical expertise of trainers and inadequate teaching materials and training

In Ghana, many TVET teachers lack up-to-date knowledge and hands-on experience with solar PV systems, which impedes their ability to effectively teach the latest techniques and technologies. According to a study by the Ministry of Education, only 52% of TVET teaching staff possessed technical qualifications in 2018.⁶¹ As Solar PV training is a new field, it seems that an even lower percentage has received specific training in solar technologies. As the SSB shared, many teachers do not know how to work with more advanced solar systems and

⁵⁹ Interview with the Director General of the Commission for TVET

⁶⁰ Interview with the Renewable Energy Association

⁶¹ Ministry of Education (2018)

software configurations are unknown to them.⁶² Also, most teachers had limited to no knowledge of recent developments in the solar industry in Ghana such as net metering⁶³.

Compounding these issues is a high turnover of skilled trainers, as industry often attracts the best talent with competitive offers, leaving TVET institutions struggling to maintain a knowledgeable teaching workforce⁶⁴. These issues not only affect the quality of education, but also undermine the development of a skilled workforce needed to drive the growth of solar energy in Ghana.

Shortage of funding for solar PV equipment

Many TVET institutes are also constrained by inadequate financial resources, which limits their ability to acquire and maintain up-to-date solar PV systems and related tools. This lack of investment not only restricts hands-on learning opportunities for students but also hinders the development of practical skills necessary for the industry. As a result, the gap between theoretical knowledge and practical application widens. These issues are even more pronounced since the introduction of the free TVET policy, as the director of one of Ghana's TVET centres shared. As the free TVET policy does not include funding for training materials, this has put a financial strain on institutions as they cannot use students' tuition to invest in the improvement of the school's infrastructure, such as the purchase of modern equipment. Especially for solar training, where equipment is more costly than in many other professions, this results in many TVET institutions having outdated solar systems that do not meet current industry standards.

Limited inclusivity in the TVET systems

Ensuring inclusivity within TVET is essential for fostering a diverse and equitable workforce in Ghana. This involves addressing several critical dimensions: gender responsive training opportunities, in particular access to TVET training by young women, support for individuals with disabilities, outreach to people from remote communities and engagement of youth in decision making processes around TVET policies. Each of these areas presents unique challenges that must be overcome to ensure that all individuals, regardless of gender, physical ability, or geographic location, have equal opportunities to benefit from vocational training. A specification of the specific barriers in Ghana's TVET systems can be found below.

Access for people with disabilities

The focus on disability-inclusive vocational training has been heightened by the UN Convention on the Rights of Persons with Disabilities (CRPD)⁶⁵. States are required to ensure that persons with disabilities can access vocational training without discrimination and on an equal basis with others. In this regard, the Ghanaian government launched The Persons with Disability Act in 2006, which mandates accessibility in public spaces and services, including TVET. However, despite the Ministry of Education's directive on disability-friendly

⁶² Interview Solar Sector Skills Body

⁶³ Focus group discussion with TVET trainers

⁶⁴ Interview Country director GIZ

⁶⁵ United Nations. Human Rights Office of the High Commissioner (2006)

infrastructure, many TVET institutes remain inaccessible for learners with disabilities. Institutions often struggle with meeting the disability friendly criteria⁶⁶. Some of the TVET institutes we visited have problematic floor gaps and have classes on multiple floors without elevators which complicates accessibility.

Gender disparities

Persistent societal stereotypes and cultural norms often portray technical fields as male-dominated, leading to a lack of encouragement and support for women pursuing these careers. Girls are frequently steered away from technical fields and STEM education, due to the belief that these areas are unsuitable for women or that they require masculine traits. This bias is compounded by a lack of female role models in technical professions and insufficient gender-sensitive policies within educational institutions. While the Ghana TVET service has designated Gender Desk Officers in all the 16 regions to handle issues of gender and persons with special needs⁶⁷, implementation of gender-responsive education systems and curricula has been lagging behind. Additionally, practical challenges such as inadequate facilities for women and limited access to mentorship further exacerbate the gender gap. While there are some specific TVET courses available for girls, these do not (yet) include solar training. The solar trainings that are available to girls are often short courses funded by international donors, but integration in formal TVET education is still lacking.

Spatial inequalities

Finally, there are also inclusion challenges in terms of geographic dimensions. As most TVET institutions are concentrated in urban centers, students may have to travel up to 10 kilometres or more to reach the nearest training facility, which can be a substantial barrier given the inadequate transportation infrastructure and associated costs⁶⁸. The lack of local training options means that many potential students from rural areas face significant hurdles in accessing education, resulting in a further entrenching of regional inequalities in educational outcomes.

In addition, as the free TVET policy includes boarding and meals, the school sometimes has to give preference to urban based students over students coming from more remote communities as the boarding facilities are at maximum capacity, thereby limiting the access for these learners⁶⁹. This experience is supported by broader research as the data shows that in 2021, four years into Ghana's free secondary school policy, 10-14 percent of all placed students failed to enrol. The country's existing physical infrastructure has been unable to absorb the 69 percent increase in enrolment, and in response, the government has implemented a dual-track system which divides the academic year into two semesters with one group of students attending school while the other is on break. While this measure has enabled the inclusion of more students in the TVET system, it has also received criticism as it puts extra strain on teachers, students and resources needed for training material⁷⁰.

⁶⁶ CTVET (2021)

⁶⁷ Interview Ghana TVET service

⁶⁸ African Center for Economic Transformation (ACET) (2022)

⁶⁹ Interview Director of the Suame Technical Institute

⁷⁰ Osei-Owusu, B., Akenten-Appiah, M. (2021)

Youth engagement

Despite being the primary beneficiaries of TVET programs, young people often have minimal input in shaping the policies and frameworks that directly impact their education and career prospects. This lack of engagement can result in a mismatch between student needs and the TVET training offer. Especially when it comes to elements like career guidance and psychosocial support are not receiving enough attention in current TVET policies.

Green awareness

Finally, facilitating a comprehensive greening approach also requires a focus on green awareness as the Assistant General Director of the Ghana TVET Service states: “We need to train and equip these learners, our future labour force, to accept greening philosophies to change their thinking and mindset”.⁷¹ On a policy level, CTVET is also taking steps to introduce greening philosophies and technologies across all TVET institutions and through curriculum development, prioritising 21st century skills and cleaner and more efficient use of natural resources⁷² However, on a practical level, green philosophies are not part of the TVET curriculum and many teachers and students we spoke to had a limited understanding of broader sustainability issues and environmental principles. Also, in Ghanaian society at large, awareness about renewable energy, the potential of the solar industry to contribute to a low-carbon transition and the economic benefits associated with using solar energy systems is largely missing, which is hampering the growth of the solar sector in the country.

5. [Best practices](#)

This section explores best practices across different TVET approaches, highlighting key elements such as competency-based training methodologies, industry partnerships, and inclusive approaches. These illustrations provide insights into innovative training models that can be built upon to strengthen solar training and TVET systems in Ghana.

Competency based training for solar engineers at Suame Technical Institute

Suame Technical Institute, better known as Suti, was established in Ghana's second biggest city Kumasi in 1973 and has since its inception trained more than 15.000 students. Suti offers 9 formal training programmes that are accredited and certified by CTVET. In 2022, they were part of the second batch of TVET providers selected by CTVET and GIZ to pilot the 3-year CBT based Solar panel technology training, the first formal exclusively solar PV training in the country. The first 20 students have been admitted to the programme which starts in October 2024. In addition to the public funded formal training, Suti offers tailor made training ranging from 1, 3, 6 and 12 months for those with prior knowledge from apprenticeship in the informal sector. This enables Suti to raise additional funds for its programmes. What makes Suti's TVET offer unique is the strong emphasis on industry relevant skills through its CBT approach in training and the partnerships with the private sector to facilitate workplace experience learning

⁷¹ Presentation by Ag. Director General of CTVET

⁷² CTVET (2021)

in the programmes. In the practice-based modules, Suti operates on a dual system where learners have two days a week theoretical classes and 3 days work in practice. This enables cross-learning between theory and practice and prepares learners well in the transition from school to work. In addition, Suti operates on the intersection of public and private partnerships, whereby the institute engages in several development partnerships to fund teacher training and purchase of new equipment for its solar training programme. This approach enables Suti to deliver high quality and accredited training on solar PV with limited public funding.

Tackling gender barriers by investing in female mechanics – the case of Solar taxi

The Solar Taxi enterprise, based in Kumasi stands out as a relevant example for greening TVET in the solar industry, particularly due to its proactive approach in tackling gender barriers. A key feature of the company is its investment in the training and apprenticeship of female mechanics through its engineering academy, addressing the traditional gender imbalance in the male-dominated solar- and auto mechanics industries. The academy empowers women by providing them with hands-on experience and specialized skills in an innovative sector. By supporting female mechanics and creating role models, the Solar Taxi initiative also contributes to shifting societal perceptions and encourages greater female participation in technical roles. This approach aligns with broader goals of greening TVET, demonstrating how targeted interventions can create a more equitable and sustainable workforce while advancing the green economy. According to the chief operation officer, women are highly motivated to succeed and make the best employees: *"They have faced so many barriers to entry and now they want to thrive, which is good for them and for our business."*⁷³

Strengthening cooperation of key system players in the solar ecosystem - Time with the DG

One novel approach to facilitate greater collaboration and engagement was launched in May this year called "Time with the DG", which is a quarterly initiative that provides stakeholders in the TVET system with a direct platform to engage with the Director General of the Ghana TVET Service. This opportunity allows for open discussions on challenges and opportunities within the TVET system, fostering greater collaboration and reducing the time spent addressing complaints and issues.

6. [A roadmap to greening TVET for the solar sector in Ghana](#)

Given the current state of the TVET system for the solar energy sector in Ghana, and taking into account the identified skills gaps, labour market demands, and existing barriers, this chapter concludes with a roadmap for greening TVET in Ghana's solar sector. This section offers seven interconnected pathways for change and a list of key recommendations for solar sector stakeholders—ranging from government and private industry to civil society and international organizations. The roadmap aims to contribute to a more sustainable and

⁷³ Interview with the Chief Operating Officer of SolarTaxi

inclusive TVET system in Ghana that equips young Ghanaians for successful careers in the solar energy labor market and supports a just energy transition.

Strengthen stakeholder engagement and coalition building

Enhanced collaboration among key players in the solar industry in Ghana is essential for greening TVET as it ensures that TVET programs align with industry needs, relevant policies and regulations and opportunities in the green economy. In Ghana these actors include the CTNET, the Ghana TVET service, Ministry of Energy, Renewable Energy Sector skills body, Renewable Energy Association, private training centres, multilateral and development partners such as the WorldBank, GIZ , the European Union and youth networks.

- **Establish a Solar Sector Network:** Create a community of practice among key stakeholders in Ghana's solar sector to facilitate knowledge sharing, collaboration, and coordinated action. Moreover, Invest in initiatives that build trust and openness among stakeholders, fostering stronger relationships and more effective collaboration
- **Develop a Joint Greening TVET Vision:** Collaboratively create a Greening TVET vision and action plan with key stakeholders, focusing on raising green awareness and promoting climate action within the TVET system. Clearly define the roles and responsibilities of various stakeholders and establish coordination mechanisms to enhance engagement and streamline efforts across the sector.
- **Implement TVET Peer-Learning Structures:** Develop a peer-learning system among TVET schools to exchange challenges and solutions, share resources, and collectively invest in state-of-the-art equipment, reducing reliance on international donors.
- **Showcase best practices:** Highlight Ghana's experience and lessons learned in greening TVET as a model for other countries. Facilitate regional exchange through the ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE), and capitalise on pan-african and international knowledge sharing events such as the ECOWAS Sustainable Energy Forum, the Africa Climate Summit and COP to inspire and inform broader efforts in the green transition.

Development of green curricula and green skills identification

As the demand for solar energy grows, TVET programs must evolve to address the skills mismatch and provide students with the knowledge and skills needed to excel in the green economy. Developing green curricula that emphasize solar energy technologies and green practices is essential to ensure that graduates are well-equipped to meet industry demand, now and in the future of work.

- **Harmonize Solar Energy Curricula:** Align and solar energy curricula across both formal and non-formal education to ensure consistency and relevance in training.
- **Monitor and Expand CBT Solar Training:** Evaluate and strengthen the ongoing three-year Competency-Based Training (CBT) solar program, with plans for a nationwide rollout to increase accessibility and effectiveness.
- **Enhance Skills Identification and Foresighting:** Collaborate more closely with the solar sector skills body and the renewable energy association to forecast labour market demands and systematically identify and address skills gaps. Include industry leaders on advisory boards of TVET institutes to provide insights on emerging needs and

opportunities and study and adapt successful practices from other countries on green skills initiatives in the solar sector

- **Strengthen workplace experience and learning (WEL)** in TVET curricula by facilitating relevant attachments and practical experiences for students. Engaging in partnerships with start-ups can provide students with hands-on experience in solar technologies and insights into entrepreneurship opportunities⁷⁴, while also encouraging business development mentoring and job shadowing with successful solar entrepreneurs.⁷⁵
- **Develop Analytical and Soft Skills:** Train students in analytical skills through real-life industry problems, and develop transversal (soft) skills such as digital literacy, critical thinking, collaboration, and effective communication to prepare students for employment both in the solar industry but also for other green and future-oriented sectors.⁷⁶
- **Strengthen Career Guidance and Mentoring:** Implement robust career guidance and mentoring programs to monitor student progress, identify gaps, and provide feedback for curriculum development, including mentorship from successful solar entrepreneurs.

Capacity building for TVET trainers

Capacity building for TVET trainers is crucial in addressing the limited skills and knowledge in solar PV technologies and the lack of hands-on experience prevalent in current training programs. As the demand for skilled professionals in the solar industry grows, trainers must be equipped with comprehensive, up-to-date expertise in solar PV technologies to effectively educate their students.

- **Increase Industrial Experience:** Encourage and provide opportunities for TVET trainers to gain hands-on experience in the solar industry, including spending time in industry settings to better understand practical applications and current technologies. Specifically focus on equipment knowhow and tool handling. Collaborating with industry experts to enhance teachers' skills and provide insights into emerging labor market trends and technologies can be a valuable approach.⁷⁷
- **Equip Institutions with Modern Technology:** Provide educational institutions with modern equipment and tools for hands-on solar training and train teachers in contemporary pedagogical methods that integrate digital education.
- **Invest in teacher retention:** To improve retention, make TVET teaching positions more attractive by offering publicly funded insurance schemes and ensuring job security.
- **Support lifelong learning:** provide opportunities for teachers to acquire new knowledge, skills, and competencies throughout including standardized regular teacher refresher training courses that incorporate both technical and soft skills development.

⁷⁴ Recommendation shared by SSC Ghana start-up Centre

⁷⁵ Reflection shared by a representative from the renewable energy association during the multi-stakeholder dialogue in Accra

⁷⁶ KNUST interview

⁷⁷ Recommendations by Solar sector skill body and GIZ

Fostering inclusivity in TVET institutes

Supporting inclusivity in TVET institutes is crucial for fostering equitable educational opportunities and a diverse workforce. Addressing inclusivity along three key dimensions—people with disabilities, gender, and spatial inequalities—ensures that all individuals have access to quality training and career development.

Access for people with disabilities

- **Enhance Accessibility:** TVET institutes should increase their accessibility by improving physical infrastructure, including buildings, transport, and accommodation facilities, to accommodate young people with disabilities. In this regard, the government should create dedicated budgets for implementing accessibility policies, financing physical improvements, and providing subsidies for suitable accommodations to promote inclusion.
- **Raise Awareness:** Increase awareness of existing standards and policies related to accessibility and inclusion among TVET stakeholders, including teachers and managers and set enrollment targets for increasing the enrollment of young people with disabilities in TVET
- **Collaborate with civil society:** Work closely with civil society organizations that support young people with disabilities to enhance effectiveness of inclusion efforts and address specific needs.

Gender responsive TVET

- **Strengthen Social Support Systems:** Enhance support for girls in education through gender-responsive career counseling services and by sensitizing families on the benefits of TVET education for girls.
- **Create and Showcase Role Models:** Increase visibility of successful women in male-dominated sectors, including the solar industry, to inspire and motivate female students. Highlight female TVET ambassadors and success stories to challenge social norms and stereotypes.
- **Support Female Leadership:** Advocate for greater representation of women in leadership positions within TVET institutions and industry, ensuring that more women are involved in decision-making roles and technical fields.
- **Organize Accessible STEM Events:** Host STEM career fairs and TVET information sessions that are digitally accessible year-round, providing opportunities for girls to learn about and engage with STEM and TVET education.
- **Promote Gender-Friendly Internships:** Facilitate internships at women-owned or women-friendly workplaces, ensuring that facilities such as dressing rooms and bathrooms are gender-appropriate and supportive of young women.

Addressing spatial inequality

- **Provide additional funding for boarding:** Offer support for accommodation to young people from remote areas to ensure they can access educational opportunities in TVET programs.
- **Enhance Digital Access and Equipment:** Increase access to free and affordable online learning portals and equip schools in rural areas with digital facilities and equipment to bridge the rural-urban divide and promote inclusive education.
- **Collaborate with Local Solar Companies:** Partner with local solar companies to use their equipment for hands-on training, providing students with practical experience and

improving the relevance of their education. Also exploring opportunities to train young people from remote communities in specific training around solar mini-grids.

Fostering meaningful youth engagement

- **Establish Youth Advisory Committees:** Create formal advisory committees comprising young people from diverse backgrounds to provide regular input on TVET policy development
- **Incorporate Youth Feedback Mechanisms:** Develop and integrate structured feedback mechanisms within the monitoring and evaluation processes of TVET programs. This could include surveys, focus groups, and feedback sessions specifically designed for youth.

Facilitating green job creation and employment in the solar industry

Creating a supportive business environment for solar companies and raising awareness among youth and the public about career opportunities in the sector is key to support employment in Ghana's solar sector.

- **Conduct more labour market research:** Perform in-depth research on the labour market to understand job demands and trends, focusing on the decency of green jobs and advocating for stable employment and service contracts over temporary positions. Creating a solar sector union could help young people to advocate for decent working conditions.
- **Create an economy of scale:** Invest in public employment programs, public-private partnerships (PPPs), and private sector initiatives to create demand and assert decent working standards
- **Support Productive Energy Use:** Promote and support approaches that enhance the productive use of energy, encouraging efficient and innovative energy solutions.
- **Expand Solar PV Applications:** Explore and promote opportunities for applying solar PV systems in various sectors such as agriculture, healthcare, and tourism. Stimulate innovation in solar technologies, like solar irrigation, to create economies of scale and generate more job opportunities for youth.
- **Improve access to funding:** create mechanisms providing affordable financing for small and medium-sized enterprises (SMEs) in the solar sector. This could include offering low-interest loans, grants, or subsidies to reduce the high cost of borrowing and support the growth and innovation of solar businesses.

Enabling policy and funding environment for the solar industry

Establishing a supportive policy and funding environment is crucial for advancing the solar industry and greening TVET in Ghana. Key steps include developing education and training policies and standards, as well as implementing policies that guide the transition to a green economy.

- **Develop a Labor Market Information System:** CTVET and the Ministry of Education should collaborate with the Ministry of Employment and Labour Relations to create a robust labor market information system. This system will provide timely and accurate data to review

TVET courses, guide career paths for young people, and inform necessary policy interventions.

- **Implement Tax Incentives:** Introduce additional tax incentives that reduce the cost of importing solar systems. Look at regional trade agreements such as the African Continental Free Trade Agreement (AfCTA) to support this.
- **Improve Quality Control and Financing Options:** Enhance quality control for solar panels, expand net metering programs for households, and offer subsidies or extended payback schemes for solar technology investments. Additionally, develop leasing structures for solar PV and improve loan terms for green enterprises to support SMEs.
- **Encourage Business Localization:** Foster a better enabling environment for setting up green businesses by providing incentives for young solar entrepreneurs. Support the localization of businesses to give Ghanaian firms a competitive advantage and encourage financial incentives like extended payback schemes to make solar technology more accessible.

Green awareness building

Building green awareness is essential for greening TVET programs to design and implement sustainable practices into curricula and TVET systems. In addition, broader green societal awareness will enhance the relevance of solar TVET education and promote a culture of sustainability in Ghana.

- **Mainstream Renewable Energy Courses:** Implement a specific course on renewable energy applications across all engineering departments to boost awareness and understanding of green technologies.
- **Include modules on climate change:** Add a module on climate change and green transitions to all TVET programs and secondary education curricula to increase awareness of the importance of renewable energy among learners.
- **Increase outreach campaigns:** Partner with media organizations to raise awareness about solar energy and sustainable practices, enhancing public knowledge and engagement with green technologies.
- **Promote Knowledge Sharing and Engagement:** Encourage meaningful engagement and knowledge sharing among educational institutions, industry stakeholders, and communities to foster a collaborative approach to green technology and sustainability.

References

- Ackah, I. (2021) The future of Ghana's energy mix: how to meet demand growth to 2030. IEA: Energy for Growth Hub. Retrieved from: https://energyforgrowth.org/wp-content/uploads/2021/08/The-future-of-Ghanas-energy-mix_-how-to-meet-demand-growth-to-2030-2.pdf
- African Center for Economic Transformation (ACET) (2022) Strengthening Education and Learning Systems to deliver a 4iR-Ready workforce. Ghana Country Report. Retrieved from: https://acetforafrica.org/wp-content/uploads/2022/10/YES_Ghana_country_report_Final_-1.pdf
- Amo-Aidoo, A., Kumi, E. M., Hensel, O., Korese, J.K. Sturm, B. (2022) Solar energy policy implementation in Ghana: A LEAP model analysis, Scientific African, Volume 16.
- Asumadu-Sarkodie, S., Asantewaa Owusu, P (2016) A review of Ghana's solar energy potential, Aims Energy 4. Retrieved from: <https://www.aimspress.com/article/10.3934/energy.2016.5.675>
- Baah-Boateng W. (2021). Youth Employment in Ghana: Confronting and addressing the phenomenon head-on from a youth perspective. Africa Insights Desk. Retrieved from: <https://includeplatform.net/publications/youth-employment-in-ghana-confronting-and-addressing-te-p-phenomenon-head-on-from-a-youth-perspective/>
- Baffour Gyau, M., Osei, M., Baffour Gyau, N. (2024) Parents' and students' perceptions about technical and vocational training in Ghana. Journal of Science and Technology, Vol. 42, No. 2 (2024), pp 127 – 14. CTVET (2021) Ghana TVET Report 2021. Retrieved from: <https://ctvet.gov.gh/wp-content/uploads/2022/09/GHANA-TVET-REPORT-2021SIGNED.pdf>
- Falchetta, G., Semeria, F., Tuninetti, M., Giordano, V., Pachauri, S., Byers, E. (2023). Solar irrigation in sub-Saharan Africa: economic feasibility and development potential. Environmental Research Letters.
- Ghana Ministry of Education (2018) Education Sector Analysis Report. Retrieved from: <https://sapghana.com/data/documents/Ghana-Education-Sector-Analysis-2018.pdf>
- Ghana Statistical Services (2022) 2021 Population and Housing Census. Retrieved from: <https://microdata.statsghana.gov.gh/index.php/catalog/110>
- Ghantous, N. (2022). Covid-19: Sub-Saharan Africa has yet to realise its renewable potential. Retrieved from: <https://www.energymonitor.ai/tech/electrification/covid-19-sub-saharan-africa-has-yet-to-realise-its-renewable-potential/>
- GIZ (2022) Sustainable Energy for Climate Protection in Ghana Making energy greener and more affordable to benefit people, industry and the environment. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Retrieved from: https://www.giz.de/de/downloads/SECC_Project%20Factsheet_SE4C_May2022.pdf
- International Energy Agency (2022) Retrieved from: <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>
- International Energy Agency (2024) Retrieved from: <https://www.iea.org/countries/ghana>
- IRENA (2024) Energy Profile Ghana. Retrieved from: https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Ghana_Africa_RE_SP.pdf

MarkWide Research Report (2024) Ghana Solar Energy Market Analysis – Industry Size, Share, Research Report, Insights, Covid-19 Impacts, Statistics, Trends, Growth and Forecast 2024-2032. MarkWide Research <https://markwideresearch.com/ghana-solar-energy-market/>

Mordor Intelligence (2021) Ghana Solar Energy Market Size & Share Analysis – Growth Trends & Forecasts (2024 – 2029) Retrieved from: <https://www.mordorintelligence.com/industry-reports/ghana-solar-energy-market>

Nilsson, B. (2019). The school-to-work transition in developing countries. *The Journal of Development Studies*, 55(5), 745-764.

Oosterom, M. and Yeboah, T. (2022) Promoting youth engagement for decent employment. Addressing the disconnects. Research Report, December 2022. Leiden: INCLUDE Knowledge Platform on Inclusive Development Policies.

Osei-Owusu, B., Akenten-Appiah, M. (2021) Retrospective Assessment of the Successes and Challenges of Double Track system in Senior High Schools in Sekyere Central District of Ghana. *British Journal of Education*, Vol. 9, Issue 9, pp.18-30, 2021

Sefa-Nyarko, C. (2024) Ghana's National Energy Transition Framework: Domestic aspirations and mistrust in international relations complicate 'justice and equity', *Energy Research & Social Science*, Volume 110.

SmartSolar Ghana (2019) Solar Companies in Ghana. Retrieved from: <http://www.smartsolar-ghana.com/solar-sector-information/solar-companies-in-ghana/>

United Nations. Human Rights Office of the High Commissioner (2006) Convention on the Rights of Persons with Disabilities. Retrieved from: <https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-persons-disabilities>

World Bank (2018) Third Ghana Economic Update: Agriculture as an Engine of Growth and Jobs Creation.