



Solar Hands-on training and
International Network of Exchange

Greening TVET for the solar energy sector in Uganda

Case illustration and roadmap



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Executive summary

Uganda's Energy Transition Plan (2023) underscores the government's commitment to a just and inclusive energy transition and sets out a strategy to achieve universal access to electricity and carbon neutrality by 2050. This is highly needed as about 43% of Uganda's population still lacks access to electricity, with rural areas being disproportionately affected—only 8% of the rural population has electricity access. Uganda's vast solar resources are seen as offering a potential solution in the energy transition. By harnessing this capacity through developing the solar energy sector, the country can address multiple pressing challenges simultaneously, including youth unemployment, climate change, and energy scarcity.

A significant barrier however is a shortage of qualified and skilled young people able to drive the growth of the solar energy sector. Remarkable, as over a million youths enter the labour market in Uganda every year. While only 6.58% of Ugandan youth (ages 15–24) were officially unemployed in 2022, underemployment remains a salient issue and nearly 90% of youth in Uganda work informally, lacking formal contracts and social security. Technical Vocational Education and Training (TVET) holds a key role in bridging the skills gap and preparing youth for employment opportunities in the solar energy sector. However, there are many obstacles in Uganda's renewable energy and TVET landscape that require a combined effort of government, private sector, civil society, TVET providers and international organisations.

This report therefore provides insights into the opportunities and barriers for greening TVET for the solar energy sector in Uganda by examining the energy and TVET landscape and the labour market context. It 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 Uganda'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.

Uganda's Energy Landscape and Solar potential

Bioenergy is accounting for 94% of Uganda's total energy use. This primarily comes from charcoal and firewood, which, albeit technically renewable, is not sustainable as it can greatly contribute to greenhouse gas emissions and environmental degradation. Solar energy offers a promising alternative as the average amount of solar energy received is 5.1 kWh per square metre each day. Solar energy levels stay high all year round in Uganda. Therefore, solar energy has the potential to contribute towards realising universal access to electricity in Uganda. Furthermore, while over 82% of Uganda's electricity is derived from hydropower, solar energy still only accounts for about 3%. This makes the electricity supply highly vulnerable to environmental disruptions like flooding and droughts. Diversifying the energy sector by enhancing the solar energy capacity is therefore crucial.

The promotion of the solar energy sector is also seen as an important strategy in providing viable alternatives for rural and remote areas not connected to the national grid through off-grid solar systems. Moreover, in addition to meeting domestic household needs, solar energy can also enhance productivity in other sectors and strengthen food security and

exports through off-grid systems like water pumps and refrigeration.

Solar energy labour market trends, challenges and opportunities

With the growing demand for solar energy and its promotion by the national government through public-private partnerships and policies –including demand and supply subsidies, loans, and tax exemptions for solar equipment – the expanding sector presents significant labour market opportunities in both the productive use of solar energy (PUSE) and the domestic household market. Decreasing costs of solar solutions and innovations across the sector are also contributing to expansion of the solar energy sector. Over the past 15 years, the off-grid sector—including solar home systems and mini-grids—has seen substantial growth and attracted foreign investment, with more than 400 off-grid solar companies now operating in Uganda. Additionally, various actors, including solar energy sector associations, research institutes, and civil society organisations, are actively promoting green awareness and solar energy across the country.

Despite these positive developments, solar companies face significant barriers to scaling, including limited access to finance and a shortage of qualified people for various positions, particularly solar installation and maintenance technicians, solar engineers and managers, technical sales representatives, and solar energy researchers. The following skills were identified as required for these positions.

- **Technical knowledge and practical skills:** Essential competencies include solar panel installation and maintenance, proper handling of batteries to prevent overheating, product quality assessment, expertise in solar thermal systems, knowledge of solar pumping systems, and the ability to repair solar components.
- **Green and transferable skills:** skills like strategic thinking and programme management are valuable in the solar sector and across other green industries. Incorporating environmental awareness into curricula enables youth to advocate for sustainable practices.
- **Entrepreneurial and soft skills:** As many technicians work informally under indecent working conditions and many students aspire to start their own businesses, there is a need to develop soft and entrepreneurial skills like communication and sales skills.

TVET ecosystem: policies, perceptions and pathways

The TVET system in Uganda is nationally organised under the Ministry of Education and Sports and supported by the establishment of relevant governmental bodies aimed at guiding and regulating TVET. Since 2008 the Uganda Vocational Qualification Framework (UVQF) has been guiding the structure and quality of different levels of vocational training in the country and the most recent TVET policy (2019) focuses on facilitating an employer-led TVET system in which private sector employers make up 66% of the newly established sector skills councils that are responsible for stimulating 'the development of national occupational standards and competency based curricula and qualifications. This should ensure that TVET programmes meet the needs of the labour market.

However, indicative of the state of TVET for the solar energy sector is the fact that there is only one outdated, nationally recognised curriculum under NCDC that is focused on solar energy. Various formal and non-formal TVET providers have since developed a range of short courses (ranging from one week to 12 months) based on this national curriculum and incorporating additional solar related information and skills to enhance and differentiate their offerings from those of other providers. Furthermore, there are no TVET programmes longer than one year that focus solely on solar energy. Solar energy in longer programmes, is only offered as a module within broader energy and electric engineering programmes.

While government promotion and investment in TVET have increased public awareness of its opportunities compared to traditional academic pathways, the perception of youth towards TVET remains mixed due to a lack of resources, educational materials, qualified teachers, and difficulties in securing internships. Youth remain sceptical about whether their education would lead to job opportunities in the solar sector. High costs and frequent breakdowns of solar systems have negatively affected perceptions of the solar energy sector, influencing views on employment prospects in the field.

Pathways for change

Based on the current status of the TVET system for the solar energy sector, the identified skills gaps, labour market needs, and existing barriers and opportunities, this report concludes with a roadmap for greening TVET in Uganda's solar sector. This framework consists of 7 interconnected areas of action, offering key recommendations for all TVET and solar energy stakeholders.

- 1. Strengthen stakeholder engagement and coalition building:** Stakeholders engaged in TVET for the solar energy sector, including formal and non-formal TVET providers, government bodies, sector associations, research institutes, and youth representative bodies, should collaborate to determine strategic direction, share knowledge, and strengthen efforts to greening TVET
- 2. Development of green curricula and green skills identification:** Addressing the current skills gap requires a comprehensive approach to green skills development, taking into account emerging labour market trends, new occupations, and sectoral innovations.
- 3. Capacity building for TVET trainers:** Preparing youth for the solar energy labour market requires a sufficient number of qualified teachers, trainers, and up-to-date teaching equipment.
- 4. Fostering inclusivity in TVET institutes:** Greening TVET for the solar energy sector should ensure that all youth, including those from disadvantaged backgrounds have equitable access to TVET.
- 5. Facilitating green job creation and employment in the solar industry:** Creating an enabling environment for private sector development is crucial to ensure that graduates are able to find decent jobs in both the formal and informal solar energy sector.
- 6. Enabling policy and funding environment for the solar industry:** Sufficient funding and enabling policies are critical. These resources play a vital role in adapting training

programmes to align with evolving solar energy market needs, implementing the recommendations outlined in the roadmap and enforcing existing policies and regulations.

- 7. Green awareness building:** promoting the environmental benefits of the solar and renewable energy sector is essential for encouraging investment and promoting greening TVET efforts. Supporting youth in understanding climate change might trigger interest in exploring other green sectors and enable them to advocate for sustainable practices within their society.

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 organisations 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 centres (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 organisation 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 analysed.

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1. Introduction

Climate change is significantly affecting the lives of young people in Uganda, a country with one of the youngest populations in the world. Environmental disruptions, such as heavy rainfall and rising temperatures, are undermining agricultural production and infrastructure, which in turn exacerbates food insecurity and social inequality. Since agriculture is the primary livelihood for most Ugandan youth, these challenges are forcing many to seek alternative means of survival. Limited job opportunities, low quality education and financial constraints hinder their ability to adapt to these circumstances,¹ while traditional perceptions of youth as irresponsible and unqualified, along with their limited political representation and social networks,² further restrict their capacity to address these challenges and shape their own futures.

With the National Youth Action Plan³ (2016), the Ugandan government recognized the need to address these challenges by supporting young people in acquiring active roles in society and the labour market. A significant opportunity arises from the government's dedication to a just and inclusive energy transition, as outlined in Uganda's Energy Transition Plan (2023).⁴ This plan sets out a strategy to achieve universal access to electricity and carbon neutrality by 2050. Solar energy can play a key role in this transition, given Uganda's abundant solar potential. By harnessing this resource, the country can address multiple pressing challenges simultaneously, including youth unemployment, climate change, and energy scarcity.

This aligns with the goals outlined in Uganda's Vision 2040,⁵ which emphasises expanding energy access to drive economic transformation, industrialization, and job creation—particularly through renewable energy sources like solar, wind, and biogas. A key barrier to realising this potential however, is the fact that the Technical and Vocational Education and Training (TVET) system in Uganda is currently failing to prepare youth with the skills necessary for the evolving labour market while it can play pivotal role in this transition by bridging the existing skills gap and support the shift to more sustainable societies and green jobs.

This report provides insights into the opportunities and barriers for greening Technical and Vocational Education and Training (TVET) for the solar energy sector in Uganda 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 Uganda'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.

¹ Barford et al., 2021

² Mwesigye, n.d.

³ Ministry of Gender, Labour and Social Development Uganda, 2016

⁴ International Energy Agency, 2023

⁵ National Planning Authority Uganda, 2023

Almost half of Uganda's population lacks access to electricity

In the vision of the national government, 80% of the population will be connected to the national grid by 2040.⁶ This is a highly relevant but very ambitious goal as 43% of Uganda's population still lacks access to electricity and only 28% of the population was connected to the national grid in 2022. Another 28% relies on solar photovoltaic (PV) technology for electricity access and only 1% of people receive their electricity from mini-grids: groups of generators and energy storage systems connected to a local network that provides power to a small community. Combined, approximately 57% of Uganda's population has access to electricity, but only 8% of rural residents have access to electricity.⁷ Since around 73% of Uganda's population lives in rural areas, a significant portion remains without access to electricity.⁸

At first sight, it should be possible to provide a large part of the population with access to electricity within a certain timeframe, as Rüdener explains that 98% of Uganda's electricity stems from renewable sources, with significant potential for growth.⁹ However she warns that over 82% of this electricity is derived from a limited number of hydroelectric power plants, making the electricity supply highly vulnerable to environmental disruptions like flooding and droughts. Therefore, diversifying the energy sector is crucial and solar energy, which currently accounts for only about 3% of the country's renewable electricity mix, has great environmental and economic potential.¹⁰

The potential of the solar energy sector

Uganda has a huge potential for solar energy as the average amount of solar energy received is 5.1 kWh per square metre each day. Solar energy levels stay high all year round, with only a 20% difference between the lowest and highest months.¹¹ Furthermore, when considering overall energy consumption, bioenergy is the most widely used source in Uganda, accounting for 94% of the country's total energy use. This primarily comes from charcoal and firewood, which, if poorly managed, can greatly contribute to greenhouse gas emissions and environmental degradation.¹² Solar energy offers a promising alternative to reduce this impact.

A significant portion of the Ugandan population recognizes the advantages of solar energy, particularly as off-grid solar systems provide viable alternatives for rural and remote areas not connected to the national grid.¹³ Beyond meeting domestic household needs, solar energy can greatly enhance social and economic well-being. For instance, it can improve healthcare services by enabling solar water pumping and refrigeration to alleviate power shortages in health centres. In agriculture, although solar technologies are currently used on a small scale for cooling and crop drying, there is vast potential to expand off-grid systems, such as solar-powered water pumps and refrigeration. Widespread adoption of these technologies by

⁶ Ibid.

⁷ GIZ in Ministry of Energy and Mineral Development Uganda, 2023

⁸ World Bank, 2023

⁹ Rüdener, S, H., 2024

¹⁰ Ibid.

¹¹ GIZ, 2022a

¹² Ibid.

¹³ Rüdener, S, H., 2024

smallholder farmers could significantly boost agricultural productivity, strengthen crop value chains, and improve both food security and export capacity.¹⁴

The push for solar energy was initially driven by the private sector, but the government is realising its potential and catching up through various initiatives and policies. Key efforts include the Energy Transition Plan¹⁵ and the National Road Map on Scaling Up Productive Use of Solar Energy (PUSE),¹⁶ developed in collaboration with international and national stakeholders. Additionally, public-private partnerships, including demand and supply subsidies, loans, and tax exemptions for solar equipment are supporting both companies and households by making solar energy more accessible to a larger portion of the population that could otherwise not afford gaining solar energy access.¹⁷

Lastly, in the context of a just and inclusive transition to a carbon-neutral economy, it is important to acknowledge that Uganda with the new Tilenga and Kingfisher oil fields will begin oil production and export for the first time in 2025.¹⁸ While the government, in the Energy Transition Plan frames this as a means to finance transitioning to a green economy, the environmental consequences remain unclear. Moreover, Bagabo et al.¹⁹ argue that pre-production activities have yet to create more jobs for women, raising concerns about equitable employment. As the solar energy sector expands, the government should give extra attention to supporting women and other vulnerable groups, such as rural youth, by providing access to relevant education and new decent job opportunities. This will help ensure that everyone can benefit from the green transition, fostering a more inclusive and equitable economy.

TVET fails to prepare youth for the labour market

The growing solar energy sector presents both a challenge and an opportunity for a country facing youth un(der)employment and an educational system that is not adequately preparing young people for the labour market. It is estimated that over a million youths enter the labour market every year, eager for decent employment.²⁰ While only 6.58% of Ugandan youth (ages 15-24) were officially unemployed in 2022,²¹ underemployment, where youth do not work full time or have a job that does not reflect their actual training and financial needs, remains a salient issue. Many young people are compelled to accept jobs that are below their skill level, pay grade, and preferred quality of work. A scoping study from the Challenge Fund for Youth in 2021 states that nearly 90% of employed youth in Uganda work informally, lacking formal contracts and social security.²² Additionally, almost half of these young workers are starting

¹⁴ Ministry of Energy and Mineral Development Uganda, 2023

¹⁵ International Energy Agency, 2023

¹⁶ Ministry of Energy and Mineral Development Uganda, 2023

¹⁷ *ibid.*

¹⁸ International Energy Agency, 2023

¹⁹ Bagabo et al. (2024)

²⁰ World Bank in Challenge Fund for Youth Employment, 2021

²¹ Uganda board of statistics in Namuleme, H., 2023

²² Challenge Fund for Youth Employment, 2021

their own businesses out of necessity rather than choice and 41% of the overall working population in Uganda is engaged in subsistence farming.²³

Unfortunately the potential for employment in solar energy is constrained by deficiencies in the current education system, particularly in Technical and Vocational Education and Training (TVET). Existing TVET programmes often fall short in equipping youth with the necessary knowledge and skills for the labour market, primarily because of the lack of alignment with private sector demands and an insufficient contribution to practical skills and soft competencies. Additionally, TVET education faces low enrollment, worsened by inadequate basic education and a negative reputation stemming from high entrance fees, poor quality, and the widespread belief that academic degrees offer better job prospects. Consequently, companies face challenges in attracting skilled labourers and increasingly rely on on-the-job training and workplace learning to address the skills gap.²⁴

Greening TVET for the solar energy sector in Uganda

To realise the potential of Uganda's solar energy sector in enhancing energy access, benefiting the environment, and creating economic opportunities, it is important to address gaps in the education system and prepare young professionals to drive this renewable energy transition. Therefore, this case study explores what is needed to prepare the TVET system for Uganda's solar energy sector and concludes with a roadmap and key recommendations for greening TVET in the solar energy sector.

2. Overview of the TVET system in Uganda

This section first describes the structure of the TVET system, with a specific focus on solar energy, and discusses relevant policies, regulations, and stakeholders. Next, it outlines the various types of solar TVET programmes available. The third part reflects on the public perception of TVET in Uganda, specifically zooming in on the perceptions of students.

Stakeholders and Policies regulating TVET

By promoting the job prospects that TVET education offers and the country's need for a practically trained and skilled workforce, the government aims to encourage more people to choose TVET over academic pathways. This is reflected in the fact that the TVET system in Uganda is nationally organised under the Ministry of Education and Sports, structured in policies and supported by the establishment of relevant governmental bodies aimed at guiding and regulating TVET.²⁵

The Business, Technical, Vocational, Education and Training (BTVET) act of 2008²⁶ contributed to regulating the TVET system, for example by separating the delivery of educational

²³ibid.

²⁴ibid.

²⁵ This section builds on an analysis of relevant TVET and renewable energy policies and stakeholders in Uganda which is available in Naluwagga et al., 2023

²⁶ The Republic of Uganda, 2008

programmes and training from quality assurance. It also informed the development of the Uganda Vocational Qualification Framework (UVQF): a guiding framework for structuring the different levels of vocational training in the country.

The UVQF falls under the Directorate for Industrial Training (DIT) which is responsible for developing occupational standards, accrediting assessment centres, and conducting competency-based assessments. The act of 2008 furthermore provided the groundwork for creating the Uganda Business and Technical Examinations Board (UBTEB) which is the coordinating body for TVET programmes in Uganda. All the nationally recognized curricula are developed by the National Curriculum Development Centre (NCDC). TVET providers develop their own programmes following these guidelines and submit them for approval to DIT or UBTEB.

The BTVET Strategic Plan 2011-2020 Skilling Uganda²⁷ succeeded the act of 2008 and focused on enhancing employability skills, competencies, and demand-driven training. The plan set ambitious goals, aiming for 80% of the students to achieve sufficient income after graduation and ensuring 50% female participation, while emphasising the inclusion and relevance of skills.

The most recent TVET policy (2019)²⁸ continues to facilitate a demand driven TVET system that works closely with the private sector to develop curriculum that fit their skills needs. One of the key priority areas is an employer-led TVET system in which private sector employers, the government and TVET providers play key roles. Private sector employers make up 66% of the newly established sector skills councils which are among others responsible for stimulating 'the development of national occupational standards and competency based curricula and qualifications,²⁹ to support that the TVET programmes meet the needs of the labour market. The Ministry of Education and Sports in turn is responsible for the coordination and implementation of this Policy. TVET providers will be involved in different levels and responsible for developing and providing training.³⁰

TVET policies for the solar energy sector

The quest for qualified employees from solar companies has not gone unnoticed by the government and other stakeholders active in the TVET ecosystem. According to the Commissioner of Renewable Energy from the Ministry of Energy and Minerals Development, the Ugandan government is actively advocating for a focus on a just transition within its skilling system. At the same time, the government acknowledges the practical challenges associated with achieving this transition.³¹

²⁷ Ministry of Education and Sports Uganda, 2011

²⁸ Ministry of Education and Sports Uganda, 2019

²⁹ Ibid.

³⁰ Ibid.

³¹ Interview with the Commissioner Renewable Energy of the Ministry of Energy and Minerals Development, in June, 2024.

This recognition has spurred policy developments emphasising the promotion of skills for renewable energy. For example, the Energy Transition Plan 2023³² and the National Development Plan III³³ highlight the necessity for capacity building and training to support the renewable energy transition. Additionally, more specific policies like the Electricity (Isolated Grid Systems) Regulations (2020)³⁴ and the Electricity (Installation Permits) Regulations (2019)³⁵ provide a framework for the required qualifications for working on isolated grid systems and electrical installations.

TVET programmes for the solar energy sector

The TVET landscape in Uganda includes a diverse array of programmes and training opportunities. These range from short-term non-formal courses to extensive formal education pathways, offered by a variety of stakeholders. Entry requirements and admission fees vary depending on the course and subject, ranging from no prerequisites to specific competencies or relevant previous educational qualifications.

Building on the World TVET database from UNESCO - UNEVOC³⁶ and insights gathered from interviews with staff from public and private TVET providers in Uganda,³⁷ the table below provides an overview of different levels of TVET programmes with a specific focus on solar energy under the UVQF. The table does not cover all possible types and categories within these levels but does provide a general overview of the available options. Just like other subjects, TVET for the solar industry can be categorised into three types of programmes: 1). Practically acquired skills (PAS), 2). Craftsman and 3). Technician. Graduate engineering programmes, which span 3 to 4 years are considered university-level and therefore excluded from this overview.

Table 1: Different levels of TVET

Level	PAS (1 week - 3 months)	Craftsman (1 - 12 months)	Technician (1 - 2 years)
Accreditation	Accredited by DIT	Accredited by DIT	Accredited by UBTEB
Type of skills	To validate skills acquired informally through on the job learning.	approximately 95% practical skills and 5% theoretical knowledge	approximately 75% practical skills and 25% theoretical knowledge.
Content	These courses are tailored to equip on-the-job learners or informal workers with specific skills and certifications.	hands-on training in the installation, maintenance, and repair of solar panels and photovoltaic (PV) systems for domestic use.	Offers solar training as a module within broader electricity or renewable energy .

³² International Energy Agency (2023)

³³ National Planning Authority Uganda, 2020

³⁴ The Republic of Uganda, 2020

³⁵ The Republic of Uganda, 2019

³⁶ UNESCO-UNEVOC, 2014

³⁷ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

Entry requirements	Minimal or no entry requirements	Entry requirements vary by course, ranging from none to basic education.	Entry requirements vary by course but secondary education is required.
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Indicative of the state of TVET for the solar sector in Uganda is the fact that there is only one nationally recognised curriculum under NCDC focused on solar energy, which multiple actors in the solar TVET landscape perceive as outdated.³⁸ However, TVET providers have since developed a range of courses and programmes based on this curriculum, incorporating additional information and skills to enhance and differentiate their offerings from those of other private training providers.

This led to a variety of DIT approved short-courses like The Solar PV Systems Installation, Maintenance, and Repair Training which provide the graduate with a certificate. The longer-term UBITEP approved programmes that lead to a diploma only offer solar energy as a module within broader electric engineering programmes. The Solar PV Systems training mentioned here can for example also be followed as a module in the National Certificate in Electrical Installation Systems and Maintenance programme, preparing students with electrical engineering skills more broadly. A two-month industrial training in the form of an internship to gain practical experience is mandatory after each programme. However, both students and TVET providers report that this is often challenging to implement due to lacking involvement of the private sector in TVET,³⁹ which is discussed in more detail in chapter 3. Most programmes furthermore do include a component on soft skills and entrepreneurial skills.⁴⁰

Diverse non-formal TVET providers offer tailored short courses

While nationally organised, Uganda's TVET landscape is diverse, with a range of non-formal TVET providers offering short courses to specific audiences. In addition to formal educational institutions like technical colleges and schools, a wide range of stakeholders are developing and providing non-formal PAS or Craftsman courses. Organisations such as NGOs like Women in Renewable Energy, solar sector associations like SENDEA, and research institutes like the Centre for Research in Energy and Energy Conservation (CREEC) offer various courses ranging from awareness training to hands-on solar installation. These courses are seen as non-formal because they vary in duration and focus, as providers tailor them to their specific expertise, sectoral needs and target audiences. Additionally, various solar companies provide on-the-job training opportunities for their (prospective) employees.⁴¹

Various PAS level and even some Craftsman level solar courses are specifically designed to support informal workers in Uganda's energy sector, including individuals with no basic education or those gaining experience through on-the-job learning. These courses provide an

³⁸ Ibid. and a meeting with the Directorate of Industrial Training in June 2024

³⁹ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

⁴⁰ Meeting with the management team of Kiryandongo Technical Institute in June 2024

⁴¹ Different meetings with Sendea, the Uganda Solar Energy Association and the Centre for Research in Energy and Energy Conservation in June 2024

opportunity for these workers to gain certified skills, enabling them to advance their careers in solar energy.⁴²

Students perception of TVET for the solar sector

At first glance, the government's efforts to professionalise and promote TVET as a pathway to employment appear to be paying off. The formal TVET institutes and various organisations offering TVET courses, visited for this study, reported high numbers of student enrollments. Although this varies across institutions and programmes, it seems that youth in Uganda are increasingly becoming aware of TVET opportunities. Furthermore, they are formally enabled to provide feedback on the programs and advocate for student rights through youth representative bodies within TVET institutions, with one student representing the institution in the Uganda National Student Association.⁴³

Despite these efforts, the perception of youth towards TVET remains mixed. While there are youth who view TVET as instrumental to gaining employment in a practical profession, young people also often participate in TVET because it offers another way into more traditional educational pathways like academia.⁴⁴

When asked about TVET for the solar industry specifically, the principal of Kiryandongo Technical Institute which is a public technical institute in Kiryandongo, explained that they offered a DIT-approved solar energy training course, which received 119 applications. However, due to limited resources from the TVET institute, only 5 students could participate. This course, which had an admission fee of 206 Euros, was offered only once because funding was provided by an NGO.⁴⁵ Furthermore, Women in Renewable Energy, an Association offering free solar training to women, received over 160 applications,⁴⁶ which exemplifies that both free and paid courses attract interest among youth.

During focus group discussions at various TVET providers in Uganda, most students acknowledged the potential of solar energy to provide energy access and economic opportunities. However, many were sceptical about whether their education would lead to job opportunities in the solar sector. While a few expressed interest in working in solar or starting their own businesses—one student even wanting to help rural communities expand energy access—many preferred to continue their education at university, aiming to become electrical engineers. Others saw their future as traditional electricians, hoping to gain skills through apprenticeships. In all cases, however, students hoped to gain a specific skill set through solar training that would set them apart from other graduates of general electrical courses.

The lack of resources, educational materials, qualified teachers, and difficulties in securing internships further fueled their doubts about TVET programmes for the solar sector.

⁴² Ibid.

⁴³ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

⁴⁴ Conversations and focus group discussions with students of Kiryandongo Technical Institute and Uganda Technical College Kyema in June 2024

⁴⁵ Interview with the principal of Kiryandongo Technical institute in June 2024

⁴⁶ Interview with the Women in Renewable Energy Association in June 2024

Additionally, the high costs and frequent breakdowns of solar systems have negatively affected the perception of the solar energy sector, influencing how both TVET programmes and employment prospects in the field are viewed.⁴⁷

3. Labour market trends, challenges and opportunities

Multiple trends across the solar energy market in Uganda potentially affect the labour market opportunities. First, it is clear that there is huge growth potential, both in the domestic household and Productive Use of the Solar Energy market (PUSE). While a portion of the population still lacks access to electricity due to high costs involved, 60.4% of households without energy access in 2018 faced supply-side gaps—meaning that a lack of infrastructure prevented them from acquiring it. This highlights the significant labour market potential for off-grid solar home systems in the domestic household market.⁴⁸ Solar for Productive Use, which, building on GIZ,⁴⁹ can be defined as ‘agricultural, commercial, and industrial activities involving [solar] electricity services as a direct input to the production of goods or provision of services,’ is also gaining significant attention in Uganda as it can greatly benefit the economy by enhancing productivity and efficiency across various sectors.⁵⁰

Second, While the solar energy sector was initially driven by the private sector, with the government’s primary focus on hydroelectric power,⁵¹ the national government is taking a more proactive role in promoting solar energy and private sector development, as can be seen in the implementation of regulatory measures, and policies, including tax incentives for suppliers.⁵² Until recently, PUSE did not receive much attention but in 2023, The Ministry of Energy and Mineral Development co-developed a National Road Map on Scaling Up Productive Use of Solar Energy providing key recommendations for stakeholders which underlines their acknowledgement of its potential.⁵³ The domestic household market for solar energy is not new to enabling policies but it is relevant to note that the government is promoting a more decentralised approach, with a focus on rural areas. The Rural Electrification Programme for example aims to add 300,000 new electricity connections each year, with about one-third of these coming from off-grid solutions.⁵⁴

Third, as a result of these developments, the solar energy sector has experienced significant growth, with decreasing costs of solar solutions and innovations across the sector also contributing to this expansion.⁵⁵ For example, over the past 15 years, the off-grid sector—including solar home systems and mini-grids—has seen substantial growth and

⁴⁷ Conversations and Focus Group Discussions with students of Kiryandongo Technical Institute and Uganda Technical College Kyema in June 2024

⁴⁸ Aarakit et al., 2021

⁴⁹ GIZ in Ministry of Energy and Mineral Development Uganda, 2023

⁵⁰ *ibid.*

⁵¹ Interview Senior Lecturer Renewable Energy, Makerere University Business School in June 2024

⁵² Ministry of Energy and Mineral Development Uganda, 2023

⁵³ *ibid.*

⁵⁴ *ibid.*

⁵⁵ Gupta, 2023

attracted foreign investment, with more than 400 off-grid solar companies now operating in Uganda.⁵⁶

However, there are still multiple factors on top of the lack of a qualified labour force, holding back market growth. First, while national efforts to regulate and support private sector development are commendable, both the solar sector for domestic households and PUSE are lacking comprehensive regulatory frameworks. There is for example no law yet to regulate PUSE and the off-grid segment is way less regulated than the on-grid sector. Both tax authorities and regulatory bodies are furthermore struggling with new policies as they lack expertise necessary to fully understand and implement these policies and new regulations. This hinders the growth of solar companies and their ability to create employment opportunities.⁵⁷ Second, Despite an increase in foreign investment and the presence of microfinance institutions, commercial banks, and governmental funds, financing remains a challenge for many companies in the sector.⁵⁸

Third, despite subsidies, financial incentives, and supply and demand support, solar solutions remain inaccessible to a significant portion of the population. This is often due to high costs, particularly when combined with expensive installation fees, or because of insufficient infrastructure.⁵⁹ Fourth, while the influx of inexpensive imported products from Asia and the Middle East, such as batteries and solar panels, may enhance the availability and affordability of solar solutions, their varying quality can negatively impact their lifespan and ease of maintenance.⁶⁰ This often leads to premature disposal and environmental damage, which can, in turn, harm public perception of solar energy.⁶¹

An evolving enabling environment promoting solar energy

The various actors involved in creating an enabling environment to address these barriers in the solar energy sector are described below

Government actors regulate and facilitate the solar energy sector

Several governmental actors are actively involved in the solar energy sector. The Ministry of Energy and Mineral Development is taking a leading role in policy development, providing strategic guidance, funding, and regulation. The Uganda National Bureau of Standards is responsible for regulating the quality of solar products available in the market, while the Electricity Regulatory Authority (ERA) issues licences to companies engaged in electricity distribution and sales, and establishes standards and codes of conduct for the sector.⁶²

⁵⁶ Ministry of Energy and Mineral Development Uganda, 2023

⁵⁷ Ministry of Energy and Mineral Development Uganda, 2023

⁵⁸ *ibid.*

⁵⁹ Centre for Research in Energy and Energy Conservation, 2023

⁶⁰ *Ibid.*, and Ministry of Energy and Mineral Development Uganda, 2023

⁶¹ Interview Senior Lecturer Renewable Energy, Makerere University Business School in June 2024

⁶² Ministry of Energy and Mineral Development Uganda, 2023

International organisations supporting solar energy in Uganda

Renowned international organisations like GIZ and SNV are providing technical expertise, and financial support to both demand-side recipients and supply-side companies.⁶³ For instance, the Energising Development Uganda (EnDev)⁶⁴ programme is piloting demand-side subsidies to help vulnerable rural and refugee communities access quality-certified solar and cooking products while also offering financial and technical support to solar companies. Additionally, funds like SIMA's Energy Access Relief Fund are providing debt for PUSE, to support private sector development.⁶⁵

Civil society organisations are advocating for solar energy

Civil society organisations, knowledge institutes, and sector associations in Uganda furthermore play a key role in facilitating the solar labour market. They are actively engaged in policy advocacy, public awareness campaigns, establishing quality standards, lobbying for financial support, and fostering connections to promote private sector development. For example, the National Renewable Energy Platform (NREP) aims to guide the strategic direction of the renewable energy sector and facilitates information access. The Uganda Solar Energy Association (USEA) in turn connects private sector companies, raises awareness, and advocates for a favourable business environment.⁶⁶

Private sector actors and the current labour market

The solar energy private sector consists of various actors. First, there are many SMEs and freelancers operating in the informal sector, who provide installation and maintenance services for solar systems. While these actors are mainly focused on installing solar home systems, they also serve subsistence farmers and the agricultural sector, provided that the installation and maintenance tasks require basic skills. Additionally, many of these actors may not have formal qualifications in solar energy; they often offer solar equipment installation alongside electrical wiring services and have learned to install solar systems on the job.⁶⁷

A recent assessment (2023) of the renewable energy market for productive use, undertaken by CREEC and other stakeholders provides a picture of the type of companies active in the formal solar energy market. Solar energy companies are servicing various sectors like agriculture, manufacturing and tourism and are dealing predominantly in solar water pumping systems but they are also selling solar refrigeration systems or solar water heaters. Furthermore solar home systems are sold to the domestic household market by a variety of companies as well.⁶⁸

Solar home systems are mostly imported from Asia or Europe and distributed by large international firms like SunKing or Engie with a presence in Uganda. Furthermore, there are

⁶³ Read more about the role of transnational organisations in the development of the off-grid solar PV regime in Uganda in Bhamidipati et al., 2019

⁶⁴ See [EnDev](#)

⁶⁵ Interview GIZ Uganda in June 2024

⁶⁶ Meeting with the Uganda Solar Energy Association in June 2024

⁶⁷ Interview Centre for Research in Energy and Energy Conservation, interview Senior Lecturer Renewable Energy, Makerere University Business School in June 2024

⁶⁸ Centre for Research in Energy and Energy Conservation, 2023

also companies that are gaining a foothold in the commercial and industrial value chain through their focus on engineering larger solar systems and remote monitoring of installed systems. This is led by local enterprises or local subsidiaries of foreign-owned companies, such as SolarNow, a company with branches in Uganda, Kenya and the Netherlands.⁶⁹

The labour market size

Gaining a clear picture of the solar labour market size is challenging due to limited information on formally operating companies in both the solar and electrical engineering sectors. This is further complicated by the fact that many electricians and businesses work informally. The numbers below do however indicate that the employment potential of the solar sector extends beyond mere possibilities.⁷⁰

Available information about the solar labour market size indicates that there were over 400 off-grid solar companies operating in Uganda in 2023. Of these, 239 are registered with the Uganda Solar Energy Association (USEA) and operate in the solar home systems, mini-grid, and solar thermal markets.⁷¹ The recent market assessment (2023) of the renewable energy market for productive use furthermore provides information on the available jobs per company. From the 11 solar companies that were interviewed as part of the market assessment and are active in off-grid solar for productive use, the majority identified as Small Enterprise and employed between 5 – 50 people. 27% identified as Medium Enterprise and employed over 50 people.⁷²

Job decency in the formal and informal sphere

Another area with limited available information is the level of job decency in the solar sector. However, conversations with CREEC, Women in Renewable Energy, and SolarNow underlined that the quality of jobs varies significantly across companies, particularly when considering factors like salary, social protection, protective clothing, and contract terms. Larger, more established companies tend to offer better employment conditions but generally, most jobs in this sector are low-paying, resulting in high employee turnover. A typical formally employed technician might earn only around 120 euros per month and often lacks medical insurance. People working in the informal sector, such as installers and maintenance workers, face even greater insecurity, including adequate safety measures, job longevity, and fair compensation.⁷³

For women, the challenges are even more pronounced. The work environment was described as unfriendly to women, and employing females is frequently seen as more costly. For instance, when men and women are required to travel and work in rural areas, additional expenses are incurred because they cannot share the same accommodations. Moreover, the need for child care adds to the costs, further complicating employment for women in this sector.⁷⁴

⁶⁹ Interview Centre for Research in Energy and Energy Conservation and interview with SolarNow Uganda in June 2024

⁷⁰ interviews with Centre for Research in Energy and Energy Conservation, the Women in renewable Energy Association and SolarNow in June 2024

⁷¹ Ministry of Energy and Mineral Development Uganda, 2023

⁷² Centre for Research in Energy and Energy Conservation, 2023

⁷³ interviews with Centre for Research in Energy and Energy Conservation, the Women in renewable Energy Association and SolarNow in June 2024

⁷⁴ Interview the Women in renewable Energy Association in June 2024

Aligning occupations with emerging labour market needs

With the expansion of the solar energy sector in Uganda, there is an increasing demand for a skilled workforce capable of keeping pace with the industry's innovations and rapid developments. This section first links solar energy market trends to key occupational needs and other structural developments required across the solar energy value chain, recognizing that many roles and supporting structures are essential for the sector's sustainability. It then delves into skills gaps and opportunities for learning and curricula development.

A successful promotion of solar energy requires solar installation and maintenance technicians

The expanding use, promotion, and increasing subsidisation of solar systems, such as panels and mini-grids, combined with the fact that most of these solutions are imported and preassembled, necessitate technicians with the skills to install and maintain these products.⁷⁵ Both the market assessment led by CREEC in 2023, and Interviews with solar industry stakeholders for this study highlighted a shortage of qualified solar installation and maintenance technicians.⁷⁶

The Installers need to be skilled in performing reliable solar installations, which includes securely mounting solar panels, correctly positioning and sizing inverters and batteries, and properly connecting the system. For maintenance, technicians should be capable of diagnosing faults in the system, resolving issues, and conducting both preventive and corrective maintenance to ensure smooth operation.⁷⁷

Additionally, the influx of cheap, low-quality imported solar products with short lifespans, coupled with installers lacking sufficient technical skills, leads to frequent system failures, poor-quality installations, and inadequate maintenance. As a result, low-quality and inconsistently installed systems become difficult for other maintenance technicians to repair. This highlights the need for qualified solar technicians who employ standardised techniques and possess the expertise to differentiate between products and assess their quality. Furthermore, effective regulatory policies and well-resourced and knowledgeable quality control inspectors are essential to prevent low-quality products from entering the market.⁷⁸

The expansion of off-grid solar solutions to rural areas provides an opportunity for solar technicians

Currently, most solar companies are based in urban centres, making it economically less feasible for them to install and maintain solar systems in rural regions due to high transportation costs. Consequently, rural communities often rely on (informal) electricians who lack specialised training in solar technology. This often results in poor-quality installations and

⁷⁵ interview with Centre for Research in Energy and Energy Conservation in June 2024

⁷⁶ Centre for Research in Energy and Energy Conservation, 2023

⁷⁷ Final roadmap development workshop with study visit participants (TVET institutes, teacher training companies, solar experts and researchers in June 2024

⁷⁸ Interview Senior Lecturer Renewable Energy, Makerere University Business School in June 2024

maintenance, leading to frequent system failures and higher replacement costs⁷⁹ This presents a significant opportunity for solar companies and qualified freelance solar technicians specialising in off-grid solar home systems, particularly in rural areas.

The larger PUSE projects and solar projects along the industrial value chain requires solar engineers and solar project managers

The sector requires qualified solar engineers and system designers to develop larger commercial and industrial solar systems within Uganda's evolving energy landscape.⁸⁰ These professionals must possess expertise in the design, specification, and sizing of solar equipment and have the ability to make a design in collaboration with a client. Additionally, they should be proficient in determining the appropriate ratings and sizes of installation accessories, such as cables and cabling components, and in producing the necessary technical drawings and blueprints to guide the installation process.

Larger projects also necessitate the expertise of solar project managers, who are responsible for overseeing the entire lifecycle of solar projects. This includes managing the project from the initial conception phase through design, financial management, installation, commissioning, and ultimately the handover of the completed solar project. These managers ensure that projects are executed efficiently, within budget, and according to established timelines and quality standards.⁸¹

Technical sales representatives can contribute to a better understanding of different solar solutions

Solar companies also require sales representatives with technical expertise to effectively market their products to consumers.⁸² While awareness of the benefits of solar energy is growing in Uganda, providing clear explanations of different products is essential for enhancing understanding of their applications. Therefore, employees and freelancers with strong communication, sales, and entrepreneurial skills are highly valuable in the solar industry. Additionally, due to variations in product quality, it is crucial for these sales representatives to possess some technical knowledge to provide accurate information and support.⁸³

Assembling solar systems in Uganda requires long-term research and planning

The fact that solar system components are not manufactured in Uganda, with complex assembly often done abroad, presents an opportunity for increased domestic value addition. To capitalise on this, Uganda needs to develop local expertise and skills by advancing manufacturing practices and integrating both international and local solar energy experience. This will require significant knowledge-building efforts by solar energy researchers, along with long-term planning and investment.⁸⁴

⁷⁹ Multi-stakeholder dialogue with international organisations, TVET providers and governmental actors active in Uganda in June 2024.

⁸⁰ Interviews with Centre for Research in Energy and Energy Conservation and SolarNow in June 2024

⁸¹ Final roadmap development workshop with study visit participants (TVET institutes, teacher training companies, solar experts and researchers in June 2024

⁸² Interview the Women in renewable Energy Association in June 2024

⁸³ Interview with Centre for Research in Energy and Energy Conservation in June 2024

⁸⁴ Interview Senior Lecturer Renewable Energy, Makerere University Business School in June 2024

A well-functioning solar TVET system requires qualified staff and supporting roles

Lastly, to address the occupational opportunities in the solar sector, a well-functioning educational system is essential, which includes qualified teachers and solar instructors. Additionally, given the fact that many electricians learn the craft on-the-job and the variety of tailored courses in solar energy, along with the presence of both formal and informal electricians who are not specialised in solar but work with solar systems, the sector urgently requires an updated standardised curricula and qualified assessors.⁸⁵ These measures are necessary to ensure a consistent level of nationally recognized skills across different technical occupations that both companies and the public can trust upon

Skills gaps and opportunities for learning and curricula development

In their development of 'a roadmap for capacity strengthening of local renewable energy training facilities,' Naluwagga et al., found that Uganda currently has approximately 3,500 trained solar technicians. Their analysis indicates that the country needs 20,000 qualified installers to provide energy access through off-grid solar systems to 5.5 million households by 2030. However, the current TVET system can only produce around 4,000 technicians within this timeframe (due to among other things, lacking resources and qualified teachers as explained in chapter 4), underscoring the urgent need to strengthen training institutions.⁸⁶ Building on their work and the identified occupational opportunities described above, this section discusses skills gaps and opportunities for learning and curriculum development in the solar TVET system.

Technical knowledge is lacking across the solar energy market

TVET graduates often lack technical knowledge of solar equipment and installation methodologies. Although TVET programmes are meant to cover basic skills, such as solar panel installation and understanding the operation of electric batteries, graduates often struggle in practice with effective installation, maintenance, and product quality assessment due to the lack of quality in education. This can for example lead to instances where graduates are unable to properly secure different types of batteries and prevent overheating, as they have only learned these skills with one specific battery type.⁸⁷ To give some more examples, various stakeholders during this research highlighted various specific solar energy skills that were missing, ranging from expertise in solar thermal systems, particularly solar heaters, and proficiency in battery systems management, and knowledge of solar pumping systems to skills in repairing solar components.⁸⁸

This highlights an urgent need for updated curricula, improved resources, and qualified instructors to provide comprehensive solar training. These educational programmes should include not only fundamental technical skills and product quality assessment but also guidance

⁸⁵ Meeting with the Directorate of Industrial Training in June 2024

⁸⁶ Naluwagga, 2023

⁸⁷ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

⁸⁸ Final roadmap development workshop with study visit participants (TVET institutes, teacher training companies, solar experts and researchers in June 2024

on the environmentally friendly disposal of dysfunctional products, as low-quality solar products often have to be thrown away.⁸⁹

Graduates are missing practical skills

Although industrial training is a mandatory component in TVET programmes, securing placements is challenging for students due to companies' distrust of students' knowledge, fees for internships required from students, or the need for personnel connections to acquire an industrial training position within a company.⁹⁰ Furthermore, students can also not acquire practical skills in the classroom due to lack of quality teaching materials. A discussion with solar energy instructors illustrated this.⁹¹ Their TVET institution had only 23 solar kits, approximately 7 batteries, 5 controllers, and 25 converters for over 230 students, with some equipment not functioning properly. This forced the teachers to group students and divide the available materials. Lacking internship opportunities and inadequate material result in graduates missing practical experience when searching for employment and forces companies to train their employers on the job.

Incorporating green and transferable skills are key in a transforming labour market

TVET tailored to the solar energy sector is crucial for preparing youth for employment in this growing sector. However, from a national perspective, it is also important to include transferable and versatile skills like strategic thinking and programme management in the curriculum. These skills are valuable not only in the solar sector but also across other industries like waste recycling that need to rapidly change as part of the green transition. Additionally, incorporating environmental awareness into curricula will help youth understand and advocate for sustainable practices in their communities. This holistic approach supports the workforce to be well-equipped to support the green transition on multiple fronts.⁹²

Entrepreneurial and soft skills can support graduates in starting their own solar company

Lastly, the solar industry in Uganda currently offers only a limited number of formal jobs at established companies, leading many technicians to work informally and students to aspire to start their own businesses.⁹³ This creates an opportunity to integrate entrepreneurial and soft skills even more into TVET programmes specifically focused on solar energy, so that graduates can start their own companies and provide employment opportunities to others.

There is a need for specific short and longer-term solar energy TVET programmes

As noted, Uganda's current TVET system lacks an updated solar energy curriculum, offering solar only as a module within broader energy programmes or as short courses. This approach provides graduates with only basic knowledge of the solar industry. To meet specific market needs, there is a need for specialised short- and longer-term programmes focusing on distinct areas of solar energy. For example, TVET programmes dedicated to installing and maintaining

⁸⁹ Multi-stakeholder dialogue with international organisations, TVET providers and governmental actors active in Uganda in June 2024.

⁹⁰ Conversations and focus group discussions with students of Kiryandongo Technical Institute and Uganda Technical College Kyema in June 2024

⁹¹ Focus Group Discussion with teachers at St. Joseph's Technical Institute

⁹² GIZ, 2022b

⁹³ Conversations and focus group discussions with students of Kiryandongo Technical Institute and Uganda Technical College Kyema in June 2024

off-grid solar solutions in rural areas are in high demand, and these differ significantly from the skills required for solar irrigation practices for installing solar-powered batteries for motorcycles, which also merits attention. Additionally, there is a need for advanced solar courses to support the wider adoption and innovation of advanced solar products like cooling systems, agro-processing mills, solar cold rooms and solar dryers and electric water pumps across various sectors in Uganda.⁹⁴

4. Barriers to greening TVET for the solar sector

In addition to the skills gaps described above, there are multiple barriers to greening TVET for the solar energy sector, which hinder its ability to effectively prepare youth for the solar labour market.

Fragmented efforts and limited coordination in Uganda's solar TVET landscape

The solar TVET landscape in Uganda is fragmented. While this research identified numerous positive initiatives from a range of knowledgeable and well-equipped local, national, and international actors, many of these efforts operate in isolation. For instance, various stakeholders develop solar training programmes tailored to specific target groups or conduct research focused on their own interests. Despite attempts at coordination through sector associations and government initiatives aimed at providing strategic direction, the lack of integrated collaboration, monitoring of efforts and comprehensive knowledge sharing hinders the advancement of the solar TVET system.

Insufficient collaboration with an emerging private solar energy sector

One of the reasons behind the current skills gap between graduates and the labour market is the lack of private sector involvement in TVET for solar. First, despite some amendable efforts like the focus of the TVET policy 2019 on facilitating a demand-led TVET system, there is limited support of the private sector in skills forecasting and curriculum development for solar energy.⁹⁵ Consequently, curricula are outdated, forcing companies to train their own staff or seek short, tailored courses from non-formal TVET providers. Second, as discussed above in the skills gaps session, although industrial training is a mandatory component in TVET programmes, securing placements is challenging for students for various reasons⁹⁶ Additionally, the limited number of solar companies in Uganda forces students to seek internship opportunities abroad or with traditional electrical firms.⁹⁷ Lacking internship opportunities result in graduates missing practical experience when searching for employment.

⁹⁴ Centre for Research in Energy and Energy Conservation, 2023

⁹⁵ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

⁹⁶ Conversations and focus group discussions with students of Kiryandongo Technical Institute and Uganda Technical College Kyema in June 2024

⁹⁷ Integration, environment & energy GmbH, 2021

Shortage of qualified solar teachers and inadequate teaching materials and training

The TVET system in Uganda faces a significant shortage of qualified teachers in solar energy, further exacerbated by limited opportunities for teacher training and a lack of quality teaching materials. During a focus group discussion with teachers from a particular TVET institution, they furthermore explained that there are limited opportunities of learning as the government does not offer refresher courses, leaving educators reliant on international organisations like GIZ for training.⁹⁸ These issues are hindering the effectiveness of the teachers in preparing students for the solar energy sector

Limited financial resources for greening TVET for Uganda's solar industry

Insufficient funding and investment in greening TVET for the solar industry lead to significant resource shortages in TVET institutions and TVET bodies. For instance, institutions often lack the financial means to purchase expensive solar equipment needed for hands-on student experience and generally rely on international donors or government subsidies to cover part of the student enrollment fees for solar programs.⁹⁹ Additionally, DIT emphasised that new programmes require adequate financial resources to equip assessors properly and ensure students possess the necessary skills for the labour market.¹⁰⁰

Limited inclusivity in Uganda's TVET system

The government has made efforts to improve inclusion in TVET, such as offering scholarships for refugees and women. Furthermore, various TVET providers are offering short courses to informal workers without requiring prior educational qualifications, supporting them in gaining recognition for their skills.¹⁰¹

Despite these examples, the TVET system in Uganda faces significant barriers to inclusivity, hindering its effectiveness in preparing all youth for emerging labour market opportunities. TVET remains expensive for people without sufficient economic resources or a scholarship, as TVET providers charge different entry fees, creating a financial barrier for prospective students.¹⁰² Furthermore, many TVET centres are concentrated in urban areas, leaving rural youth with limited access. Additionally, the system lacks comprehensive support for individuals with disabilities and often does not offer training in local dialects.¹⁰³ Women face challenges due to traditional gender roles, including expectations around household responsibilities and a scarcity of female role models in the solar energy sector.¹⁰⁴

⁹⁸ Focus Group Discussion with teachers at St. Joseph's Technical Institute

⁹⁹ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

¹⁰⁰ Meeting with the Directorate of Industrial Training in June 2024

¹⁰¹ Visits to Huys Link Community Initiative, Kiryandongo Technical Institute, St. Joseph's Technical Institute and Uganda Technical College Kyema in June 2024

¹⁰² *ibid.*

¹⁰³ Integration, environment & energy GmbH, 2021

¹⁰⁴ Interview the Women in renewable Energy Association in June 2024

Mixed perception of the economic and environmental potential of solar energy

Despite national promotion of both TVET for renewable energy and the use of solar energy, and increasing public awareness of solar energy's potential to provide energy access, there remains a mixed perception surrounding the economic and environmental opportunities associated with increased solar energy usage. This is not supported by the limited local financial support for companies and the low perception of employment potential in the solar sector among students and the public. The situation is worsened by a shortage of decent job opportunities, low wages, and the high costs and failure rates of solar systems often ending up in the environment, which negatively impact the image of solar energy. Consequently, this barrier contributes to a negative perception and limited interest in TVET for the solar industry.

Lack of a supportive business environment for job growth in solar energy

As detailed in Chapter 3, despite various policy, regulatory, and funding initiatives, the private sector continues to encounter significant challenges in its growth. Companies face limited access to finance, while the absence of a comprehensive policy implementation plan and the inconsistent application of existing tax exemptions by authorities further complicate operations.¹⁰⁵ Additionally, the rapid development of the solar sector has outpaced the expertise of product assessors, leading to inadequate enforcement of regulations and inconsistent product quality. Furthermore, affordability concerns and the underdeveloped solar value chain in rural areas hinder the effective distribution and sale of solar products.¹⁰⁶ This may result in limited job growth and negatively impact the willingness of students to participate in TVET for the solar energy sector.

5. Best practices in addressing barriers to greening TVET for the solar sector

The Ugandan solar TVET landscape offers inspiring examples of initiatives and actors that address some of the barriers mentioned above, providing valuable lessons that can be applied elsewhere.

Monitoring of renewable energy TVET programmes and graduates

The Centre for Research in Energy and Energy Conservation (CREEC) utilises online platforms and tools to provide information on its TVET programmes, connect businesses and students with training opportunities, and monitor the impact of different training programmes. Their CREEC Academy is a market-driven renewable energy training platform that provides information on available programmes and can receive applications. Additionally, CREEC uses the data management tool Main Level Connect to track graduates, gain feedback and monitor their participation in the labour market. This enables CREEC to make informed decisions regarding its renewable energy TVET offerings, driving strategic choices in this field.¹⁰⁷

¹⁰⁵ Centre for Research in Energy and Energy Conservation, 2023, 2023

¹⁰⁶ Ministry of Energy and Mineral Development Uganda, 2023 and various interviews with Uganda solar industry stakeholders in June 2024

¹⁰⁷ Interview with Centre for Research in Energy and Energy Conservation in June 2024

Supporting women in accessing training and employment in the solar energy sector

Through short solar and other renewable energy training courses specifically targeted at women, the Women in Renewable Energy Association (WREA) aims to equip women with skills needed to access the solar energy labour market and supports them thereafter by trying to link graduates' to job opportunities. Next to training, the association advocates for women in renewable energy by addressing workplace challenges, such as gender disparities and women-unfriendly working environments through advocating for better policies and offering negotiation and public speaking training to women. By providing an advocacy platform, mentorship, offering TVET courses and fostering networking, WREA supports women's active participation and inclusion in the renewable energy industry in Uganda.¹⁰⁸

Taking a value chain approach to promote e-mobility

To support the transition of boda bodas (motorcycle taxis) from fuel to electric power, GIZ adopted a comprehensive value chain approach. Their goal was to enable drivers to use e-battery-powered motorcycles. Recognising that this shift demands greater awareness, affordability, and accessibility, GIZ launched campaigns targeting communities and advocated with government officials to promote supportive regulations. They also worked with stakeholders to provide training in e-battery assembly in Uganda, contributing to the affordability and furthermore set up charging stations where drivers could exchange empty batteries for charged ones. Employees at these stations received training in customer service and e-battery knowledge.¹⁰⁹ This initiative highlights that greening TVET for the solar industry requires a holistic approach, including community awareness and advocacy for supportive policies.

6. Greening TVET for the solar sector in Uganda roadmap

Based on the current status of the TVET system for the solar energy sector in Uganda, and in consideration of the identified skills gaps, labour market needs, and existing barriers, this chapter concludes with a roadmap for greening TVET in Uganda's solar sector. This framework to guide capacity building on greening TVET in Uganda consists of 7 interconnected areas of action, offering key recommendations for all stakeholders—ranging from government and private industry to civil society and international organisations—active in the solar energy field. The roadmap is designed to build a TVET system capable of preparing young people for successful careers in the solar energy labour market and contribute to a just energy transition

Strengthen stakeholder engagement and coalition building

Stakeholders engaged in TVET for the solar energy sector, including formal and non-formal TVET providers, government bodies, the NCDC, DIT, UBTEB, sector associations, research

¹⁰⁸ Interview the Women in renewable Energy Association in June 2024

¹⁰⁹ Multi-stakeholder dialogue with international organisations, TVET providers and governmental actors active in Uganda in June 2024.

institutes, and youth representative bodies, should collaborate to determine strategic direction, share knowledge, and strengthen efforts to greening TVET for the solar energy sector.

- **Create a centralised network:** Uniting all stakeholders involved in the provision of TVET for solar energy. This platform should facilitate knowledge exchange, advocate for policies, promote collaboration, align efforts, and ensure that training programmes, research, and initiatives are complementary and build on each other.
- **Develop a national greening TVET for solar energy sector strategy:** Setting clear goals, priorities, and guidelines for all stakeholders. This strategy should be backed by government policies and support that encourage integrated collaboration and provide a strategic framework for solar training and education.
- **Facilitate meaningful youth engagement in coordinating platforms and national strategy development:** Ensure that greening TVET for the solar sector aligns with the lived realities and needs of young people. This can be achieved by including youth representative bodies from TVET institutions in strategic conversations.
- **Provide up-to-date information on the availability and quality of various TVET programmes for solar energy:** Learn from, and potentially build on the use of online tools and platforms, such as those utilised by the Centre for Research in Energy and Energy Conservation (CREEC) and other actors, for monitoring and delivering TVET programme information. This will support strategic decision-making by both government and the private sector, while guiding potential students in choosing the most suitable TVET programmes.

Development of green curricula and green skills identification

Address the current skills mismatch between graduates and the solar energy labour market by adopting a comprehensive approach to green skills development. This should account for emerging labour market developments, new occupations, and rapid advancements in the solar energy sector.

- **Develop and update nationally recognized and standardised curricula, training programmes and teaching material specifically for the solar energy sector:** Focus on both basic and advanced knowledge and skills required across the solar energy sector, including transferable and soft skills to ensure that youths are prepared for the ever changing solar labour market.
- **Collaborate with the private sector to improve employer-led TVET curriculum for the solar industry:** Facilitate constant labour market scans and skills forecasting mechanisms through strengthening sector skills councils for solar energy and private sector advisory committees. Additionally, implement feedback mechanisms between recent graduates, companies and TVET institutions. This will support curricula in accurately reflecting the occupational profiles and future skills needs of the solar energy sector.
- **Strengthen the implementation of two-month industrial training for solar energy:** Develop mechanisms to uphold existing policies, initiate financial incentives for

companies, and raise awareness of the benefits of preparing students with practical experience in the solar energy sector.

- **Provide continuous training and capacity-building for exam assessors and curriculum developers:** Ensure that solar energy curricula and assessments stay aligned with the latest industry developments and sector-specific skills. This guarantees that qualifications accurately reflect the skill levels needed by employers and consumers.

Capacity building for TVET trainers

Preparing youth for the solar energy labour market requires a sufficient number of qualified teachers, trainers, and up-to-date teaching materials and equipment. This will support students to acquire relevant knowledge and skills for the solar energy sector.

- **Facilitate lifelong learning:** Provide training for teachers incorporating knowledge on new innovations including standardised regular teacher refresher training courses that incorporate both technical and soft skills development and didactics to ensure that their knowledge is up-to-date.
- **Provide sufficient and up-to-date teaching materials and quality equipment:** Support teachers in delivering practical experience and relevant knowledge to students in the rapidly evolving solar energy sector.
- **Increase industrial experience and alignment of teachers and teaching material:** Solar energy companies and the government should together offer internship opportunities to trainers supporting them on experiencing the latest developments in solar energy.
- **Enhance the attractiveness of the teaching profession:** Providing competitive salaries, decent working conditions, and opportunities for professional growth through continuous training and learning.

Fostering inclusivity in TVET institutes

Greening TVET for the solar energy sector should ensure that all youth, including those from disadvantaged backgrounds such as rural areas, women, individuals with disabilities, and refugees, have equitable access to TVET. This will provide them with the opportunity to participate in and contribute to the transformation of the solar energy sector.

- **Recognize the diverse needs of youth:** Offer training in local languages and adapt curriculum and infrastructure to accommodate specific disabilities. Ensure that TVET programmes include accessible materials, such as braille and audio content, and make physical adjustments to enhance overall accessibility. Additionally, improve access for rural youth by covering transportation costs and establishing TVET centres in these regions, or provide lodging at boarding schools. Furthermore, address gender barriers through offering childcare services, and part-time courses that recognize household responsibilities. Promote the presence of female role models in the sector to inspire female students.
- **Eliminate or reduce entry fees for TVET programmes:** Collaboration with the private sector and international donors to expand existing scholarship opportunities to cover additional costs for disadvantaged groups, including refugees and women.

- **Strengthen the establishment of student representative bodies within TVET institutes:** These bodies should include youth from diverse backgrounds as they advocate for and represent the needs of all students equitably, ensuring that their concerns and requirements are communicated and addressed within the sector.
- **Strengthen the inclusion of informal workers in TVET:** Support TVET providers with finance and resources to offer more short courses for informal workers. This will help expand their skill sets, validate existing skills, and provide them with nationally recognized certificates.

Facilitating green job creation and employment in the solar industry

Greening TVET for the solar sector is beneficial only if there are ample decent economic opportunities for graduates in both the formal and informal solar energy sector. This necessitates creating an enabling environment for private sector development, catering to both the domestic household market and other sectors utilising solar energy for productive use.

- **Improve access to finance for solar energy companies:** Leveraging existing initiatives, such as supply and demand-side subsidies and debt funds, and stimulate national financing through investments and loans from government and private sector. This enables businesses to scale more effectively and potentially create more jobs.
- **Allocate budget and training to governmental bodies:** Support actors like the Uganda National Bureau of Standards and the tax authority with financial means and knowledge to uphold solar energy, product quality and tax regulations. This will reduce confusion for solar system suppliers and government staff regarding new policies and regulations.
- **Facilitate public-private partnerships on decent work:** Develop and uphold decent work standards specifically designed for the solar energy sector to make employment in solar energy more attractive for graduates.
- **Develop policy frameworks specifically for the off-grid solar market:** This is currently largely missing and is needed to support solar companies active in the off-grid solar market to reach goals for off grid electricity access set by the national government, specifically in rural areas.

Enabling policy and funding environment for the solar industry

Sufficient funding and enabling policies are critical for TVET institutions and other stakeholders engaged in solar energy training. These resources play a vital role in adapting training programmes to align with evolving solar energy market needs and implementing the recommendations outlined in the roadmap and enforce existing policies and regulations.

- **Prioritise the allocation of funds for demand driven solar energy TVET:** This includes investments in curriculum development, labour market analysis, and skills forecasting mechanisms to ensure graduates are equipped with relevant competencies.
- **Increase government funding to TVET institutions:** To support capacity building for trainers, procure modern solar teaching equipment, and subsidise student enrollment in

solar energy training programs. These measures will enhance the quality of training and attract more students to the sector.

- **Provide funding for collaboration between research institutions and the private sector:** use research to drive innovation in solar energy training. This supports consistent updating of TVET curricula and policies to reflect the latest developments and technologies in the solar energy market.
- **Create financial incentives for TVET and renewable energy policies.** Instead of creating policies, motivate stakeholders to implement current frameworks like the Electricity (Isolated Grid Systems) Regulations (2020) and the Electricity (Installation Permits) Regulations (2019). Additionally, prioritise the implementation of recommendations from the TVET Policy 2019.

Green awareness building

The government, private sector, civil society, and the public should focus on green awareness building to highlight the significant environmental sustainability benefits of the solar and renewable energy sector. While expanding energy access and promoting economic advancement are important, there is also a role for renewable and solar energy in contributing to a greener future. The sector can create jobs, reduce long-term electricity costs for households and businesses, and simultaneously decrease reliance on traditional energy sources. Emphasising both the environmental and economic benefits is essential for encouraging investment and promoting greening TVET programs for the solar sector. Supporting youth in understanding climate change might trigger interest in exploring other green sectors as well and enable them to advocate for sustainable practices within their society.

- **Leverage existing advocacy organisations:** Provide funding and capacity building to organisations such as Women in Renewable Energy, that are actively engaged in awareness campaigns and the dissemination of information regarding the economic and environmental potential of solar energy, targeting communities and prospective TVET students. Furthermore, work with organisations like SENDEA to target government and private sector actors specifically to lobby for promoting TVET and advocating for finance and policy development.
- **Integrate courses on environmental awareness into national curricula:** Collaborate with knowledge institutes, such as the Centre for Research in Energy and Energy Conservation with experience in developing environmental awareness modules. This integration will equip students with an understanding of climate change and enable them to advocate for these practices within their communities.
- **Mainstream Renewable Energy Courses:** Introduce a dedicated course on renewable energy applications in all engineering departments to enhance awareness and understanding of green technologies.
- **Address the negative perception that solar systems are expensive and low-quality:** Ensure clear information provision from governmental actors, consumer platforms, and companies. Educate supply-side actors on these issues, enabling them to provide households and businesses with detailed insights into the varying quality, costs, and

long-term benefits of solar products. Additionally, offer guidance on proper disposal methods for broken products to mitigate environmental damage.

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