RECP
Africa-EU Renewable Energy Cooperation Programme

euei pdf
energy for development

Vocational Training for Renewable Energy in Africa

Developing the next generation of energy professionals

Paper adapted from a study of the
Africa-EU Renewable Energy Cooperation Programme

This publication has been financed through the Africa-EU Renewable Energy Cooperation Programme (RECP), specifically its Action Area 4: Technology, Innovation, and Capacity Development, initiated by the governments of Austria and Finland. Action Area 1, 2, and 4 activities are implemented by the EU Energy Initiative Partnership Dialogue Facility (EUEI PDF). More information on all RECP activities can be found on www.africa-eu-renewables.org.

Realised by:
European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF)
c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

P.O. Box 5180
65726 Eschborn, Germany
E info@euei-pdf.org
I www.euei-pdf.org

Authors:
Peter Cattelaens
Dr. Jörg-W. Fromme

Date of Publication:
June 2014

Contents

1 Introduction 1

1.1 Programmatic Context: the RECP 2

2 The challenges for RECP's strategic approach to TVET 3

2.1 Scope and technological focus 3

2.2 Value chain focus 4

2.3 RECP ambitions: speed boat or tanker? 7

2.4 Challenges between the TVET and RE sectors 8

3 Skills and competences for renewable energy 11

3.1 Employment patterns and jobs 11

3.2 Skills required 12

3.2.1 Solar PV 12

3.2.2 Biogas 13

3.2.3 Wind power 14

3.2.4 Hydropower 15

4 Technical Vocational Education and Training (TVET) in Africa 16

4.1 Overview 16

4.1.1 Structure and institutions 18

4.1.2 Curricula, training material, distance learning 19

4.1.3 Modalities and delivery of TVET 19

4.1.4 Instruments for TVET 20

4.1.5 Gender inequities 20

4.2 Public versus private TVET 21

4.3 Supplementary TVET activities/continuous training 22

5 Renewable energy - TVET approaches and projects 24

5.1 TVET and the electricity sector 24

5.2 Selected examples of successful TVET approaches for renewables 25

5.2.1 Solar training in Tunisia 25

5.2.2 PV training in Kenya 25

5.2.3 Rural electrification in Nepal 26

5.2.4 TVET at the energy and water campus in Gabon 26

5.2.5 Vocational training centres in Tunisia and Djibouti 27

5.2.6 Mali and Burkina Faso – Initial and continuous training programme for rural electrification 27

5.2.7 Strong business associations offering PV training in Uganda and Tanzania 28

5.3 Lessons for TVET in renewable energy 29

6 Strategic approaches to TVET for renewable energy 31

6.1 TVET for renewable energy: caught between two diverse sectors 31

6.2 RECP interventions: slower than speed boat, faster than tanker 32

6.3 Private sector involvement: the dialogue function of the RECP 33

6.4 Further education and training 35

6.5 Promotion of gender equality 36

7 Approaches, interventions and activities 37

8 Selected possible starting points 41

8.1 Stakeholders as project partners 41

8.2 African platform for TVET in renewable energy 42

9 Selection criteria for vocational training under the RECP 43

10 List of references 44

11 Links 46

ANNEX 1: Selected examples of TVET reform practice 47

ANNEX 2: Country Mapping Ghana 49

ANNEX 3: Country Mapping Mozambique 61

ANNEX 4: Country Mapping Rwanda 71

ANNEX 5: Country Mapping Senegal 82

ANNEX 6: Country Mapping Sierra Leone 91

List of tables

Table 1: Renewable energy skills according to installation scale 7

Table 2: Employment factors relating capacity and output to employment 11

Table 3: Skills required for solar photovoltaics projects 13

Table 4: Skills required for biogas projects 13

Table 5: Skills required for wind projects 14

Table 6: Skills required for hydropower projects 15

Table 7: Examples of TVET systems in Africa, 17

Table 8: Modalities for provision of TVET 20

Table 9: Involvement of the private sector 35

Table 10: TVET activities and their characteristics 39

Table 11: Implementation partners and their role 42

List of figures

Figure 1 : Renewable energy value chain 4

Figure 2 : Renewable energy skills along the value chain 6

Figure 3 : Map of TVET activities (with RE) in Sub-Saharan Africa (source: DFIC) 30

Figure 4 : Characteristics of interventions / measures 32

Acronyms and abbreviations

ADEME - Agence de l'Environnement et de la Maîtrise de l'Energie (Environment and Energy Agency)

AU - African Union

AUC - African Union Commission

BEP - Brevet d'Études Professionnelles

BTS - Brevet de technicien supérieur

CAP - Cycle d'Aptitude Professionnelle

CBET - Competency Based Education and Training

CFP - Certificat de Formation Professionnelle

CREE - Community Rural Electrification Entity

CREP - Community Rural Electrification Program

CSP - Cycle de Spécialisation Professionnelle

CSP - Circular Switched Power

CTCET - Centre for Continuous Professional Teacher and Community Education and Training

DRC - Democratic Republic of Congo

EAC - East African Community

ECBP - Engineering Capacity Building Programme

ECOWAS - Economic Community of West African States

EDF - Électricité de France

EPC - Engineering Procurement Construction

EUEI PDF - EU Energy Initiative - Partnership Dialogue Facility

EU - European Union

FET - Further Education and Training

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GSA - German Solar Academy

IDA - International Development Association

IEA - International Energy Agency

ILO - International Labour Organization

ISP - Institute for Sustainable Power

KEREA - Kenya Renewable Energy Association

kW - Kilowatt

MSTVT - Ministry of Science and Technical Vocational Training

MW - Megawatt

NGO - Non Governmental Organization

PPP - Private Public Partnership

priVET - private Vocational Education and Training

PV - Photovoltaic

RECP - Renewable Energy Cooperation Programme

REN Alliance - International Renewable Energy Alliance

RE - Renewable Energy

SARETEC - South African Renewable Energy Technology Centre

SEEG - Société d'Energie et d'Eau du Gabon

SHPP - Small Hydropower Promotion Projects

SHS - Solar Home Systems

SME - Small and Medium Enterprise

SPS - Solar PV Pico Systems

TOT – Training of Trainers

TVET - Technical and Vocational Education and Training

TEVET - Technical Education, Vocational and Entrepreneurship Training

TEVETA - Technical Education, Vocational and Entrepreneurship Training Authority

UNESCO - United Nations Educational, Scientific and Cultural Organization

UNISA - University of South Africa

Wp - Watt peak

1 Introduction

Energy sectors worldwide are undergoing rapid transformations towards a more sustainable and low-carbon pathway utilising renewable resources. In Africa in particular, renewable energy technologies not only present a more future-oriented technology choice but are in addition a promising way for expanding access to electricity to a larger part of the population (both on and off the grid). To bolster this transformation process on the African continent and to build renewable energy markets, however, the capacity to develop, innovate, and operate renewable energy installations is needed.

Skills to be developed for the renewable energy sector have to cover a wide range of different aspects of the value chain of renewable energy projects, depending on the choice of technology for a particular project. For solar photovoltaic systems, for example, engineers as well as technicians will be required to cover the whole value chain from assembly of solar PV modules, to project development skills for PV system design, resource assessments, business plans, etc. Project planning skills are central, while particular technical and electrical skills will be needed to construct and assemble solar PV plants. Similarly, wind, hydropower, bioenergy or geothermal power plants need particular sets of skills in order to develop, build, and operate projects.

Appreciating this need for skills development, the Africa-EU Renewable Energy Cooperation Programme (RECP) has developed two components on higher education and technical and vocational education and training (TVET). While the required skills vary greatly, the level of training and education in African countries, its provision through public and private institutions, the quality and intensity of teaching, and various other factors, are similarly different from country to country.

This publication assesses the status quo and the need for TVET. It sheds light on the differences in technical skills required in the renewable energy sector and shows how they may vary according to technology (e.g. hydropower, solar photovoltaic, solar water heating, biomass for electricity generation, biogas, geothermal, etc.) and type of application (e.g. small off-grid household system vs. larger on-grid plant). It will thus seek to provide an assessment of the status quo of technical training for renewable energy in Africa, and address the most critical issues to be taken into account when providing training.

The study was initially conducted with a view to providing support to TVET and training for renewable energy in a second step, after the assessment through this publication. However, it notably also stands in its own right as an overview of the sector continent-wide and is in the position to inform decision-making on support interventions for renewable energy skills development more broadly. For this latter reason, and because to RECP´s and EUEI PDF´s knowledge no such publication exists, the study has been adapted to suit an external audience. Despite not having the presumption of being exhaustive, it forms a clear, concise

and exemplified overview of TVET for renewable energies in Africa and of possible entry points to ensure effectiveness and impact.

1.1 Programmatic Context: the RECP

The Africa-EU Renewable Energy Cooperation Programme (RECP) aims to substantially accelerate the use of renewable resources in Africa and increase access to energy services. Action Area 4 of the Africa-EU RECP deals with Technology, Innovation and Capacity Development. Its sub-component on Vocational Training is to be further developed. The first step in this Action Area 4 consists of the elaboration of a strategic approach and the second step in the development of concrete activities. One of the principles of the RECP is to complement existing donor initiatives, where possible. Further, by mandate, it focuses specifically on the countries of Sub-Saharan Africa.

The present publication starts by setting the scene for the RECP strategy in terms of the technology and value chain focus, as drawn from the RECP objectives and guidelines. Then the skills and competencies needed in the renewable energy sector are addressed. Thereafter, vocational training in Sub-Saharan Africa is described and some specific country examples are given. The following section considers the status of TVET in the context of renewable energy and provides some examples of existing projects and programmes.

A suggestion is developed for the RECP strategy for vocational training related to the renewable energy sector. The last chapter of this report outlines possible approaches for the implementation of vocational training activities in the field of renewables in Sub-Saharan Africa. Finally, criteria are proposed for the selection of future vocational training activities under the RECP.

2 The challenges for RECP's strategic approach to TVET

2.1 Scope and technological focus

The RECP's approach to TVET is based on the RECP Strategy 2020 and hence relates to its technological focus. The prime focus of the RECP is electricity production through renewable energy technologies. The scope of applications has been loosely defined as *meso-scale* – somewhere between double-digit kW and double-digit MW projects. A number of additional central issues inform this focus.

Electrification in Africa remains a challenge, especially in Sub-Saharan Africa where electrification rates range at 15 % or less[1] and are the lowest in the world. In particular in rural areas, access to grid electricity for lighting, appliances, cooking or productive uses is a rarity. Alternatives comprise stand-alone systems on household level, e.g. solar pico photovoltaic systems (SPS) or solar home systems (SHS).

Similarly, where the grid does not extend to, mini-grids based on a renewable resource or in combination of conventional and renewable technologies (e.g. solar and diesel) can be economically viable and effective options to supply electricity through mini-grids. Options such as these are becoming increasingly popular in villages with sufficient population density and economies of scale to nourish demand for electrical services beyond lighting. The capacities of such installations for the electrification of smaller remote areas range around 1kW – 1 MW or as a supply to islands, commercial or public facilities 100kW – multiple MW.

In addition to off-grid electrification, many African countries face insufficient generation capacities in their electricity grids while the demand by consumers is often rising rapidly. The results are frequent power outages. Renewable energy technologies often play an economically and technically viable solution to increase generation capacities through large-scale power plants as well as smaller scale grid-connected application e.g. through net-metering approaches.

With the focus on electricity production, technologies used for all of these solutions include various forms of solar energy, hydropower, biomass and biogas options, geothermal, as well as wind energy.

Whether on- or off-grid application, solar or hydro technologies, wind or geothermal energy sources, the skills and competences required for the design, installation, operation and maintenance for systems differ greatly.

[1] IEA, 2012

Skills in solar photovoltaics appear relevant in all kinds of off-grid applications, yet differ substantially for solar lanterns, solar home systems, solar street lightings, and smaller stand-alone systems for battery charging or productive uses, up until grid-connected home installations, or until larger ground mounted systems.

Many parts of Africa are abundant with biomass. The use of biomass from the agro-industry, or from agricultural or kitchen waste often presents an attractive potential for generation capacity. Biogas, especially on a commercial scale, represents another area with potential, whether used as a direct source, bottled gas or for electricity production. In the agroindustry the anaerobic treatment of wastewater and the production of electricity from biogas it produces could be seen as another area of application. Yet, the application of biogas technologies at larger scales is only starting, and competencies need to be developed accordingly.

Wind energy is similarly relevant at various scales. Large-scale wind parks provide a valuable opportunity in many countries at very competitive prices. Small-scale wind energy solutions for hybrid systems are a good option with technologies advancing.

Hydro-power solutions are partly relevant as well. While large-scale hydro projects are not considered under the RECP's meso-scale, smaller hydropower schemes provide opportunities for electrification or increased generation capacities.

2.2 Value chain focus

While skills vary greatly per technology, an approach in analysing the differences in skills requirements is through the analysis of the different steps in the renewable energy value chain. Approaches to trainings and TVET more generally can thus be based on, and tailored to the needs of a specific renewable energy technology, according to the different steps in the value chain.

As figure 1 illustrates, the renewable energy sector has, generally speaking, four major elements to its value chain, in addition, to cross-cutting and enabling activities that span all other elements of the value chain.

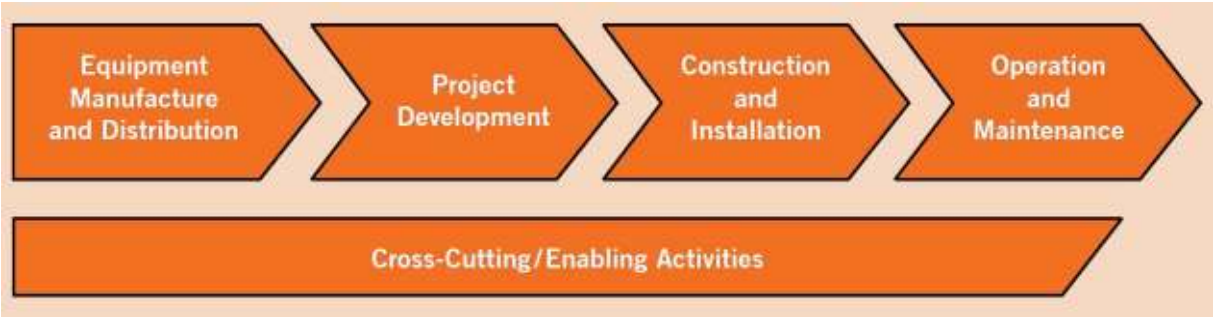


Figure 1 : Renewable energy value chain

Source: ILO, 2011

In brief and general terms, all elements, **manufacturing** is only done in countries that already have a significant manufacturing base in general and have started to produce for the technologies mentioned above (e.g. PV modules). It requires skills not necessarily specific to the renewable energy sector, such as metal work, assembly, etc. compared to installation, operation and maintenance (O&M) of such equipment, where skills required are more specific to renewable energy. Manufacturing of renewable energy equipment is certainly attractive in terms of the value added to local economies and employment generation. However, given the relative size of the respective markets, the number of countries in Sub-Saharan Africa that will build up a manufacturing base for technologies such as solar or wind energy in the near future currently remains limited. **Assembly** of equipment, **distribution** and design of smaller systems, however, should be possible in most countries.

Project development for renewable energy projects is relevant for larger-scale projects and requires additional specialisation in renewable energy, especially concerning assessment of resource and technical feasibility such as wind energy measurement or assessment of biomass potential. Additional skills require general project development capacities that also apply in other sectors (e.g. development of business plans and bankable proposals).

Construction and installation require skills that typically are similar to the construction sector and related services sector. Depending on the size of the installations, specific skills may be required for the erection and commissioning of electricity producing systems.

Operation and maintenance can often be provided by the same technicians that did the installation. The remoteness of many of the installations (e.g. for off-grid electrification) requires a broad range of competencies. Non-technical skills such as accounting for community based systems may also be relevant.

As the below figure summarises, the skills needed range from general engineering and crafts skills to more specialised skills, e.g. for operation and maintenance.

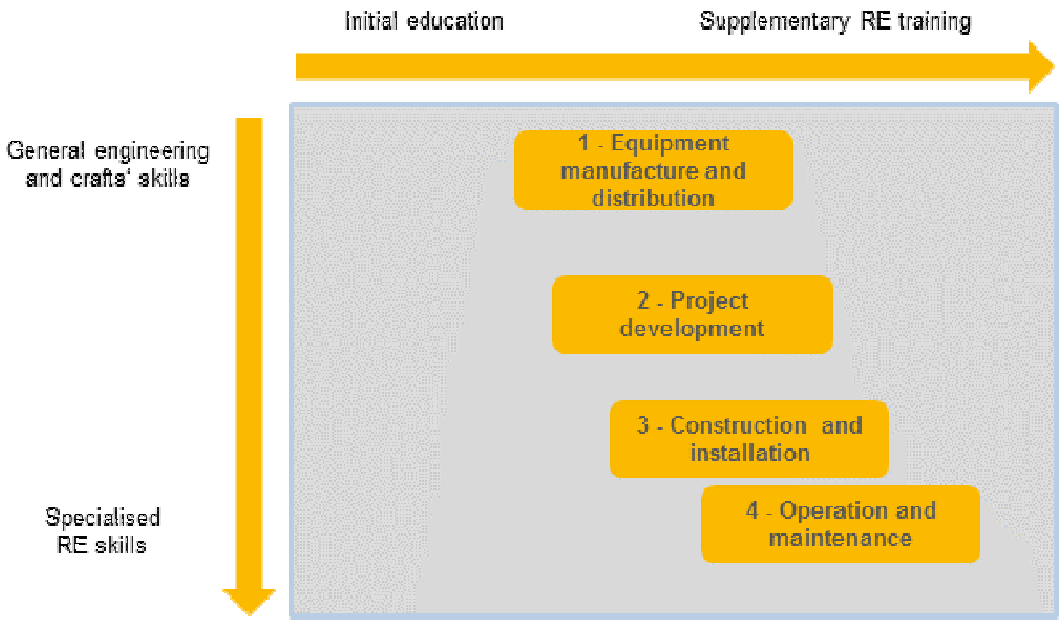


Figure 2 : Renewable energy skills along the value chain

Depending on the skills required, the delivery of training for the acquisition of skills also differs. In many instances, existing initial education and training courses ensure the availability of general skills. For skills specific to renewable energy, the delivery and training often takes place in the form of supplementary TVET. Operation and maintenance could be seen as a particularly relevant skillset for ensuring that any investment into an installation is protected once the installer is no longer responsible.

The table below expands on the value chain illustrated in figure 1 by detailing the skills required based on the size of a project.

Scale	Stage of value chain	Technology	Specific skills required
Large and medium scale projects	1 and 2	all	Limited
	3	all	Qualification of workers in sectors of construction and related services
	4	all	Qualification of workers involved in installation or with relevant technician & craft's skills

			Qualification of employees of engineering services businesses
	Additional for biomass	Biogas production and others	Qualification of workers for harvesting, transport equipment, technicians with agro/bio skills
Small scale projects	3 and 4	Solar PV (small) hydro heat pump biomass heating	Qualification of workers with broad skills (plumbers, electrician, roofer, etc.) Education of community (e.g. for off-grid installation)

Table 1: Renewable energy skills according to installation scale

As becomes evident from the previous remarks, the largest need for technicians, with the most direct impact of TVET interventions, leading to the advancement of renewable energy, may well be in the area of construction, installation and operation and maintenance, i.e. stages 3 and 4 of the value chain of the respective renewable energy system.

In relation to the RECP approach to TVET, this leads to the conclusion to concentrate on these areas with a focussed approach when developing the required skills. This can, for example be done by initially concentrating on training activities with a short- and medium-term impact, e.g. for those directly related to the development of a renewable energy. Where this is an option, and industrial capacities already exist, the RECP could also target manufacturing capacities (stage 1 of the value chain).

2.3 RECP ambitions: speed boat or tanker?

The RECP aims to contribute to the development of renewable energy markets in Africa, thereby also increasing the local value added in the longer run. The challenge for the RECP is making a difference by, on the one hand, integrating the renewable energy and TVET sector perspectives and, on the other hand, generating concrete impacts leading to real skills development. This may often be further complicated by a broad stakeholder landscape, in particular of there is a lot of activity already on renewable energy or within the TVET system.

Contributing to long-lasting impacts involves the institutionalisation of TVET for renewable energy in a given country. Curricula need to be developed, accredited, notably taught, certificates to be accepted, etc. Processes such as these take a long time in large TVET

systems that are often multi-layered. The Ministry of Education in a given country may be responsible for the overall governance of the TVET sector, while another Ministry (e.g. energy) has the thematic expertise. In some African countries, more than 20 different Ministries are responsible for TVET. Experience from many countries shows that change in such TVET structures is sometimes difficult and can be very heavy on time and resources. The risks of not achieving the project objectives within a reasonable time and resource framework must be recognised as being relatively high when working on the systemic level.

At the same time, the achievement of quick impacts is often taking place in the context of concrete projects and thus at the expense of (institutional) sustainability, illustrated for example by a number of PPP approaches across the continent.

With the scope of interventions envisaged under the RECP, the approach to vocational training in its Action Area 4 will need to address these challenges and walk on the thin line of being a speed boat and a tanker. On the one hand, it should aim to produce direct results, improving the skills and capacities of people, perhaps in the context of the implementation of concrete renewable energy projects. On the other, a programme such as the RECP will need to make sure that such results are transferred into an institutional context, e.g. through the accreditation of a curriculum[2]. With this in mind, it will be important for both approaches to ensure a close integration with the private sector. Both for the demand of skills, as well as for the supply of skilled labour, the RECP, with its aim of 'knowledge and technology transfer and cooperation between businesses in Africa and the EU'[3] is in a very good position to deliver. In particular the synergies with the RECP *Action Area 2: Private Sector Cooperation* will play an important role, by which, for example, European companies could asked to deliver the 'training-of-trainers' on latest technologies.

2.4 Challenges between the TVET and RE sectors

The availability of skilled labour will strongly support, if not drive, the implementation of renewable energy projects and further contribute local value addition in assembly, project design, and operation and maintenance (and perhaps even manufacturing in some instances).

In theory, such skilled labour should be supplied by the national TVET system. However, TVET systems in African countries tend to be very complex, sometimes involving numerous ministries in addition to the respective Ministry with thematic responsibility (here: energy).

[2] This will be expanded on in the following parts of this publication.

[3] See RECP Strategy 2020.

This makes it challenging to implement the changes required for the introduction of renewable energy in TVET curricula[4].

An appreciation of these problems, is taking place in some countries, however. For Kenya, for example, a TVET sector mapping report states in 2009:

> 'The current TVET curriculum is weak and not flexible enough to meet the technological changes and diverse needs of different clients. Furthermore the quality of TVET graduates has declined in recent years due to poor instructional methods, outmoded/inadequate training equipment and lack of meaningful work experience and supervision during attachment'.[5]

While these observations are made in the context of technological changes in general, it could be argued that in a fast-paced and quickly changing field such as renewable energy, this will be even more so the case. For the renewables sector, this is further elevated by the fact that teachers are lacking practical experience with equipment.

In rural areas, where renewable energy technologies could and should play an important role for electrification, these problems are even more evident. There, technical schools are often even less equipped, teachers less qualified, and the primary education of students of lesser quality. This will then ultimately lead to the question to what extent existing structures of the national TVET systems can ensure the provision of quality outcomes within.

Another of the challenges for TVET for renewable energy is the linkage between private sector and the teaching institutions. Linking the economic or industrial sector with the labour market is traditionally already difficult for any public education / TVET system with any sector.

The analysis of the Kenyan example shows:

> 'It is noted that in Kenya, the education and industry sectors exist separately from each other and while the importance of the school-to-work transition of students is being advocated, discussion of these matters has failed to probe deeper, resulting in a lack of realistic policy linking school education to the labour market.'

In the emerging renewable energy sector this applies even more due to the fact that this sector is often not yet well structured. The voices of the private sector, associations, are often not yet established, or, if they are, still weak. An exchange of the skills required rarely takes place. The determination of skills gaps and training needs thus needs to be taken into

[4] The characteristics of TVET in Africa are described in the following chapter.

[5] John Nyerere, 2009

consideration, making use of a deliberate inclusion of the private sector into the development of TVET curricula.

Another challenge is presented by the fact that the labour market often does not differentiate between engineers and technicians but rather looks for skills and competences. Universities have often started earlier than vocational training institutions with teaching on renewable energy technologies. The role and scope of teaching and the abilities of the tertiary sector as well as those of the TVET sector have to be closely analysed and clearly defined for the renewable energy sector. When this is observed, the interface between university education and vocational training can be of extreme value for the development of skills. Universities and TVET schools can work closely together for example in areas such as the training of TVET trainers, the joint of centres & equipment for practical training, or the joint use of training material (basic modules and practical examples).

In sum, it can be noted that these challenges potentially present major hurdles in the successful implementation of renewable energy training programmes through the TVET sector and should each be carefully analysed when designing new programmes.

3 Skills and competences for renewable energy

As has been noted in the above chapters, skills and competences for renewable energy projects vary greatly across technologies, types of application (e.g. on- or off-grid), and stage of the value chain, resulting in different employment patterns.

3.1 Employment patterns and jobs

In project development and in the construction and installation of renewable energy plants, the work related to these is mostly project-based. There is rarely a continuity of employment, except when there is a steady flow of projects in a bigger market. Comparing the relatively early stages of most renewables markets with the resource potential, however, most African countries have significant potential to catch up.

In operation and maintenance employment patterns are more stable. Renewable energy installations often have a lifetime of 20 to 30 years, or more, if equipment is well maintained or renewed. These projects require operation services and maintenance for the same period. Depending on the technology, the employment generated in operation and maintenance can be significant. For biomass power plants, for example, O&M can be as high as in the construction phase. For markets, characterised by a large number of small scale renewable energy projects, e.g. for rural electrification, the amount of work to be done in O&M is likely to increase over time (e.g. for repair), resulting in an increased for the demand of skilled workers.[6] A global study by Rutovitz and Atherton (2009) provides an indication of the person years needed per MW of installed capacity for three different technologies, as shown in the table below. Most work hours in construction and installation are needed for solar PV. For Operation and maintenance, biomass technologies are most work intensive.

Technology	Person Years per MW of capacity	
	Construction / Installation	Operation and maintenance
Solar PV	31.9	0.40
Wind onshore	2.5	0.40
Biomass	3.9	3.10

Table 2: Employment factors relating capacity and output to employment[7]

Source: Rutovitz and Atherton (2009)

[6] ILO 2011

[7] ILO 2011

3.2 Skills required

The skills and competencies required for the installation of renewable energy technologies are universal across the world and have been assessed by various publications. For most technologies, electricians or electrical installers update their existing skillsets with a view to the installation of solar PV, wind, hydropower or biomass (for electricity generation). However, there are also application-dependent skills, which need to be identified and catered for, e.g. in areas such as the administration of mini-grids, the storage of power (with batteries), electricity distribution, etc. In addition, technology-specific mechanical engineering or civil engineering related skills are required in the construction phase of hydro, wind or biomass projects.

The TVET-relevant qualifications are further detailed in the following chapters.

3.2.1 Solar PV

As shown above, the solar photovoltaics sector is much diversified (from pico PV and solar home systems up until large-scale MW-sized power plants).

The specific skills required for small-scale solar PV installations relate to electricity generation. The work may be done by an electrician with additional solar PV skills or by a specialised photovoltaic installer. In countries where renewable energy sectors are more advanced, there are often specific TVET courses and certifications for solar installers. For rooftop installations, technicians may need to have roofing skills. When installations have to be attached to grid electricity, connections will need to be made by the technician and metering technology will need to be installed.

For household installations, but in particular for larger solar power plants, construction work includes the preparation of the site and the installation of numerous power lines. Various levels of professional skills are thus needed in the area of civil, mechanical and electrical engineering. Maintenance of installations will be needed when problems occur. The skills required are largely similar to those involved for the installation of a system.

For smaller systems in particular, technical installers will also be required to be familiar with a supply and demand analysis for the design and sizing of a system. If, for example, an installation is to be made at a household with a small demand profile (e.g. from appliances such as lighting, radio and cell phone charging), a technician will need to analyse such demand and size the system accordingly. Similarly, entrepreneurial skills, including management and financial skills may be required for designing and selling smaller systems (see cross-cutting and enabling activities in figure 1).

	Construction/erection and installation	Operation and maintenance
High skilled	Commissioning engineers (electrical)	Recycling specialists
Medium skilled	Distribution and wiring electricians Quality assurance specialists Control and software technicians Installers Construction professionals Project and installation technicians	Photovoltaic maintenance specialists (electricians specializing in solar) Diesel engine technicians for hybrid systems Inspectors CSP maintenance specialists Accounting clerks Organisation and administration clerks
Low skilled	Transportation workers Construction professionals	Inspectors

Table 3: Skills required for solar photovoltaics projects

3.2.2 Biogas

The physical installation of biogas power plants requires construction skills specialised knowledge of the equipment. Input preparation, gas production, electricity generation, heat production or any combination of those require technicians and craft skills for day-to-day operations and maintenance, preferably technology-specific. For larger biogas electricity generation (50 KW and above) a sound understanding of the respective biochemical processes is required in order to make the plant run smoothly.

	Construction/erection and installation	Operation and maintenance
High skilled	Chemical, biological, mechanical and electrical technicians	
Medium skilled	Environmental technicians Laboratory technicians and assistants Control and Software technicians Construction professionals General electricians, plumbers, roofers Accountants Commissioning technicians (electrical)	Gas handling Laboratory technicians and assistants Operation and maintenance specialists
Low skilled	Construction professionals General construction workers Transportation workers	Gas handling Operation and maintenance specialists

Table 4: Skills required for biogas projects

3.2.3 Wind power

In most cases, project management and the erection and construction of wind turbines are undertaken by construction companies and professional services firms. This is particularly the case for large wind parks. For smaller installations, e.g. in hybrid systems, this could be part of the company responsible for the project design. Skills required involve civil engineering skills for foundations, towers, etc. as well as mechanical engineering. Skills required on a permanent basis can be provided by technicians and skilled craftsmen to operate and maintain systems, in particular everything around the nacelle, including turbine, gear box, etc. For smaller-scale turbines, integrated into hybrid systems for example, this may include work on batteries, or diesel backup systems. While many hybrid systems may be located in rural areas and have their own local management model (e.g. through a community), technicians for operation and in particular maintenance may not be employed on a full-time basis (and not be based in the communities).

While some requirements for large-scale wind power plants and large turbines go considerably beyond the scope of vocational skills, it is important for wind technicians involved in the installation (or operation and maintenance) to be able to work at the height of the nacelle of up to 120 meters.

	Project development and design	Construction/erection and installation	Operation and maintenance
High skilled		Business developers Commissioning engineers (electrical)	
Medium skilled	Wind measurement technicians Land use and soil technician	(Small) wind turbine installers Construction electricians Power line technicians Construction workers Quality control inspectors Instrumentation and control technicians	Mechanical technicians or fitter/wind service mechatronics technicians Operation and maintenance specialists Power line technicians Field electricians
Low skilled		Construction workers Transportation workers	

Table 5: Skills required for wind projects

3.2.4 Hydropower

As an established technology, technical skills required for hydropower plants are stable. Work on larger power plants (which would be beyond the scope of the RECP), involve mostly civil engineering by construction workers. The installation of large turbines is traditionally being done by a technology provider and closely linked to the company developing the project.

For smaller hydropower installations skills needed are similar (civil engineering works). However, the installation of turbines and associated electrical, mechanical and control equipment could also be part of the power plant, requiring electrical and mechanical engineering as well as information technology skills at technical level.

Community-level off-grid schemes may also be in need for technician and electrician skills to operate and maintain both the power plant and the grid infrastructure.

	Construction/erection and installation	Operation and maintenance
High skilled	Engineers (civil, mechanical, electrical) Commissioning engineer (electrical)	Engineers (civil, mechanical, electrical) Physical and environmental scientists (hydrologists, ecologists)
Medium skilled	Technicians (civil, mechanical, electrical) Skilled construction workers	Operation and maintenance technicians
Low skilled	Construction labourers Transportation workers	

Table 6: Skills required for hydropower projects

4 Technical Vocational Education and Training (TVET) in Africa

While the previous chapter was an attempt to provide an overview on the technical skills required for different renewable energy technologies (in order to, ultimately, be developed through the TVET system), the following will seek to provide an analysis of the TVET sector in Africa[8].

UNESCO and the International Labour Organization (ILO) define TVET in their 2001 Revised Recommendation Concerning Technical and Vocational Education as

> '[…] a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life'.[9]

Activities to bring about the educational process are usually differentiated between *initial training* and *supplementary training*. This includes continuous training corresponding e.g. to further training of employees or an up-grading of existing skills as well as additional training for the upgrading of fresh graduates.

For most African countries, the provision of such training, summarised as TVET, provides a major challenge. Support to their own efforts is rendered to many governments by international donor partners, whose attention to TVET has been increasing, not least because TVET has been defined as one of eight priority areas in the African Union's Second Decade of Education (2006-2015)[10].

4.1 Overview

The differences in TVET systems are vast and very often can be traced to the roots of the education sector (and their respective origins). As is exemplified for some countries in the following table, TVET activities are delivered at different levels in different types of institutions. As a commonality, it can be noted that in all of sub-Sahara Africa *formal* TVET

[8] It should be noted that this overview cannot cover the specificities of the education sectors of 54 African countries (or their TVET systems). Rather, it will pick on points of particular interest or commonality across countries.

[9] www.unesco.org

[10] UNESCO, 2013

programmes are school-based. Their duration is between three and six years, depending on the country and the model.

Country	TVET delivered at	Duration	Model
Central African Republic	CAP Baccalauréat de technicien at secondary level Brevet de technicien supérieur (BTS) at higher level	3 years 3 years 3 or 4 years	French
Democratic Republic of the Congo	Cycle de Spécialisation Professionnelle (CSP) Cycle d'Aptitude Professionnelle (CAP) Brevet d'Études Professionnelles at secondary level	1-2 years 4-5 years	French
Gabon	At secondary level: Certificat de Formation Professionnelle (CFP), CAP, Brevet d'Études Professionnelles (BEP)	1-3 years	French
Kenya	Technical Secondary Schools or after primary	4 years	English
South Africa	FET colleges after grade 9	3 years	English
Tanzania	Post-primary vocational training centres, distance learning at secondary level	2 years	English
Uganda	Community polytechnics, farm and technical schools, vocational training centres at lower secondary level Technical and vocational colleges and institutes at higher secondary level	3 or 4 years 2 years	English

Table 7: Examples of TVET systems in Africa[11],[12]

While often a considerable challenge, vocational training is high on the agenda of many African countries. Numerous initiatives have been undertaken in a most countries, relating to both initial and of continuous training. The objective of their efforts is to improve the

[11] GIZ, 2013

[12] Additional TVET systems and project examples (with both positive and negative lessons) are described in further detail in Annex 1. Annex 2 sheds light on a number of particular countries.

quality and the performance of TVET delivery, at national and (sub-)regional level (i.e. with the setting up of networks).[13]

Enrolment rates in formal TVET at secondary level are 5% or less in most African countries.[14] Nevertheless, TVET is an integral part of secondary education. Vocational education and technical training take place in special vocational and technical schools or technical institutes.

Improving the quality is the objective of numerous reform processes in various countries. Good practice for such reform exists. Senegal, Ethiopia and Zambia stand out as positive examples[15]. Senegal conducted a needs analysis and is developing TVET through a public-private-partnership and attempts to integrate traditional apprenticeships into the national training policy. In Ethiopia, a demand-driven, flexible, integrated and high quality TVET system was built by involving all stakeholders in the planning, policy-making, training delivery, monitoring and evaluation of the system. As a consequence of its TVET reform, Zambia had the second highest growth rate (+765%) in the number of secondary students enrolled in TVET programmes between 1999 and 2007.

Comparing different TVET systems is challenging due to the many differences the systems as well as their overarching education structures, as is demonstrated already by the numerous names employed to describe them: Technical Vocational Education and Training (TVET), Vocational Training, Vocational Education and Training, Technical Education, Industrial Training, Professional Technical Education, etc.

4.1.1 Structure and institutions

TVET is institutionally integrated in the regular educational system, at secondary level, upper and post-secondary as well as sometimes at tertiary level. In many countries, different government bodies and ministries share supervisory responsibilities. More often than not, these are loosely (if at all) coordinated, unregulated and fragmented. Four ministries are, for example, responsible in Swaziland, 13 in Kenya. More positive examples (often after lengthy reform processes) are provided by South Africa, Botswana, Mauritius, Tanzania, Malawi, Zambia and Namibia.

Structural linkages between the TVET sector and the real economy are mostly weak if at all existent. Only a few countries are officially envisaging collaboration between the private sector (e.g. Mauritius, Mozambique, Namibia and Swaziland).

[13] IGC, 2012

[14] UNESCO, 2013

[15] IGC, 2012 (see Annex 1 for further detail)

TVET in urban and rural areas is often institutionally separated and provides a particular challenge for all. Delivery and quality in rural areas is low in many countries. However, more broadly, the quality of training is still perceived as being too low. Education is mainly focused on theory and certification, the more important acquisition of practical skills is often neglected. The social prestige of TVET tends to be low, leading to the attraction of less qualified and/or motivated students.

Regional (i.e. cross-country) cooperation on TVET issues is not frequent and difficult to realise. While this is to some extent understandable due to the differences in education structures and TVET systems, there is at the same time a potential for synergies, e.g. on the training-of-trainers, cross-border certification and accreditation, or similar. This could, for example, be realised through regional Centres of Excellence.

4.1.2 Curricula, training material, distance learning

The content of TVET programmes is largely defined by the curricula for particular courses and job profiles. For the integration of renewable energy into the TVET system, there could be opportunities for both, upgrading existing curricula by integrating modules in existing curricula and professions covering renewables, or developing new curricula.

The focus of training within the TVET systems is mostly on practical (technical) skills and competences. Training in entrepreneurial skills, including economic or management skills is less common. However, in many cases the lack of proper teaching equipment impacts substantially on the quality technical skills acquisition of students. Similarly, the quality is jeopardised by the lack of practical experience of teachers, the generally rather low payment levels (and resulting motivational issues), and a general lack of training for trainers/teachers.

Course material, as well as pedagogical tools, equipment, and demonstration material are central to teaching those curricula. For renewables in particular, the practical dimension is considerable. Companies (including European) are often instrumental in the development of demonstration material or projects.

Distance and blended learning is starting, for example in South Africa and Tanzania. In Zambia, distance learning represents 2% of training institutions in Zambia. UNESCO for example is experimenting with mobile training units (comprising trucks, tents, trainers, materials, etc.) to provide short courses in disadvantaged areas, e.g. in Northern Senegal. Initial results are encouraging and have generated much interest, for example, in The Gambia as well as in Tunisia and Djibouti.

4.1.3 Modalities and delivery of TVET

The following table reflects the range of modalities for the delivery of TVET that can be differentiated.

Institution-based	Provided by the	Under supervision of the Ministry of

<table>
<tr><td rowspan="5">training (initial and supplementary)</td><td rowspan="2">formal education system</td><td colspan="2">Education</td></tr>
<tr><td colspan="2">Outside supervision of the Ministry of Education</td></tr>
<tr><td rowspan="3">Provided outside the formal education system</td><td colspan="2">Public</td></tr>
<tr><td rowspan="2">Non public</td><td>For profit</td></tr>
<tr><td>Not for profit</td></tr>
<tr><td rowspan="3">Workplace-based training (initial and supplementary)</td><td rowspan="2">Pre-employment training</td><td colspan="2">Modern apprenticeship</td></tr>
<tr><td colspan="2">Traditional apprenticeship</td></tr>
<tr><td colspan="3">In-service training</td></tr>
<tr><td colspan="4">Combination of multiple types of training (e.g. sandwich programs, dual systems)</td></tr>
</table>

Table 8: Modalities for provision of TVET [16]

4.1.4 Instruments for TVET

In order to establish a mechanism by which the quality of the TVET system could be improved, some countries introduced a levy on all employers to (e.g. Malawi, South Africa, Cape Verde, Mozambique, Rwanda, etc.). The funds collected support public institutions as well as training programmes from the private sector, apprenticeships, the development of the informal sector and continuous training activities.

Private sector investment in TVET is tolerated, if not encouraged. Kenya for example seeks to actively promote private investments into TVET.

4.1.5 Gender inequities

Gender inequities in TVET are generally reflected in the lower enrolment rates of girls in secondary education. Countries where girls account for fewer than 15% of TVET enrolment include Eritrea, Ethiopia, Malawi, Namibia, Niger and Uganda. For this group of countries, the share of TVET enrolment in overall secondary enrolment is less than 5%. In other countries, such as Botswana, Chad, Mauritania, Mozambique and Senegal, the proportion of girls in TVET was between 30-40% in 2005.[17]

[16] ILO 2011

[17] www.africaneconomicoutlook.org

4.2 Public versus private TVET

TVET is delivered not only by public schools, but also by private providers. The latter could include profit-oriented training institutions as well as not-for-profit ones or NGOs and religious institutions. School-based public institutions are generally fewer in number than those in the private sector.[18] As highlighted above, TVET in Africa includes formal and informal apprenticeships and to a limited extend enterprise-based training. For the provision of skills via private institutions, the term *priVET* is often used.

In many countries, the delivery of TVET is to a large extent undertaken by the private sector. In Benin, Ivory Coast, Mali and Niger, for example, private TVET centres train more than 65%, 52%, 75%, and 66% respectively of all trainees[19]. In Uganda, private institutions deliver some 81% of TVET training[20].

Training integrated into companies (e.g. in the form of internships or integrated apprenticeships) are rarely an integral part of TVET systems. In some countries, apprenticeships are a tradition, yet take mostly place informally and outside TVET systems. In particular in the informal economic sector, young people are often taken on as apprentices. While they acquire practical skills through their on-the-job-training, they do rarely receive any theoretical education.[21]

Particularly in West Africa, traditional apprenticeships often offer the best opportunity for the acquisition of employable skills in the informal sector. Some West African countries such as Benin, Ghana, Mali, Senegal and Togo are undergoing a restructuring process of their TVET systems in order to incorporate traditional apprenticeships, including certification mechanisms. Similarly, South Africa and Ethiopia are opening their TVET systems to the needs of the informal economy.

Practical workplace-based training through apprenticeships exists in some countries. Benin and Burkina Faso modernised their traditional apprenticeship system into a *dual* system where learners alternate between the classroom (for theoretical learning) and the workshops of the master artisans (to acquire practical skills). Others, Ghana and Senegal for example, have developed programmes to upgrade the pedagogical skills of the masters in an effort to improve the overall effectiveness of skills transfer.[22]

---

[18] AUC, 2007

[19] www.africaneconomicoutlook.org

[20] UNESCO, 2010/2011

[21] ISSER, 2012

[22] Dr. George Afeti, TVET Consultant to AU

State support for non-government TVET providers varies from country to country. In addition to the masters training in support of the quality of apprenticeships, the Ghanaian government provides some government funding to private training institutions (through the Skills Development Fund). Ivory Coast and Mali for example are more generous to private providers.[23] In Rwanda, on the other hand, there is no financial support, except a provision of information about private training offers and access to curricula and teaching material.[24]

In almost all countries, non-governmental provision of TVET is increasing in terms of the number of institutions providing it, and in terms of the enrolment rates of students. This trend is linked to the fact that private providers often train for the informal sector (which is an expanding job market all over Africa). Public institutions often train for the industrial sector (that is stagnant or less rapidly developing in many countries).

Though private TVET institutes delivery the majority of training, as shown above, the first choice of students, tend to be public schools due to lower fees charged and the perception of better quality. While public institutions seem to have a better image, the majority of female students are enrolled in private institutions.[25]

4.3 Supplementary TVET activities/continuous training

The overwhelming share of training within the public TVET system is delivered as initial training. As highlighted above, however, the current status of most public and often private institutes as well, providing initial TVET may not be of a quality necessary for renewable energy technologies. Supplementary and continuous training may thus often be required for existing skills to be upgraded for renewable energy technologies (e.g. of electricians to install solar photovoltaic systems). Some observations related to supplementary education and training in Sub-Saharan Africa can be summarised as follows.

In many countries, further education and training is not a field of activity for the public TVET sector but is left to the private sector. Formal and accredited continuous education and training are quite limited and their magnitude is difficult to estimate. TVET target groups are mainly technicians, craftsmen and artisans. Supplementary training may reach these often better than initial TVET. This is particularly true for communities outside urban centres, as is pointed out for communities as in Malawi (Community Training Center) and South Africa (Centre for Continuous Professional Teacher and Community Education and Training, CTCET, of UNISA).

[23] ARR Forum, Dr. George Afeti

[24] African Economic Outlook, OECD 2008/2009

[25] AUC, 2007

Enterprise-based training takes place where the sector is already well-established (also by utilities) and/or where firms have already reached a certain size. Enterprise-based training is taking place where a combination of general and specific skills is required and where the interest of trainees in certification is low. As for initial TVET, continuous training of those active in the informal sector (micro-enterprises, self-employed workers) is a typical field of activity for NGOs and donor projects.

For graduates from training institutes (as well as high schools) who are not immediately able to find employment, further education is an important element to improve their employability. The up-grading of these sometimes forms part of labour market policies. A successful is provided by Tunisia, where the Ministry of Environment initiated and paid for supplementary training in green skills for TVET graduates. This was supplemented with a funding scheme for municipalities who employed some of these students on green projects. This way, many graduates were able to start self-employment. Similar schemes exist in Algeria where the TVET sector cooperates with a state agency that provides loans for self-employment.

5 Renewable energy - TVET approaches and projects

As highlighted, the skills development for the renewable energy sector is diverse, and so is the TVET landscape. Bringing the two together is not an easy exercise. In addition to TVET approaches, numerous training activities are on-going with the implementation of renewable energy projects. Most of those concentrate on further education and training. They are often focused on the project's needs; theory is limited and sometimes not covered well enough. Yet, the training is valuable, especially with regard to the practical dimension with real equipment. Such *on-the-project*trainings also provide valuable opportunities for *train-the-trainers* approaches, by including them into these training-programmes. Trainees, however, very often have already undergone technical training in the (conventional) power sector.

5.1 TVET and the electricity sector

The electricity sector is in many countries not traditionally considered as an integral part of the vocational training system. Often, state-run electric utility companies operate training centres for their own purposes. Students are trained on all kinds of technological aspects revolving around electricity generation and distribution through networks. There was thus traditionally no direct need for a parallel structure in the TVET system.

For technical training on renewable energy technologies, however, this provides at least a dual challenge. On the one hand, state-run utilities often have limited interest in renewable energy technologies. In particular in off-grid areas, where renewables can bring their strengths to full potential, state utilities may also not have a mandate. A second problem is that renewable energy policies are usually centred on the assumption that the private sector will fill the limited delivery capacity of the public sector (utility). The private sector often has very limited access to the technicians from the public sector, resulting in a gap of skilled labour in particular in the low- and medium-voltage area.

The general gap between the skills required for the implementation of renewable energy technologies and those provided by initial education is arguably a substantial one. It could be argued that in many countries neither governmental nor the non-conventional training institutions (see below) are in a good position to cover these skills requirements. In addition, there is a disconnect between the energy industry and the training institutions, perhaps leading to the conclusion that often, companies themselves (or associations, where they exist and are strong enough) may be better positioned to provide technical training.

Apart from the variations in the quality of training, the general acceptance of such rather targeted training by companies provides a challenge, however. Skills are not accepted across an entire sector, training is not accredited, etc. An employee may not be able to use a diploma obtained in one company to apply for another. While the provision of training through the private sector is critical, efforts should be undertaken to institutionalise and

standardise it at least to a minimal degree to ensure an acceptance of the training provided across the sector.

5.2 Selected examples of successful TVET approaches for renewables

The following examples illustrate how TVET and the renewable energy sector are successfully working together in some African countries. These were chosen as illustrations of both conventional and more innovative approaches for bringing the two sectors together.

5.2.1 Solar training in Tunisia

The Tunisian case exemplifies the fact that the lack of skills may hamper the development of a renewable energy market. Qualified installers for both solar water heaters and solar photovoltaics were missing. The association of installers entered into an agreement with the government to develop a training system for installers in order to assure the quality of solar water heaters and solar photovoltaics system installations. The industry, its association, and TVET players defined the skills needs. As a response, curricula, and, to ensure the quality, standard examinations were developed. Various vocational training centres, including private ones, are offering the training, including the exams. Certificates are handed out after the successful completion of the training.

As an incentive, and to ensure quality in installation, operation, and maintenance, the government has linked the disbursement of certain subsidies for the installation of solar photovoltaics and solar water heaters to the successful completion of those exams. The funding for the training scheme is partially assured from the training levy that all firms have to pay.

5.2.2 PV training in Kenya

The German Solar Academy (GSA) in Nairobi was established by three companies within the framework of a PPP project. It offered its training activities to artisans and engineers from Kenya, Tanzania and Rwanda, employed at the ministries (of energy), utilities, and rural electrification projects, as well as to participants from private companies. After a first phase of training, the project was discontinued as there was no link to the institutional structure of TVET and commercial viability could not be achieved.

However, thereafter, with a strong push by the Kenyan Renewable Energy Association (KEREA), solar training has been integrated into an institutional framework, building on the needs created by the 'Energy (Solar Photovoltaic Systems) Regulations, 2012'[26] which introduced compulsory licensing for the following professions:

- Solar PV system technicians (3 different types of licenses);

[26] www.renewableenergy.go.ke

- Solar PV system manufacturers;
- Solar PV system importers, vendors or contractors (3 different types of licenses).

Applications for licensing need to be made to the Energy Regulatory Commission which grants licenses according to minimum educational (academic) qualification and professional (job) experience as defined in the energy sector.

In the framework of Development Partnerships with the Private Sector, GIZ supports the development of training for these certifications, in particular by developing adequate curricula for Training-of-Trainers (TOT) and industry-specific training.

KEREA is playing an active and decisive role in the development of the further education and training programmes. It has hosted a number of consultation processes with private sector representatives as well as TVET players and government. Another partner closely involved is Strathmore University, host of the *Regional Competence Centre on Renewable Energy and Energy Efficiency technologies for East Africa*. Partnerships with institutions in Uganda and Tanzania help spread their work in the region.

5.2.3 Rural electrification in Nepal

Though in Asia, the Nepalese example demonstrates a well-structured effort for community training on renewables. It highlights the challenges which the sector faces when striving for sustainability in its training activities.

In the framework of the Energizing Development (EnDev) Program and its Small Hydropower Promotion Projects (SHPP) Contribution for Community Rural Electrification Programme (CREP), training was to be offered to participating communities. Competences and responsibilities, however, were not clearly defined between stakeholders initially involved. The result was that training did not take place, or was of poor quality. SHPP recognized this gap and started to offer training workshops to the participating communities on a project basis. The integration of the project into the TVET sector is limited, however, and thus an example of an important element for the sustainability for the hydropower projects, but at the same time one of a lack of sustainability for the wider training system.

5.2.4 TVET at the energy and water campus in Gabon

The Central African Campus in Libreville started its training activities in January 2013 on the premises of the Vocational Training Centre of the National Company for Power and Water (*Société d'Energie et d'Eau du Gabon*, SEEG). The cooperation between utility, training sector, and a university is the result of efforts started by SEEG and the International Institute for Water and Environmental Engineering 2iE and the campus benefits from fiscal advantages provided by the government.

The campus offers TVET as initial and continuous training in the fields of power and water. Continuous training is offered with short seminars (1-2 weeks) and with qualifying training (4-8 months, including a certificate).

While the current focus is on conventional electrical installations (see above chapter on TVET and the conventional power sector) training on renewables will soon be added.

5.2.5 Vocational training centres in Tunisia and Djibouti

In Tunisia and Djibouti, a parallel approach to TVET for renewable energy is implemented by the German Chamber of Skilled Craft Saar. The project builds up pilot vocational training centres by installing training equipment, developing training content and curricula, and training trainers. In addition, the Chamber facilitates the interaction with the private sector, in particular (local) installers.

Acceptance of the intervention and a strong buy-in from stakeholders has been created through a thorough labour market demand analysis and very in-depth consultation prior to the design of activities. Steering committees have been created and actively involve the organised part of the private sector (through its associations) as well as the informal part through direct representation of firms. Supplementary further education and training are delivered to trainers as well as skilled workers by means of a mobile unit, which is fully equipped with systems and pedagogical means such as mobile solar and PV systems, including modules, batteries, storage, as well as elements of demonstration for safety and protection of the environment.

German skilled crafts SMEs are involved in the setting-up of training centres and (mobile) training units. The development of business ties and the associated technology transfer facilitates the placement of Tunisian and Djiboutian trainees for internships in German SMEs. The trainees receive a solid training in the SME in Germany for a fixed time, and are exposed to all aspects of installing renewable energy systems and running an SME.

The central challenge remaining, however, is that the centre of excellence approach will be transferred to other regions in the two countries.

5.2.6 Mali and Burkina Faso – Initial and continuous training programme for rural electrification

The French utility EDF manages a vocational training programme for rural electrification in Africa funded by the European Development Fund (EDF) Energy Facility and the French ADEME. The project started in Mali and Burkina Faso as pilot countries and shows, after 2 years, interesting achievements.

EDF works with local entities (electricity companies, rural electrification agencies, engineering schools, technical colleges, and training centres) as well as the relevant ministries (Secondary and Higher Education, Vocational Training). Operational partner for the project is the 2iE - International Institute for Water and Environmental Engineering,

specialized in TVET and tertiary education, and involved in numerous training measures and programmes all over Africa. After the roll-out in Mali and Burkina Faso, the programme is planned to be extended to further countries in West Africa and to further professions.

The project kicked off with an in-depth analysis and a characterisation of all the jobs, skills and qualifications needed for rural electrification to take place. In a second step, the training programme, its curricula, and associated accreditation schemes were developed jointly with the Ministries of Education. Six pilot institutions have subsequently been selected in Burkina Faso, where training activities have started. 40 trainers are being trained. In addition to the training of more than 80 operators that will be provided until September 2014, the training of inspectors to monitor the quality of implementation is an important element in the project.

The equipment of pilot training centres, based on modern pedagogical concepts and technologies is another important element of the 3-year programme. Public sector vocational training schools are also engaged in continuous education. Their premises are used for training after the regular hours of primary education, by which additional revenues are generated for the schools.

The approach to integrate both the energy and the TVET sector is designed and implemented rigorously. A central challenge of the project, however, is the capacity and the potential uptake in rural electrification agencies, which are the main future employers for the trainees.[27]

5.2.7 Strong business associations offering PV training in Uganda and Tanzania

In some countries renewable energies associations are emerging as important stakeholders in the private sector. The Ugandan Renewable Energy Association (UNREA) and the Tanzania Solar Energy Association (TASEA) can be considered as potential partners for defining training needs and developing suitable TVET activities. Donor partners such as GIZ are supporting associations with capacity development in order for them to better be able to define the training and labour needs their members may have. In that context, in Uganda, for example, UNREA is developing a curriculum for technical training.

In addition to the private sector association, the Center for Renewable Energy and Energy Conservation at Makerere University in Kampala, Uganda, is working with to apply and adapt technologies to the specific Ugandan and local environment requirements with an emphasis on systems with components that can be locally manufactured.

[27] The website http://formationelecruraleafrique.org provides comprehensive information on the needs identified and the training offered, as well as a collection of all job profiles that have been established.

5.3 Lessons for TVET in renewable energy

With this review of a number of (selected) examples in mind, various lessons emerge that any future approach to TVET for renewable energy should bear in mind.

- The central commonality that can be observed is that there is a tendency towards the development of new curricula or modules.
- Good practice of TVET centres with renewable energy training (or planning of such) includes a thorough needs analysis of both the potential for employment of trained individuals, and of the exact skills that need to be developed in a given renewable energy market (or a certain sub-segment of it).
- The implementation of renewable energy projects is often accompanied by continuous training activities – upgrading skills of existing electrical installers for example. In many cases, there are few or no ties to the TVET sector. Such training could for example easily be opened to teachers from existing training providers.
- Stand-alone projects without any connection to an institutional structure could be considered as bad practice, because in most cases there is no lasting impact beyond the training of a certain number of technicians. However, integrated into the efforts of renewable energy associations, for example, a wider spill-over could be achieved.
- Good practice examples often include the involvement of the local or private sector from abroad.
- The training of trainers is central. However, even more crucial than for student training, the availability of adequate and modern technologies and proper training equipment, if possible at international standards, are critical, if the training is to take place locally.
- While high standards are important, it is just as important to train on equipment that is used locally in the market that is operated in.
- The identification of good trainers is difficult and often needs time. Finding the right people, qualified technically, but importantly also pedagogically, willing to work in the TVET sector, is a challenge.

The following map attempts to provide an overview of general TVET and TVET related to renewable energy in Africa. Indicated by the red and green dots, it shows where TVET structures exist and TVET training takes place, and on the other hand where some technical renewable energy training was found. Often, however, the renewables related training is at very early stages and needs yet to be fully integrated into the TVET system.

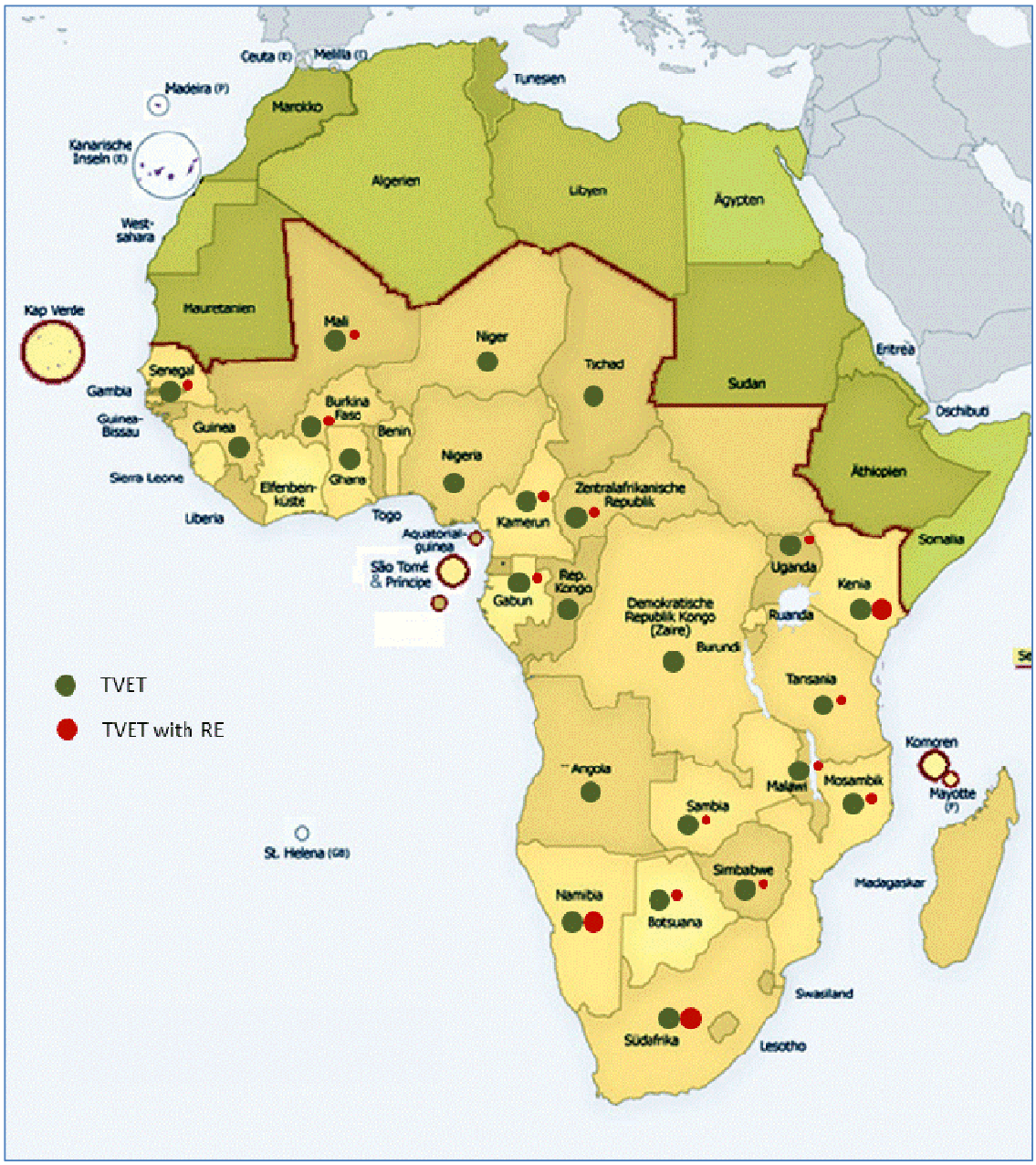


Figure 3 : Map of TVET activities (with RE) in Sub-Saharan Africa (source: DFIC)

6 Strategic approaches to TVET for renewable energy

The above chapters sought to characterise technical skills needed for the implementation of renewable energy projects as well as the vocational training sector in African countries, and they gave examples of particular TVET activities across the continent that were found to be particularly exemplary.

In the following, the strategic approach for the RECP to TVET for renewable energy is now being developed. TVET activities developed under *RECP Action Area 4: Technology, Innovation, and Capacity Development* are contextualised within the wider RECP framework. Where possible, future activities will build on work going on in other Action Areas, notably *Action Area 2: Private Sector Cooperation* and *Action Area 3: Project Preparation and Flagship Investment Projects*. While these suggestions target the RECP in particular, there is an evident wider relevance, also due to the lack of attention to the issue of training for renewable energy on a systematic/programmatic level.

6.1 TVET for renewable energy: caught between two diverse sectors

As was highlighted a number of times, TVET and renewables are two very diverse, sometimes very immature sectors. One of the central characteristics of TVET is that is has relatively well defined structures and systems that tend to move slowly. The renewables sector on the other hand is (or can become) very dynamic, if conducive conditions are in place.

Emerging from this is that two very different courses of action can be taken for activities under the RECP:

1. **To link as close as possible to the renewable energy sector**, and in particular its industries, and cater for the training needs of particular renewable energy projects, while they are being implemented. This approach would involve short-term and specialised training courses. Quick wins can be achieved but the sustainability will present a challenge.
2. **To link into the TVET structures**, and in the public training institutions, and seek to realise a long-term structural change, bringing about a programme for renewable energy training that is implemented in the entire sector. While this approach will bring long-lasting impacts it will also require a substantial engagement over years and resourceful efforts.

The figure below seeks to show these two dimensions with the most common training activities.

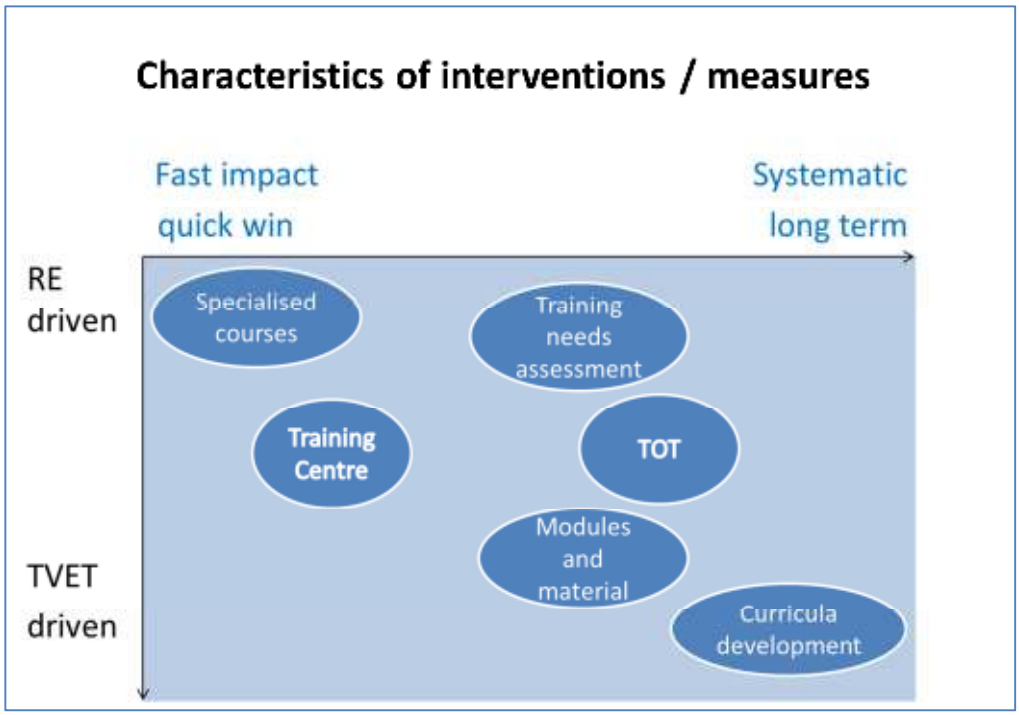


Figure 4 : Characteristics of interventions / measures

6.2 RECP interventions: slower than speed boat, faster than tanker

From the perspective of the central objective of the RECP, i.e. *developing renewable energy markets*, it should be noted that the best of solutions may, as so often, be in the middle of the two approaches described above and in the figure. Ideally, the shorter impact of linking to renewable energy activities should be combined with longer-term effects on the TVET system. To achieve this, a focus needs to be put onto the integration of the two sectors, and an interface needs to be created to develop synergies between them.

Renewable energy markets are dynamic. Once the political and regulatory conditions are in place that guide their implementation and attract investors' interest, these markets will rapidly develop, as can be observed in South Africa for example, but also in smaller and economically less potent countries in certain market segments (e.g. geothermal in Kenya, or off-grid solar in Ghana). Capacity needs in these markets that are developing from a low base, are vast. The development of the market in general, but also the development of particular renewable energy projects could thus be significantly slowed down, or brought to a halt entirely, if capacities are not built up quickly. It will thus be important to bridge these gaps with short-term trainings, where they are necessary to prevent a capacities gap. The interventions that the RECP should focus on, should address this point.

At the same time, the programme has (as do donors more generally) a wider remit and responsibility. For markets to develop in the longer term, capacity development needs to take place not on an ad-hoc basis, but in a structured and systematic manner. For that, the

TVET system is the best place for the introduction of curricula, and the distribution through vocational training schools, both public and private, combined with an accreditation and certification of acquired skills. In that context, the objective of any RECP intervention should be to ensure that any work at system level is taken up in the future by local institutions, or at the very least supported by other partners.

If looked at from the implementation modalities and approaches within the RECP programme structure and the general conditions under which the programme operates, it seems as if a middle way between speed boat and tanker is the most appropriate. With interventions, limited in terms of financial resources as well as time constraints, the programme will not be able to implement TVET sector reforms or implement and accompany TVET programmes over a period of several years. Change at TVET system level requires in-depth work with the TVET sector, which in itself is a very long term approach. Of course, any intervention planned, will need to build on the current developments, including wider TVET reform processes.

From a market development, as well as the programme perspective, it thus becomes clear that any approach the RECP takes should be *slower than a speed boat, but considerably faster than a tanker.*

6.3 Private sector involvement: the dialogue function of the RECP

As highlighted above, the conventional energy sector in Africa is largely driven by public utilities that have traditionally conducted their own training. The renewable energy sector, in contrast, is largely driven by private operators. It is the firms and companies, both local and international that set market forces free, including for the delivery of trainings.

Of course, for various issues such as policy, regulation, legal frameworks, but also technical issues such as grid codes, grid connections, etc. the private sector is to some extent dependent on the public sector. Several of the issues at the interface of the two sectors, evidently also relate to training or particular aspects of it. An installer of a small solar photovoltaics system, for example, needs to work together with the grid operator when connecting a system to the grid. The operator will want to be assured that the installed system as well as the connection is made in a proper manner and that the installation is of high quality.

The enforcement of certain quality standards in installation, operation, and maintenance is an issue that deeply concerns the qualifications of technicians that need to be monitored and assured through exams, and prior to that delivered through training. Dialogue and the setting-up of certain processes (on accreditation, certification, etc.) between the various actors are critical to achieve this.

In addition to such important links that need to be established between private and public sector, the private sector is also best place to articulate what types of skills workers need –

and employ such skilled people after their training. However, the private sector should not only be in a demanding position, but just as much be inclined and supported to provide training and offer opportunities such as apprenticeships or internships.

Innovations to adapt and apply existing technologies in new contexts are best done by the private sector. Support to innovation can, however, also come from public institutions and training and skills development for people to master their technologies (and be creative in applying them), e.g. in off-grid areas electrification approaches.

Innovation capacities can further be enhanced by cooperation with companies from Europe with more advanced technologies. Trainings could be conducted by EU companies, internships or traineeships in more established companies in the renewables market, or similar approaches, could help increase the innovative capacities of trainees. Synergies could be sought with the direct implementation of renewables projects and commercial activities (awareness and training). Similarly, EU companies could, also through donor-driven projects, provide training under the guidance and with the involvement of the TVET sector. The provision of equipment is another form of cooperation. For EU companies there may be a marketing opportunity, while for local companies or training centres, training equipment is often one of the issues affecting its quality.

A dialogue and facilitation function could be with the RECP to support this. It is evident that the private sector needs to be included in any project the RECP seeks to start and that it needs to play a critical role in the definition of a training programme. An overview of the role of the private sector (in addition to the above mentioned items) is provided in the table below.

Challenge	Role of private sector	Implementation issues
Definition and anticipation of needs	The private sector shall benefit from qualified graduates, but needs to identify the skills gaps and needs	Ensure ownership Building structures rather than delivering courses only
Identifying technologies and equipment	Anticipate market needs	Communication structure, product cycles
Lack of trainers with practical experience	Provide trainers (TOT)	Only few qualified – motivation?
Lack of practical experience of graduates	Provide traineeships Provide equipment	Many micro enterprises and SMEs: difficult HR development, TVET seen as responsibility of government,

		work with associations
Quality/upgrading of current staff	Invest in their training	Appropriate training offer needs to be developed, funding? Use accreditation schemes to develop market

Table 9: Involvement of the private sector

As this section highlights, there are numerous opportunities in immature and more mature markets to engage the public and private sector through dialogue and engage, and build on the private sector. It seems critical that with any intervention starts with on a demand-pull basis for skilled labour rather than a supply-push approach. This should, for example, result in starting with a detailed determination of skills gaps and training needs, and the initiation of supplementary TVET activities such as the provision of trainings for the existing work force of renewable energy firms (also see next chapter).

6.4 Further education and training

As highlighted in previous chapters, further training and continuous education are important elements in the delivery of training for renewable energy technologies, in particular to ensure that capacity gaps are not hampering the development of the market. Further, in many countries the quality of the TVET system at the level of primary education and initial training will not immediately allow for renewable energy technologies to be taught.

Yet, the implementation of renewable energy project requires experienced labour. Complex installations such as mini-grids cannot, for example, be installed by young graduates but require more experienced technicians. Primary education and training tends to be within governmental structures and change is difficult to bring about quickly (speed boat vs. tanker). The RECP's training activities could thus build on supplementary training activities as a starting point, i.e. as a means to bridge the renewable energy/economic and TVET sectors.

While supplementary training activities, however, the long-term sustainability is an important issue that needs to be tackled. Any approach developed should aim to create a longer-term and long-lasting impact in the TVET system and be integrated into it, perhaps also in order to benefit from public funding sources in the future.

A certification system enforced by a regulatory framework with the aim of increasing the quality of renewable energy deployment can be a good starting point. As the example of Tunisia and Djibouti above has shown, it may be sensible to upgrade existing technicians

through training programmes, and in a second step certify their training. The cooperation in supplementary training, however, needs to build on cooperation (and dialogue) with renewable energy sector stakeholders, such as industry associations, as well as public and private operators of projects. This ensures that business takes up offers for further education and training (also see Kenyan example). The integration with the TVET system for such courses is a challenge which needs to be taken up right from the beginning.

The harmonisation and integration with national job creation strategies and policies is critical. Mechanisms such as the retraining (supplementary training of unemployed), the promotion of self-employment, and the support of start-ups, as installers or for maintenance and repair, are important ways for people to find employment after further education.

6.5 Promotion of gender equality

As was highlighted in the introductory parts, gender equality is a central issue in particular in technical professions in Africa (as in most other parts of the world). TVET approaches under the RECP need to recognise this and promote, to the extent possible, promotion strategies that will increase the number of women taking up renewable energy trainings and professions. This can for example be achieved through particular funding mechanisms or scholarships for girls/female students, through the employment of female trainers, particular awareness campaigns and targeted marketing activities towards girls and women.

7 Approaches, interventions and activities

Based on the assumption that an approach is taken in-between speed boat and tanker, some key activities and elements that RECP interventions can build upon are elaborated in the following.

In order not to overload support interventions in the light of limited resources and implementation time, interventions should concentrate on selected technologies that are applicable in a larger number of countries where the RECP will become active. This will increase the effectiveness of the portfolio of the programme. Similarly, within one intervention, there should be a clear focus on one technology, rather than providing training for several technologies at the same time.

In some cases, it may make sense to broaden the scope in some ways, however. For a given technology, there could be a great benefit for a country, in first defining *all* capacity needs that may arise, including those beyond the technical vocational level. A capacity development strategy (e.g. for solar), including the academic and engineering side, can define responsibilities and the scope of training for the entire technological sub-sector.

Curriculum development is seen as a relatively simple measure that can be quickly implemented. However, practical experience shows that the challenge is not developing the curriculum but rather assessing the needs, integrating the private sector and adapting new curricula before they become outdated. Most importantly, implementing the training of a curriculum presents a major challenge. Most of the below measures are directed towards this.

Training of trainers (TOT) is one of the most critical components with significant influence on the quality of training, as highlighted above. It should be integrated in creative ways (see private sector approaches below) into every RECP activity. Similarly, the objective of interventions should be to work closely with market players and contribute to their development. Practical exposure for teachers through traineeships in renewable energy firms and projects for example is an important tool to increase practical skills of trainers.

An integration of training activities with the university landscape of a given country may also be beneficial. Training-of-trainers for example could be done by university staff, equipment could be shared, etc.

Actual training activities can take a variety of forms. While an RECP intervention could support direct trainings for a longer period, it could also provide an initiation of something bigger that may be taken up by others. Training can focus on a variety of targets groups and will largely depend on the stakeholder landscape and existing capacities within the sector. Once a demand or need is identified, training could target a particular group of companies, a particular group of people or institutions and people from the public sector. Training can be

initial, supplementary or continuous. Similarly, the courses can be specific custom-tailored courses (e.g. on system design, specific technologies, grid-connection, or similar).

For the implementation of trainings (as well as train-the-trainers approaches to some extent), equipment is key. In some cases, the RECP should not hesitate to provide hardware and training/pedagogical equipment to training centres.

One of the principles of the RECP, its integrated approach, relates to its internal world, i.e. the four Action Areas it operates in, as well as the external world, i.e. national projects and programmes, private sector operations, as well as other donors' interventions, etc. The programme has a distinct emphasis on complementing these.

Other valuable elements include an integration of funding mechanisms through training levies, (see Tunisian example), dedicated funding mechanisms for training (e.g. Ghana Skills Development Fund), or cofounding arrangements with investments into renewable energy projects, in order to ensure the sustainability of interventions. When supporting particular training institutions, it should always be explored to what extent these can perhaps also generate their own income (through the provision of additional training, the sharing of equipment with universities, or similar approaches). Quality control, certification, and accreditation are important elements, where a policy/regulation approach fits well with the remit of the RECP and that add to the sustainability of any training/TVET approach.

Less classical but potentially very effective activities include for example:

- The development of mobile training units for remote areas
- The development of country-specific multi-stakeholder platforms for exchange of experience, coordination and possibly planning
- Medium- and long-term demand assessment and forecasting and resulting TVET planning

In the following matrix a few selected TVET support activities are characterised and compared.

Table 10: TVET activities and their characteristics

Action / Characteristics	Training needs assessment and gap filling concepts	Provision of curricula and equipment	Training centre	Training of trainers	Private sector facility
Type of intervention	Systematic assessment of training needs and development of gap filling training concept	Upgrade existing training structures for primary and/or further education and training	Establishment of a RE training centre esp. for further education, focused on certain technologies	Concept and delivery of courses for training of trainers, possibly with exposure in Europe, practical training in firms	Competition for training activities mainly for private sector, criteria geared to technological focus, RE associations, etc. Based on experience with PPP
Type of impact	Long term Stakeholder interaction initiated	Medium to long term, equipment short term	Short and medium term, long term if institutions/funding structure is assured	Medium to long term Depending on future role of trainers	Short and efficient, possibly medium term as sustainability can be criterion
Main stakeholders	RE industry which are off-takers for the trainees, ideally RE association, training providers, government for accreditation/certification	Existing training structures and centres	RE industry which are off-takers for the trainees, ideally RE association, government for accreditation /certification	Existing training providers New training providers	Private training providers or RE firms Multiple stakeholders can be required
Link to demand & Economic Sector (ES)	Economic sector is main partner for needs assessment and concept	ES should define needs ES associated development of curricula and selection of equipment	Ideally ownership, possibly PPP ES as private operator Design, provision of equipment for training Provision of trainers (e.g. part time)	Involved in definition of content	Full ownership and responsibility

Geographic scope	National	National or supranational	Regional, national	National or supranational/regional	Regional, national
Reproducibility	Yes as for methodology, pilot and/or programme for several countries, dissemination and guide for training needs assessment shall be included	Good if core course can be adapted in reproductions Experience with modules and pedagogical equipment could be transferred	Yes, as a function of ownership and funding	Good if core course can be adapted in reproductions	Can be a criterion
Level of funding required	Starting with € 0.1 Mio.	Starting with € 100,000	Depending on ambitions starting with € 1 Mio.	Starting from € 50,000, better € 100,000	Depending on ambitions starting with € 1 Mio. (5 x up to 200,000)
Timeline	9 months	9 – 15 months	3 – 10 years	From 3 months	2 to 5 years
Challenge	Assure that further action shall follow, e.g., by cooperation with donors	Include further education and private providers	Start quickly, avoiding red tape, to assure the sustainability, e.g., commercial viability	Include further education and private providers Assure impact: which courses are to be thought?	Generate enough momentum in order to assure numerous high level proposals May be a two-step procedure

8 Selected possible starting points

As highlighted several times above, integrating the two diverse and often immature sectors is a difficult task that will ultimately and critically depend on the stakeholders involved.

8.1 Stakeholders as project partners

Many projects, involving training for renewable energy fail due to limited absorption capacities on one or the other side. The continuation of training after the end of the project ensures sustainability but is dependent on the availability of partners. Further, TVET projects sometimes lack impact and quality because their link to the economic renewable energy sector is too weak. The starting points for TVET interventions are thus closely related to the structure of partner institutions. In the following table, the stakeholders are mapped in relation to possible TVET renewable energy projects.

Partner	Characteristics and role	Relevant Type of activity
RE associations & industrial associations	Close to labour market/demand & skills needs/gaps	Identification of skills gaps Curriculum development Traineeships
Private training providers	Stability and impact? Funding mechanism	Delivery of training courses TOT
Energy/Rural electrification agencies	Close to skills gaps Interest and flexibility? Incorporation of off-grid solutions	Identification of skills gaps Traineeships
Public TVET structures	Delivery of primary TVET – only in rare cases supplementary training Accreditation of curricula TOT	Development of curricula (primary only?) TOT
Ministries for economic development	Local value added for RE Involvement of private firms in training Funding for further education and training (training levy?)	Identification of skills gaps Traineeship
NGOs	Provision of RE & associated training	Training in remote areas Improving of gender balance
Universities	Academic training in RE Experience in RE training Some equipment / centres	TOT Training centres

Energy ministries	Promotion of RE, electrification, quality and safety of installations	Accreditation requirement for further education
TVET ministries and authorities	Qualification and TVET strategies Accreditation (of training providers, may be courses) Quality control	Accreditation of curricula Training centres Training of inspectors

Table 11: Implementation partners and their role

8.2 African platform for TVET in renewable energy

A wide range of experience and knowledge is available on the TVET sector generally, and the sheer number of TVET activities on renewable energy is increasing rapidly with markets developing. An exchange of experience, knowledge, and course material could hence be of great value to African countries planning to further improve or invest in their renewable energy training sector. With the RECP's remit as a continental programme, and its ambitions towards knowledge-sharing and exchange, it seems most appropriate for the programme to support such efforts on a regional or continental basis.

Main activities of an African TVET Platform for Renewable Energy could include:

- Exchange of experience and best practice to benefit the countries already active, but in particular those still at the beginning of their efforts in developing the policies, approaches and implementation of TVET for renewable energy;
- Sharing of certification procedures for supplementary education and training;
- Development of regional accreditation and certification processes;
- Studies on demand and skills and competences needed;
- Exchange or regional cooperation on high level activities planned (e.g. for training of trainers);
- Exchange of training material and access to avoid costs associated with developing everything from scratch;
- Development of continental or regional blended learning/e-learning for TOT.

Such a platform would:

- Provide a high visibility to the issue of TVET for renewable energy;
- Be attractive for European industry to cooperate with;
- Benefit countries with poorer structures;
- Give access to a wide range of renewable energy and TVET projects.

9 Selection criteria for vocational training under the RECP

The RECP has the flexibility to support a variety of interventions. A clear signal from a partner country, partner organisation, or similar, should be the prerequisite, however. Partners can vary, and thus will the selection criteria include a variety of factors.

- Clear, systematic, reliable and proven demand base – ideally built on needs analysis - including long-term perspectives
- Systematic connection to private renewable energy sector
- Sustainability of project concept
- Adequate institutional setup
- Prospective of sustainability
- Relationship to relevant investment perspective (e.g. donor projects)
- Requirements in design of content and selection of trainees & students
- Experience in design implementation and operation of renewable energy projects
- Expected impact on renewable energy market development
- Long term employment generation impact
- Sustainability of the activity, including development of institutional set-up
- Integration between renewable energy and TVET sector
- Contribution to gender equality
- Model character and reproducibility
- Regional approaches and cooperation models

10 List of references

Development of TVET International Agency Policy from 1970, World Bank Institute 2008.

From Prejudice to Prestige: Vocational Education and Training in Ghana, COTVET 2012.

Gauging countries commitment to skills development for economic transformation, African Center for Economic Transformation (ACET), Eugenie Maïga, June 2013.

Lessons for Developing Countries from Experience with Technical and Vocational Education and Training, IGC, Christian Kingombe, 2012.

Making Skills Development Work for Economic Transformation in Africa: Demystifying the Suit and De-stigmatizing Vocational and Technical Education, ACET, Eugenie Maiga, 2013.

Project performance assessment report, Republic of Zambia, Technical education vocational and entrepreneurship training development support program, IEG Public Sector Evaluation, World Bank, 2011.

Proposed Indicators for Assessing Technical and Vocational Education and Training, Inter-Agency Working Group on TVET Indicators, ETF, ILO, UNESCO, 2012.

Renewable energies in Africa, JRC Scientific and Technical Report 2011.

Renewables 2012 – Global status report, REN21, 2012.

Report on the Implementation of the Technical Vocational Education and Training, Apr. 2012 – African Union.

Restructuring TVET as part of the Educational Reforms in Rwanda, A case on Public Private Partnership in Rwandan TVET, Dr. Ibrahim C. Musobo and John Gaga, Feb. 2012.

Skills and Occupational Needs in Renewable Energy 2011, ILO Skills and Employability Department and European Union.

Skills and Occupational Needs in Renewable Energy, ILO 2011.

Skills Defined by Curricula: Sub-Saharan Africa, ISSER, 2012.

Skills for green jobs, a global view – Synthesis report based on 21 country studies, ILO 2011.

Solar PV Curriculum Development Workshop Report, Kerea, 2012.

Strategy to Revitalize Technical and Vocational Education and Training (TVET) in Africa, African Union 2007.

Strengthening TVET teacher education, UNESCO 2012.

Teachers and trainers for the future – Technical and vocational education and training in a changing world, ILO 2010.

Technical & Vocational Education and Training (TVET), Sector Mapping in Kenya, John Nyerere, 2009.

Technical and Vocational Education and Training in Ethiopia, Pramila Krishnana and Irina Shaorshadze, IGC 2013.

Technical education programmes with specialisation in renewable energy, need of the hour? Alan S. Rocha, Vijay Kumar Agrawal, Shashikant Gupta, Joshua Earnest, 2010.

TVET Issues and Debates, World Bank Institute 2008.

Upgrading informal apprenticeship - A resource guide for Africa, ILO 2012.

Which Way to Go? Political Realities vs. Best Practice. The Case of Mozambique, Billetoft, J., (2011) in NORRAG NEWS, Towards a New Global World of Skills Development? TVET's turn to Make its Mark, No.46, September 2011, pp. 92-93.

World Energy Outlook, IEA, 2012.

11 Links

www.unesco.org/new/en/dakar/education/technical-and-vocational-education-and-training/

www.ibe.unesco.org/fileadmin/user_upload/Publications/WDE/2010/pdf-versions/Uganda.pdf

www.arrforum.org/publications/occasional-papers/40/95-technical-and-vocational-education-and-training-for-industrialization.html

www.africaneconomicoutlook.org/en/in-depth/developing-technical-vocational-skills-in-africa/the-rationale-for-technical-and-vocational-skills-development/taking-stock-of-technical-and-vocational-skills-development/access-to-technical-and-vocational-education-in-africa/

www.africaneconomicoutlook.org/en/in-depth/developing-technical-vocational-skills-in-africa/the-rationale-for-technical-and-vocational-skills-development/taking-stock-of-technical-and-vocational-skills-development/delivery-modalities/

www.africaneconomicoutlook.org/en/in-depth/developing-technical-vocational-skills-in-africa/the-rationale-for-technical-and-vocational-skills-development/taking-stock-of-technical-and-vocational-skills-development/access-to-technical-and-vocational-education-in-africa/

www.renewableenergy.go.ke/downloads/policy-docs/the_energy_management_regulations_2012.pdf

www.oici.org/resources/at-the-crossroads-choices-for-secondary-education-in-sub-saharan-africa/

www.unevoc.unesco.org/worldtvetdatabase.php

de.scribd.com/doc/6627668/Policy-Frameworks-Major-Policy-Issues-in-TVET-in-Africa

www.unevoc.unesco.org/fileadmin/user_upload/docs/1963-UNESCO-TVET-KenyaENG_LR.pdf

norrag.wordpress.com/2013/02/26/private-tvet-in-africa-preserving-traditional-forms-differently-managing-novel-ones-creatively/

ANNEX 1: Selected examples of TVET reform practice

Ethiopia

Ethiopia has achieved an annual increase rate of 30.5% in TVET enrolment from 2005 to 2009. This growth has been achieved by a combination of considerable expansion of public spending (intensive short-term teacher training and building of TVET centres) and increased TVET provision by private institutions. According to different sources private TVET providers are estimated for between 30% and 50% of all TVET in Ethiopia, NGOs providing a significant share of TVET in the country.[28]

In the Ethiopian context it appeared important to build a demand-driven, flexible, integrated and high quality TVET system. The Government of Ethiopia to this end has involved all stakeholders in the planning, policy making, training delivery and monitoring and evaluation of the TVET system. Therefore, the on-going reform seeks to increase the engagement of the private sector, both of private TVET providers and enterprises as future employers of TVET graduates.

Since 2006 the Ministry of Capacity Building has been implementing the Engineering Capacity Building Programme (ECBC: improvement of the competitiveness of the private sector), with GIZ assistance.

Zambia

The Government of the Republic of Zambia through the Ministry of Science and Technical Vocational Training (MSTVT) undertook vocational training reforms in the late 90s. The Government established an autonomous national training authority, the Technical Education, Vocational and Entrepreneurship Training Authority (TEVETA), responsible for regulation and quality assurance and managing the competitive fund (TEVET Fund) to finance training in all types of training institutions. Further sources of funding are given through cost recovery (student fees) and a proposed payroll levy on enterprises.

The TEVETA register includes a total of 297 technical and commercial training institutions in Zambia in 2012. Between 40 and 45% of the institutions are owned by private organizations and the share of churches and government lay each around 20-22%.

Zambia had, as a consequence of its TVET reform, the second highest growth rate (+765%) in the total number of secondary students enrolled in TVET programs between 1999 and 2007.[29]

[28] IGC, 2012

[29] IGC, 2012

Senegal

Senegal is developing TVET through PPP approaches. Parties involved are employers' professional organisations, wage-earner professional organisations and local authorities. A needs' analysis has been conducted; funds are coming from the Senegalese government and French technical assistance. In this framework TVET consists of initial and supplementary training with duration between 2 months and 2 years, alternation between training centre and enterprise and with diplomas, professional degrees and certificate acknowledgements by the enterprises.

An extension of the curricula for professions of energy mastery is currently been developed with following six targeted trainings: Markets of energy, electricity and photovoltaic solar, solar thermal, performance of the envelope: isolation, woodwork, ventilation/airtightness, cooling and air conditioning as well as civil construction for wind, biogas digesters[30].

Mozambique

The reform project of the Mozambican TVET sector was financed through funds of the World Bank and a number of bilateral donors (incl. ca. USD 30 million IDA credit).

Results of the lengthy reform process include that the TVET system has been described as increasingly stratified. The top of the system is now characterised by a small number (4-5) of refurbished and reasonably well-equipped TVET institutions capable of providing adequate skills training based on the CBT approach. Institutions beyond the top, however, suffer from a lack of attention, lack of equipment, and thus a resulting teaching quality issue. Large institutes, and most importantly, an increasing number of them, are under-resourced, poorly equipped, and described as far from being able to offer training at a level matching the requirements of the labour market. Further, the withdrawal of development partners meant that the government's expansion plans prove difficult to keep up to.

Some of the reasons that have been identified include that the process war largely a political one that focused mostly on supply-side concerns. The process has been perceived as receiving too little coordination between parallel TVET reform projects, also resulting in development partners approaches to TVET and projects not being harmonised[31].

From the Mozambican case, it is evident that a balance needs to be found between political realities and international best practices, that government and development partners should be driving the same agenda.

---

[30] Dr. M. Sene & M. Loum, 2012

[31] NORRAG NEWS, 2011

ANNEX 2: Country Mapping Ghana

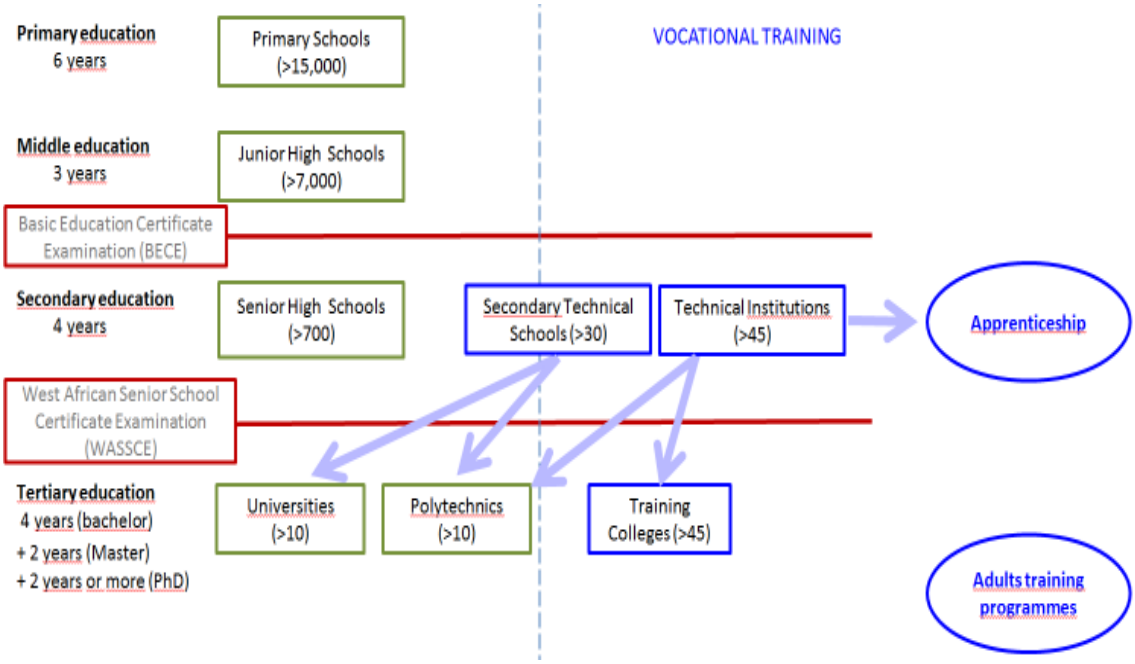
1 Facts & Figures

Surface	238,533 sq km[32]	Total literacy rate	71.5% [32]
Population	25,199,609 (2013 est.)[32]	Educ. Expenditure	8.2% of GDP (2011)[32]
Capital	Accra, 2.3 mio[32]	GDP per capita	US$ 3,400 (2012 est)[32]
Pop. growth rate	2.19% (2013 est.)[32]	Inflation rate	9.2% (2012 est.) [32]
Median age	20.7 years[32]	HDI	0.558 [33]
Urban population	51.9% (2011) [32]		

2 Education system and TVET

2.1 Overview

Ghana's educational System is highly centralized. The Ministry of Education and its agencies are responsible for the entire educational system in the country.[34]



Political framework and objectives

- National TVET Qualifications Framework Policy[34]
- The objectives of the Policy are to integrate all of its TVET qualifications in terms of content and complexity so as to facilitate comparison of qualifications, to confer national

[32] www.cia.org
[33] hdr.undp.org
[34] www.teachinghana.org/education-system

recognition of all qualifications that are registered on the framework, and to facilitate the subjection of all qualifications through a process of quality assurance before they are registered.[35]

- Ghanaian Government's intention is to increase informal sector workers' skills, particularly in the context of the traditional apprenticeship system.[36]
- The Ministry of Education aims to secure 50% female enrolment in TVET by 2015.[34]

2.2 Education and TVET system

- In the formal sector there is a parallel system for vocational technical institutions alongside the senior high school system.
- Employment rates of TVET graduates in Ghana are low, which leads to suggest that TVET has been too supply-driven and focuses on training which has a low market demand.[37]
- According to OECD, 60% of junior secondary school leavers (not continuing school) enter apprenticeships. Apprenticeships are training programmes in a designated trade under which an apprentice receives formal instruction and on the job training. [37]
- 19% of the working age population has previously undertaken an apprenticeship and 7% are currently apprentices; this compares to 8% who have undertaken any other vocational or technical training. [38]
- Presently, non-formal apprenticeship training accounts for 80-90% of all skills training in Ghana, compared with 5-10% from public training institutes, and 10-15% from NGOs. [39]
- Teacher shortages in TVET, combined with a lack of learning resources necessary to deliver a practical curriculum, have led to reductions in the quality of provision and reduced students' interest.
- Most teachers have no specialized training at all in technical education. Traineeships of trainers to obtain new knowledge on technology applications and needs in the practical world have been started but are not practiced broadly enough.[38]

TVET enrolment level

- Total enrolment in secondary vocational system in 2012 was 79,986 students (3.6% of total enrolment in secondary education). [40]

Gender

- Female enrolment rate in formal secondary vocational training in 2012 was 37.4%. [40]

---

[35] http://www.cotvet.org/new/policies.php?nav=1#.U9jvCeN_vaV
[36] COTVET 2011 - www.gesci.org/assets/files/COTVET%20report.pdf
[37] Akyeampong, 2010 - www.gesci.org/assets/files/COTVET%20report.pdf
[38] Monk, C., Sandefur, J. and Teal, F., 2008
[39] Krystyna Sonnenberg, Global Partnership for Education, 2012
[40] www.indexmundi.com

2.3 TVET institutions

- TVET delivered through public and private schools, vocational training institutes and informal institutes.
- Ministry of Education records 129 public TVET institutions and 151 private ones in 2010; estimations of the OECD are much higher (440 and 500). [35]
- According to the Ministry of Education, 27% of the TVET institutions are Integrated Community Centres for Employable Skills, 21% are Ghana Education Service (GES) Technical Institutes, 19% are National Vocational Training Institute Centres, 16% are Community Development Centres, 10% are Social Welfare Centres, 6% are Leadership Training Institutes, 1% are Opportunities Industrialisation Centres and 1% are Agricultural Training Institutes.[35]
- The Catholic Church is the largest private provider of TVET in Ghana.
- Industry groups such as the Association of Ghana Industries and the Ghana Employers' Association are becoming active in the TVET sector. They now are engaged in negotiations and in the piloting of more structured industrial attachment with tertiary TVET institutions.[41]

2.4 TVET challenges [42]

- Lack of facilities and materials for training students
- Inadequate technical teachers or facilitators/trainers
- Limited number of training institutions for technical teachers
- Difficulty in career progression of trainers/teachers
- Negative public attitudes and perceptions towards technical and vocational education and training
- Mismatch between acquired skills and market needs.
- Weak link with private sector to facilitate on-job training and employment opportunities for trainees.
- Limited budget for TVET from the government despite it is a high budget demanding sector

3 Renewable energy market

3.1 Overview

- Electrification rate 72% (2011) [43]

[41] TVET Sector Mapping 2008

[42] IJSTR, June 2013 - www.ijstr.org/final-print/june2013/Challenges-Facing-Technical-And-Vocational-Education-In-Ghana.pdf

- Total installed capacity — 2,011 MW (2010)[44]
  Of which 60% hydropower and 40% thermal generation
- RE without hydro — Below 1% of total power generation[45]
- Electricity demand — 1,400 MW (2010), growing at about 10% per annum[43]
- Solar energy — Almost 10,000 solar panels installed in communities that do not have access to the national power grid (2012)[46]

The Strategic National Energy Plan (SNEP - 2006-2020) presents 10 Key Policy Objectives, amongst which are the following:

- Accelerate the development and utilization of renewable energy and energy efficiency technologies so as to achieve 10% penetration of national electricity and petroleum demand mix respectively by 2020.
- Strengthen institutional and human resource capacity in energy development.

Main focus of Ghana's National Energy Policy on:[47]

- Support of mini-hydro installations
- Biofuel generation projects
- Increased support of the national solar manufacturing sector.

Renewable Energy Act 2011 (Act 832) provides the necessary fiscal incentives for renewable energy development by the private sector (IPP). Furthermore, it establishes a regulatory framework for grid-connected renewable energy power generation.

3.2 Potentials and main barriers

Renewable Energy Potentials

Scale	Solar	Wind	Modern biomass; waste to energy	Medium / small hydro
Exploitable Potential	20 MW	200 – 300 MW	90 MW	150 MW
Remarks	Average solar irradiation is 3.5-4.5 kWh/m2/day	Strongest wind regime occurs along the Ghana/Togo	Suitable climate for Jatropha for production of	68 sites were identified for constructing mini

[43] Ministry of Energy - www.ghanabusinessnews.com/2011/10/17/ghana-connects-72-of-population-to-electricity-but-3-northern-regions-below-national-average/
[44] www.reegle.info/policy-and-regulatory-overviews/GH
[45] Association of Ghana Solar Industries
[46] www.bloomberg.com/news/2012-11-07/ghana-seeks-1-billion-for-renewable-energy-resources.html
[47] Ministry of Energy, 2012 - www.ecreee.org/sites/default/files/ghana.pdf

		border(9-9.9 m/s)	diesel and 2 million tons/a(95MW)of municipal waste for energy generation	or micro hydropower plants

Main barriers[48]

- Low level of awareness and in addition capacity constraints in project management and regulation.
- Less emphasis on mainstreaming energy in the education system, resulting in lack of adequate energy experts and technicians.
- Lack of coordination among stakeholders engaged in the energy sector.
- Need for improved support policies for the private sector's involvement to foster sustainable and efficient energy generation.
- Lack of specific bioenergy policies or regulatory frameworks to monitor and supervise investment projects in the biofuel sector.
- Import duties of 5% to 20% on solar systems.[49]
- Difficulties raising funds from local financial institutions to undertake investments in low carbon technologies for RE developers and end-users.

3.3 Private sector

- The Private Enterprise Foundation (PEF) was founded on the initiative of four major business associations namely, Association of Ghana Industries (AGI), Ghana National Chamber of Commerce, Ghana Employers Association (GEA) and the Federation of Associations of Ghanaian Exporters (FAGE). These business associations felt the need to come together to exert greater influence on policy initiatives for the creation of an enabling environment in which private sector businesses could thrive as partners in economic development of the country.[50]
- The PEF plays a key role on development partnerships with the private sector (DPPs) in Ghana through combining business interests with development objectives and intensifies public private activities in Ghana.
- The mining community is increasingly aware of the need for vocational training and community development and the companies will address the issues through the

[48] www.reegle.info/policy-and-regulatory-overviews/GH
[49] ghanasolarindustries.com/PDFarticles/AGSI_Background_Research_Report_2011.pdf
[50] http://www.gaccgh.org/private-enterprise-foundation-pef

establishment of an accredited vocational training school and introduce a quota to assure local employment.

- The Association of Ghana Industries (AGI), established in 2006, is a voluntary business association of over 1,200 members.
- Manufacturing solar devices until now not very successful.

3.4 Main donors' activities

A number of donors are providing financial and technical support to the Government of Ghana through their implementing agencies. These include the World Bank (IDA), the African Development Bank (AfDB), the Global Environmental Fund (GEF), the Swiss Agency for Economic Affairs (SECO)., Japan International Cooperation Agency, the Swedish International Development Cooperation Agency (SIDA), as well as France, Spain, India, Denmark and China with their respective implementing agencies. The biggest energy sector project which is running currently is the Ghana Energy Access and Development Project (GEDAP) which consolidates funding from Multilateral, Bilateral and Government.

Coordination of donor support takes place within the framework of the Donor Sector Group, established under the Multi Donor Budget Support (MDBS) framework. [51]

Main relevant activities are:

- EU-UNDP Low Emission Capacity Building Programme (LECBP) – 2011-2016

  Technical assistance also in form of training workshops
- UNEP Green Economy Advisory Services in partnership with GIZ

  Supporting Centres of Excellence, enhancing local knowledge and building capacity
- ECOWAS

  Renewable Energy Investment Initiative (EREI)

  Renewable Energy Facility (EREF)
- GIZ Project Development Programme (PDP) for renewable energies promotion of German-Ghanaian renewable energy business partnerships
- The UN Foundation's Energy Access Practitioner Network in cooperation with African Renewable Energy Alliance (AREA) facilitates the Sustainable Energy Network Ghana (SENG). [52]
- USAID - "Power Africa Initiative", a $7 billion investment.

[51] energypedia.info/wiki/Ghana_Energy_Situation

[52] GBN 21.05.2013 - www.ghanabusinessnews.com/2013/05/21/ghanas-seng-becomes-first-country-affiliate-of-un-led-energy-network/

4 Labour market (RE)

4.1 Actual situation

- Present unemployment rate estimated at around 13-15% [53], youth unemployment about twice as high (15-24 years) (students Industrial Attachment Programme)
- Informal economy sector generates 80-90% of employment [54]
- Global competitiveness index Rank 114/148
- Higher education and training 3.4 (valued 1to 7 (best))
- On-the-job training, 3.9
- Local supplier quality 4.2
- "Ease of doing business" Rank 67/189 [55]
- GDP per person employed amounts to 4,448 $ for 2009-2013 in constant 1990 PPP, an increase of 10% compared to the previous period. [56]
- In 2010 the manufacturing sector employed 1.12 million persons, out of which about 60% female employees.[57]
- The agricultural sector employed 56% of the labour force and generated 34.3% of GDP in 2007, where energy plays a vital role in irrigation, harvesting, processing, transporting etc.[58]
- The industrial sector employed 15% of the labour force and generated 26% of GDP in 2007.[58]

4.2 Planned or on-going RE projects

- Construction of 2 MW ground-mounted solar park (Volta River Authority) with 22.8 million Euro KfW support [59]
- 6-8 MW PV installations - Volta River Authority[60]
- Construction of the country's first grid-connected solar farm is due to start in the first quarter of 2014 on a 155 MW PV project in Nzema, in Ghana's Western Region, said to be Africa's largest PV power plant to date - Mere Power Nzema, subsidiary of the British Blue Energy's. [61]

---

[53] Today, July 2013 - www.todaygh.com/2013/07/13/gsiap-to-solve-unemployment/
[54] Friedrich-Ebert-Stiftung 2011 - www.fesghana.org/uploads/PDF/FES_InformalSector_2011_FINAL.pdf
[55] www.doingbusiness.org/data/exploreeconomies/ghana/
[56] data.worldbank.org/indicator/SL.GDP.PCAP.EM.KD
[57] LO/FTF Council 2012
[58] https://www.cia.gov/library/publications/the-world-factbook/geos/gh.html
[59] thechronicle.com.gh/mahama-commissions-ghanas-first-solar-power-plant
[60] www.pv-magazine.com/news/details/beitrag/ghana--pvs-next-steps_100006369/#ixzz2kRPEiq7M
[61] www.pv-tech.org/project_focus/aiwiaso_ghana

- The German company EnD-I AG and the British one Blue Skies are developing a concept and a detailed business plan for a biogas plant. DEG already financed the feasibility study.[62]
- Volta River Authority (VRA's) Wind Power Development Programme[63]
  Estimated capacity: 150 MW
  Number of sites to be used: 8
  Tentative start of wind measurement: The end of the third quarter of 2012
  Expected duration for wind measurement: 1 year
  Tentative date for commissioning wind farm: Within the second half of the year, 2014
- Construction and operation of a grid connected wind farm (50 MW) in the city of Prampram (Promoter: NEK Ghana Ltd., CAPEX: €73.7mio, OPEX: €1.9 mio)[64]
- Construction and operation of a waste to energy unit (20 MW) for electricity supply and heating in the city of Tema[31]
- Pilot biogas project from the Energy Center (TEC) together with UNIDO, Ministry of Trade, Industry and Energy (MOTIE) of Korea, the Korea Institute of Energy, Technology Evaluation and Planning (KETEP) and the Ministry of Trade and Industry (MoTI).[65]
- Clenergen Ghana Limited is entered in to an Agreement to install a 2 MW/h gasification Biomass power plant on-site in order to provide a direct supply of carbon negative renewable electricity. The project will incorporate a direct supply of feedstock cultivated using 400 acres of land under lease by Ghana Manganese Company Limited.[66]
- Denham Capital Management and three of its portfolio companies - Endeavor Energy Holdings, BioTherm Energy, and Fotowatio Renewable Ventures (FRV) plan an investment of over $1.0 billion in 1,000MW of power generation in West Africa with a special focus on Ghana, including wind power generation, solar power generation and thermal power generation. Endeavor seeks to provide as much as 800MW of thermal power generation in Ghana representing a total investment of over $0.8 billion.[67]
- GG Energy Holdings intends to invest $150 million over the next five years to enable the installation of nearly 75 MW of solar PV and bio-mass power plants to power industrial and mining production facilities in Ghana, Kenya and Tanzania. [67]
- KMR Infrastructure aims to develop 15 MW of biomass installations in Ghana. [67]
- NextGen Solar plans to set-up 30MW of generation capacity via solar power plants in Ghana.[34]

---

[62] www.biomasse-nutzung.de/biogas-obst-abfalle-ghana-afrika/
[63] Prospects of wind energy in Ghana, ERIC OSEI ESSANDOH, Sept. 2012
[64] EREI 2013
[65] www.energycenter.knust.edu.gh/pages/news.php?id=118
[66] www.clenergen.com/ghana/projects/ghana-manganese-company
[67] www.usaid.gov/powerafrica/partners/private-sector

5 Relevant Vocational training activities

5.1 Main donors' activities

- Ghana Skills Development Initiative (GSDI) – GIZ , 01/2012 – 06/2014 - Supports the offer of demand-oriented further training for small enterprise owners (Master Craftspersons) and apprentices in the informal sector.
- UNEVOC Network activities
- IFAD Rural Enterprises Programme – including self-employment training and vocational training.

5.2 Further vocational training activities

- The Energy Center (TEC) at the Kwame Nkrumah University of Science and Technology (KNUST) was established to provide the necessary training and research especially in renewable energy. Many short courses were already organized in areas like Solar Thermal Power, Solar PV Systems Design and Installation, Small Wind Turbines Manufacturing, Bioenergy/Biogas/Biofuels and Energy Policy and Planning with an introduction to Long-range Energy Alternatives Planning (LEAP) and RETScreen software packages. TEC is firmly embedded within the university's energy-related institutional framework.[68]
- TEC has been established as regional center for West Africa and is already involved in ECOWAS activities.
- DSTC (DENG Solar Training Center), founded in April 2005, is an internationally certified training facility offering training courses in the design, installation and maintenance of solar systems, as well as Solar Water Pumping training courses in technical collaboration with Global Sustainable Energy Solutions (GSES) of Australia, and the Department of Mechanical Engineering and Agriculture of Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi. Initial co-financing was secured from Deutsche Investitions- und Entwicklungsgesellschaft mbH Germany (DEG).
- The Association of Ghana Solar Industries has training among its "main objectives".

5.3 Links of TVET to RE private sector

- Very few links between the private sector and the TVET sector are recognizable so far.
- The contribution of the private sector is requested in many instances, i.e. with the offer of internships, especially for the training of trainers.
- The Ghana Green Skills Development Initiative works with crafts associations to fill this gap.

[68] www.energycenter.knust.edu.gh/pages/sections.php?sid=41

- Industrial and private sector linkages with TVET on RE in general are weak.

6 Suggestions for TVET RE activities by the EUEI PDF

Based on the potentials of renewable energies and current initiatives, the main areas of relevancy for TVET in Ghana seem to be mini-hydro and biofuels/ biogas as well as solar PV.

Connections to donor programmes should be sought so as to leverage the RECP effort.

6.1 Possible project ideas

- Development of a national "TVET for RE platform" to co-ordinate all relevant activities between the private sector and public institutions from TVET and energy sector.
- Training for mini-hydro

  The roles of the Volta River Authority (VRA) and the private sector need to be clarified in a needs analysis. Operation and maintenance shall present an important part of this training.
- Solar PV

  Demand seems to be given for both on and off- grid; maintenance of the large system shall be included.
- Biofuels and biogas

  A needs analysis through the entire value and supply chain shall be a starting point.

For all of the above, the short term needs and further education should be catered for in co-operation with ongoing donor projects and/or the VRA. At the same time it may be worthwhile to integrate the a.m. RE subjects to the primary TVET activities. This could include:

- Development of courses and course material and upgrading for new curricula with the TVET system.
- Train-the-trainers activities.

6.2 Possible main partners

The main partners representing the demand for skilled labour to cooperate with are:

- Volta River Authority (VRA)
  With their training centre(s) and the VRA Schools, located at Akosombo and Akuse in the Eastern Region and the Western Region of Ghana
- Association of Ghana Solar Industries
  Should be enabled to take up a role in TVET by defining and advocating needs and resources, assuring the development of further education and training; entrepreneurial training should be included.

Main partners to be strengthened for the delivery of training could be:

- TEC
- DSTC
- VRA Training facilities
- Official TVET institutions

Training of trainers should incorporate as many training providers as possible.

7 Main stakeholders

For TVET RE project development

- *Association of Ghana Solar Industries (AGSI)* - www.ghanasolarindustries.com/
- DSTC Deng Solar Training Centre - www.deng-ghana.com
- The Energy Center (TEC) of the Kwame Nkrumah University of Science and Technology (KNUST) - energycenter.knust.edu.gh
- Volta River Authority
- Council for Technical and Vocational Education and Training (COTVET) - www.cotvet.org
- National Apprentice Training Board (NATB) - under COTVET
- National Technical and Vocational Education and Training Qualifications Committee (NTVETQC) – under COTVET
- Industrial Training Advisory Committee (ITAC) - under COTVET
- Training Qualify Assurance Committee (TQAC) - under COTVET
- Ghana Skills Development Initiative (GSDI) - under COTVET
- Skills Development Fund Committee - under COTVET
- Ghana National Chamber of Commerce and Industries - www.ghanachamber.org/website
- Association of Ghana Industries - www.agighana.org

Further Stakeholders

- National Coordinating Committee for TVET (NACVET)
- National Vocational Training Institute - www.nvtighana.org
- Ministry of Education, Science and Sports (MOESS) - www.ghana.gov.gh
- National Education Reform Implementation Committee
- Ministry of Energy and Petroleum - www.ghana.gov.gh
- Environmental Protection Agency - www.epa.gov.gh
- Energy Commission – www.energycom.gov.gh
- Ministry of Employment and Labour Relations - www.ghana.gov.gh/index.php/2012-02-08-08-18-09/ministries/247-ministry-of-employment-and-labour-relations
- Ghana National Chamber of Commerce and Industries - www.ghanachamber.org/website

- Ghana Employers Association - www.ghanaemployers.com
- *Energy Foundation Ghana* - www.ghanaef.org/
- *Sustainable Energy Network of Ghana (SENG) – see details under 3.4.*

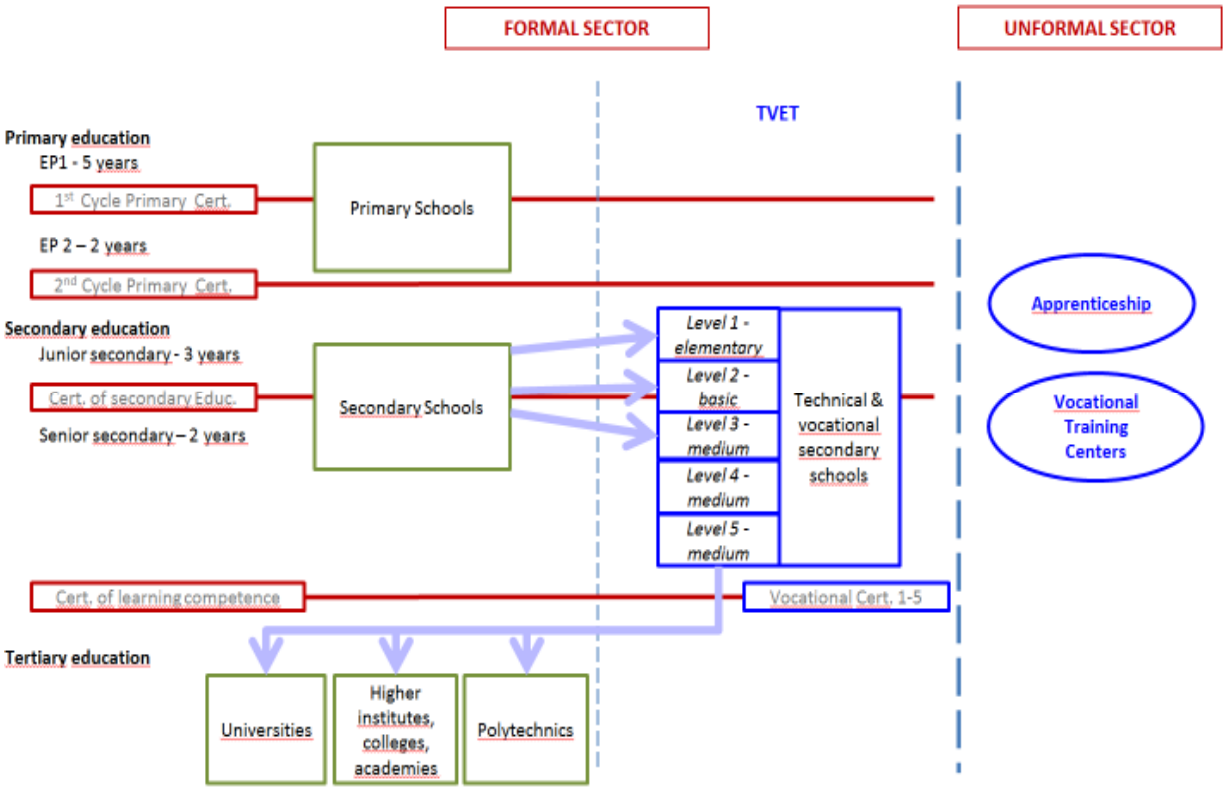
ANNEX 3: Country Mapping Mozambique

1 Facts & Figures

Surface	799,380 sq km [69]	Total literacy rate	56.1%[69]
Population	24,096,669 (2013) [69]	Educ. expenditure	5% of GDP (2006)[69]
Capital	Maputo, 1.59 mio (2009) [69]	GDP per capita	$1,200 (2012)[69]
Pop. growth rate	2.44% (2013) [69]	Inflation rate	2.1% (2012)[69]
Median age	16.8 years [69]	HDI	0.327 (2012)[70]
Urban population	31.2% (2011)[69]		

2 Education system

2.1 Overview



Political framework and objectives

- Law No. 6/92 of 6 May 1992: general framework of the education system
- Decree No. 11/90 of 1 June 1990: Authorisation for private education (free or fee-paying) in all types of schools and at all educational levels

[69] www.cia.gov/library/publications/the-world-factbook
[70] www.indexmundi.com/facts/topics/education

- Subsector Strategy for Adult Literacy and Education and for Non-Formal Education (AEA/ENF) (Ministry of Education, 2001)
- Higher Education Law No. 5/2003
- Second Strategic Plan for the Education Sector 2005–2009 (Ministry of Education, 2005)
- Strategy for Technical and Vocational Education in Mozambique 2002–2011
- Employment and Vocational Training Strategy 2006–2015
- Strategic Plan for Higher Education for the period 2011–2020 is currently in draft format[71]

2.2 Education & TVET system

- TVET in Mozambique is primarily offered through government schools and training centres managed by a diverse number of different Ministries. More recently, some private training providers have entered the market and offer specialized training programs for their private sector clients (mostly new foreign investors), but these programs still only accommodate a minority of students in the TVET system. Accordingly, unlike other education sub-sectors which are managed and supervised under a single Ministry the TVET system involves a number of government Ministries and private sector partners that need to be drawn together under a single planning framework to give the system coherence and uniformity.
- The technical education and vocational training system, which is responsible for shaping the skills profile demanded in the labor market, has been slow to respond to changing labor market demands in the formal sector. Employer surveys and labour market studies in formal sector enterprises point to a mismatch between the labour supply and the evolving needs of labour market, which require more skilled workers.
- Low school enrolment and low literacy rate due to language problem.
- Technical and professional education is taught at technical schools and institutes, offering courses covering three major areas (industrial, commercial and agricultural education) at elementary, basic and medium levels. [72]
- There is little appropriate education such as vocational training or lifelong skills learning to cater for youth who have dropped out after some primary or secondary schooling. [72]
- Continuing education and professional development: Between 2005–2009, 171,288 people (30% female) were enrolled in various professional training courses at national level. [72]
- Those students graduating from technical education receive diplomas that are equivalent to those awarded in general education.[72]

[71] OSOSA 2012 - www.osisa.org/sites/default/files/mozambique_yale_final.pdf
[72] World Data on Education. 7th edition, 2010/11 - www.ibe.unesco.org/fileadmin/user_upload/Publications/WDE/2010/pdf-versions/Mozambique.pdf

TVET enrolment level

- Enrolment in secondary vocational system in 2011 was 37,176 (4.77% of total enrolment in secondary education).[73]

Gender

- Rate of female enrolled in formal secondary vocational training in 2011 was 34.08%.[73]

2.3 TVET institutions

- In 2009 there were 36 technical secondary schools for elementary level (ET - 5,810 trainees), 28 for basic level (ETB - 23,667 trainees) and 19 for medium level (ETM - 7,848 trainees).[72]
- TVE schools and institutes are mostly operated by the National Directorate of Technical Education (DINET) of the Ministry of Education [74]
- Vocational Training Centres (VTCs) are operated by the National Institute for Employment and Vocational Training (INEFP). The target group is mainly employed or unemployed individuals (including school leavers).[75]
- There are twelve INEFP vocational training centres offering short courses ranging from one week to one year [75]
- There are also 81 private training centres which have been authorised by the Ministry of Labour (MINTRAB) to provide vocational education. [75]
- ADPP Mozambique (Planet Aid's local sister organization) operates 3 vocational schools and also trains teachers.
- The Eduardo Mondlane University (UEM) runs renewable energy studies in a number of graduate level courses, which has helped provide expertise to many energy-related government department and agencies.[76]
- The Faculty of Engineering of UEM is responsible for training engineers in 4 different fields, namely, Mechanical, Electrical, Civil and Chemical and is involved in the SOLTRAIN project.
- Traditionally, linkages between both TVE schools and vocational training centres and the industry have been limited, partly due to a shortage of internship placement opportunities within industry. [75]

[73] www.indexmundi.com/facts/topics/education
[74] Nuffic 2011 - www.nuffic.nl/en/library/mozambique-country-report.pdf
[75] Nuffic 2011 - www.nuffic.nl/en/library/mozambique-country-report.pdf
[76] IRENA January 2013 - www.irena.org/News/Description.aspx?NType=NWS&PriMenuID=16&catid= 84&News_ID=292

2.4 TVET challenges

- No clearly-articulated policy framework on adult education, youth education, and technical and vocational training and skills-training. [77]
- Centres for vocational skills development are not sufficiently responsive to current labour market needs because both their training methods and equipment are out of date.[77]
- Critical shortage of qualified, competent and up-to-date teachers/trainers, shortage of teaching aids due to budget constraints, dilapidated workshops, outdated curricula and insufficient career guidance and internship arrangements with industry. [75]

3 Renewable energy market

3.1 Overview

- No clearly-articulated policy framework on adult education, youth education, and technical and vocational training and skills-training. [78]
- Centres for vocational skills development are not sufficiently responsive to current labour market needs because both their training methods and equipment are out of date.[77]
- Electrification rate: 11.7% (2008) [79]
- RE installed capacity: 2.2 GW electricity capacity (2010)[80]
- RE electricity generation: 99.7% of electricity generation (2009) / hydro [80]
- RE goal: 6 GW (hydro, solar and wind 2 GW each) [80]
- Hydro: 2 GW (2012) [80]
- Biomass: 78% of primary energy supply (2012)[81]
- Solar: 1 MW (2012)[81]
- Wind: 0.3 MW (2012)[81]
- Experience with renewable energy besides hydro is still limited to pilot projects.[82]

Political framework and objectives

- National Energy Policy (1998)
- Energy Sector Strategy (2000)

---

[77] OSOSA 2012 - www.osisa.org/sites/default/files/mozambique_yale_final.pdf
[78] OSOSA 2012 - www.osisa.org/sites/default/files/mozambique_yale_final.pdf
[79] www.irena.org/remaps/countryprofiles/africa/mozambique.pdf
[80] www.map.ren21.net/PDF/ProfilePDF.aspx?idcountry=116
[81] www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf
[82] PV Magazin Nov. 2013 - www.pv-magazine.com/news/details/beitrag/special-report-africa--tanzania--mozambique_100013524/#axzz2nfMyG2ld

- Energy Reform and Access Project (2003-2011), encouraging the development of renewables.
- Policy on the Development of New and Renewable Energy (2009)
- National Policy and Strategy for Biofuels (2009) - high priority of the biofuel resource in Mozambique's economic and energy policy.
- National Strategy for Renewable Energy 2011-2025 (EDENR 2011-25) – Aiming at developing national renewable resources for generating electric power.
- Government is procuring a large portion of the imported PV equipment through its rural electrification agency (FUNAE). [82]

3.2 Potential and main barriers

Renewables	Solar	Hydro	Wind	Biomass	Geo-thermal
Theoretical potential	1.49 mio [83] GWh	12,000 MW [84] (incl. 1,000 MW small hydro)	-	-	-

- Wind power in Mozambique is in an early stage of development. A wind energy resource atlas is under devlopment.[83]
- The country has a large potential for supplying electricity for off-grid applications, especially through solar PV, small hydro and biomass waste from forest and/or agricultural waste.[84]

Main barriers[85]

- The development of the National Electricity Council (CNELEC) into an independent regulatory agency
- Very limited resources of the public sector for managing the energy sector
- Emerging gas development.

3.3 Private sector

- The companies N&M Logotech Lda. and Serviços em Energias Alternativas were already involved with the SOLTRAIN I project

[83] IRENA 2012 - www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf
[84] IRENA January 2013 - www.irena.org/News/Description.aspx?NType=NWS&PriMenuID=16&catid= 84&News_ID=292
[85] www.reegle.info/policy-and-regulatory-overviews/MZ

- The German Fosera is relatively strong in the market with the establishment of its own PV production line in Mozambique.[86]

3.4 Main donors' activities

Local programmes

- Mozambique's first solar panel factory commenced construction in April 2012 in Maputo as the result of bi-lateral cooperation between the governments of Mozambique and India. Estimated production capacity is 5 MWp.[87]
- Renewable Energy for Rural Development Programme (RERD), 2010-2015, funded by Belgium and the Netherlands (23.4 mill EUR).[88]
- Access to Modern Energy Services (GIZ-AMES)
- Entrepreneurial Solar Energy Project in Changalane, Maputo Province; project is funded by the governments of Finland and Austria and hosted by the Development Bank of Southern Africa. The project aims to provide an innovative energy solution to rural communities. [89]
- Energy Development and Access Programme (EDAP) - a $ 219 mio programme covering the whole sector (access to electricity in urban, peri-urban and rural areas, renewable energy, stakeholders' capacity building), AFD, World Bank, European Investment Bank.[90]
- The European Commission is financing rural electrification in Cabo Delgado, Tete and Sofala with EdM, PV electrification in rural areas with FUNAE and capacity building in energy planning and management for the MoE. [91]
- DFID is giving TA on Biofuels to the National Directorate of Renewable Energy of the MoE. [92]

Regional programmes

- Energy and Environment Partnership in Southern and East Africa (EEP) – Promotion of renewable energy, energy efficiency and clean technology investments - Jointly funded by the Governments of Finland, Austria and recently joined by the UK's Department for International Development.

---

[86] PV Magazin Nov. 2013 - www.pv-magazine.com/news/details/beitrag/special-report-africa--tanzania--mozambique_100013524/#axzz2nfMyG2ld

[87] PVTech April 2012 - www.pv-tech.org/news/mozambiques_first_solar_panel_factory_commences_construction

[88] www.btcctb.org/en/country/21/projects-list

[89] www.adpp-mozambique.org/en/comunity-development/renewable-energy-sources

[90] www.afd.fr/webdav/shared/PORTAILS/PAYS/MOZAMBIQUE/projets/EDAP%2012%202012%20engl.pdf

[91] energypedia.info/wiki/Mozambique_Energy_Situation

- Energising Development - EnDev - is an impact-oriented initiative between the Netherlands, Germany, Norway, Australia, the United Kingdom and Switzerland. EnDev promotes the supply of modern energy technologies to households and small-scale businesses.
- Promoting Renewable Energy Programme (PREP) from the Dutch government (DGIS) has a focus on Mozambique.[92]

4 (RE) Labour market

4.1 Actual situation

- It is estimated that Mozambique has a total work force of 9.6 million of which the vast majority (70%) are engaged in the agricultural sector, followed by the trade and services sector which account for 18 per cent. The manufacturing, mining and construction sectors, account for only about 5% of the total workforce.
- Overall, only 5-6 % of the population (520,000 people) is actively engaged in the formal sector. About 80% of the total formal sector employment is made up of trade and services (including public administration, education, health and social services.
- Employers are unanimous in stating that they face labour supply constraints and, in particular, constraints in finding particular skills. The March 2014 National Employment Dialogue identified "outdated and inefficient education systems, including technical and vocational training" as a major constraint to job creation.[93]
- A recent study carried out by the Ministry of Planning interviewed a range of employers across the country on the general employability of Mozambican youths. The study concluded that "the general perception [of employers] was that the Mozambican youth workforce has immense limitations in terms of quality. Those with secondary schooling do not have skills that are directly applicable to industry. And those with technical or university training have received theoretical information, rather than the practical skills needed to respond to the demands of firms. Due to this, companies are obliged to offer additional training programs or recruit foreign workers."[25]
- The unemployment rate is estimated at 23.2% by the Organisation of Mozambican Workers[94]
- Industry stands for 23.9% of GDP (2012 est.)[95]
- Global competitiveness index Rank 137/148 [96]

[92] energypedia.info/wiki/DGIS_Promoting_Renewable_Energy_Program
[93] Mozambican Labor force Markets in the Dace of a Natural Resource Boom; USAID, 2014; p. 34 - 36
[94] allafrica.com/stories/201309190201.html
[95] www.cia.gov
[96] World Economic Forum - reports.weforum.org/the-global-competitiveness-report-2013-2014

- Higher education and training 2.3 (valued 1to 7 (best))
- On-the-job training 3.33
- Local supplier quality 3.4

- "Ease of doing business" Rank 139/189 [97]

4.2 Planned RE or on-going projects

- 4,000 MW worth of hydro projects (2010)[98]
- Amsterdam-based company Eaglestone NV plans to invest at least 40 percent of 100 million euros of a renewable energy fund in renewable energy projects in Angola and Mozambique, which is presently studying two possible wind energy projects. [99]
- Solar-wind powered irrigation for Mipandi Farmers Association, a project from the British NGO Renewable World together with The Clean Energy Initiative. Installation of a 1kW wind turbine and 200w solar array.[100]

5 Relevant vocational training activities

5.1 Main donors' activities

- GIZ runs a major education and TVET program including "Implementation of the Technical & Vocational Education Reform in industrial maintenance trades". Part of that has been the establishment of a well-equipped renewable / solar training centre in Maputo funded by the Access to Modern Energy Services (GIZ-AMES).
- Southern African Solar Thermal Training and Demonstration Initiative II (SOLTRAIN) financed by the Austrian Development Agency (ADA), 2012-1015.
- In the frame of the Entrepreneurial Solar Energy Project (ADPP, see 3.4), students from One World University (OWU), which is operated by ADPP, led the implementation of a project that installed six solar power stations. The students are also helping to train community members in using, managing, and maintaining the stations. The project aims to train 2,400 people (approx. 400 families) on how to obtain solar energy from sustainable small-scale energy power stations in Changalane. Also 50 local business people will receive training on how to use the new technology to develop their businesses, 200 community leaders and members will be given capacity training on how to use the new technology to improve their economy and general living standards.[101]

---

[97] www.doingbusiness.org/data/exploreeconomies/mozambique
[98] www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf
[99] BloombergBusinessweek, June 2013 - www.businessweek.com/news/2013-06-28/eaglestone-seeks-angola-mozambique-renewable-energy-investments
[100] www.renewable-world.org/content/wind-powered-irrigation-mipandi-farmers-association
[101] www.adpp-mozambique.org/en/comunity-development/renewable-energy-sources

5.2 Further vocational training activities

- The farmers of the Mipandi Farmers Association will be trained in basic maintenance of wind/solar systems (see 4.2).[102]

5.3 Links of TVET to RE private sector

None is known.

6 Suggestions for future activities by the EUEI PDF

6.1 Possible project ideas

For the RECP TVET activities the various solar applications related to electrification are presenting a suitable focal area. The support of the local manufacturing could present a second field of TVET activities.

The landscape is characterised by numerous donor activities and other actors. It is thus suggested to start with a stock taking and needs analysis.

This needs analysis should include:

- Donor activities
- Private sector actors (including the module manufacturing)
- TVET institutions and their offerings
- FUNAE and other governmental players regarding the perspectives of the various PV application
- The entire value chain from sales to maintenance.

The results of that needs analysis should be discussed in a workshop with the aim to establish suitable co-ordination mechanisms (roundtable or national platform).

The main line of activities to be structured based on the results of the needs analysis are expected and suggested to be:

- Interfacing between TVET sector and RE sector so that skills development can be aligned with investments and economic and technological developments in the RE
- Facilitating the self-organization of the emerging renewable energy "industry"
- Developing short-term and medium occupational RE-technology training courses for graduates and practitioners
- Integration of RE-technologies in the relevant curricula at all vocational levels

[102] www.renewable-world.org/content/wind-powered-irrigation-mipandi-farmers-association

- Training of trainers: cooperation between RE projects (private and donors) and TVET teachers courses which aim at the same time at further education for RE projects needs and training of teachers

6.2 Possible main partners

- National Fund for Rural Electrification (FUNAE) - www.funae.co.mz
- National Directorate for Technical Education (DINET)
- National Institute for Employment and Vocational Training (INEFP)
- Relevant RE donor projects such as:
  - Renewable Energy for Rural Development Programme (RERD), 2010-2015, funded by Belgium and the Netherlands (23.4 mill EUR)[103]
  - Access to Modern Energy Services (GIZ-AMES)
  - Entrepreneurial Solar Energy Project in Changalane
  - Energy Development and Access Programme (EDAP)
  - The European Commission's rural electrification project.

7 Further stakeholders

- Ministry of Education and Culture (MEC) - www.mec.gov.mz
- Ministry of Energy - www.me.gov.mz
- National Institute for Educational Development (INDE)
- Confederation of Business Associations of Mozambique (CTA) - www.cta.org.mz
- Eduardo Mondlane University (UEM), Faculty of Engineering - www.uem.mz
- Mozambique Solar Thermal Technology Platform (at Eduardo Mondlane University)
- Executive Committee for Professional Education Reform (COREP) - www.portaldogoverno.gov.mz/noticias/educacao/junho-2010/corep-procura-regular-ensino-tecnico

[103] www.btcctb.org/en/country/21/projects-list

ANNEX 4: Country Mapping Rwanda

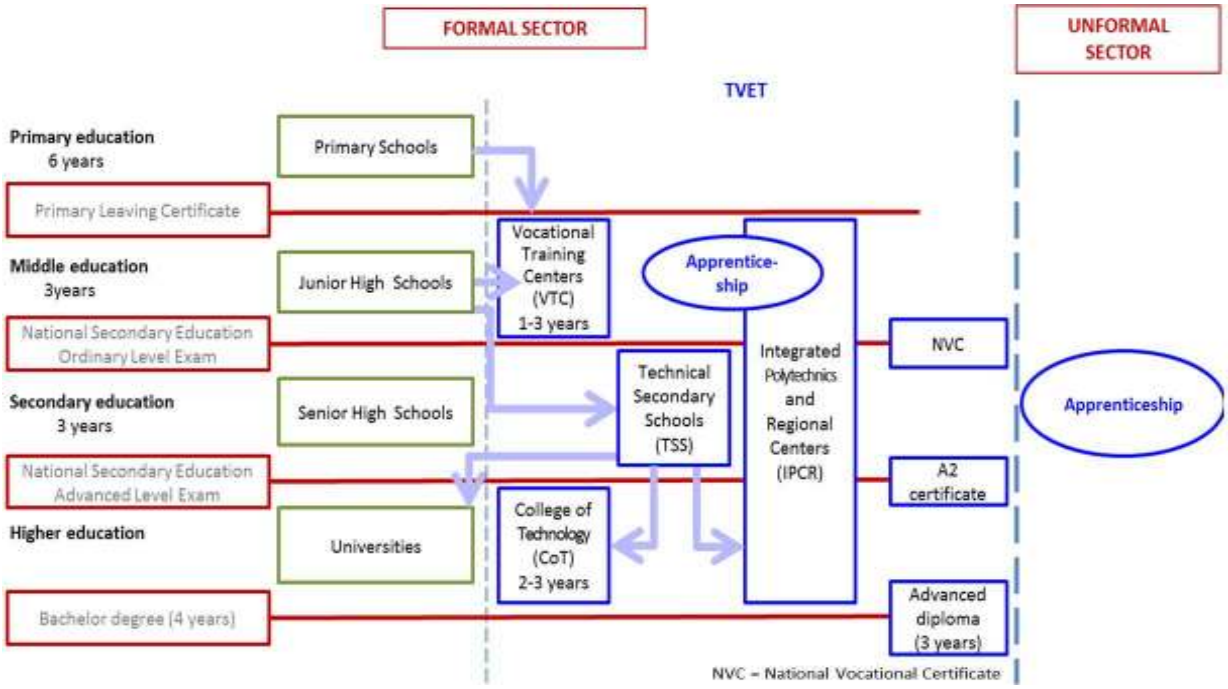
1 Facts & Figures

Surface	26,338 sq km[104]	Total literacy rate	71.1%[104]
Population	12,012,589 (2013) [104]	Educ. Expenditure	4.8% of GDP (2011) [104]
Capital	Kigali, 0.91 mio[104]	GDP per capita	$ 620 (2012) [104]
Pop. growth rate	2.7% (2013) [104]	Inflation rate	6.3% (2012) [104]
Median age	18.7 years[104]	HDI	0.434[105]
Urban population	19.1% (2011) [104]		

2 Education system

2.1 Overview

All formal TVET provision forms are part of the national education system and fall under the Ministry of Education.



Political framework and objectives

- The National Policy of Science, Technology and Innovation
- The TVET Policy (MINEDUC, 2008): identification of vocational standards and national needs

[104] www.cia.gov/library/publications/the-world-factbook/
[105] hdr.undp.org/en/data/profiles/

- Reform of the TVET sector in 2008: two new authorities have been installed within the Ministry of Education (MINEDUC)[106]
  - Workforce Development Authority (WDA): organization of the TVET strategy on the national level
  - Integrated Polytechnic Regional Centres (IPRCs): centres of expertise on a regional level.
- Education Sector Strategic Plan (ESSP) – 2010 to 2015, see also here
- Objective for 2017: 65% of upper secondary education enrolment in TVET.[107]

2.2 Education & TVET system

- TVET plays a key role in combating Rwanda`s serious lack of qualified people in the workforce, especially in technical sectors.[108]
- There are currently three different types of TVET institutions under the integrated formal TVET scheme, which require different entry level qualifications and offer different levels of certificates and diploma.
- The unskilled and unemployed population without formal educational background may join TVET on short courses or on NVC levels. [108]
- Most students from VTCs (low level vocational training) go to look for work after completing a short course (39.8% in 2011) [109] or a year training (40.9%) and obtain a certificate, and may come back for another year or two of training thereafter.
- Unformal TVET takes place at considerable level through traditional apprenticeships in garages, cobbler-shops and other artisan facilities.[110]
- TVET institutions in Rwanda have difficulties in attracting qualified trainers due to poor incentive schemes as well as lack of sufficient infrastructure and equipment. [110]
- Partnerships between MINEDUC, TVET service providers and private sector players in order to boost TVET skills development by providing opportunities for industrial attachment, internship and apprenticeship for TVET trainees in a coordinated manner. [110]
- Only few private sector training institutions are providing opportunities for practical industrial exposure to trainees. [110]
- The Private Sector Federation is engaged to a significant degree in the planning and development of the education system in order to meet the skill requirements for the

[106] www.vvob.be/vvob/en/programmes/rwanda-technical-and-vocational-education-and-training
[107] Mapping Study Rwanda, Edukans Netherlands, October 2012
[108] planipolis.iiep.unesco.org/upload/Rwanda/Rwanda_technical_vocational_education_policy.pdf
[109] MINEDUC 2012
[110] Dr. Ibrahim C. MUSOBO and John GAGA, ADEA 2012 - schoklandtvet.pbworks.com/w/file/fetch/59834571/031012_Draft%20TVET%20Mapping%20Report.docx.

development of the Rwandan economy. It also provides Technical and Vocation Training to Rwandans.[111]

- 12 economic sectors have been recently identified and earmarked as priority for TVET investment and initiatives, among which is "Clean and sustainable energy".[112]

TVET enrolment level

- In 2012, 144,695 students were enrolled in TVET-programs, corresponding to 38% of the total enrolment in upper secondary education.[112]

Gender

- Rate of female enrolled in TVET is 49.3% in 2012.[112]

2.3 TVET institutions[112]

- In 2012 there were 278 providers of TVET-programs in Rwanda. Privately owned TVET had a share of 71% percent whereas public owned TVET accounted for the remaining 29%.[112]
- The Northern Province which is the most populated of the country is very badly represented in TVET. [112]
- Private providers are parents associations, association of individuals, groups of people, religious organizations or NGOs.[112]
- Both public and private schools charge school fees to students, but school fees in government schools are subsidized and therefore lower.[112]
- Private schools fund themselves but depend on government for registration, accreditation, evaluation and certification.[112]

2.4 TVET challenges

- Curricula and teaching methods are not responding to labor market demands and lack effectiveness and relevance to the reality of the workplace. Lacks inadequate hand-on competencies and workshops are equipped with poor and inadequate instructional material and equipment.[112]
- The low reputation of TVET teachers is aggravated by low salaries. Similarly qualified employees in enterprises receive 3 – 4 times higher salaries. This results in lower teachers motivation, considerable teaching hour deficit and strong fluctuation tendencies.[112]
- Performance is inadequate because their practical technical competencies, pedagogical preparation and motivation are underdeveloped.[112]

[111] Mapping Study Rwanda, Edukans Netherlands, October 2012
[112] Mapping Study Rwanda, Edukans Netherlands, October 2012

- The lack of pro-activity to involve private sector players in curriculum development leads to implementation of curricula that is not very responsive to the labor market needs. The low Public-Private Partnership (PPP) is still an obstacle to effective delivery of TVET. A demand-driven and outcome-based TVET requires a strong partnership between TVET institutions and enterprises.[112]
- Gender imbalance in TVET engineering courses.[112]
- Young people annually leave schools without sufficient vocational preparation and continuing TVET capacities are not capable to prepare them for the labor market. Even existing continuing training capacities are not recorded, systematized, promoted nor integrated into strategic programs.[112]
- Inappropriate management of Technical Schools and Vocational centers, the missing link with the potential employers and the lack of school monitoring and performance evaluation are the main reasons for the Schools' insufficient contribution to the development of much needed human capital.[112]
- Under-funding is a structural problem in the TVET sector. The budget allocated is still relatively low compared to needs and priorities required to effectively implement the TVET policy.[112]

3 Renewable energy market

3.1 Overview

▸ Electrification rate	10.8% (2013)[113] (goal: 70% in 2017)
▸ Installed electricity capacity	72.5 MW (2009) [114] 59.1% hydro 40.5% thermal 0.4% solar
▸ RE installed capacity	59% of installed power (2011) [115] 59.3 MW Hydro (2012)[115] 10.4 MW Biomass (2010)[115] / 85.5% of primary energy use (goal: 50% in 2020) [116] 0.3 MW Solar (2012)[117]

[113] www.btcctb.org/files/web/tender/REQUEST%20FOR%20EXPRESSION%20OF%20INTEREST%20No%20487%20-%20PO%20-%20013_0.pdf

[114] www.reegle.info/policy-and-regulatory-overviews/RW

[115] www.map.ren21.net/PDF/ProfilePDF.aspx?idcountry=140

[116] www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Rwanda%20-%20Energy%20Sector%20Review%20and%20Action%20Plan.pdf

[117] www.map.ren21.net/PDF/ProfilePDF.aspx?idcountry=140

- RE installed capacity 45% of total generation[117]
- RE goal for 2017 310 MW hydropower[118]

Political framework and objectives

- National Energy Policy (2008)
- National Energy Strategy (2008 - 2020) with focus on exploitation of Rwanda´s geothermal potential and increase use of solar water heaters[119]
- Government policy to promote rural electricity: Solar-PV generators and small, micro and pico hydropower through private suppliers[119]

3.2 Potential and main barriers

Renewables	Solar	Wind	Geothermal	Small & medium hydro
Theoretical potential[120]	Average horizontal irradiation is 5.5 kWh/ m2/day	Not available	Potential exists for between 170 – 320 MW of geothermal power generation	Hydropower potential in the country is estimated to be 500 MW[121]

Main barriers[119]

- Delayed implementation of regulations established in law due to crisis in the energy market
- Regulatory framework for sustainable energy is still in its initial phase
- No coherent framework for the regulation of renewable energy - The development of such a framework is an essential element of the National Energy Policy
- Need for:
  - capacity-building,
  - the establishment of standards and codes of practice
  - suitable guidelines for the use of renewable energy
- National utility is still responsible for the tariff-setting for electricity - can lead to an imbalanced tariff structure.

[118] www.christianaid.org.uk/images/low-carbon-africa-Rwanda.pdf
[119] www.reegle.info/policy-and-regulatory-overviews/RW
[120] energypedia.info/images/7/77/ENERGY_POLICY_and_STRATEGY.pdf
[121] http://www.afribiz.info/content/renewable-energy-potential-in-rwanda

3.3 Private sector

Rwanda´s economy is growing by an average rate of 8.3% for the last 5 years. Clean and affordable energy is seen as a key element for further sustainable growth of the economy. Therefore the Government is identifying the private sector as the main driver for renewable energy development by referring to the financial and human resource requirements needed to obtain growth in the renewable energy sector.[122]

- The private sector is welcomed as a participant at any and all levels of the energy supply industry.
- Where public-private partnerships (PPPs) are desirable, government will work with private sector entities to ensure the speedy structuring and financing of PPP projects in the energy sector.
- MININFRA will work closely with other government agencies established to assist private investors in all sectors of the economy, particularly the Rwanda Investment and Export Promotion Agency (RIEPA), the Rwanda Revenue Authority (RRA) and the PPP Unit in the Prime Minister's Office.
- Currently three stable workshops are active in the manufacturing of pico-turbines. [122]
- Only few companies in Rwanda are active in the field of solar energy. They focus mainly on the market for larger systems for public institutions, e.g. hospitals, schools, etc. through public tenders. In addition they and others are also trying to sell solar home systems but the market for solar lanterns and small home systems is still in its infancy. Recently, an increasing focus on solar water heating systems has also emerged.[122]

3.4 Main donors' activities

The coordination of the donor activities in the electricity sector is carried out by the Ministry of Infrastructure (MININFRA). Among the numerous activities the following are to be mentioned:

- Grant from the Global Environment Facility Trust Fund (World Bank/GEF) of US $ 4.5 Million for Rwanda Sustainable Energy Development Project (SED Project) funded through Africa Renewable Energy and Access program (AFREA). [123]
- Grant from the Nordic Development Fund of 4 Million Euros for the development of Solar Water Heaters under SolaRwanda Programme (2012 – 2015). [123]

[122] www.climatechange.be/jicdmtender/IMG/pdf/National_Efforts_to_promote_CDM_in_Rwanda-PPPFin_Mode_de_compatibilite_.pdf

[123] www.rura.rw/index.php?id=96

- The UK Department for International Development (DFID) has developed a results based financing scheme to support renewable energy enterprises in the solar PV, micro hydro and institutional biogas sector. The programme will be implemented by GIZ. [124]
- The Belgian Development Agency (BTC) participates in rural electrification based on photovoltaic systems by means of the Energy for Rural Populations through Renewable Energy Project (EPRER) and is currently in the process of establishing a Wind Atlas.[125]
- World Bank, Opec Fund, The Saudi Fund for Development and BADEA - Electricity Access Rollout Project (EARP) aims to connect at least 70% of the population to the grid by 2017 .[124]
- Promoting Renewable Energy Programme (PREP) from the Dutch Government - cooperation with International Fertilizer Development Center (IFDC), KfW, BTC and MININFRA. [125]
- The French Development Agency through its debt relief programme for Rwanda is providing support to the national electricity access programme. [124]
- The EC supports in particular two areas with a total budget of € 50 million: [124]
    - energy solutions for off-grid public institutions (PV systems)
    - micro hydro plants
- GIZ - Private Sector Participation in Micro-hydro Power Supply for Rural Development (PSP Hydro) 2006 to 2013.
- GIZ "Result-Based Financing Programme" designed to disseminate renewable energy technologies, starting in January 2014.

Furthermore Rwanda is part of the following regional projects:

- The three-year, $7 million facility, dubbed Capital Access for Renewable Energy Enterprises, is operating in Kenya, Tanzania, Rwanda and Uganda, and is supported by the Swedish International Development Co-operation Agency - Global Village International Partnerships (GVEP) is working with MININFRA to implement projects which supports the renewable energy sector in particular hydro power, pico solar and institutional capacity building. [126]
- Energy and Environment Partnership in Southern and East Africa (EEP) – Promotion of renewable energy, energy efficiency and clean technology investments - Jointly funded by the Governments of Finland, Austria and recently joined by the UK's Department for International Development.
- African Development Fund – "Scaling-up Energy Access Projects" with implementation through EWSA.

---

[124] energypedia.info/wiki/DGIS_Promoting_Renewable_Energy_Program

[125] energypedia.info/index.php/Rwanda_Country_Situation#Biomass_Energy_Strategy_.28BEST.29

[126] The East African November 16, 2013 - www.theeastafrican.co.ke/business/Swedish-agency-invests--7m-in-renewable-energy/-/2560/2075552/-/9e8dtxz/-/index.html

4 (RE) Labour market

4.1 Actual situation

- The unemployment rate was estimated around 2.4% in 2011, youth unemployment (15-24 years) around 0.7%.[127]
- Industry stands for 13.9% of GDP (2012 est.)[128]
- Global competitiveness index — Rank 66/148 [129]
  - Higher education and training — 3.0 (valued 1to 7 (best))
  - On-the-job training — 3.82
  - Local supplier quality — 4.1
- "Ease of doing business" — Rank 32/189 [130]
- In the labor market, most graduates from these institutions are not found relevant and therefore, not employable. This has resulted into massive skills gaps that are mostly filled by migrant labor from neighboring countries. It is not uncommon to find in Rwanda that at least 50% of vocational skills laborers in motor garages, hotels, hair saloons, building construction sites, and repairs and maintenance of household electronics, furniture, etc. are provided by foreigners while Rwandan streets are full of unemployed youth some of whom are graduates from these technical and vocational schools. The government is aware of the magnitude of the problem and is taking measure.

4.2 Planned RE or on-going projects

- In July 2013 the Government has sealed a $23 million energy deal with a Dutch firm, GigaWatt Global, to develop an 8.5 Megawatts solar power plant at Agahozo Shalom Youth Village in Rwamagana District, Eastern Province. [131]
- Further IPP projects with PPA for the development of 9.6 MW of hydro power plants (in construction phase) and 9 micro hydropower plants. [132]
- Ngali Energy is developing micro hydropower projects for 45 MW. [132]
- Rusumo Falls Hydro Power Plant with a generation capacity of 80 MW shared between Burundi, Rwanda and Tanzania. The construction will start in 2013 and its completion is forecasted for 2016. The Netherlands will invest 12 million euro through the World Bank and the African Development Bank.[133]

---

[127] www.indexmundi.com/facts/indicators/SL.UEM.TOTL.ZS
[128] www.cia.gov
[129] World Economic Forum - reports.weforum.org/the-global-competitiveness-report-2013-2014/
[130] www.doingbusiness.org/data/exploreeconomies/rwanda
[131] Newtimes July 23, 2013 - www.newtimes.co.rw/news/index.php?i=15427&a=68894
[132] www.rdb.rw/rdb/energy.html
[133] energypedia.info/wiki/PREP_Highlight:_Rwanda_Country_Program

- Exploratory drillings on 3 wells for geothermal resources to power project started in June 2013 and will determine planning and design of further geothermal projects. [134]

5 Relevant vocational training activities

5.1 Main donors' activities

The SolaRwanda Programme (2012 – 2015) includes training of agents/distributers and shall also benefit TVET graduates. To this purpose a steering team was put up composed of staff from MANUMETAL, WDA, Tumba College of Technology, IPRC-Kigali and Nelson Mandela Education Center.

The involvement of development partners such as GTZ, DED, JICA, APEFE, VVOB and VSF (Veterinaires Sans Frontieres) in the TVET sector in Rwanda especially after 2000 has been a pivotal game changer as far as partnerships in the sector are concerned. Between 2004 and 2007, the mentioned development partners in partnership with the Ministry of Education of the Government of Rwanda (MINEDUC) entered into a formal partnership to support the TVET sector in the country.

This partnership involved supporting the sector through individual schools, TVET associations through the TVET desk that functioned from within the Ministry of Education. As a result, a partnership between the Ministry of Education, GTZ and JICA supported the NTS (Network of Technical Schools) to formalize and become TEVSA (Technical & Vocational Schools Association) covering almost all TVET service providers in the country.

5.2 Further vocational training activities

- Within the framework of the Rwanda domestic biogas programme (2007-2011), Technical and Vocational Education and Training (TVET) institutes embarked on curriculum development to integrate biogas into regular courses and for the provision of tailor made short courses; on the job training also took place. [135]
- At the time being some institutions are planning to offer TVET in the fields of "Clean and sustainable energy for renewables", especially IPRC Kigali.[136]
- GIZ operates a vocational training program which also includes trades such as electrical and electronics under the political umbrella of Ministry of Economic Planning and Finance (MINECOFIN).

[134] Newtimes July 19,2013 - www.newtimes.co.rw/news/index.php?i=15423&a=68792
[135] SNV Netherlands Development Organisation, Case study 40 Rwanda - www.snvworld.org/sites/www.snvworld.org/files/publications/the_rwanda_domestic_biogas.pdf
[136] WDA October 2013 - www.wda.gov.rw/content/rwanda-best-model-tvet-effectiveness-says-togo-minister

- Until December 2013 the Rwanda Renewable Energy Association (RREA) had a cooperation with the Vocational Training Centres of Bavarian Employers' Associations (bfz) for training activities. [137]
- UNIDO's "Integrated Programme for Capacity-Building to Enhance Industrial Recovery, Competitiveness and Sustainability" includes recovery of manufacturing capacity through enterprise rehabilitation and restructuring and institutional capacity building for small and medium-sized enterprise (SME) development with emphasis on women entrepreneurs.[138]
- In 2008, partnership in the TVET sector was created between MINEDUC, JICA, GTZ and NTS giving birth to TEVSA (Technical and Vocational Schools Association in Rwanda). This partnership was aimed at impacting all TVET providers in the country for improvement.

6 Suggestions for TVET RE activities by the EUEI PDF

6.1 Possible project ideas

Mini and micro hydro as well as solar PV and solar thermal are regarded as the technologies where most needs are emerging.

Through the GIZ project "Promotion of the Economy and Employment" and with its TVET component there is a starting point regarding need analysis undertaken by a manpower survey to supplement the existing data by examining employment promotion needs.

Co-operation with the private sector can also be enhanced through the national employment agency and the Private Sector Federation.

Since 2009, in the courses selected for support at participating schools, vocational students have been benefiting from needs-based, up-dated curricula and modernised teaching materials. This has been achieved with the support of the Association of Technical and Vocational Schools (TEVSA).

The TVET activities in the hydropower sector should pursue two objectives

- Construction and maintenance of hydropower plants
- Manufacturing of pico-hydro power projects.

Short courses are well established in the Rwanda TVET systems and could thus serve as a starting point in the form of pilot courses and at the same time are used to assess qualification levels and skills gaps.

---

[137] www.sequa.de/index.php?option=com_content&id=1321%3Aostafrika-regionale-verbandskooperation-fuer-erneuerbare-energien&catid=83%3Asequade&Itemid=62&lang=en

[138] www.unido.org/en/where-we-work/offices/regional-offices/officeethiopia/regional-brief/rwanda.html

A round table should be established to co-ordinate and focus short and long term development of hydro power capacities. Partners in such a round table could include be representatives from institutions such as:

- Ministry of Economic Planning and Finance (MINECOFIN)
- Rwanda Renewable energy Association (RREA)
- Private Sector Federation (PSF)
- Association of Technical and Vocational Schools (TEVSA)
- The Workforce Development Authority (WDA)
- Donors active in hydropower development
- Major firms active in manufacturing of hydropower development.

After the initial pilot courses a curriculum development and training of trainers shall be developed.

7 Main stakeholders

- Ministry of Education (MINEDUC) - www.mineduc.gov.rw
- Energy, Water and Sanitation Authority (EWSA) - www.ewsa.rw
- Workforce Development Authority (WDA) - www.wda.gov.rw
- Rwanda Renewable energy Association (RREA)
- Technical and Vocational Schools Association (TEVSA) - www.tevsa-rwanda.org
- Private Sector Federation (PSF) - www.psf.org.rw
- EDC (Education Development Center), a US NGO conducting the Akazi Kanoze Livelihoods Project - www.edc.org/category/rwanda

ANNEX 5: Country Mapping Senegal

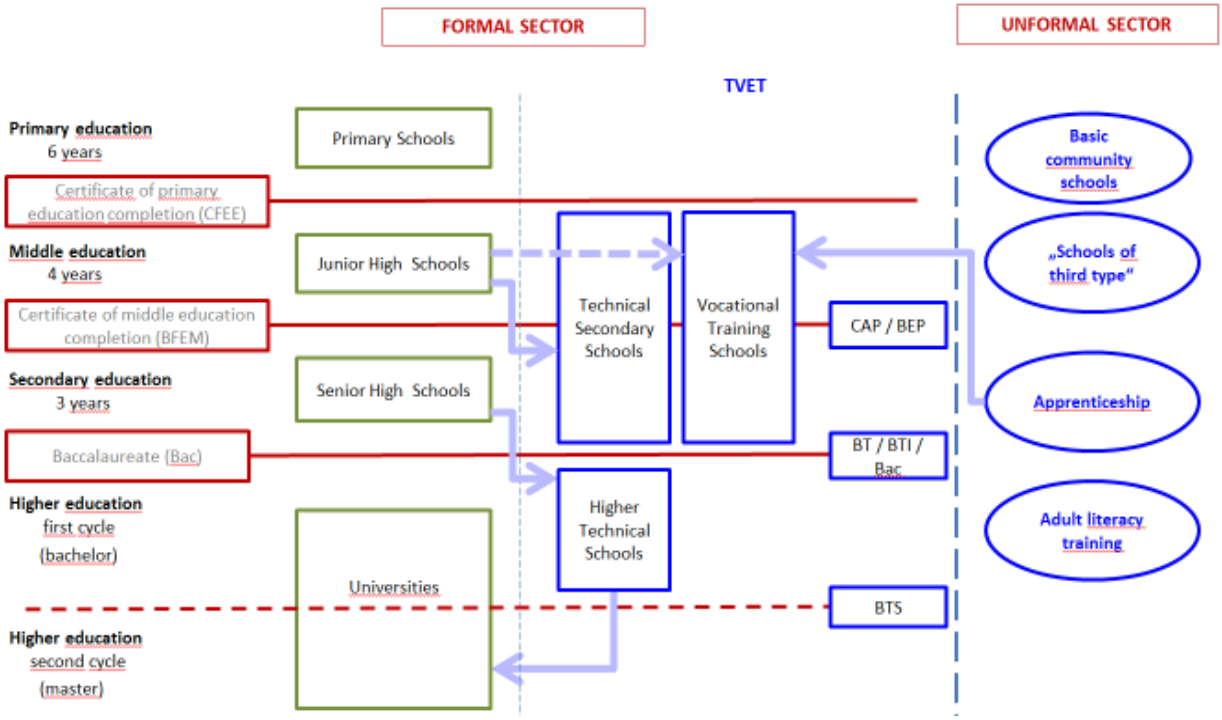
1 Facts & Figures

Surface	196,722 sq km[139]	Total literacy rate	49.7% [139]
Population	13,300,410 (2013)[139]	Educ. expenditure	5.6% of GDP (2010)[139]
Capital	Dakar, 2.78 mio. (2009)[139]	GDP per capita	$2,100 (2012)[139]
Pop. growth rate	2.51% (2013) [139]	Inflation rate	1.4% (2012)[139]
Median age	18.2 years [139]	HDI	0.47 (2012)[140]
Urban population	42.5% (2011) [139]		

2 Education system

2.1 Overview

- Senegal's educational system is based on the French system and integrates TVET in the formal education sector.



Political framework and objectives

- Three ministries respectively in charge of
  - secondary education, regional university centres and universities
  - pre-school, elementary and middle school education

[139] CIA World Factbook - www.cia.gov
[140] Human Development Reports - hdr.undp.org/en

- technical and vocational training

- The Ministry for Technical Education and Vocational Training (METFP) is working on a reform in order to adapt technical education and vocational training to the labour market
- Technical and financial support of the reform through: Luxembourg, AFD, GTZ, JICA, KOICA, CTB, APEFE, BAD, BID, BIT, PNUD, ONUDI, ACDI, UNESCO, etc.
- On-going improvement of TVET system[141]:
  - Sectorial studies for identification of needs
  - Involvement of private (productive) sector
  - Training of trainers
  - Construction and rehabilitation of infrastructure
  - Development of new curricula.

2.2 Education & TVET system

- Estimated number of apprentice: 400,000 – 600,000 (2011)[141]
- Integration of apprenticeship /non formal sector into educational system (10,000 per year)[141]
- 52% of TVET graduates found a job in 2010 compared to 7% in 2007 [141]
- Experiment with Mobile Training Units (comprising trucks, tents, trainers, materials etc.) to provide short courses in disadvantaged areas (UNESCO)
- Work-linked training (alternate training) and distance learning.

TVET enrolment level

- Enrolment in secondary vocational system in 2012 was 37,516 (4.5% of total enrolment in secondary education).[142]

Gender

- Rate of female enrolled in formal secondary vocational training in 2012 was 51.44%.[142]

2.3 TVET institutions

- In 2010 there are 213 institutions for TVET, out of which 70 are public (33%) [141]
  - 36 CRETF (Female Regional Center for Technical Education) and CETF (Female Center for Technical Education)
  - 9 technical colleges
  - 25 vocational training centers
- 143 private institutions (67%)[143]
- Private trainings have fees two to three times higher than in mainstream education [143]

---

[141] METFP 2012
[142] www.indexmundi.com
[143] METFP 2012

- In 2010, 56% of TVET learners were in private institutions [143]
- Only 5 institutions are located in rural areas (2%)[144]

2.4 TVET challenges

- High degree of instability and institutional inconsistencies [145]
- Lack of institutions [145]
- Lack of career opportunities [145]
- Imbalance of the training offered (concentration around Dakar and Thiès, on BTS and BT certificates and on higher education level) [146]
- Low diversification of programmes (51 training programmes compared to 120 in emerging countries). [143]

3 Renewable energy market

3.1 Overview

- Electrification rate: 40% (2011) , only 22% in rural areas[147]
- Biomass: 57% of primary energy supply (2010)[147]
- RE installed capacity : 0.002 GW electricity capacity (2010)[148]
- RE electricity generation: 10.3% (2011)[148]
  - Solid biomass: 1.7%
  - Hydro: 8.3%
  - Solar PV: 0.2%
- RE goal for 2020: 15% of electricity supply[149]
- Solar: 2.5 MW in 2010[148]

Political framework and objectives

- Special Programme for biofuels (2008)
- National Biogas Programme (2009)
- Renewable Energy Law (2010)
- Support Scheme for renewable energy under the law:[149]
  - Especially for solar and wind plants

[144] METFP 2012
[145] AfriMap 2010 - www.afrimap.org/english/images/report/AfriMAP_Senegal_Education_Full_EN.pdf
[146] www.afd.fr/webdav/shared/ELEMENTS_COMMUNS/seminaires/formation-28-06-06/Niang.pdf
[147] Senegal Renewables Readiness Assessment 2012, IRENA
[148] www.map.ren21.net/PDF/ProfilePDF.ashx?idcountry=151
[149] www.reegle.info/policy-and-regulatory-overviews/SN

- Tax break is available on the income and corporate income tax and the value-added tax for renewable energy investments

- National Strategy for Renewable Energy in development [150]
  - Provides conditions of power purchase and remuneration of electricity generated by renewable energy plants and their connection to the grid
  - Provides conditions of power purchase of surplus renewable energy-based electricity from self-producers
  - Fix maximum intake of renewable energy sources
  - Electrification with a large emphasis to private sector investments (concessions)

3.2 Potential and main barriers

Renewables	Solar[151]	Wind[151]	Biogas[152]	Hydro[153]
Estimation of technical potential	75 MW in 2013 187 MW in 2020	100 MW in 2012 180 MW in 2020	1,769 GWh	1,400 MW

Main barriers [153]

- Limited financial support mechanisms for the promotion of renewable energies
- There are many obstacles relating to the sector's regulation and overall governance
  - Important reforms are delayed and the delay in implementing proposals already engaged is particularly noticeable
  - Feed-in tariffs were proposed under the 2010 renewable energy law, but have not yet come into effect
  - Renewable energy electricity projects are held back due to the lack of dedicated regulatory framework. The implementation of the renewable energy law of 2010 is dedicated to improve the situation.

3.3 Private sector

- Senegal is home to the first Solar PV module manufacturing in West Africa (SPEC), with a yearly capacity of 25 MW [154]
- Some domestic manufacturing capacity has grown up around Senegal significant experience in the deployment of certain renewable energy technologies (e.g., small-scale solar, wind for water pumping) [155]

---

[150] Senegal Renewables Readiness Assessment 2012, IRENA
[151] Study MVV decon GmbH 2010 - www.ecowrex.org
[152] Société SAEB 2012
[153] Senegal Renewables Readiness Assessment 2012, IRENA
[154] IRENA News January 2013
[155] IRENA 2012

- Several local enterprises distribute a large range of better-quality lighting products based on LEDs and typically powered by solar photovoltaic (PV) panels. These enterprises also distribute other solar PV products such as solar home systems (SHS) of various capacities. [156]

3.4 Main donors' activities

- GIZ / KfW - PERACOD Programme to promote rural electrification and a sustainable supply of domestic fuel (2003-2015)
- EU, AFD, GIZ, IRENA, World Bank – Africa EU Renewable Energy Cooperation Programme (RECP) 12/2012–02/2014 - Implementation of the renewable energy law (Tariffs, Scenarios, Tendering, and model PPAs)
    - World Bank and IFC - Lighting Africa Programme
    - Public-Private Infrastructure Advisory Facility (PPIAF) - multi-donor trust fund
    - Africa Renewable Energy Access program (AFREA).

4 (RE) Labour market

4.1 Actual situation

- The unemployment rate was estimated at around 48% in 2007, youth unemployment (15-24 years) was estimated at around 14.8%[157]
- Industry stands for 22.6% of GDP (2012 est.)[158]
- Global competitiveness index — Rank 113/148 [159]
    - Higher education and training — 3.1 (valued 1 to 7)
    - On-the-job training — 3.01
    - Local supplier quality — 4.8
- "Ease of doing business" — Rank 178/189
- Working population — 88% agriculture/livestock, 5% civil servants, 3% commerce, 2% handicrafts, 2% others

4.2 Planned RE or on-going projects

- Construction and operation of a grid-connected 15 MW bioenergy power plant, using typha and rice husks in the city of Diama (Northern Senegal)[160]
    - Promoter: SGI
    - CAPEX: EUR 38 mio

---

[156] Senegal Policy Report Note, Lighting Africa 2012
[157] www.indexmundi.com
[158] www.cia.gov
[159] World Economic Forum - reports.weforum.org/the-global-competitiveness-report-2013-2014
[160] EREI 2013

- OPEX: EUR 38/MWh
- LCOE: EUR 119/MWh

- Construction and operation of a 49.5 MW grid connected wind park in the coastal area of Senegal, in the city of Kebemer[24]
  - CAPEX: USD 147.2 mio
  - OPEX: USD 4 mio (1st year)
  - LCOE: USD165/MWh
- Rural electrification project (PV - diesel hybrid systems) by the global company Isofoton - investment of Euro 16 million (EU financing) - creation of 10,000 800 KW systems in the regions of Kaolak and Fatick and 20,000 1.5 MW systems in the Kolda region over a period of three years[161]
- Several rural electrification concessions.

5 Relevant vocational training activities

5.1 Main donors' activities

- In the Casamance region the local development association UDB developed and built together with Kinderhilfe Senegal e.V. a professional school with 7 handicrafts professions, forming 250 youth each year. Engineers without borders (Ingenieure ohne Grenzen e.V.) added the construction of solar school to this existing complex and starts training at the end of 2013 in the fields of solar energy and renewable energy. [162]
- PERACOD II funded by the EU Energy Facility, the DGIS and the French Development Cooperation to promote renewable energies, rural electrification and a sustainable supply of domestic fuel, 2004 to 2016
- Within the joint programme from IFC and World Bank "Lighting Africa" some training activities are occasionally conducted in cooperation with third parties.

5.2 Further vocational training activities

- Centre d'Études et de Recherches sur les Énergies Renouvelables (CERER) at the University Cheikh Anta Diop in Dakar - provides training for professionals, retraining and further training for researchers and technicians interested in the Center's activities
- The Polytechnic School (ESP), as part of the University Cheikh Anta Diop in Dakar, has been integrating renewable energy content into its curriculum for a long time, but there is no dedicated programme[163]

---

[161] Solar International July 2012 - www.solar-international.net/article/75672-Senegal-project-to-be-carried-out-by-Isofoton.php

[162] www.ingenieure-ohne-grenzen.org/de/Regionalgruppen/Regensburg/Projekte/Fachschule-fuer-Solartechnik-und-Erneuerbare-Energie-in-Senegal

[163] Senegal Renewables Readiness Assessment 2012, IRENA

- Centre Sectoriel de Formation Professionnelle (CSFP), a PPP between government, local authorities and professional organisations, extends its curricula to professions of energy mastery[164]
- The Senegalese private company Touba Energy Solutions Sarl is a service provider in the fields of renewables and also offers education and training services[165]

5.3 Links of TVET to RE private sector

- TVET reform implemented which aims to better align education with employment needs through the development of links with the private sector
- Participation of the private sector in identification of programs, in occupational analysis and at the Forum
- 6 professional organizations from 3 sectors of activity covered by the project are participating in the development of programs to be developed are in the EFE change management committee
- 68 participants from the productive sector participated in the occupational analysis
- Private sector participated in the forum on "TVET institutions serving industry and business competitively". Various employers' associations did some publicity
- Senegalese professional organisations of BTP sectors (the professional association of building contractor and public works in Senegal – SPEBTPS – and the building and public works national association –SNBTP-) and the council managing the BTP sectorial centre are part of the PPP construction for the CSFP in the fields of renewable energy.[166]
- At ESP each department has a liaison teacher to the private sector.[167]

6 Suggestions for TVET RE activities by the EUEI PDF

6.1 Possible project ideas

Regarding the RE technologies in question on grid and micro grids seem to provide a potential as a function of the electrification, especially within the concessions awarded.

Solar energy and the use of biomass should be subjects of TVET; the potential development of wind energy needs to be seen given limited wind speeds of 3.8-4.1 m/s.

Given the large number of stakeholders on the training and on the implementation of TVET a national TVET RE or HRD RE platform should be established. This platform should as first steps:

---

[164] CSFP, Moustapha LOUM 2012

[165] energy.sourceguides.com/businesses/byB/serv/edu/byGeo/byC/Senegal/Senegal.shtml

[166] CSFP, Moustapha LOUM 2012

[167] Senegal Renewables Readiness Assessment 2012, IRENA

a) Take an inventory of all existing training offers

b) Work with the stakeholders, especially from the privates sector, on a needs' and skills gap assessment

c) Coordinate further development of TVET for RE.

In this respect the TVET and the academic/university level education could be integrated as there are a large number of common stakeholders.

Training of trainers and upgrading of facilities should be a second axis of activities. The choice of the training institutions to be funded (e.g. training equipment) could be undertaken by means of a competition for which the linkages to the private sector, training concepts, etc. should be decisive in order to encourage those.

A third line of activities could be developed on further education and training and the raising of quality standards. The linkage of investment in RE and TVET should be strengthened by using future concessions and public subsidies to leverage investment in (further) education and training by the firms. This means that contractors would be required a certification for which they would have to pass certain training as it is done in Tunisia for solar water heaters and in Kenya for PV.

6.2 Possible main partners

- The Polytechnic School (ESP)
- Centre Sectoriel de Formation Professionnelle (CSFP)
- The private owners of concessions, as they should be interested to facilitate the use of renewable energy
- Technical school for solar energy and renewables in Baila, Casamance.

7 Main stakeholders

- Ministry of Professional Training, Apprenticeship and Handicraft - www.mfpaa.gouv.sn
- Ministry of Youth, of Employment and of the Promotion of Civic Values - www.jeunesse.gouv.sn
- Ministry of Energy (MoE)
- National Agency for Renewable Energies (ANER)
- Ministry of Renewable Energy (MER)
- Inter-Ministerial Committee on Renewable Energy
- University Cheikh Anta Diop in Dakar and its subsidiaries - www.cies-uni.org/en/senegal
  - Center for Studies and Research on Renewable Energy (CERER) - http://196.1.95.4/cerer

- École Supérieure Polytechnique (ESP) - www.esp.sn

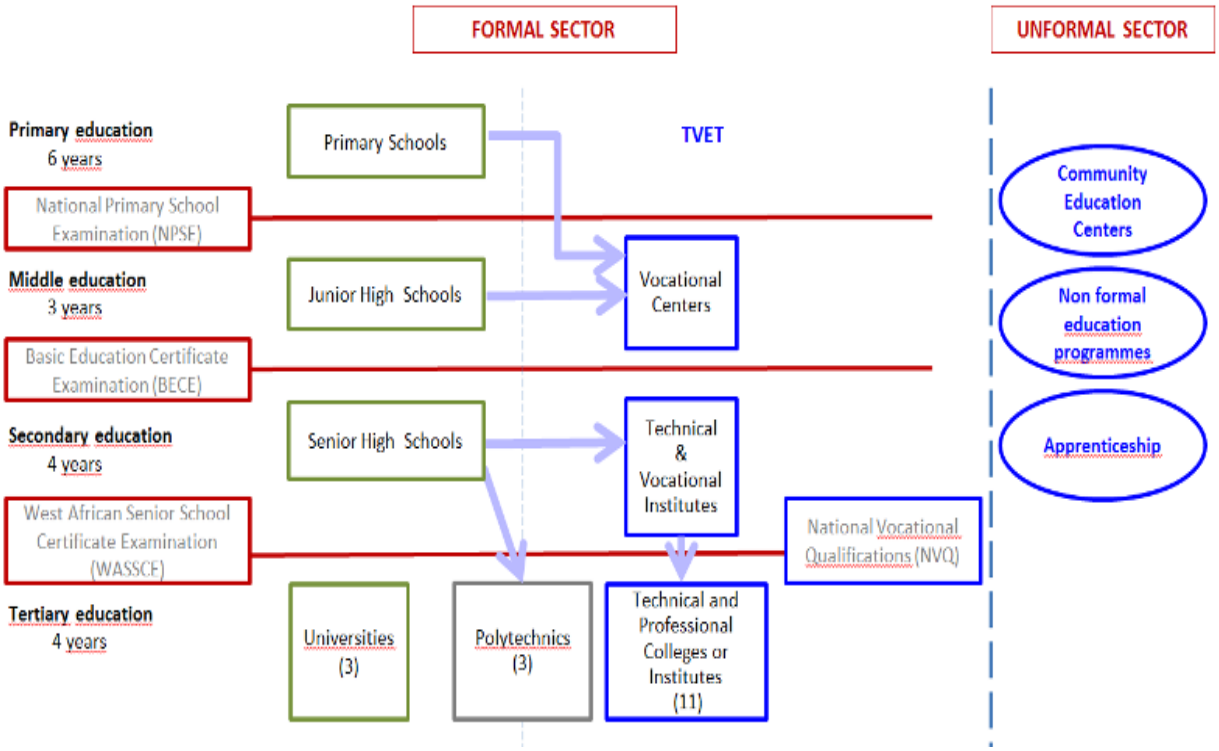
ANNEX 6: Country Mapping Sierra Leone

1 Facts & Figures

Surface	71,740 sq km[168]	Total literacy rate	43.3%[168]
Population	5,612,685 (2013)[168]	Educ. Expend.	3.6% of GDP[168]
Capital	Freetown, 0.95 mio (2004) [168]	GDP per capita	$1,400 (2012)[168]
Pop. growth rate	2.3% (2013)[168]	Inflation rate	12.9% (2012)[168]
Median age	19 years[168]	HDI	0.359 (2012)[169]
Urban pop.	39.2% (2011)[168]		

2 Education system

2.1 Overview[170]



Political framework and objectives

- New Education Policy 1995

[168] www.cia.gov/library/publications/the-world-factbook/
[169] hdr.undp.org/en/data/profiles/
[170] education.stateuniversity.com/pages/1334/Sierra-Leone-EDUCATIONAL-SYSTEM-OVERVIEW.html

- National Education Master Plan 1997–2006; emphasis of the 6-3-3-4 system education on technical and vocational skills training[171]
- Education for All National Action Plan 2004
- Education Act of 2004
- Sierra Leone Education Sector Plan 2007-2015[172]

2.2 Education and TVET system

- In 2010 one out of four children between 6 and 11 did not go to school [173]
- Only 32% of the children leaving primary education enter secondary education[174]
- According to the Minister of Education 40% of teachers are unqualified and do not want to go through the formal system of training[175]
- Given that 2/3 of the adult population is involved in subsistence agriculture, vocational education concentrates on agricultural skills and related proficiencies such as mechanics, carpentry and bricklaying[176]
- The London based City and Guilds is the main external accreditation and certification body for the middle and lower level TVET qualifications [177]
- Links between the various institutions are weak[178]
- Introduction of distance learning.[171]

TVET enrolment level and gender

Type of school	Years	Nr. of schools	Total enrolment	% females	Qualifying exam
Junior Secondary	12-14	354	175,867	41.1%	BECE
Junior Technical Secondary	12-14	70	2,050	30%	BECE
Senior Secondary	15-17/8	112	51,794	36.2%	WASSCE
Senior Secondary Technical and Vocational	15-17/8	42	9,868	66.6%	NVQE

171 www.col.org/SiteCollectionDocuments/05SierraLeone_EnviroScan.pdf
172 planipolis.iiep.unesco.org/upload/Sierra%20Leone/Sierra_Leone_ESP.pdf
173 UNESCO June 2013 - unesdoc.unesco.org/images/0022/002217/221758f.pdf
174 parrainezuninstituteur.over-blog.com/pages/Le_systeme_scolaire_en_Sierra_Leone-3668906.html
175 AYV Jan. 2013 - africayoungvoices.com/2013/01/the-people-of-sierra-leone-are-stifling-the-system-of-education-dr-minkailu-bah/
176 www.classbase.com/Countries/Sierra-Leone/Education-System
177 www.theigc.org/sites/default/files/christian_kingombe_paper.pdf
178 World Bank 2013 – Republic of sierra Leone Higher and Tertiary Education sector Policy Note 2013

Enrolment rates grew for junior secondary schools from 14 % to 32 % between 2004 and 2010 and from 43 % to 62 % for senior secondary schools. During the same period enrolment rates for TVET passed from 16% in 2004 to 8% in 2011.[179]

2.3 TVET institutions

- Several Community Education Centers (CEC), Vocational Centres (VC), Technical and Vocational Institutes (TVI)
- Many private institutions, mostly regulated by the National Council for Technical, Vocational and Other Academic Awards (NCTVA)[180]
- Three polytechnics offering academic courses as well as technical and vocational courses and programmes [181]
- Opportunities Industrialization Centers (OIC) International is managing and financing 4 vocational centers in Sierra Leone.[182]

2.4 TVET challenges

Even though the government in its Education Sector Capacity Development Strategy (2010/11) clearly identifies the need for a demand-led TVET-system that meets international standards, its budgetary priorities lie within primary education. The country spends less than 5% of its educational budget on TVET. Subsequently, there is a lack of qualified teachers and the infrastructure and equipment of TVET facilities is often poor.

Further challenges:

- TVET delivery has poor linkages with labour market and is subject to poor quality infrastructure, equipment, material and staffing[181]
- Lack of alignment between labour market needs and curricula[179]
- Lack of strategic coherence between existing Government initiatives and development partners' projects[179]
- A national harmonized policy for TVET[181]
- A national accreditation system for all TVET centres and institutions.[181]

3 Renewable energy market

3.1 Overview

- A national accreditation system for all TVET centres and institutions.[181]
- Electrification rate: < 10%[183]

[179] UNESCO June 2013 - unesdoc.unesco.org/images/0022/002217/221758f.pdf
[180] www.col.org/SiteCollectionDocuments/05SierraLeone_EnviroScan.pdf
[181] www.theigc.org/sites/default/files/christian_kingombe_paper.pdf
[182] www.oici.org/about-us/

- Total installed electricity capacity (2011): 477 MW[184]
  - Hydro 89.9%
  - Thermal 10.1%
- RE installed capacity: 0.1 GW (2010)[185]
- RE goal for 2020: 2% of power generation (140 GWh/a)[186]
- Hydro capacity: 429 MW (2011) [187]
- Solar capacity: 0.025 MW (2010) [188]

- **Political framework and objectives**
  - NPA Act (1982), defines the responsibilities of the NPA, and the development of hydroelectric projects
  - National Energy Policy and Strategic Plan (2009): [186]
    - Focus on hydro-potential
    - Solar PV: Small decentralized solar PV installations in towns and rural areas in existence to feature for remote locations in rural electrification programme
    - Ethanol project expected to provide some 50 MW electricity
    - Setting up Mechanisms to exploit Climate Initiatives to assess and package renewable energy projects
    - Seeks national and international cooperation to support the development and management of RE
    - Support RETs training in tertiary and other learning institutions
    - Establishment of codes of practice, guidelines and standards for RE
  - National Energy Implementation Strategy (2012)
  - To reach the SEFA goals and improve the country's energy sector by 2030, it is estimated that Sierra Leone will require investment and/or financial support of approximately $7.8 billion over 18 years.
  - As part of the implementation of the ECOWAS white paper on energy access, the need to integrate energy access into national and regional poverty reduction strategies has been recognised. As stated above, the Poverty Reduction Strategy Paper (PRSP 2008-2012) for Sierra Leone recognized the need to provide electricity as one of the key priorities.

---

[183] www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/IIAP%20Short%20%28En%29%20Int%C3%A9rieur.pdf
[184] Afribiz Dec. 2013 - www.afribiz.info/content/renewable-energy-potential-in-seychelles-2
[185] www.map.ren21.net/PDF/ProfilePDF.aspx?idcountry=160
[186] www.mewr.gov.sl/pdf/energy%20policy%20&%20strategic%20plan.pdf
[187] www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/IIAP%20Short%20%28En%29%20Int%C3%A9rieur.pdf
[188] Afribiz Dec. 2013 - www.afribiz.info/content/renewable-energy-potential-in-seychelles-2

3.2 Potential and main barriers

Renewables	Solar	Wind	Biomass	Hydro
Exploitable potential	-	-	2,706 GWh[188]	1,513 MW[188]

Main barriers

- Lack of a determined energy sector policy as well as a legal and regulatory framework is a barrier to private sector entry in the electricity supply chain.[189]
- Lack of an energy sector policy as well as a legal and regulatory framework is a barrier to private sector entry in the electricity supply chain [190]
- Lack of qualified technicians, capable of installing, maintaining and repairing solar PV systems [191]
- There is neither the appropriate technology nor the indigenous capacity to design, manufacture, market, distribute, install and maintain renewable energy technologies (RETs).[192]

3.3 Private sector

- The role of the private sector in the Sierra Leone economy is weak: Industry, mining, energy, and manufacturing account for 8% of the GDP only in 2010 and 2011[193]
- Small-scale business enterprises have cashed-in on electricity provided by solar panels to provide services to private individuals in areas of the country with irregular or non-existent power supply[194]
- Private companies are also involved in production and supply of renewable energy solutions to the public [194]
- There is a dearth of both dealers of solar products and availability of qualified solar technicians to install and manage the technology[27]
- Sierra Leone requires huge investment support in the energy sector to meet the SEFA goals by 2030. Successful execution relative to the goals would mean increasing access to electricity to about 100%, increasing energy efficiency to a level of 12-15% and increasing renewable energy level to about 7,000 ktoe. Importantly, these stated objectives of the

[189] www.reegle.info/policy-and-regulatory-overviews/SL
[190] Regional energies in East Africa, country chapter Sierra Leone, GIZ 2009
[191] www.undp.org/content/dam/sierraleone/docs/focusareadocs/undp_sle_energyprofile.pdf
[192] www.mewr.gov.sl/pdf/energy%20policy%20&%20strategic%20plan.pdf
[193] Ministry of Finance and Economic Development, Bank of Sierra Leone and Statistics Sierra Leone. May, 2012
[194] African Renewable Energy Dialogue Oct. 2013 - www.area-net.org/fileadmin/user_upload/AREA/AREA_downloads/AREA_Conference_13/Bai-Kurr_Renewable-Energy_Sierra-Leone.pdf

Government of Sierra Leone (GoSL) align completely with the goals of the Sustainable Energy for All (SEFA) Initiative.

3.4 Main donors' activities

- The Environmental Foundation for Africa (EFA), in conjunction with the Ministry of Energy, Government Technical Institute, Environmental Resources Management Foundation and Njala University with funding from Climate and Development Knowledge Network (CDKN), is in the process of assembling all relevant information about the actual and potential use of renewable energy for the development of Sierra Leone [195]
- World Bank - Sierra Leone Energy Access Project
- UNIDO supports the hydropower development together with the Chinese government.[196]
- The European Investment Bank (EIB) has disclosed plans to collaborate with other donor partners namely: the World Bank, African Development Bank (AfDB) and Kreditanstalt fur Wiederaufbau (KfW) in the area of Sierra Leone's energy sector, through the West Africa Power Pool (WAPP)

4 (RE) Labour market

4.1 Actual situation

- In 2011 Approximately 70% of youth are underemployed or unemployed [197]
- Industry stands for 14.9% of GDP (2012 est.)[198]
- Global competitiveness index — Rank 144/148 [199]
  - Higher education and training — 2.4 (valued 1to 7 (best))
  - On-the-job training — 3.29
  - Local supplier quality — 4.0
- "Ease of doing business" — Rank 142/189 [200]

4.2 Planned RE or on-going projects

- Mujimoto Sierra Leone, in partnership with state-owned China National Electric Engineering Company (CNEEC) and renewables company New Generation Energy, plans to develop solar-thermal facilities with a capacity of up to 500 megawatts[201]

---

[195] Awareness Times May 2013 - news.sl/drwebsite/publish/article_200522872.shtml
[196] SEM, April 2012 - www.sierraexpressmedia.com/archives/38039
[197] www.undp.org/content/sierraleone/en/home/countryinfo/
[198] www.cia.gov
[199] World Economic Forum - reports.weforum.org/the-global-competitiveness-report-2013-2014/
[200] www.doingbusiness.org/data/exploreeconomies/sierraleone

- Germany's privately owned BC Bangert is eying solar plants with an output of 100 megawatts[201]
- Makeni project of Addax Bioenergy is the first sugarcane-based power generation project for ethanol production to be registered under the CDM in Africa (capacity of up to 15 MW). Financing and equity partners are: AfDB, the Emerging Africa Infrastructure Fund (EAIF), the Netherlands Development Finance Company (FMO), the German DEG, the South African Industrial Development Corporation (IDC), the Belgian Development Bank (BIO) , ICF Debt Pool, the Swedish Development Fund (Swedfund) and FMO. Exploitation will start in 2014. [202]
- UNIDO is funding 13 turn-key solar photovoltaic power plants – twelve 5-kilowatt peak plants and one 16 kWp plant. Sunlabob Renewable Energy, a Laos-based social enterprise, has been awarded two contracts for the design, supply, installation and local training of these projects for which completion they will work with local partners.[203]

5 Relevant vocational training activities

5.1 Main donors' activities

- Environmental Foundation for Africa (EFA) built the Biodiversity Conservation & Renewable Energy Learning Center, funded by the Critical Ecosystem Partnership Fund (CEPF), with supplementary financial and in-kind contributions from other partners, including the Environmental Protection Agency of Sierra Leone, WAPFR project, Ministry of Agriculture, Forestry and Food Security-Forestry Division, Architects Without Borders (Denmark – building design)[204]

5.2 Further vocational training activities

- The Ministry of Education, Science and Technology (MEST) encourages the development of RETs curriculum in schools and other institutions of learning[205]
- Government has established a training institute called the Barefoot Women Solar Training Center in Konta Line village, Port Loko district, with support from the Government of India to train both literate and illiterate solar technicians[206]

---

[201] Mail Guardian July 2013 - mg.co.za/article/2013-07-20-sierra-leone-needs-35bn-investment-to-restore-power-sector

[202] Thomson Reuters Foundation Oct. 2013 - www.trust.org/item/20131004162131-1pnux/

[203] EcoSeed Feb. 2013 - www.ecoseed.org/renewables/solar/16118-sierra-leone-to-be-lit-up-by-13-off-grid-solar-projects

[204] www.iucn.org/news_homepage/news_by_date/?9204/Biodiversity-Conservation-and-Renewable-Energy-Learning-Centre

[205] www.mewr.gov.sl/downloads/FINAL_ENERGY_POLICY_13_AUGUST[1]-final.pdf

[206] African Renewable Energy Dialogue Oct. 2013 - www.area-net.org/fileadmin/user_upload/AREA/AREA_downloads/AREA_Conference_13/Bai-Kurr_Renewable-Energy_Sierra-Leone.pdf

- The local NGO Safer Future Youth Development Project tackles the country's 60% youth unemployment, training people in vocational skills, including solar.[207] A Competence Centre for Renewable Energies (CCRE) has been established.
- Establishment of the Biodiversity Conservation & Renewable Energy Learning Center at the outskirts of Freetown (see 5.1)
- Possibly World Bank Youth Employment Support.

5.3 Links of TVET to RE private sector

None is known.

6 Suggestions for future activities by the EUEI PDF

As hydropower currently seems to be taken care of and biomass and gas don't seem mature, the solar sector should be selected. Given the low electrification rate, off grid solutions will need to strive and should be focussed on.

It is suggested to develop a comprehensive solar PV training programme which should aim at:

- Facilitating the development of PV solutions (mainly off grid electrification solutions) by providing skilled labour to contractors
- Introducing solar PV into the TVET system
- Supporting the development of local PV entrepreneurship.

This includes the following components:

- Immediate action programme offering short term courses for practitioners, TVET graduates and teachers including practical exposure with contractors if possible
- Introduction of PV in the TVET system, taking up the experience of the German Education and Employment Promotion Programme support project
    - Development of modules / curricula – assessing existing curricula for electrical / electronic trades
    - Training of trainers of the TVET system
- Developing courses for solar entrepreneurs including issues such as:
    - Basics of PV
    - Sizing of systems
    - Maintenance and spare parts
    - Sales and distribution
    - Entrepreneurship incl. accounting
    - (micro)finance

Possible points of energy and partners for this approach are:

[207] www.saferfuture.org/joomla/content/blogcategory/75/87/lang,en/

- Sunlabob, a German owned contractor building twelve 5-kilowatt peak plants and one 16 kWp plant in Sierra Leone in 2013 – who has already built solar power facilities in rural areas of Liberia, Mozambique, Ethiopia, Eritrea and Guinea Bissau, and is currently working to light up over 60 schools throughout Uganda in partnership with the World Bank
- Environmental Foundation for Africa (EFA) already active in training activities
- NGO Safer Future Youth Development Project with the Competence Centre for Renewable Energies (CCRE)
- St. Joseph Training School given their experience in catering for TVET needs of the mining sector.

The possible roles and contribution of the a.m. institutions need to be determined in the project development phase. The most adequate institution should be equipped with the necessary training material. This should include panels to be installed.
The challenge for this approach is seen in the development of the solar sector given the low electrification rate on one hand and the absence of government policies or programmes to promote PV on the other hand.

7 Main stakeholders

- Ministry of Education, Science and Technology (MEST)
- Ministry of Energy and Water Resources - www.mewr.gov.sl
- Njala University (offering bachelor degree in energy studies [208] - njalauniversity.edu.sl
- St Joseph's Vocational Institute (associated to GIZ project "From mines to minds") – www.giz.de/fachexpertise/downloads/giz2013-en-psp-sierra-leone-london-mining.pdf
- Sierra Leone Opportunities Industrialization Centers (SLOIC) - www.oici.org/where-we-work/sierra-leone
- Sierra Leone Business Forum (SLBF) - www.slbf.sl
- The Sierra Leone Chamber of commerce - www.chamberofcommerce.sl
- Environmental Foundation for Africa (EFA) - http://efasl.org.uk/wp-content/uploads/Combined-EFA-SBP-V206.pdf
- Competence Centre for renewable energy (CCRE) - http://www.saferfuture.org/joomla/content/view/64/86/lang,en
- Sunlabob - www.sunlabob.com

[208] World Bank July 2013 - www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/09/26/000333037_20130926124018/Rendered/PDF/ACS43930PNT0P10x0379833B00PUBLIC00.pdf