Private Sector Federation
(PSF- Rwanda)

SECTOR SPECIFIC SKILLS NEEDS ASSESSMENT
ENERGY

DRAFT REPORT

JANUARY, 2022

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LIST OF ABBREVIATIONS AND ACRONYMS

EDCL		Energy Development Corporation Limited
EnDev		Energising Development
EPD		Energy Private Developers Association
ESWG		Energy Sector Working Group
EUCL		Energy Utility Corporation Limited
GoR		Government of Rwanda
ICT		Information Communication Technology
MININFRA		Ministry of Infrastructure
NDC		Nationally Determinant Contribution
NST		National Strategy for Transformation
PSF		Private Sector Federation
PWC		Price Water House Coopers (Rwanda) Limited
RDB		Rwanda Development Board
RECEP		Renewable Energy Cooperation Program,
REF		Renewable Energy Fund
REG		Rwanda Energy Group
RURA		Rwanda Utilities Regulatory Authority
SF		Shell Foundation
TWG		Technical Working Group
TVET		Technical and Vocational Education and Training
LMIS		Labor Market Information System
ILO		International Labour Organization
MINIFRA		Ministry of Infrastructure
U.S		United States
DRC		Democratic Republic of Congo
IREMA		International Renewable Energies Agency
MINEDUC		Ministry of Education
UR		University of Rwanda
NISR		National Institute of Statistics
HLI		Higher Learning Institutions
HE		Higher Education
IPRCs		Integrated Polytechnic Regional Centres
ACCEESD		African Center of Excellence in Energy for Sustainable Development
BLS		Bureau of Labour Statistics

EXECUTIVE SUMMARY

The energy sector plays a pivotal role in supporting socio-economic transformation as the life-blood of development and has an inherently systemic link to the growth of other sectors of the economy. Since energy is a critical input to other key economic sectors, such as manufacturing, construction, mining and quarrying, Agro-processing, transport, and tourism. A sound, comprehensive, and enabling environment and energy policy framework are critical in achieving stainable economic growth.

Ensuring access to modern, sustainable, and affordable energy services is a crucial and fundamental aspect of the country's economic development, poverty eradication, and socio-economic transformation agenda[1]. Lack of modern energy services stifles income-generating activities and hampers the provision of basic services such as health care and education. In addition, smoke from polluting and inefficient cooking, lighting, and heating devices is a leading contributor to respiratory diseases and deaths in Rwanda[2]. We here provost-effective effective, appropriate solutions for the poor are enabled, particularly in rural areas where energy services are scarce or expensive, poverty reduction can occur. Additionally, shifting consumption from biomass-based energies to clean energies like electricity and LPG reduces pressure on forest resources, protecting land arability and mitigating climate change through sustainable environmental conservation.

Although supporting other sectors of the Rwandan economy, the energy contribution to the Rwandan economy is low as well as the jobs created. From 2001 to 2021, the sector' (energy) share to the national GDP was 1%. Furthermore, in 2012, RDB identified only 1,668 Labor units in the energy sector in Rwanda. Despite this negligible contribution to GDP, it is fundamental to the development of other sectors and its production in MW is constantly growing.

The skills assessment in the energy sector, commissioned by the Private Sector Federation (PSF), was primarily aimed at a range of users, especially the PSF players, to foster track issues and impediments surrounding poor performance and weak competition capacities within the sector facilities, but also to shed light on advocacy with planners and policy-makers for the energy sector. Also, another study's main objective was to assess the skills requirements of the energy sector in Rwanda over the period 2020–2030 and formulate recommendations thereof.

To carry out a comprehensive, credible, and informative energy skills profile for Private sector companies, a holistic and inclusive method including the energy chain value was used. The profiling was carried out nationwide, in 4 provinces as well as the City of Kigali. Among other approaches used, was a consultant meeting with representatives and board of directors of companies, senior

[1] According to the UN Foundation almost 3 billion people rely on traditional biomass for cooking and heating, and about 1.5 billion have no access to electricity, with 1 billion more having access only to unreliable electricity networks.

[2] Smoke from polluting and inefficient cooking, lighting, and heating devices kills over four million people globally a year. Global Burden of Disease Issue, *The Lancet*, December 2012.

managers, PSF Chambers, public and private training institutions, policymakers, and public agencies to gather relevant information from various stakeholders. The study gives short, medium, and long-term recommendations that would make the energy sector more competitive that are spread across three segments of the energy value chain:

The skills needed are felt at the level of all segments. According to companies operating in the energy sector, the most common and important skills identified were electricity transmissions, distribution management.

Also, this study highlights certain findings which are categorized under conceptual skills, technical skills, and soft skills.

- **Conceptual skills**

As a reminder, conceptual skills are abilities that allow an individual to understand complex situations and develop creative and successful solutions. It can be understood as the capacity of someone to address difficult scenarios with an innovative approach. Conceptual skills in demand in the sector are:

- Adaptability Skills and suitability to the new technological trends
- Understanding Customer Needs
- Organizing and planning skills
- Strategic thinking
- Product research and development

- **Technical skills**

Technical skills are hard skills that often require industry-specific training or knowledge gained either on the job or through short courses. They refer to the specialized knowledge and expertise needed to accomplish complex actions, tasks, and processes relating to computational and physical technology as well as a diverse group of other enterprises. Technical skills in demand in the energy sector are related to the field hereunder:

- Electric Power Engineering;
- Electrical Interconnection Engineering;
- Electrical Design Engineering;
- Distribution management and Electrical Engineering;
- High voltages and/or high currents;
- Mechanical and thermal issues;
- Multi rail operation;
- Troubleshooting and Quality Control Analysis.

► Soft Skills - Generic Skills

Soft skills are known as abilities that relate to how the work is run and how a person interacts with other people in the performance of his job duties. Popular soft skills include communication, teamwork, and other interpersonal skills. Soft skills, sometimes called generic skills, can be confused with conceptual skills. There is an important nuance that makes it possible to mark the difference between these skills. The following field is related to the demand for soft skills in the energy sector.

- ♦ Managerial skills;
- ♦ Managing Resources (Human, Financial, logistics, ….);
- ♦ Leadership skills;
- ♦ Business Fundamentals;
- ♦ Financial Management;
- ♦ Project Manager;
- ♦ Strategic Planning;
- ♦ Monitoring, Operations Analysis;
- ♦ Systems Evaluation;
- ♦ Systems Analysis;
- ♦ Operation Monitoring.

In the context of this assignment, the issue of skills is to be understood holistically in the energy sector. Two main causes are the basis of the skills gap in the energy sector in Rwanda. Firstly, the problem of training in Higher Learning Institutions and Universities in Rwanda, which are qualified too theoretical, and secondly, it is an issue of developing expertise young people coming out of academic institutions who are on the job market, alongside the most experienced people

The skills needed are felt at the level of all segments. According to companies operating in the energy sector, the most common and important skills identified were electricity transmissions, distribution management.

Short-term

- Set up a platform driven by the PSF for interaction amongst private companies, policymakers, higher education learning institutions, IPRCs, and TVETs to permanently collaborate so as to rethink teaching systems that meet business expectations;
- Encourage private companies to set up research and innovation units to help them constantly innovate.

Medium-term

- Conduct advocacy by requesting foreign private companies to put in place a mechanism of transferring technical knowledge and know-how to local staff;
- Electrical engineers should be trained in mini-grid design;
- Train electrical engineers in rural hydropower civil engineering;
- Electrical engineers should be trained in automation drives;
- Train electrical engineers in network development skills.

Long-term

- Gas transmission and distribution
- Town Gas Production and Plant Maintenance
- Technical services for municipal gas

CHAPTER ONE: INTRODUCTION

1.1 Background and Context

1.1.1 Background

The energy sector is a key sector of development in Rwanda, as in any country in the modern world. There is no single socio-economic sector that does not need energy for its development. Man has always needed energy all the time, and the indispensable character of energy in the modern world is increasing. Each country strives to develop its clergy sources and to increase energy production capacity to meet its ever-growing needs while protecting the environment. It is at the centre of almost national policies.

The energy sector is a key sector for the socio-economic development of a country and understanding of the critical role the energy sector enhances its development. Rwanda has made a lot of effort to develop this sector to transform the daily lives of its citizens as well as its residents and to empower other sectors to develop. For several years, this sector was the monopoly of the State. However, with the end of the government monopoly in the energy sector in 2011[3], the country had significant growth in electricity production. Thus, since the opening of the sector to private companies, the amount of MW produced has grown steadily.

In addition, to be part of the dynamic of the future and also concerned about the protection of the environment, Rwanda is investing in green energy sources and getting involved in the trends of the green economy. Thus, it is understandable that efforts are visible in the development of skills related to green energy in general and solar energy in particular. The particular interest in this energy is because this resource of energy is the subject of much research in the context of maximizing the quantity of energy conserved for a long time, it should accessible energy at the lowest cost to the entire population.

For certain and lasting competitiveness, Rwandan companies should think about the production of certain solar energy materials instead of being consumers. The manufacture of certain equipment in the country would allow Rwanda to develop certain skills related to this technology, thus allowing it to be truly competitive in green energy.

There are many sources of energy, which are divided into two categories: renewable and non-renewable sources of energy. The difference between the two types of energy is simply that renewable sources can be easily replenished, whereas non-renewable sources cannot. And Rwanda has potentially five renewable energy families, which include solar energy, wind energy,

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[3] law n°21/2011 of 23/06/2011 governing electricity in Rwanda

hydroelectricity, biomass, and geothermal energy. Hydroelectricity is the most important renewable energy source in Rwanda in terms of electricity production.

Renewable as well as non-renewable energy sources can be used as primary energy sources to produce useful energy, such as heat, or they can be used to produce secondary energy sources such as electricity or hydrogen. To fit into the objectives as well as the aim of this assignment, it shall be noted that this work will focus mostly on electricity, which is the key secondary energy source that underpins the socio-economic activities in Rwanda.

The advent of the private sector has not only contributed to increased energy production but also to creating jobs in the energy sector, whose employees need to strengthen their skills to ensure the competitiveness of companies operating in that sector. Where private companies in the energy sector face a lack of skills locally, they resort to the skills of expatriates. Private companies investing in energy cover the three energy segments, namely generation, transmission, and distribution.

To carry out a comprehensive, credible, and informative energy skills profile for Private sector companies, a holistic and inclusive method that includes the energy chain value was used. The profiling was carried out nationwide, in 4 provinces as well as the City of Kigali. Among other approaches used, the consultant met with representatives of the and board of directors of companies, senior managers, PSF Chambers, public and private training in state policymakers mand makers, public agencies that the PSF to gather relevant information from various stakeholders.

1.1.2. Context

More of Rwanda's rural areas are characterized with very few industries, have not expressed an important need for energy to support their economy before 1994. Overall, the country had around 41 MW of internally produced power without expressly importing at least an extra MW. Three hydropower plants provide the electricity in the country. Two were the Rwanda properties, while the one was and remains a common property that belongs to CPGL's countries. Respectively, Ntaruka and Mukungwa power plants had a capacity of producing 11,25 MW and 12,45 MW, while Rusizi II was producing 43,8 MW, of which 14.6 MW were for Rwanda[4].

Table 1: Targets and strategies of the Rwanda energy sector

Targets[5]	Strategies
• Biomass (wood energy) to drop from 79.9% to 42 % by 2024	• The Rural Electrification Strategy is approved and currently in implementation.

4 https://en.wikipedia.org/wiki/List_of_power_stations_in_Rwanda

5 Rwanda development Board (RDB) website

Targets[5]	Strategies
• Access to electricity to expand to 100% by2024 (whereb2% will be on gon-the grid 48% off-grid)	• Involvement of private sector companies to accelerate and achieve the targeted off-grid electricity access.
• Productive users to be connected 100% by 2022	• For two years, an agreement of cooperation between Independent Power Producers and EDCL for the supply, installation, and provision of after-sales services is available.
• Rwanda plans to achieve 556MW installed power generation capacity by 2024	• To be produced from hydroelectric, geothermal, methane gas, and peat

The Government of Rwanda (GoR) is committed to increasing its energy production capacity to both improve the socio-economic living conditions of its population and meet the growing energy needs due to the industrialization of the country. The Government is also committed to increasing its energy production. Thus, it reached a capacity of 218 MW in 2020 with installed production capacity and aims to increase the capacity of its network to 556 MW in 2024, to provide access to electricity to 100% of the population in 2024[6].

Rwanda has many varied sources of energy for the production of electricity, which supplies the national electricity distribution network. Some of these sources are exploited while others are not yet exploited.

The energy sources exploited and their products are:

- 218 MW installed capacity
- 98 MW hydroelectric
- Thermal power: 103 MW
- 12 MW solar

The thermal source energy of electricity comprises sources that depend on fossil fuels (peat, gas, or oil) elements contained in the Earth's subsoil. It makes it possible to manufacture electricity in thermal power stations with flames, also called power stations with flames or traditional thermal power stations, thanks to the heat released by the combustion of these elements. They have been in use for decades and their production is on the national electricity distribution network.

According to the available sources of energy in the country, the energy resources available in Rwanda are not being exploited to their full potential. The country will have to bring together all

6 https://www.usaid.gov/powerafrica/rwanda, 16 April 2020

the resources in financial and human capital to sufficiently exploit the existing potential and produce 556 MW to meet the target government of 100% electricity access by 2024[7]. Without considering the potential of wind energy, which is insignificant and solar energy, modest, the combined energy produced from hydroelectric, geothermal, methane gas, and peat energy sources represents an estimated energy production potential of 1,453 MW.

All combine sub-sectors in the energy sector are yet to become large employer in Rwanda. For example, according to the study conducted by Rwanda Development Board (RDB) in 2012, the energy sector in Rwanda's private sector employed 1,668 labor units as managers, professionals (engineers), liberal professionals, technicians, and artisans. However, unlike agriculture and other sectors, the energy sector employs qualified personnel in Rwanda.

The energy production, transmission, and distribution sub-sector had a share of 24.8% of labor units; retail of water products had 20.4%, and water collection, treatment, and supply had 15.4% of the total labor units[8].

1.2 Rationale

The GoR recognizes the need for qualified and skilled human resources to address the imbalance in the supply and demand of skilled labor and is dedicated to ensuring that skilled workers are available in the labor market to meet actual market demands. Despite the progress made since 2008 in Rwanda's education and skills development areas, significant barriers remain, creating challenges in matching skills and opportunities in the labor market[9].

Credible and comprehensive labor market data and information in the private sector and training institutions are required to make strategic and sustained investments in skills development. Presently, there is inadequate data and information on skills gaps in the private sector and the match and/or mismatch between the supply of skills by various training institutions (Technical and Vocational Education and Training [TVET] and higher institutions) and labor market demand, particularly in the priority sectors.

Specific core global objectives of the energy policy include developing the requisite institutional, organizational, and human capacity to increase accountability, transparency, national ownership, and decentralized implementation capacity for sustainable energy service delivery.

In addition, though RDB has a Labour Market Information System (LMIS), it is still new and hence difficult to know the actual skills needs and gaps of various sectors of development, let alone identify the skills challenges and opportunities that various sectors are facing or having. It is also

7 Idem

8 Rwanda Skills Survey 2012, Energy Sector Report

9 Economic Development and Poverty Reduction Survey II (2013–2018)

not possible to conduct medium and long-term labor force forecasts for the various sub-sectors in the private sector.

This is mainly because of the lack of a series of cumulative credible data and the limited use of robust methodological approaches. This skills survey is a strategic start toward building a credible skills database for decision-making and planning.

It is in the above context that the Private Sector Federation (PSF) commissioned a skills assessment of the energy sector.

1.3 Objectives and Scope of the Assignment

1.3.1 Overall objective

The main objective of this study is to conduct a skills assessment of the sector to enable it to be more efficient in terms of human capital. It should be emphasized that the skills assessment will not relate to a company, a group of companies, or a sub-sector but will holistically cover the energy sector.

The problem of the energy sector is described and analyzed in relation to the three segments that constitute the main phases of the process that leads to making energy available to consumers. Thus, the skills assessment of the energy sector will be conducted both through the three segments and through different sources of energy production.

The following are the energy segments:

- **Power production** refers to the total production of primary energy by energy-producing enterprises in a given period. In Rwanda, energy is essentially produced from peat, methane gas, hydro-power, solar energy, and fuel.
- **Electrical power transmission** is the bulk movement of electrical energy from a generating site, such as a power plant, to an electrical substation. The interconnected lines that facilitate this movement are known as transmission N networks in addition, the Rwanda Energy Group (REG) has a business monopoly on power transmission.
- **Power distribution** is the final stage in the delivery of electric power; it carries electricity from the transmission system to individual consumers. Distribution substations connect to the transmission system and lower the transmission voltage to a medium voltage ranging between 2 kV and 35 kV with the use of transformers. Since the sale of electricity is the monopoly of REG, as much as transmission, power distribution is the responsibility of REG.

The production of power from any energy source is entirely open to the private sector. As for power transmission and distribution, they remain the exclusive domain of REG, which means this state agency keeps the monopoly. Companies can intervene in these segments only as subcontractors. However, for micropower plants and mini-grids, for a few years, the private sector operators have been allowed to distribute electricity to their clients in a slow ball area. This study aims at three folds:

- First, the results of the study that covers the ten sectors, including the energy sector, will allow raising the level of competitiveness of their products compared to those of competing companies in similar sectors from abroad or in countries from other regions.
- Second, it is expected that the PSF will use the working documents created as a result of this study to inform investors about the skills situation in the sector.
- Third, in the end, this study will be used by designers of national policies to develop policies based on concrete and tangible data.

Indeed, this study will assess the essential skill issues related to each of the aforementioned segments subsectors, attempt to understand the causes, and then propose solutions that could contribute to resolving the problem of skills shortage and skills gap that this economic sector is currently facing.

1.3.2 Scope of the study

This skills assessment was conducted on ten sectors, among which the energy sector has been focused on the skills available, skills required, and skills gaps in private companies across Rwanda. In this regard, the PSF assessed the skills gap and the skills shortage in the sector, highlighting the skills needed currently and projecting the skills requirements to 2030.

1.4 Methodological Approach

To carry out a comprehensive, credible, and informative energy sector skills profile for private sector companies, a holistic and inclusive method that includes the full sector chain value was used.

A holistic approach was used in this assessment. Among other methods, the consultant had meetings with representatives of the board of directors of companies, senior managers, PSF Chambers, public and private training institutions, policymakers, and public agencies that the PSF deemed relevant for the success of this assessment.

To develop the skills profile of the sector, it is important to clearly define the scope of the work and to use a methodology that makes it possible to identify real skills, which are different from qualifications and expertise.

As a reminder, skill is an ability that someone has to accomplish a task correctly, promptly, and in compliance with norms and standards. A job qualification consists of fulfilling the requirements for a job. For its part, expertise consists of having both knowledge gain knowledge in education and intensive practices a proven experience in a particular field.

1.4.1 Evidence-based quantitative and qualitative data

To produce an evidence-based report, the PSF embraced a sequential qualitative research approach by developing a questionnaire and an interview guide. The core questions asked in the research instruments were centered on recruitment and talent acquisition issues, skills gaps, resources for capacity building, apprenticeships, coaching and mentoring, management skills, and future skills needed. The issues were adopted and updated from international skill survey instruments. Questionnaires and interviews were helpful in gathering primary data related to the help gather and highlight the skills gap in the same sector.

The targeted source of information aimed to capture both primary and secondary data. Secondary data were gathered from a variety of published literature (policy documents, strategies and statistics, companies' business plans, etc.) and institutional reports, whereas primary data were gathered through interviews with key informants from companies and institutional stakeholders, as well as questionnaires distributed to establishments dealing with day-to-day skills issues.

A list of people met, public institutions, and private companies visited is attached to the present document (See details in the Annex).

1.4.2 Primary data collection

The design of the skills needs assessment in the energy sector was based on consultations with sector stakeholders and consensus-building among sector specialists and experts. Data were collected and analysed from both secondary and primary sources. The primary data collection was done in March and August 2020.

The process took a long time because of COVID-19, which happened when it started. Working from home through teleworking and the application of other barrier measures to avoid the spread of the virus did not facilitate interviews with stakeholders in the sector, thus affecting primary data collection from certain key stakeholders. An online questionnaire was launched to fill in the interviews. Indeed, this made it possible to collect a variety of data directly provided by players in the sector.

The study population was comprised exclusively of private companies operating in the energy sector, to which the questionnaire was addressed, while interviews were conducted both with public institutions and private operators. At the inception phase, it was established that 20 establishments operating in energy would be consulted. Of more than 60 questionnaires sent to private companies, 22 respondents replied. Their answers were completed with information collected from interviews conducted with private and public institutions whose lists are annexed to the report.

1.4.3 Secondary data collection

The literature review was useful for collecting secondary data. The planning documents and strategies of the GoR and studies conducted in the same field in Rwanda as in other countries have been reviewed.

Specifically, were reviewed national planning tools such as Vision 2050, NST1, Rwanda Energy Policy of 2015, and Energy Sector Strategic Plan to find planned targets and appreciate the skills required to achieve targeted objectives.

Some documents were reviewed but not limited to: REG's New Electricity Connection Policy, Anticipating skill needs for green jobs and a practical guide produced by the International Labour Organization (ILO), Rwanda's Energy Profile and Potential Renewable, Energy Resources Mapping Toward Sustainable Development Goals, Skills Audit in the Energy Sector Off-Grid, Rwanda Energy Skills Survey-BDF 2012, and Renewable capacity highlights-IRENA 2021 were reviewed in order to look for to previous similar duties, etc.

1.4.4 Assessment Process

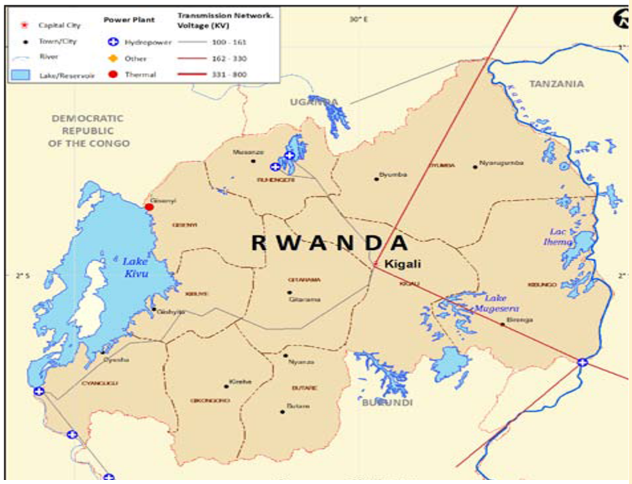
The assessment was conducted through a process that was guided by systematic conduction of steps that led to obtaining data that shed light on to the real situation in terms of skill in the sector. The assessment process is illustrated in the graph below

1.5 Layout of Energy Sector Report

The sector skills need assessment has six chapters: Chapter 1 illustrates the overriding principles and methodology of the document elaboration. Chapter 2 provides a brief overview of Rwanda's energy sector, focusing on the sector profile and its subsectors, size, and characteristics. The chapter further tackles the energy sector's occupational profile. Chapter 3 sets out the drivers of change and their skill implications. Chapter 4 outlines the energy skills status. The chapter further tackles the current skills demand and supply, skills gaps, anticipated skills demand, and their policy interventions by 2030, and ends up with the main barriers to closing skills gaps. Chapter 5 addresses skill response to the identified skills gaps. Finally, the last chapter presents the conclusion and key recommendations of the assessment report.

CHAPTER TWO: ENERGY SECTOR PROFILE IN RWANDA

2.1 Introduction



Energy is widely distributed in the country and its sale at a good price contributes to attracting investors, who then create jobs and thus play a decisive role in poverty reduction. It is indisputable that delivering electricity to a rural area enhances the quality of life, improves education in remote locations, improves health facilities, improves communication, and, in short, alters socio-economic life in a significant way.

In Rwanda, examples speak for themselves in the fields of health and education, where schools and health structures are either connected to grids or have their solar power, or other sources of energy.

Table 2: Source of energy in Primary schools from 2016 to 2019

Indicator/Year	2016	2017	2018	2019
Number of schools with on-grid electricity supply	**853**	**1,606**	**1,693**	**1,800**
% of schools' within-grid electricity supply	30.0%	55.8%	58.2%	60.8%
Number of schools with Solar power	**637**	**709**	**605**	**562**
% of schools with Solar power	22.4%	24.6%	20.8%	19.0%
Number of schools with Electric power generator supply	**128**	**138**	**159**	**169**
% of schools within Electric power generator supply	4.5%	4.8%	5.5%	5.7%
Number of schools with a Biogas system	**10**	**8**	**11**	**5**
% of schools with a Biogas system	0.4%	0.2%	0.4%	0.2%

Source: *2019 Education Statistics, MINEDUC, 2020*

By complying with the national energy policy objectives, especially the one related to ensuring the availability of sufficient, reliable, and affordable energy supplies for all Rwandans, and its neighbours. Some schools are connected to an electrical network or have a standalone source of electricity. For example, according to the table 2, 60.8% of schools have grid electron-grid supply, 19% have solar power, 5.7% have electric power generator supplies, while 0.2 % have biogas systems. This is proof that Rwanda Energy is part of the international dynamic that promotes energies as renewable energies[10]. As known and published in government strategic documents, the GoR has committed to achieving an ambitious target of 100% access to electricity by 2024 for Rwanda residents and households depending on firewood as their source of energy for cooking from 79.9% (2016/17) to 42% by 2024[11].

Rwanda's competitiveness in attracting investors grows as it increases its capacity for energy production, electrification, and expanding access to electricity and the environment is protected as the forest is not destroyed. Although Rwanda had decided to promote the energy sector with major objectives targeting the year of 2014, the sector remains the least in employing workers. According to the study conducted by RDB in 2012, private companies in the energy sector employed only 1,668 people, including employees as managers, professionals (engineers), freelancers, technicians, and artisans.

To achieve the goal of providing access to electricity to all Rwandans and residents by 2024, the country must acquire new know-how in the energy sub-sectors of stand-alone solar PV systems, solar PV mini-grids (100 kW) with battery storage, micro-hydropower mini-grids (100 kW), and biomass power mini-grids (100 kW).

A recent study on skills audit in energy off-grid in Rwanda in 2017 presents among other the global skills needs currently and by 2030 to develop the energy off-grid sub-sectors. The same study states that the nature of off-grid electrification is such that it is a stop-gap measure and the demand decreases with increasing grid extension. Below, are projections of skills required in 2017 and the respective projected skills needed in 2022 and 2030 in general, without going into detail.

Table 3: Required skills needed in energy off-grid sub-sector

Skills Level and Occupation	Current Requirement 2017	Requirement 2022	Requirement 2030
Specialists and managers	137	74	119
Professionals	58	68	117
Technicians	69	107	459
Artisans	220	254	691
Grand Total	**484**	**503**	**1386**

Source: *Skills audit in energy off-grid sub-sector in Rwanda 2017*

10 MINEDUC Rwanda Education Statistics, 2019.
11 National Transformation Strategy (NST 1), 2017–2024

2.2 Challenges faced by the sector

The energy sector is a sector that has not been very developed to exploit all the energy resources available to the country. Except for hydroelectric power, which has been in use since the colonial period, all other energy sources exploited in Rwanda, notably energy notable than gas and solar energy, are newly exploited.

2.3 The contribution of the Energy Sector to Socio-Economy Development

Without energy, not a single country in the modern world can develop. The improvement of the quality of life of the population, the development of an Indus, try or the economic development of a country at large, all depend on the energy that is both affordable and available to all.

Many countries are investing in green energy, which is an unavoidable way to finance their sustainable development. Rwanda is part of this new dynamic. It has carried out studies to find out its potential in solar energy, wind energy, thermal energy, methane gas, etc. Significant investments have been made in solar energy and methane gas energy production. Going forward, there are other projects to maximize energy production from these energy sources as well as other green energy sources.

For Rwanda Energy Policy, the mission of the Rwanda energy sector is to "create conditions for the provision of sufficient, safe, reliable, efficient, cost-effective, and environmentally appropriate energy services to households and all economic sectors on a sustainable basis[12].

Its contribution to GDP is negligible. For example, every year from 2001 until 2020, its contribution was 1% of GDP[13]. However, this sector has a strategic mission of supporting other socio-economic sectors by providing energy to allow them to achieve their objectives.

2.4 Rwanda Energy Policy

The Rwanda National Energy Policy is developed to address the critical challenges faced in the energy sector and then bring this sector to catalyse the broad economic growth and contribute significantly to facilitating the achievement of the country's socio-economic transformation agenda. Eight challengers were identified as follows[14]:

- Energy security and a sound demand-supply balance;
- Access to modern energy services has increased dramatically;

[12] Rwanda Energy Policy, 2015, Ministry of Infrastructure
[13] National Institute of Statistics (NISR), National Institute of Standards and Technology, Gross Domestic Product, 2020
[14] Ibid

- Improvement and streamlining of stakeholder coordination to ensure effective partnership and delivery on set targets;
- A robust legal and regulatory framework is required;
- Development of institutional, organizational, and human capacity is required.
- Inadequate infrastructure requires huge investment;
- high cost of electricity generation fuel;
- Vulnerability to climate change.

To address the aforementioned challenges, the policy established six specific core global objectives of the energy policy[15]:

i. Ensuring the availability of sufficient, reliable, and affordable energy supplies for all Rwandans;
ii. Creating a favourable environment for increased private sector participation in energy supply and service delivery;
iii. Encouraging and incentivizing more rational, efficient use of energy in public institutions, and amongst industrial and household end-users;
iv. Ensuring the sustainability of energy exploration, extraction, supply, and consumption so as to prevent damage to the environment and habitats;
v. promoting safe, efficient, and competitive energy production, procurement, transportation, and distribution;
vi. Developing the requisite institutional, organizational, and human capacity to increase accountability, transparency, national ownership, and decentralized implementation capacity for sustainable energy service delivery.

The National Energy Policy in force in Rwanda aims to modernize the sector and increase electricity production. It is open to private operators and is concerned about the environment.

2.5 Size and Characteristics of the sector

Rwanda is not a country with very significant energy potential. However, the country has yet to use half of its reserve of energy resources for the production of electricity. Rwanda's total electrical energy production potential is estimated at 1,500 MW[16]divided into different energy sources, including hydroelectric, methane gas, peat, geothermal, solar, and wind power. Over the

[15] Idem.
[16] Africa Development Bank Group, Rwanda Energy Sector Review and Action Plan, 2013.

years, Rwanda has increasingly developed energy source exploitation projects to increase its capacity to produce electricity, which is essential in the country's industrialization process.

Table 4: Future Power Tracking

Estimated future energy generation Technology		
Technology	**Estimated quantity in MW**	**Constraints**
Hydro	313	Climate change
Methane	350	For 50 years
Solar	Available	30MW identified
Peat	267	For 30-50 years
Geothermal	300	Not yet proven
Wastes	Proven	Law Capacity
Biogas	Not known	But available

Source: *Rwanda's Energy Profile and Potential Renewable Energy Resources Mapping Toward Sustainable, Development Goals, Cardiff University Cardiff, UK*

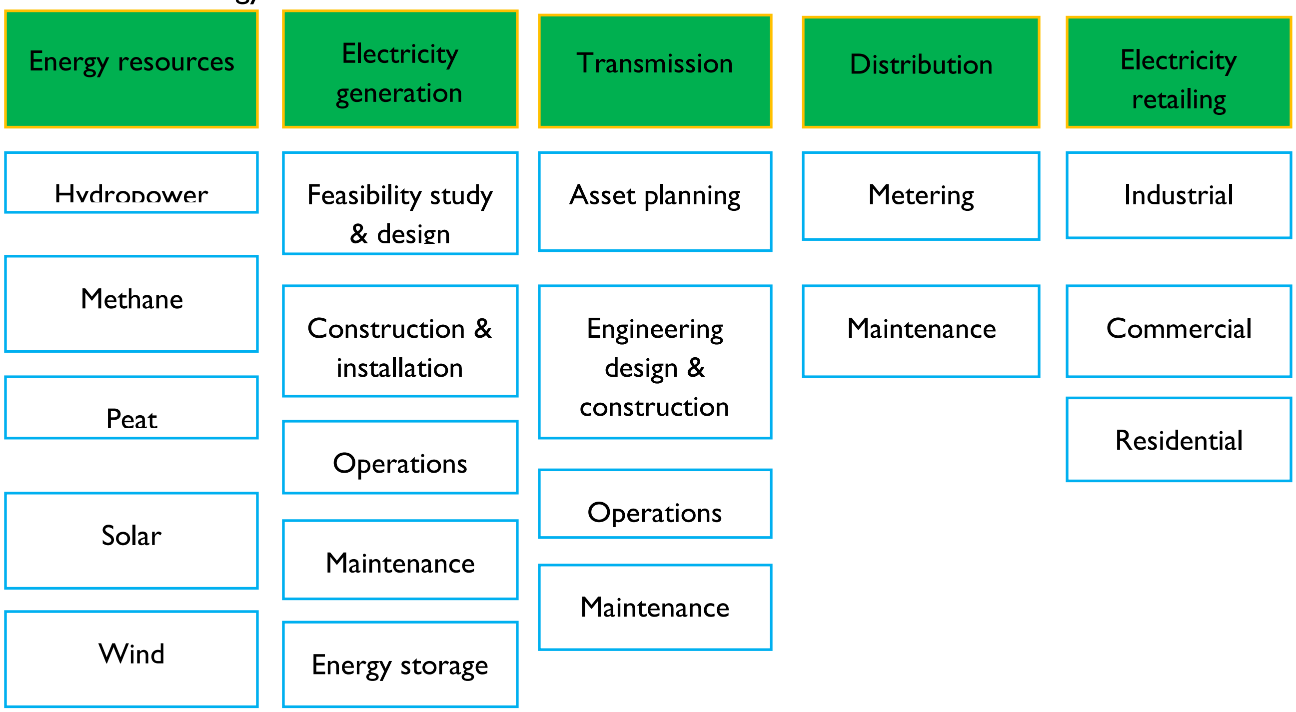
Today, all sources of energy are not yet exploited, and those that are exploited are not exploited. Thus, this sector is still promising in terms of job creation in its three segments: energy generation, transmission, and distribution.

2.5.1 Sector Value Chain

Based on a literature review on the energy sector with special reference to skills and occupational needs in the energy sector, energy skills assessment and profiling, discussions with sector stakeholders in Rwanda, a questionnaire, and the experience of the Sector Lead, a value chain of the energy sector in Rwanda was developed, which has six core activities, namely:

- Resource Assessment;
- Product or Project Development;
- Manufacture;
- Distribution;
- Installation; and
- Operation and maintenance.

The Rwanda Energy Value Chain



2.5.1.1 Energy resources

It is the initial phase of the energy project that conducts the pre-feasibility analysis. It assesses the availability, quantity, suitability, and adequacy of the energy resources for exploitation. According to the energy value chain in Rwanda, the core competencies required for this step are electrical engineers, mechanical engineers, and chemical engineers.

2.5.1.2 Electricity Generation

Electricity generation is the first process in the delivery of electricity to consumers. It is electricity generated from fossil fuels, nuclear power plants, hydropower plants (excluding pumped storage), geothermal systems, methane gas, solar panels, biofuels, wind, etc. In Rwanda, electricity is produced from:

- Hydropower
- Methane
- Solar
- Geothermal
- Wastes
- Biogas

- **Potential Energy Resources**

The important sources of energy in Rwanda with the potential to generate electricity are listed here below. Some of them are already exploited, while others have not yet. Geothermal is the most important potential source of energy that requires extensive studies before generating energy.

Hydropower: Rwanda's overall hydropower potential has been estimated at up to 400 MW, although this varies by study. An assessment of the energy sector undertaken by the African Development Bank in 2013 estimated Rwanda's domestic hydropower potential at 313 MW, broken down into 130 MW of domestic and 183 MW of regional hydro resources[17].
Peat to power: A detailed study and assessment of peat bogs in Rwanda and their potential use as a source of fuel for power generation published in 2016 stated that " from the 13,571-ha area studied, approximately 23 to 33 million dry tonnes of peat can be produced from an exploitable area of 4,057 ha. This peat can produce between 97 and 129 TWh for 30 years, at an estimated level of between 121 and 161 MW[18].
Geothermal energy resources: Rwanda's geothermal resource quantity estimation needs extensive studies to be proven. At this time, it shall be noted only that, studies have identified Karisimbi, Kinigi, and Gisenyi.
Solar energy: The study about solar energy in Rwanda was conducted by the United States (U.S.) National Air and Space as well as the University of Rwanda in partnership with the Ministry of Infrastructure (MININFRA) Department of Meteorology in 2007. It was found that Rwanda's Eastern Province has the greatest. It was estimated that the monthly average global solar radiation varies between 4.3 and 5.2 kWh per meter squared per day in the overall regions of the country. However, the eastern province has the greatest potential for generating energy from solar resources. In 2014, in addition to many households' electrification through solar PV installations, Rwanda had two solar PPV-based power plants, one of 250 kW and the other of 8.5 MW, connected to the national grid[19].
Methane gas: It was confirmed by the latest study that Lake Kivu has 60 to 70 cubic kilometres of methane (CH4) from which 44.7 cubic kilometres can be extracted. There is a small annual accumulation of 0.14 cubic kilometres per year. The amount of electricity that can be produced from this methane depends on the extraction. This efficacy is currently estimated at 28%, lower than the 40 to 60% initially expected. Thus, the initial forecasts of 700 MW of production over 50 years (to be divided between Rwanda and the Democratic Republic of Congo (DRC) have been revised downwards to 350 MW.
Biomass. Small-scale power generation using residues from agriculture (such as bagasse or rice husks) or biomass briquettes (from compacted waste residues or charcoal dust) is feasible at low levels of capacity. However, due to the lifestyle in urban areas, there is the possibility of

[17] Rwanda's Energy Profile and Potential Renewable Energy Resources Mapping Toward Sustainable, Development Goals, Cardiff University, Cardiff, UK

[18] Idem.

[19] Rwanda's Energy Profile and Potential Renewable Energy Resources Mapping Toward Sustainable, Development Goals, Cardiff University, Cardiff, UK

finding considerable amounts of recyclable waste such as organic waste, paper, cardboard, and wood that can be used to generate electricity.

2.5.1.3 Electrical transmission

Electrical transmission is the process of delivering generated electricity, usually over long distances, to the distribution grid located in populated areas. An important part of this process includes transformers, which are used to increase voltage levels to make long-distance transmission feasible[20].

The national transmission lines of high voltage increased from 374.4 km in 2007 to 744 km in 2017. Rwanda's electricity network is made up of different transmission lines that pull power from various generation stations across the country. Indeed, since 2017, Rwanda's transmission network has been mainly a combination of 110 kV (470.5) and 220 kV transmission lines (273.5 km)[21].

2.5.1.4 Distribution

Distribution is used broadly to include electrification hubs, network electrical distribution, sales, marketing, and delivery of products from manufacturers to wholesalers, retailers, and consumers. Hubs, sub-stations, and antennas are the main subdivisions of Rwanda's distribution network. Cumulatively, since about 2010, a total distribution network of at least 16,162 kilometres has been developed and built across the country, to extend electricity producers to consumers, where 5,590 km (35%) are medium-voltage lines while 10,572 km (65%) are low voltage distribution lines, according to the data retrieved from the Cardiff University, Cardiff, UK. The current Rwanda electricity distribution network is made up of 30kV, 15kV, 17.32 kV, and 5.5 kV lines that cover the entire country. It was also estimated in the current electrification plan of Rwanda that, to achieve up to 100% electricity access by 2024, a total of 1016 km of MV lines will have been completed by then[22].

The low voltage at which customers are connected is 400V (three-phase, 230V single-phase) and the network is currently, covered by 10,572 km of low voltage lines, giving access to on-grid electricity access to 34% of Rwanda households[23].

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20 https://energyeducation.ca/encyclopedia/Electrical_Transmission
21 Rwanda's Energy Profile and Potential Renewable Energy Resources Mapping Toward Sustainable Development Goals, Cardiff University, Cardiff, UK
22 Ibid
23 Ibid

2.5.1.5 Electricity retailing

Electricity retail is the final sale of electricity from generation to the end-use consumer. "Electricity" is a homogeneous commodity. In principle, the nature of this commodity is unaffected by scale. Therefore, the same product, namely electromagnetic energy carried over a network, is delivered to large, energy-intensive factories and small consumers in other parts of the system[24]. The core requirements for strategic knowledge are: Economics, Statistics, Finances, and Marketing

The need for skills in the energy sector, as elaborated above, in general, corroborates the needs expressed by the operating establishments. The skills gap in the Rwandan labor market in the energy sector covers both the planning, financial, and technical fields.

2.6 Employment and Labour market features and trends

The Rwandan economy has the reputation of being one of the most dynamic African countries and is diversified in different economic sectors. This dynamism and diversification of the economy would not be possible without a developed energy sector. The energy sector accompanies Rwanda's economic transformation by increasing production, with support provided to all socioeconomic sectors of the country.

Rwanda's power generation capacities have been increasing steadily for more than 10 years, and to contribute to this development, the country plans to increase from 218 MW in 2017 of installed generation capacity to 556 MW by 2024. It is foreseeable that the energy sector's development will follow the creation of jobs covering the three segments as it is predicted around the world the sector: energy production, transport, and energy distribution. In addition, being a country that attracts a lot of foreign investment, the field of the electrical equipment industry should attract investors to Rwanda for the development of renewable energies, in particular in the solar energy sub-sector which is growing in the country and around the world.

According to a study on the energy skills assessment sector, the energy establishments in the private sector had 1,668 labor units employed, including managers, professionals (engineers), liberal professionals, technicians, and artisans in 2012. In addition, the production, transmission, and distribution energy sub-sectors together shared 24.8% of labor units; retail of water products, 20.4%; and water collection, treatment, and supply, 15.4% of the total labor units. According to these figures, it turns out that the water sector has much more labor units than the energy sector. Also, of the total employees, women constituted 15.8%, while expatriates accounted for 3.2%[25].

[24] https://www.researchgate.net/publication/287574357_Electricity_Retailing

[25] Rwanda Skills Survey 2012, Energy Sector Report, RDB

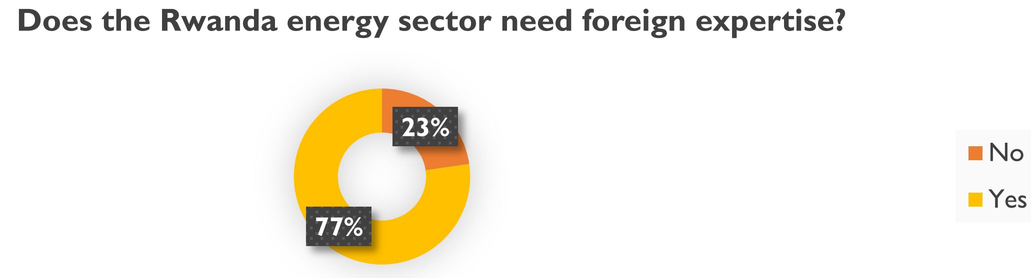

Figure 1: Need for foreign expertise in Rwanda's energy sector

Source: *Primary data, 2020*

Given the figures revealed by the survey conducted in 2020, 23% of the energy sector workforces in Rwanda are expatriates. The growing workforce of foreign origin is due to the expansion of investments, which is reflected in the increase in MW produced.

Another reason for the foreign expertise increment in energy sectors is the number of private companies in the energy sector that attract many expatriates who, at the end of the day, transfer knowledge to the local workforce.

However, it is recommended to keep some reserve of about 23%. Considering the MININFRA, EDCL, and GIZ/En DEV's concern about research results on skills audit in the energy off-grid sub-sector in Rwanda in 2017, the four institutions indicated that the skills situation is worse than what the survey indicates. According to these institutions, this is because private enterprises exaggerate their competencies for fear that how they respond during such surveys may be used to eliminate them from government business opportunities. Following this observation, it can be deduced that it is clear that off-grid skills are not yet really available locally[26].

The situation in the off-grid energy sub-sector should not be specific to this sub-sector; it could be generalized to the entire energy sector. As skills development is the result of practicing alongside a more experienced professional and/or the result of numerous training courses, the lack of skills highlighted by MININFRA, EUCL, and GIZ can be considered a weakness, which can be shared by all sub-sectors of energy.

2.7 Energy sector Occupational Profile

The energy sector is managed by the source of energy and also about the aboutness of energy, namely: production, transmission, and distribution.

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[26] Capacity Development and Employment Services Board (CESB) Skills Audit in Rwanda's Energy Off-Grid Sub-Sector, May 2017.

Rwandan sources of energy production, in particular electricity generators, are hydropower, methane gas, peat, and solar energy. Potentially, wind and geothermal energy are energy resources capable of generating electricity but which have not yet been exploited. Only occupations related to energy sources exploited or potentially exploitable in Rwanda were considered in this assignment.

It should be noted that the generation of electricity in Rwanda has relied for several years on the hydropower resource of electricity. For more than 10 years, solar energy, methane gas, and peat have also been exploited to generate electricity, thus creating occupations typical of these energy sources.

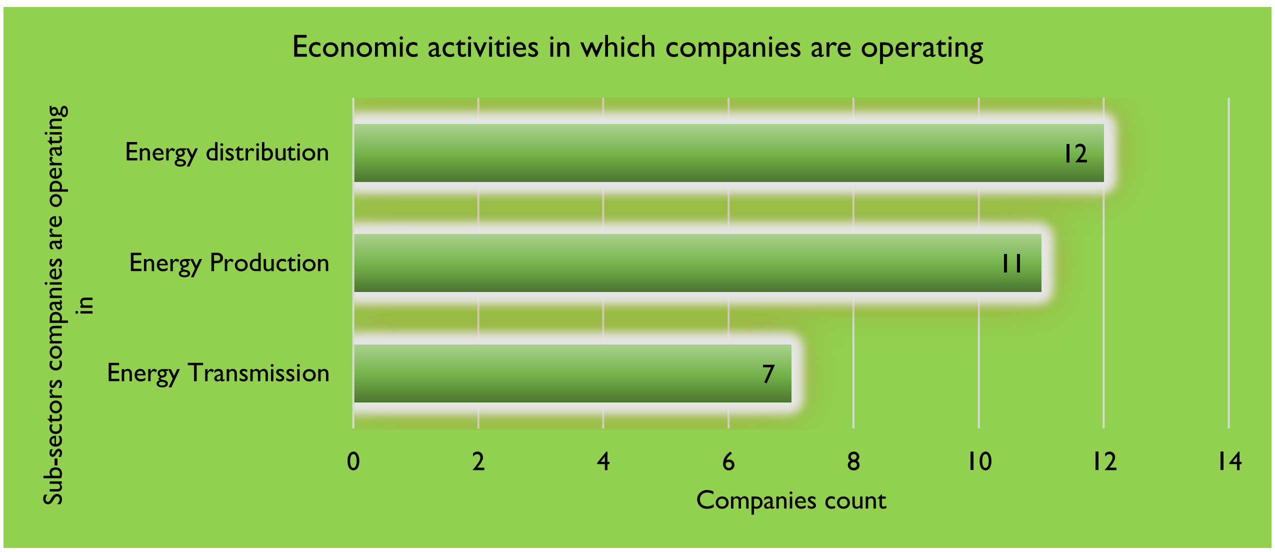

Figure 2: Distribution of energy establishments by segment

According to the figure above, private companies operating in the energy sector are most representative in the energy transmission sub-sector. This is quite normal. The high-voltage electricity transmission network is the monopoly and property of the government company, REG. The private companies that are in this sub-sector are subcontracted by REG to build the high-voltage lines or to maintain them. On the other hand, mini hydroelectric or solar power plants can be owned by companies that both produce and distribute electricity.

CHAPTER THREE: DRIVERS OF CHANGE AND THEIR SKILLS IMPLICATION

3.1 Introduction

There is a dynamic at the global, continental, and national levels that influence and redetermine the evolution of the energy sector in any country in the world. The variables determining global change and trends in the energy sector can be numerous but the most important areas follow.

3.2 Promotion of Renewable around the world

The planet is preoccupied with the scarcity of energy resources in the world, so it was decided to create 2009, the International Renewable Energies Agency (IRENA) to promote renewable energies. Since the setup of this institution, renewable energies have seen an explosion of investments in research and infrastructure, and consequently, have had a positive impact in terms of job creation across the world.

It should be noted that, for the eighth consecutive year, global investments in renewable energy exceeded $200 billion. The World Bank report pointed out that since 2004, the world has invested around $2.9 trillion in green energy sources. The continued growth of investments in renewable and clean energy received a strong incentive. While the cost of solar electricity fell by 73% between 2010 and 2017, many investments were attracted to this energy sub-sector to promote the expansion of its production. For the International Renewable Energy Agency, the downward trend will continue[27].

Except for investments in large hydropower plants, solar power alone in 2017 attracted investments of $ 160.8 billion, up 18% in one year. To this end, it accounted for over 57% of the total investment this year in all renewables, which was $278.8 billion. Together, investments in the production of coal and gas, estimated at 103 billion dollars, have been far exceeded by investments in solar energy alone. It should be noted that China alone concentrates more than half of the world's new solar capacity.

In addition, it was revealed that renewable energy employment has continued to develop since 2012. For example, in 2017, the number of people employed was 10.3 million, while in 2018, the number increased to 11 million. Jobs created in these years are distributed in manufacturing, trade, and the installation of renewable energy technologies[28]. In particular, "the solar PV industry retains the top spot, with a third of the total renewable energy workforce. In 2018, PV employment expanded in India, Southeast Asia, and Brazil, In 2018, PV employment expanded in

[27] www.irena.org Advantages Job Creation
[28] www.irena.org Advantages Job Creation

India, Southeast Asia, and Brazil; unlike in China, the United States, Japan, and the European where unions had reported the loss of jobs in this sector[29].

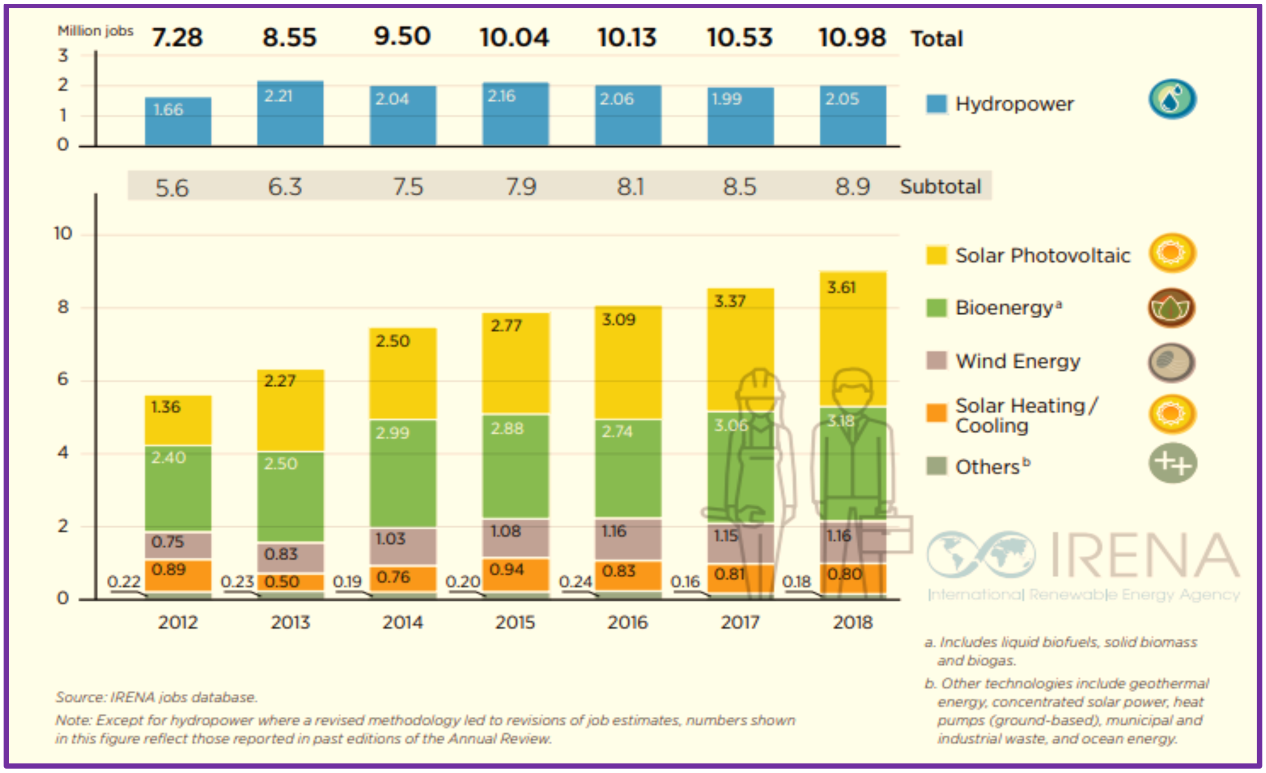

Figure 3: Employability per renewable source of energy

Source: www.irena.org › benefits › Job-Creation

Not only does IRENA allow investment attraction and job creation in renewable energy buggies, but it also plays a key role in knocking down the cost of electricity generated by renewable energies. Very recently, the journalist Anne Cagan quotes IRENA's report of June 23, 2021, which confirms the extension of renewable energies around the world. For IRENA, if renewable energies are now the cheapest source of electricity, it is linked to a dramatic improvement in the competitiveness of solar and wind technologies in the years 2010–2020.

In ten years, the cost of electricity has fallen by[30]:

- 85% for large-scale solar photovoltaic;
- For concentrated solar thermal, the figure is 68%;
- Onshore wind: 56%;

[29] Idem.

[30] Anne Cagan, Sciences Environnement Énergie, Numerama author annecagan, June 2021

- Offshore wind has a 48% share.

The progressive reduction in the cost of renewable energy recorded for the last 10 years is the result of research by scientists in these sub-sectors. That research has allowed us to produce more preferment equipment in terms of energy generation and storage.

Rwanda is not lagging in investments in solar energy. It acquired its first photovoltaic station in 2011, in the Ngoma District, of 2.4 MW. Then, it successfully constructed two photovoltaic stations in Rwamagana District, one of 8.5 MW in 2015 and the other of 3.3 MW in 2018.

To facilitate universal energy access, the GoR has defined a strategy of promoting stand-alone solar systems that consist of solar panels to provide power electricity to households. Thus, people who live far from the power network can access electricity, so the target of 100% of power access by 2024 can be achieved[31].

3.3 Reduction of carbon emissions

Climate change is one of the challenges the world is facing and which trains climate deregulation. Consequently, decision-makers around the world strive to make decisions to reduce and mitigate the effects of greenhouse gas emissions, including carbon.

Policymakers of the world have decided to care about climate degradation because it was concluded by scientists that stated that human activities are responsible for climate change[32]. The sources of energy identified as producing greenhouse gases are essentially Fossil fuels mainly coal, petroleum products, and, natural gas[33].

For the protection of the planet against the sources of energy that produce greenhouse gases, responsible governments decided to promote clean energy. Thus, for example, Canada decided in 2015 to make clean energy a trade priority, so its federal government committed to making it easier for Canadian companies to export low-carbon innovations, services, and smarts[34].

Less advanced countries should seize the opportunities for technology sharing offered by more advanced countries, like Canada. This could contribute get knowledge and skills in the clean energy sector.

3.4 National Drivers

Through its two key documents, the GoR assigned to the energy sector the mission of creating conditions for the provision of sufficient, safe, reliable, efficient, cost-effective, and

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31 Rwanda Rural Electrification Strategy, MININFRA, June 2016
32 Greenpeace France regulations-climatiques-origines-impacts
33 Idem.
34 Idem.

environmentally appropriate energy services to households and all economic sectors on a sustainable basis.

To develop the energy sector in Rwanda, the energy policy holds back five key policy principles and priorities to be followed for policy implementation[35]. Almost all the principles encourage the private sector to invest in the energy sector in Rwanda. As follows, among five key principles and priorities, four of them aim at the promotion of the private sector's investment in the energy sector. These key principles and priorities are:

1. Building decentralized energy policy implementation capacity.
2. Promote value-for-money and increase market competition in energy development.
3. "Smart" subsidies aligned to social protection principles.
4. Private operation of government-owned power plants
5. Promoting private sector participation

[35] Energy Policy of Rwanda, March 2015

CHAPTER FOUR: SKILLS STATUS IN RWANDAN ENERGY SECTOR

4.1 Introduction

The energy sector is booming where there are many private investments of foreign origin, which invest mainly in the exploitation of methane gas, peat, and solar energy for electricity generation.

The presence of foreign investment has increased the foreign workforce in the energy sector, which has decreased from 3.2% in 2012 to 23% by 2020. Often, CIOs, Technical Directors, and a few other technicians are expatriates in foreign companies, financed by foreign capital.

4.2 Current Skills Demand and Their Specific Future Economic Implication

4.2.1 Skills Demand in the Sector

Skills in demand in the sector are divided into three categories: conceptual skills, technical skills, and soft skills.

- **Conceptual skills**

As a reminder, conceptual skills are abilities that allow an individual to understand complex situations and develop creative and successful solutions. It can be understood as the capacity of someone to address difficult scenarios with an innovative approach. Conceptual skills in demand in the sector are:

- Adaptability Skills and suitability to the new technological trends
- Understanding Customer Needs
- Organizing and planning skills
- Strategic thinking
- Product research and development

- **Technical skills**

Technical skills are hard skills that often require industry-specific training or knowledge gained either on the job or through short courses. They refer to the specialized knowledge and expertise needed to accomplish complex actions, tasks, and processes relating to computational and physical technology as well as a diverse group of other enterprises. Technical skills in demand in the energy sector are related to the field hereunder:

- Electric Power Engineering;
- Electrical Interconnection Engineering;
- Electrical Design Engineering;
- Distribution management and Electrical Engineering;

- High voltages and/or high currents;
- Mechanical and thermal issues;
- Multi rail operation;
- Troubleshooting and Quality Control Analysis.

► **Soft Skills - Generic Skills**

Soft skills are known as abilities that relate to how the work is run and how a person interacts with other people in the performance of his job duties. Popular soft skills include communication, teamwork, and other interpersonal skills. Soft skills, sometimes called generic skills, can be confused with conceptual skills. There is an important nuance that makes it possible to mark the difference between these skills. The following field is related to the demand for soft skills in the energy sector.

- Managerial skills;
- Managing Resources (Human, Financial, logistics, ….);
- Leadership skills;
- Business Fundamentals;
- Financial Management;
- Project Manager;
- Strategic Planning;
- Monitoring, Operations Analysis;
- Systems Evaluation;
- Systems Analysis;
- Operation Monitoring.

4.3 Current Skills Supply and Their Specific Future Economic Implication

Professionals in the energy sector in Rwanda are trained in local universities, IPRCs and TVETs. Graduates from these basic training institutions are employed in establishments in the energy sector.

4.3.1 Skills supply institutions

Traditional training institutions produce skilled labor with basic training that allows them to acquire the appropriate skills. Each academic year higher technical and university education institutions provide young graduates with different qualifications for the labor market. Not all graduates are absorbed by the market. If we look at the tables below with two fields whose graduates are among others recruited in the energy sector but cannot all of them be recruited in this sector each year.

Table 5: Students in Public tertiary institutions from 2017 to 2019 by field of education

Field of Education/Year	2016/17	2017/18	2018/19
Information and Communication Technologies	3,227	2,470	3,080
Engineering, Manufacturing, and Construction	8,357	10,109	10,364

Sources: Ministry of Education[36]

Table 6: Students in private tertiary institutions from 2017 to 2019 by field of education

Field of Education/Year[37]	2016/17	2017/18	2018/19
Information and Communication Technologies	6,082	5,070	6,347
Engineering, Manufacturing, and Construction	2,871	4,132	3,856

Considering several numbers of tables 6 and 7, high learning institutions provide enough engineers in Rwanda's labor market. The two tables show that graduates of Information and Communication Technologies supplied by Rwanda's high learning institutions labor market is not a little number, in comparison with Rwanda's level of industrialization. In addition to these graduates, it considering Rwanda graduates from foreign countries.

Table 7: Graduates from fields about occupations of energy sectors in University Rwanda (UR) 2019

N°	Fields of Graduation	Male	Female	Total
1	BSC (HONS) in building and construction technology	61	3	64
2	BSC (HONS) in civil engineering	141	35	176
3	BSC (HONS) in electrical engineering	60	10	70
4	BSC (HONS) in electronics and telecommunication engineering	81	32	113
5	BSC (HONS) in mechanical engineering	49	8	57

Source*: College of Science and Technology UR, Graduation list, 2019*

Given the figure above, the number of graduates in 5 fields only of training in University Rwanda (UR) and one year, graduates could be enough to provide sufficient workforce to Rwanda's energy sector in case the number of annual graduates remains at least the same from UR. However, the issue would not be the number of qualified people know-how-how or the ability to carry out the required job.

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[36] https://mineduc.gov.rw/index.php

[37] Idem.

In additional, reference made g to figures produced by MINEDUC through the National Tracer Survey for TVET and Higher Education Graduates and Employer Satisfaction published in 2019, some findings question computation of the graduates from Rwanda High Learning Institutions (HLI).

By referring to classification in the tracer study adopted by NISR, it was found that the sectors of economic activity that empathy lay majority of HE graduates are: the education sector (43.3%); followed by other services 12.6% which included activities such as activities of trade unions, hair, dressing, and other beauty services, cleaning of textile and fur products, repairing of different items and furniture, home furnishings. Administrative and support service activities were rated at 7.3%; human health and social work activities (5.6%); public administration and defense, compulsory social security (5.4%), financial and insurance activities (4.4%) and professional, s, scientific and technical activities (5%), electricity, gas, steam, and air condition (1.9%)

Also, the tracer revealed that higher education graduates with masters' degrees are employed at 90.7% while 9.3% are unemployed; HE graduates with diplomas are employed at 83.7% while 16.3% are not employed, and higher education graduates with bachelors' degrees are employed at 55.4% while 44.6% are not employed[38].

By considering the nature of their job held, the study demonstrated that 18.5% of HE graduates are underemployed, while 81.5% of HE graduates are not underemployed. It was found that, by field of training in HE, the biggest proportion of graduates 32.3% who are underemployed are in agriculture, forestry, fisheries, and veterinary; 31.7% of graduates from information and communication technologies; followed by 25% of graduates from engineering, manufacturing, and construction; while the least underemployed is in health and welfare 5.5%.

Some key informants have justified this situation by saying that the number of universities and other institutions of higher learning has increased access to education through evening programs, weekend and distance learning programs, and, consequently, HE graduates do not match the job opportunities in the labor market with the advance in technology, which has replaced the need for some specific types of jobs such as bank tellers[39].

Given the above figures, the real issue is not the shortage but the quality and diversity of both training areas and investments. As a consequence of the situation revealed in the preceding paragraphs, this study recommends that some components and materials of solar energy can be produced locally, thus, it will therefore also require training skilled labor operators this industry instead of being limited to installations and maintenance of solar energy equipment.

[38] Idem

[39] Idem

4.3.2 Sector Apprenticeships

Professional apprenticeships in the energy sector are provided by TVETs and IPRCs. These technical and vocational training structures provide short-term training to raise the skills of people in employment without formal training or workers with training who wish to raise their levels or update their knowledge and skills.

4.3.3 Employer Investment in Skills

The strong companies that design and manufacture the machines used in power stations, which are exclusively foreign, often have training structures, the training of which is sanctioned by certificates. The holders of these certificates are the only ones qualified to work in the assembly of machines in hydroelectric power stations, for example.

Private companies in the energy sector do not have training centers designed to upgrade their employees' skills to adapt to technological developments, thereby increasing their competitiveness. Nevertheless, some establishments collaborate with one or the other training institutions on the few areas of interest that both parties share. The areas of collaboration with training institutions are listed below.

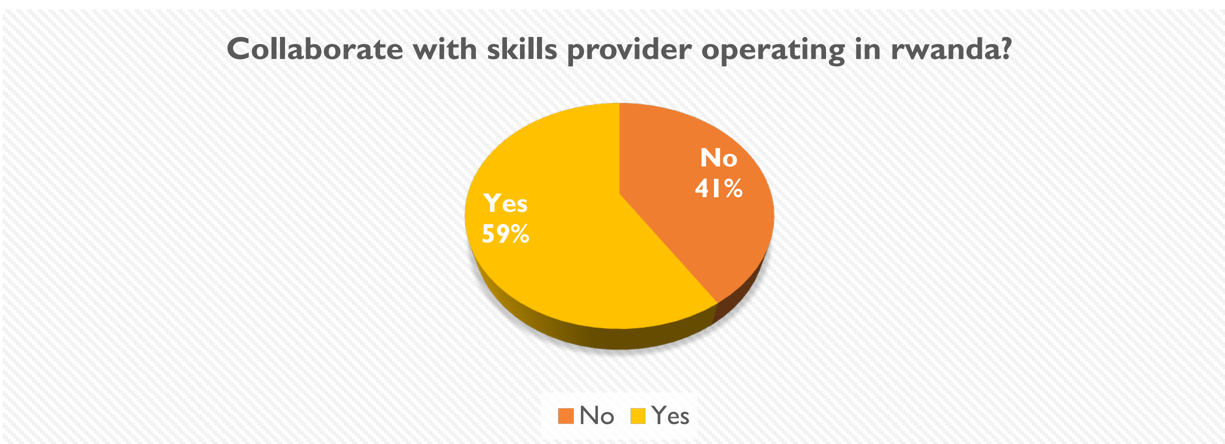

Figure 4: Interaction between Skills providers and Establishments

***Source**: primary data*

Even if not a big majority, 59% of establishments operating in the energy sector collaborate with Rwandan institutions' skills providers, while 41% of them do not interact with skills providers. The competitiveness of a company is due to its creativity, improvement of services' quality, etc. Without training, it is difficult to propose new products, improved products, or new improved services to clients. In a competitive environment, 41% of establishments that do not interact with skill provider institutions will face competition difficult to overcome.

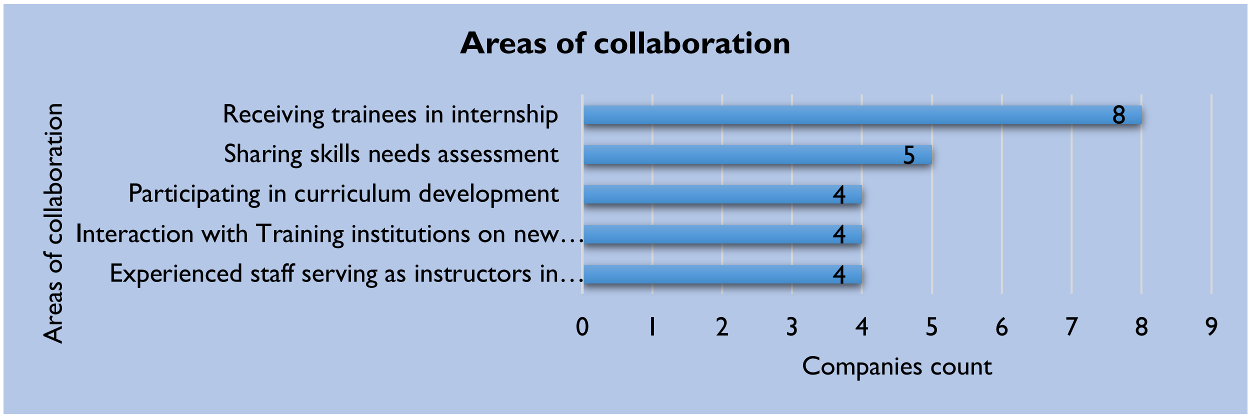

Figure 5: Areas of collaboration between skills provider and establishment

Source: *Primary data*

Establishments interacting with skills providers in various areas predict a bright future for skills development. If skills provider institutions collaborate with employers in curriculum development and on new technological trends, there are many chances to align training institutions with the needs of their clients, who are employers.

Skills issues are critical, so a MINEDUC study on the employability of TVET and HLI graduates, as well as employer satisfaction, has advised Rwandan institutions of higher learning to reconsider their programs by making them more professional and specialized[40].

4.3.4 Existing structures Skills development of energy employees

Two structures assure continuous training of employees in the energy sector, both from the private and public sectors in Rwanda sectors are two: The African Center of Excellence in Energy for Sustainable Development (ACEESD) and the Training Center of EUCL.

4.3.4.1 African Center of Excellence in Energy for Sustainable Development

The centre offers both short-term training and diploma training for masters and doctor levels in various fields of energy. This centre is a result of cooperation between the World Bank and the GoR. Its training targets employees working both for private and public sector employers and also young graduates from universities who are interested in renewable energy. Here, below, are some training offers by the Center for Masters Ph.D. Ph.D. levels:

- Smart & Micro-grid Technologies (Wind, Solar, Mini-Hydro, Biomass, Geothermal);
- Battery management systems (BMS);
- Power system dynamics;

[40] National Tracer Survey of TVET and HE Graduates and Employer Satisfaction

- Power Electronics for renewable energy, generation, transmission, and distribution systems;
- Control systems (stochastic systems, stability analysis, system identification);
- Industrial controls;
- smart and micro-grid system optimization
- Economic Evaluation of Renewable Energy Technologies;
- Inter-State Energy Trade Policy;
- Utilities Management;
- Energy environment;
- Energy benchmarking;
- Energy pricing.

4.3.4.2 Energy Utility Corporation Limited (EUCL) Training Centre

This is a training centre held by the public company in charge of providing energy utility services in the country through operations and maintenance of existing generation plants, transmission and distribution networks, and retail of electricity to end-users. In executing its mandate, the company strives to achieve capacity development programs for staff.

EUCL organizes training for its staff, at which they are often joined by staff from private companies. Private companies testify that this centre contributes to upgrading their knowledge and know-how in specific fields of energy in which they are trained.

4.4 Skills Gaps, Anticipated Skills Demand, and their Policy Interventions by 2030

4.4.1 Skills gap

In the context of this assignment, the issue of skills is to be understood holistically in the energy sector. Two main causes are the basis of the skills gap in the energy sector in Rwanda. Firstly, the problem of training in Higher Learning Institutions and Universities in Rwanda, which are qualified too theoretical, and secondly, it is an issue of developing expertise young people coming out of academic institutions who are on the job market, alongside the most experienced people.

Below is a graph reflecting the overall qualification needs of energy sector establishments in Rwanda.

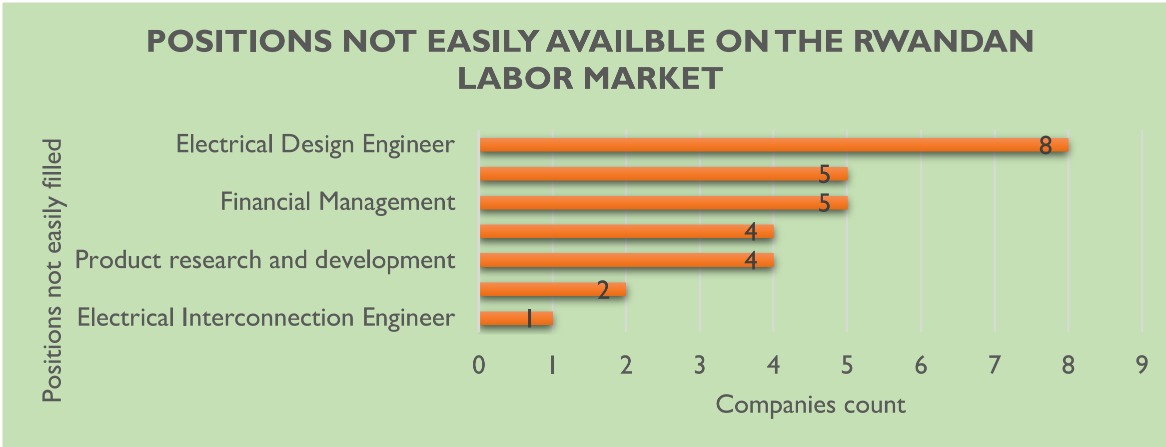

Figure 6: Scarcity of certain expertise in the Rwandan energy sector

Source: *Primary data*

According to the figure above, out of 29 responses received through the survey, 8 responses recognized electrical design engineer as a job position that is not easy to fill in the Rwanda labor market. Therefore, it is the most needed qualification in the Rwanda labor market, according to the survey. In addition, the survey ranked the job positions of project manager and financial manager in the second place, and those of electric power engineer and product research and development in the third place as being difficult to fill in the Rwanda labor market.

An electrical design engineer is the rarest qualification needed in the Rwanda labor market for the energy sector. Its responsibilities include developing new electrical systems for a variety of applications, conducting research on system ideas and drawing up plans for these systems, typically using a computer program, and developing system specifications and layouts. As the core business of this job is related to research and thus to the modernization of electrical systems, the establishments operating in the energy sector are less competitive in terms of innovation and modernization due to shortage of Electrical design engineers.

According to the USA Bureau of Labour Statistics (BLS), the employment growth rate for electrical design engineers' projections was to be 7% between 2016 and 2026 around the world. The ever-changing world of technology and the increasing use of electronic devices, along with the growing use of automated production equipment, are believed to be the main reasons for this expected growth rate[41]. As a key job in the energy sector, electrical design engineers in Rwanda, like in other countries around the world, must obtain numerous qualifications in this field, with a plan to provide them with ongoing training to be better equipped with the following skills to be more effective:

- Communication Skills;

[41] https://www.jobhero.com/job.../electrical-engineering/design-engineer

- Organizational, leadership, and creative skills;
- Designing and laying out new electrical systems;
- Creating system models and simulations;
- Testing new systems and marketing design changes if needed;
- Producing necessary designs reports and documentation;
- Assisting in the manufacture of new electrical systems.

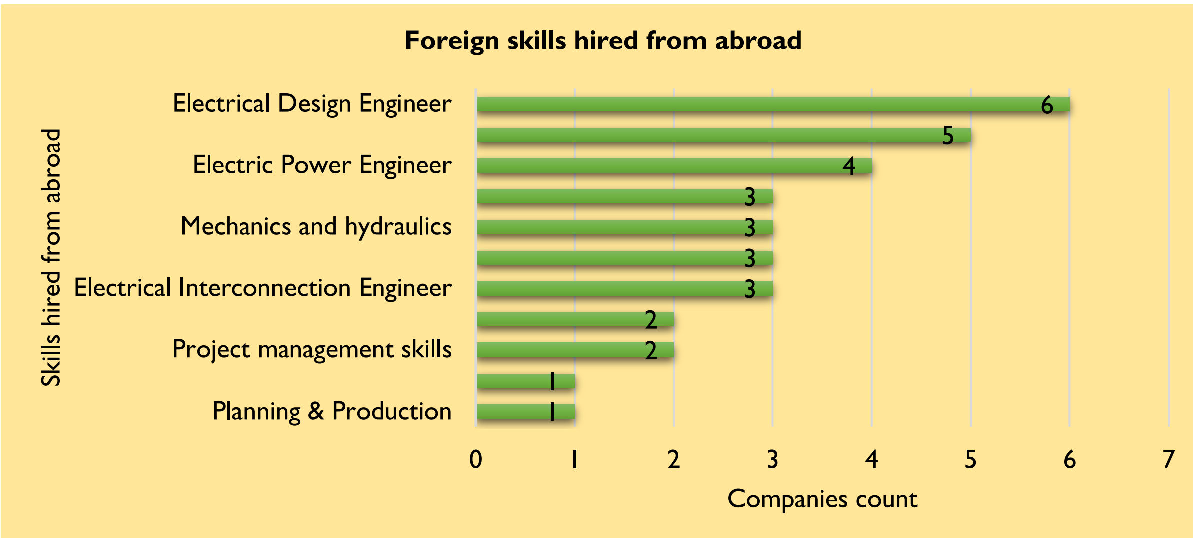

Figure 7: Foreign Skills Hired from Abroad

A previous figure shows that all of the 11 skills listed are recruited abroad by establishments operating in the energy sector in Rwanda but different proportions. The most sought-after expertise abroad is first of all that of an Electrical Design Engineer, followed by expertise in the ability to dismantle and assemble machines, and thirdly, that of an Electrical Engineer. The 3 expertise were identified as being in high demand outside Rwanda, but, it should be highlighted that, through interviews, an engineer in charge of a micro-hydroelectric power station in a remote area revealed to the consultant that during the construction of the plant, the contracting company hired a specialist welder directly from Austria, as there was no qualified welder in the country to do the work.

4.4.2 Anticipated Skills Demand, and their Policy Interventions by 2030

Except for organizational skills, which received 6 choices, the other soft skills obtained 1 to 2 choices out of 56 answers. Technical skills are the most requested in occupations.

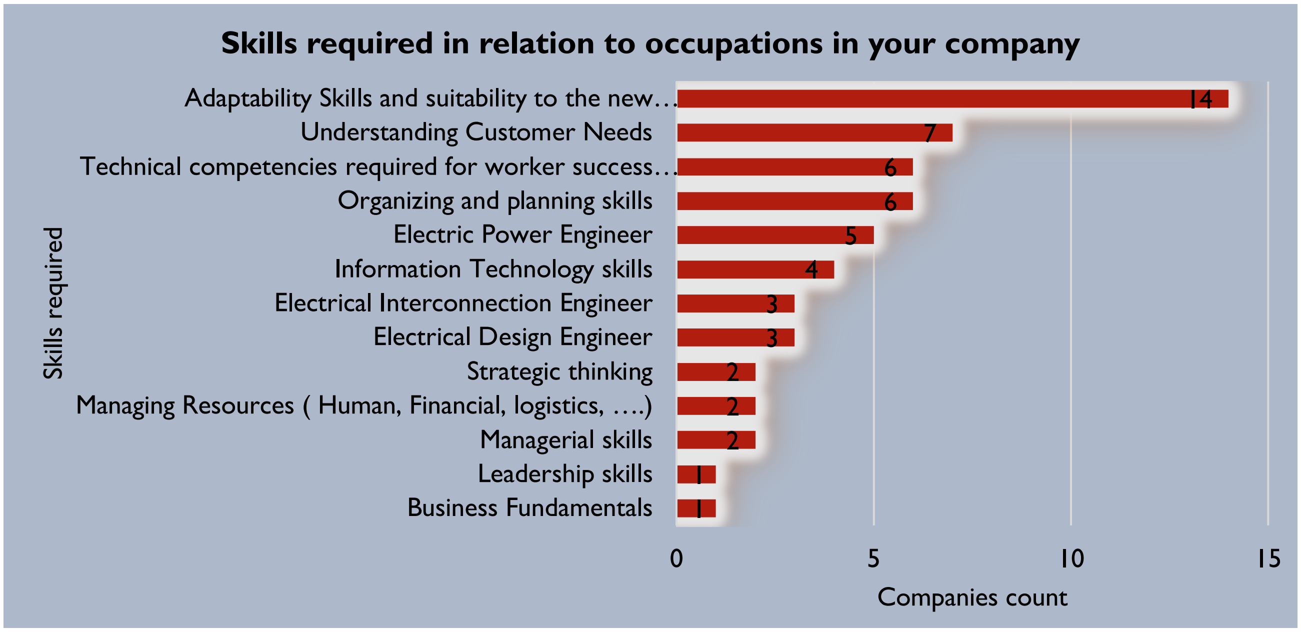

Figure 8: Skills required for occupations in energy establishments

***Source**: Primary data*

Adaptability and suitability skills to the new technological trends are some of the key skills that allow an establishment to be competitive in the medium and long term. It enables a company to fit into the technical and scientific dynamics that shape the evolution of the sector while also anticipating its own. The privileged choice of these skills is encouraging, and even reassuring for the Rwandan energy sector because it testifies to the existence of visionary entrepreneurship. By analysing skills required by occupations and how they follow each other by priorities, the first 4 skills are Conceptual skills related to strategic management allow that establishment to be more competitive. On the other hand, in the figure below, it was found that the skills that require the hiring of expertise from another country are mainly technical skills, which are scarce in Rwanda. Both categories of skills are needed by establishments for their performance. Likely measurable, technical skills are also easily identifiable.

The skills needed by establishments in the energy sector were assessed against the skills desired to be S- Mark and HACCP certified.

Here bellow in order of importance the skills, once available, establishments can both be S-Mark and HACCP certified and, also, help them to improve their management, planning process, and the planning implementation:

1. Safety and health skills
2. Competence in quality control
3. Product processing skills
4. Regulatory compliance skills

5. Production design
6. Marketing skills
7. designer of electrical engineers
8. Engineer in Electrical Interconnection
9. Managerial skills
10. Organizing and planning skills

However, the ten skill areas mentioned above are global and can be confused with qualifications and knowledge, which are in fact presumptions of skills. It is important to identify the skills needed for each qualification to equip the workforce with the know-how that leads them to real skills. Below are the skills that qualifications and knowledge holders need to be part of a skilled workforce.

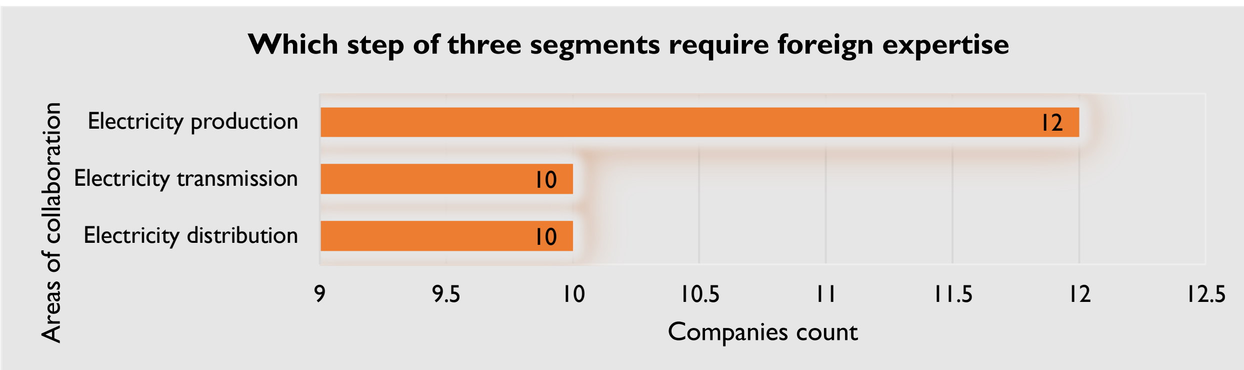

Figure 9: Foreigner expertise per segment in Rwanda energy sector

***Source**: Primary data*

According to the figures above, there is more foreign expertise in electricity production than in electricity supply. The presence of the foreign labor force in the energy sector is distributed among the three segments or sub-sectors of energy, but with predominance in the production of energy. Their importance is remarkable during the construction of the power plants and the installation of a photovoltaic power plant. In principle, when a foreign company is contracted to provide machinery for power plants, they are consecutively contracted to build the power plant, so the contracted company comes with its expatriate staff from abroad, only because the staff is familiar with its technology.

Table 8: Skills required per group of skills

N°	Group of skills	Specific skills
1	Safety and Health skills	Identifying Hidden Hazards Verbal Hazard Communication Convincing Presentations Providing Training Budgeting Knowledge of Regulatory Organizations How to Pass Inspections Gathering & Interpreting Data Accountability
2	Quality control Skills	Ability to understand, interpret, and communicate with data Looking Toward the Future Mastering sated Procedures Product Quality Quality Checks Communication Laboratory Procedures Safety Standards Quality Standards
3	Product processing skills	Agile model Lean model for software development Waterfall model Iterative model Spiral model DevOps methodology
4	Regulatory compliance skills	Regulatory Agencies Internal Controls ISO Risk Assessments Regulatory Submissions Government Regulations
5	Marketing skills	Data-driven marketing Data analytics Writing and Editing Skills Email Marketing Skills Social Media Skills Paid Social Media Advertising Skills

N°	Group of skills	Specific skills
		Basic Design Skills Mobile Marketing Data visualization Campaign management Content creation and storytelling Omnichannel Communication Digital Advertising Creativity
6	Electrical Design Engineer	Project Management Engineering Design Autodesk AutoCAD MATLAB Programmable Logic Controllers/Automation Project Management Engineering Design Electronic Troubleshooting Test Engineering C, C++, VHDL, and HDL Programming Languages
7	Electrical Interconnection Engineer	Electrical Systems Hardware Analog Control Systems Electrical Design SKM Other Skills
8	Managerial skills	Technical skills, Conceptual skills and Human or interpersonal management skills.

4.5 Main barriers to the closing skills gaps

In the context of this assignment, the issue of skills is to be understood holistically in the energy sector, both through knowledge acquired from learning institutions and expertise developed in the job environment alongside the most experienced people.

4.5.1 Higher learning education system

As higher and university education is organized today, it offers fewer opportunities for students and trainees to familiarize themselves with the workplace. Students do not have enough opportunities to learn from the professional environment and, therefore, not enough opportunities to acquire practical knowledge, develop adequate actions to perform specific tasks, and assimilate the rigor of respect for protocols for performing professional tasks.

In Rwanda, technician engineers in electricity, electronics, civil engineering, renewable energy, and other technical fields are trained in the IPRCs. While engineers in electricity, electromechanics engineers, civil engineering, IT engineers, economics, and other qualified people, employed in the energy sector, are trained at universities located in Rwanda, including UR.

The IPRCs train their students for three years, and it is in the third year that students do 8 weeks of internship to learn about the professional environment. For technical and professional training that requires practical know-how in the field, 8 weeks out of three years is not enough. An alternative education between training in school and working in a company would allow students to come out of the academic environment with both, enough theoretical knowledge, know-how, and a love for the profession.

4.5.2 Expertise development of young graduates

The expertise of young employees is developing alongside that of the more experienced. Also, the expertise is developed through continuing training organized by training institutions in the country or abroad. Il shall be recognized that the private investment in the energy sector is not old enough in Rwanda, and, the energy sector itself was not developed about the number of MW distributed in the country. As result, the sector was poor in terms of skills, at opportunities to learn alongside highlighting experience professionals have long been limited. Furthermore, the interaction between the IPRCs, for the continuous training of establishment personnel, is not sufficiently developed to update levels regularly about technological developments.

CHAPTER FIVE: SECTOR SKILLS RESPONSE TO ADDRESS THE IDENTIFIED SKILLS GAP

5.1 Proposed Ways to Bridge the Skills Gaps

There are several skills needed to bridge the skills gap faced by one or by all three segments. In addition, there are some occupations with difficulties in getting skills, which oblige them to resort to expatriates.

Table 9: Skills needed

N°	Occupation	Skills
1	Energy Development	Electrical Design Engineer
		Ability to dismantle and assemble a machine
		Electric Power Engineer
2	Energy Transmission	Electricity Transmission and Distribution Management skills
		Automation Drives
		Network development skills
		Network planning and strategy techniques
3	Machine maintenance	Operations and Maintenance techniques
		Solar Thermal Repair Technician
		Solar thermal repair skills

5.1.1 Future Skills for Key Occupations in Energy Sector

By 2030, Rwanda will have to invest in renewable energy, in this case, green energy, which is indeed solar energy and wind energy, without ignoring hydroelectricity. For its competitiveness in 2030, through the Public-Private Partnership Program, the energy sector must assert itself through the mastery of green energy.

The energy skills that Rwanda needs in 2030 are what will allow its private sector to have the knowledge and know-how related to the process of solar energy production, ranging from the manufacture of equipment to electricity generation. That said, the manufacture of key solar energy equipment must be considered in Rwanda, particularly the manufacture of solar panels and solar batteries for the efficient storage of electricity.

The projection of skills that the sector will need in the future should not be limited to the installation of materials but should extend to the manufacture of certain materials. It is also on this condition that the energy sector in Rwanda can dream of its real competitiveness.

Table 10: Projection of skills required by 2030

N°	Occupation	Skills
1	Energy Development	Mini-Grid Design
		Rural Hydropower Civil Engineering
		Electric Power Engineer
		Energy Management
		Energy Efficient Building Design
		Energy Auditing
		Wind Turbine
		Deep understanding of photovoltaic materials, equipment, and codes–particularly article 690 of the electrical code, which addresses safety procedures
2	Energy Transmission	Electricity Transmission and Distribution Management skills
		Automation Drives
		Network development skills
		Network planning and strategy techniques
		Gas transmission and distribution
		Town Gas Production and plant maintenance
		Town gas technical services
3	Machine maintenance	Operations and Maintenance techniques
		Solar Thermal Repair Technician
		Solar thermal repair skills
4	Manufacturing of Photovoltaic materials	Solar panels manufacturing
		Solar battery manufacturing

5.2 Energy Sector Benchmarking

5.2.1 Technology Situation

It means renewable energy technology in Rwanda is made up of five sub-technologies such as biomass, solar, peat, geothermal, and hydropower. Biomass is the most used and dominates both the demand and supply sides of the Rwandan economy. With many areas receiving abundant rainfall and most streams and rivers remaining untapped, micro-hydro power represents a significant potential for rural power supply. Solar irradiation is high - between 4-6 kWh/m2/day - but diffusion is hampered by the high initial cost and limitations on high load usage. Biogas is promising for thermal energy needs for farms and small institutions, especially considering many households that own cows and other livestock. The geothermal exploration in Rwanda is still at the geoscientific surface exploration stage. Gisenyi and Bugarama's prospects are given priority for locating sites for exploratory wells.

Currently, the total installed capacity to generate electricity in Rwanda is 218 MW, from more than 40 power plants, mainly hydro. Hydropower plants in Rwanda contributed about 101.062 Mw in 2018, or about 50 percent of Rwanda's energy use. An estimate of the potential for solar energy in Rwanda included the potential for on-grid and off-grid photovoltaic (PV) and concentrated solar power (CSP). The solar power plant in Rwanda contributed about 12.02 Mw. Most Rwandans live in rural areas where traditional biomass, mainly wood fuel, has remained the leading source of energy for cooking. The statistics show that biomass (mostly wood fuel) accounts for about 83% of the total energy consumed. Off-grid energy technologies are not connected to the national electricity grid and provide energy services to different households.

5.2.2 Hydropower Plant

Hydropower is the foremost energy resource in Rwanda utilized for power generation. The Hydropower Atlas has identified 70 hydro sites in the country with a combined capacity of 15 MW[42]. Over the last decade, Rwanda's hydropower sector has shown tremendous progress. The overall installed capacity of power is about 218 MW. Hydropower makes up approximately 46.3% of the total installed capacity. 21 hydropower plants are grid-connected and accountable for 101 MW. They include the national and shared regional power plants. The hydropower plants are either publicly owned and operated, leased to private companies, or privately owned (IPP). There are currently 11 off-grid micro-hydro power plants supplying isolated networks in Rwanda for a total capacity of 1.311 MW.

5.2.3 Peat to Power

A detailed study and assessment of peat bogs in Rwanda and their potential use as a source of fuel for power generation published in 2016 stated that from the 13,571-ha area studied, approximately 23 to 33 million dry tonnes of peat can be produced from an exploitable area of 4,057 ha. This peat can produce between 97 and 129 TWh for 30 years, at an estimated level of between 121 and 161 MW[43].

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[42] Robert NYAMVUMBA, Marcel GAKUBA, Expression of interest for Scaling Up Renewable Energy Program (SREP) financing for energy projects in Rwanda, April 2014.
[43] Idem

5.2.4 Geothermal energy resources

Rwanda's geothermal resource quantity estimation needs yet an extensive study to be proven. At this time, it shall be noted only that, studies have identified Karisimbi, Kinigi, and Gisenyi[44].

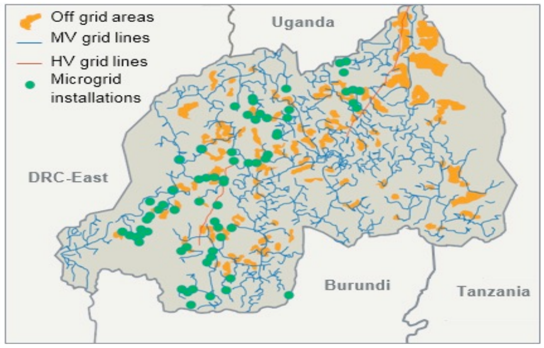

Figure 10: Current Microgrid Installations and Designated Off-Grid Areas

5.2.5 Solar Energy Technology

Energy from the sun is called solar energy, which means that solar energy is energy from sunlight. Solar energy is a type of renewable energy that will never run out and is sometimes called radiant energy. These are different kinds of radiant energy emitted by the sun. The most important ones are light, infrared rays, ultraviolet rays, and X-rays. Today, satellite data shows that the territory of Rwanda is in the global zone where the daily global radiation (annual average) is between 4 and 6 kWh/m2/day. The current average of solar radiation is about 4.5 kWh/m2/day for most of the country, and its sunshine time per day is 8 hours, which makes solar energy in Rwanda economically viable. The Government of Rwanda is targeting 100% electricity access by 2024 by promoting the use of renewable energy, mostly on-grid and off-grid solar PV systems. Two solar PV plants, namely GIGAWATT Global Solar Power (8.5 MW) and Jali Solar Power (0.25 MW) located in Rwamagana and Gasabo districts, respectively, are connected to the National Grid[45]. Households far away from the planned national grid coverage are encouraged to use solar photovoltaics (PVs) to reduce the cost of access to electricity. Rwanda's total on-grid installed solar energy is 12.08 MW.

5.2.6 Biomass Energy Technology

Biomass energy is the oldest energy source used by humans. Biomass is organic matter produced by plants, both terrestrial (those grown on land) and aquatic (those grown in water), and their derivatives. It includes forest crops and residues, crops grown especially for their energy content on energy farms, and animal manure.

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[44]: Towards universal energy access by 2020 in Rwanda, Ministry of Infrastructure, page 7

[45] http://www.rura.rw/index.php?id=67

Biomass can be burned for heating, cooking, and even generating electricity. The most common source of biomass energy is the burning of wood, but energy can also be generated by burning animal manure (dung), herbaceous plant material (non-wood), peat (partially decomposed plant and animal tissues), or converted biomass such as charcoal (wood that has been partially burned to produce a coal-like substance). Biomass can also be converted into a liquid biofuel such as ethanol or methanol. Biomass is also largely consumed for cooking, with wood being used by rural households and charcoal by urban households[46].

The use of modern bio-energy systems in Rwanda started with the promotion of institutional and domestic biogas technology whereby, as of June 2016, 10,216 households and 81 institutions (schools & prisons) were connected with biogas systems with the provision of cooking energy, lighting energy, quality fertilizer, and employment creation opportunities[47]. Biogas systems installed in schools and prisons have reduced firewood consumption by close to 60% and 40%, respectively, along with significantly improved hygienic conditions and cost savings. Currently, 11 out of 14 prisons use biogas for cooking. This has reduced the cost of cooking in prisons by 50% in comparison to using electricity[48].

Figure 11: Improved Cooking Stoves

***Source**: REG, 2019*

[46] http://www.mininfra.gov.rw/index.php?id=85
[47] http://www.rura.rw/index.php?id=67
[48] http://www.mininfra.gov.rw/index.php?id=85

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The future of the energy sector is determined by climate change, the scarcity of energy resources, and the increasing need for energy resources in different countries. The economic growth of a country calls for an increase in consumption with the possibility of hurting the environment.

To face these challenges, Rwanda, as an environmentally friendly country, is investing in renewable energies and green energy to adapt to the future. It is with this in mind that, in collaboration with the World Bank, Rwanda has set up the African Center of Excellence in Energy for Sustainable Development to develop the skills of its electricity specialists in renewable energy.

Rwanda's commitment to developing renewable energy has attracted investment in solar energy and the construction of mini-hydropower plants. Consequently, foreign expertise also follows these investments for the simple reason that they come to assemble the machines at the power stations or arrive as owners and managing directors. This increase in investments in renewable energy and also in non-renewable energy, has made this sector one where the expatriate workforce is growing. Through the "African Center of Excellence in Energy for Sustainable Development", Rwanda is giving itself the means by developing the skills of its youth in the field of energy in general and renewable energy in particular.

6.2 Recommendations

The implementation of the recommendations will be coordinated by PSF. To make the energy sector more competitive, the recommendations made are spread over three main periods:

Recommendations	
I. Short-term	
Activities/Actions	**Responsible**
♦ Set up a platform driven by the PSF for interaction between companies on the one hand and university educational institutions, IPRCs, and TVETs on the other hand, which allows both parties to collaborate permanently to rethink teaching systems that meet business expectations	Learning institutions and Establishments
♦ Encourage private companies to set up research and innovation units to help them constantly innovate	Establishments
II. Medium-term	
♦ Conduct advocacy requesting foreign private companies to put in place a mechanism of transferring technical knowledge and know-how to local staff	RDB
♦ Train electrical engineers in Mini-Grid Design	High Learning Institutions
♦ Train electrical engineers in Rural Hydropower Civil Engineering;	High Learning Institutions
♦ Train electrical engineers in automation Drives	High Learning Institutions
♦ Train electrical engineers in Network development skills.	High Learning Institutions
♦ Operations and Maintenance techniques of Photovoltaic materials	TVET
♦ Solar Thermal Repair Technician	TVET
♦ Solar thermal repair skills	TVET
III. Long-term	
♦ Gas transmission and distribution;	High Learning Institutions

Recommendations	
♦ Town Gas Production and plant maintenance	High Learning Institutions
♦ Town gas technical services.	High Learning Institutions
♦ Train in the design and manufacture of some of the components of solar energy such as solar panels regulators (PWM MPPT), batteries, as well as converters	High Learning Institutions

ANNEXES

Annex 1: Respondents to the Questionnaire

N°	Company	Respondent	Location	Sub Sector
1	DAVIS&SHIRTLIFF	Treasurer	City of Kigali/ Nyarugenge	Energy distribution
2	HALDI GROUP LTD	CEO	City of Kigali/ Gasabo	Energy Transmission, Energy distribution
3	GREAT LAKES Energy Ltd	Managing Director	City of Kigali/Kicukiro	Energy Production
4	CLEAN ENERGY TECHNOLOGIES LTD	MD	City of Kigali/ Gasabo	Energy Transmission, Energy distribution
5	DASSY ENTERPRISE	MD	City of Kigali/ Gasabo	Energy Transmission, Energy distribution
6	RECONS LTD	MD	City of Kigali/ Gasabo	Energy distribution
7	ZOLA ELECTRIC	HR	City of Kigali/	Energy Production, Energy distribution
8	ARC power	Manager	Eastern Province/ Bugesera	Energy distribution
9	Engine Mobisol Rwanda	HR&Admin	City of Kigali/ Gasabo	Energy distribution
10	Alpha cables	Manager	City of Kigali/ Gasabo	Energy Production
11	Centennial Power ltd	Head of Design and Construction	City of Kigali/ Gasabo	Energy Production
12	Serve and smile ltd	Manager	City of Kigali/ Gasabo	Energy Production
13	Nguuvu utilities Rwanda	Manager	City of Kigali/ Nyarugenge	Energy Production
14	Yet Rwanda	Manager	City of Kigali	Energy Production
15	JUL RWANDA LTD	MD	City of Kigali/ Gasabo	Energy Transmission, Energy distribution
16	ELV TECHNOLOGIES LTD	MD	City of Kigali/ Nyarugenge	Energy Transmission, Energy distribution
17	IGNITE POWER	Manager	City of Kigali/ Gasabo	Energy Production
18	NURU energy	HR	City of Kigali/ Nyarugenge	Energy distribution

N°	Company	Respondent	Location	Sub Sector
19	NGALI energy	Board member	City of Kigali/ Gasabo	Energy Production
20	PEAT ENERGY company	MD	City of Kigali/ Kicukiro	Energy Transmission, Energy distribution
21	Kazan hydroelectric ltd	MD	Northern/Rulindo	Energy Transmission, Energy distribution
22	Judy Energy Ltd	HR	City of Kigali/ Gasabo	Energy Production

Annex 2: Questionnaire Guide

Questionnaire for ONLINE SURVEY - Energy Sector

Target respondent: Managers, Directors, Company owners.
Instruction: No part of this questionnaire can be reproduced, stored in a retrieval system, or transmitted in any form or by any means -electronic, photocopying, or otherwise - without the consent of the information provider. All information provided herein will be treated confidentially and will solely serve the purpose of assessing skills gaps and desired skills that will enable PSF to strategically plan for the Sector in which the information holder company belongs.

SECTION I: ESTABLISHMENT DETAILS

1. Name of the Company:
   Response: ……………………………………………
2. Position in the company
   Response:
3. Province

☐ City of Kigali
☐ Eastern Province
☐ Northern Province
☐ Southern Province
☐ Western Province

4. District:

Your response…………………………………...

5. In which of the following sub-sector(s) does your company operate?
   ☐ Energy Production
   ☐ Energy Transmission
   ☐ Energy distribution

6. What is the size of your company? (Tick as appropriate)

☐ 1-3 employees (Micro size)

☐ 4-30 employees (Small size)

☐ 31-100 employees (Medium size)

☐ 100 + employees (Large)

7. What is the total workforce of your company?

Your Response: …………………………………...…………………….

7.a. How many managerial positions do you have in your company?

Your response: ………………………………………………………………

8. b. Out of the total workforce of the company, how many male staff do you have?

Your response: ………………………………………………………………

7.c. How many women hold a managerial position out of your total workforce?

Your Response: ……………………………………………………………………...

SECTION II: EXISTING SKILLS

9. Does the company have positions occupied by foreigners?

☐ Yes

☐ No

8.a. If yes, which categories of positions are not easily filled in the Rwandan labor market? Tick one or more?

☐ Financial Management

☐ Electric Power Engineer

☐ Electrical Interconnection Engineer

☐ Electrical Design Engineer

☐ Product research and development

☐ Project Manager

☐ Strategic Planning

☐ Other(s)

9. What are the most important occupational areas that the company that requires skilled/qualified personnel (e.g. Plumber, Electrician, bookkeeper, Seller, etc.)?

Occupational area	Qualified trade/occupational area?	Not Qualified trade/occupational area?
Electrician		
Plumber		

Mason		
Welder		
Dam Operator		
Maintenance technician		

10. As per Skills required about occupations in your company, please tick skills that need its level to be improved

- ☐ Understanding Customer Needs
- ☐ Information Technology skills
- ☐ Managerial skills
- ☐ Organizing and planning skills
- ☐ Managing Resources (Human, Financial, logistics, ….)
- ☐ Leadership skills
- ☐ Business Fundamentals
- ☐ Strategic thinking
- ☐ Adaptability Skills and suitability to the new technological trends
- ☐ Electric Power Engineer
- ☐ Electrical Interconnection Engineer
- ☐ Electrical Design Engineer
- ☐ Technical competencies required for worker success in the sector
- ☐ Others

SECTION III: REGULATORY STANDARDS

11. Tick one or more desired skills to meet S-Mark standards for the product certification requirement

- ☐ Product processing skills
- ☐ Production design
- ☐ Regulatory compliance skills
- ☐ Quality control
- ☐ Safety and Health skills
- ☐ Others:

11.a. What are the skills desired for the company to meet HACCP certification standards?

- ☐ Product processing skills

- ☐ Production design
- ☐ Regulatory compliance skills
- ☐ Quality control
- ☐ Safety and Health skills
- ☐ Documentation and records skills
- ☐ Compliance with HACCP principle
- ☐ Others:

SECTION IV: REQUIRED SKILLS

12. Does the company have a Medium or Long-term Business strategy?

- ☐ Yes
- ☐ No

12.a. If yes, does the company have sufficient skills to deliver on its Business strategies?

- ☐ Yes
- ☐ No

12.b. If no, tick one or more of the following skills that the company should acquire to implement its business strategies.

- ☐ Managerial skills
- ☐ Organizing and planning skills
- ☐ Marketing skills
- ☐ Strategic thinking skills
- ☐ Electrical Design Engineer
- ☐ Electric Power Engineer
- ☐ Electrical Interconnection Engineer
- ☐ Others:

TRAINING PROVIDERS

13. Does your establishment collaborate with skills providers operating in Rwanda (Universities, Higher learning institutions, TVET, etc) to ensure that skills suppliers meet skills demand?

- ☐ Yes
- ☐ No

13.a. If Yes, indicate one or more areas of collaboration listed below

- ☐ Sharing skills needs assessment
- ☐ Participating in curriculum development
- ☐ Receiving trainees in an internship
- ☐ Experienced staff serving as instructors in Training institutions
- ☐ Interaction with Training institutions on new technological trends
- ☐ Others

13.b. Does your establishment collaborate with skills providers from abroad?

- ☐ Yes
- ☐ No

13.c. If yes, in which area of skills development do you collaborate?

Response:

SECTION VI: SPECIFIC SKILLS ENERGY VALUE CHAIN

14. For more efficiency and rationality, Does the Rwanda energy sector need foreign expertise in the production, transmission, and distribution of electricity?

- ☐ Yes
- ☐ No

14.a. If yes, at which step of the three segments require foreign expertise

- ☐ Electricity production
- ☐ Electricity transmission
- ☐ Electricity distribution

15. What foreign skills are hired from abroad?

- ☐ Knowledge of electricity, mechanics, and hydraulics
- ☐ Ability to dismantle and assemble a machine
- ☐ Negotiation skills
- ☐ Electrical Design Engineer
- ☐ Team management skills
- ☐ Project management skills
- ☐ Welding skills
- ☐ Electrical Interconnection Engineer
- ☐ Electric Power Engineer
- ☐ Others

16. Why do recruiters target foreign expertise for the specific segment?

Response:

17. Is the technical loss of energy during transmission and distribution due to skill issues?

- ☐ Yes
- ☐ No

17.a. If yes, tick one or more skills (transmission and distribution) that needs improvement.

- ☐ Network planning and strategy techniques
- ☐ Network development skills
- ☐ Operations and Maintenance techniques
- ☐ Operations and Maintenance management skills
- ☐ Electricity Transmission and Distribution Management skills
- ☐ Others

18. What skills are required to distribute gas directly at homes in Rwandan towns and cities?

- ☐ Town Gas Productions and plant maintenance
- ☐ Gas systems and operations
- ☐ Gas transmission and distribution
- ☐ Town gas technical services

19. Does photovoltaic energy suffer because of poor skills?

- ☐ Yes
- ☐ No

19.a. If yes, tick one or more skills that need improvement

- ☐ Solar thermal repair skills
- ☐ Solar panel installer
- ☐ Solar Thermal Repair Technician
- ☐ Technician
- ☐ Others

20. Are the electrical materials produced by the company certified by RSB?

- ☐ Yes
- ☐ No

20.a. If no, tick one or more ample reasons to get an RSB standards certificate

- ☐ Lack of required skills
- ☐ Sub-standard equipment
- ☐ Lack of production process

☐ Others