RDB RWANDA DEVELOPMENT BOARD

RWANDA SKILLS SURVEY 2012

ENERGY SECTOR REPORT

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List of Acronyms

GOR	Government of Rwanda
HCID	Human Capital and Institutional Development
HLI	Higher learning Institutions
IPRC	Integrated Polytechnic Regional Center
KIST	Kigali Institute of Science & Technology
NCHE	National Council for Higher Education
NSIR	National Institute of Statistics Rwanda
NUR	National University of Rwanda
NUR	National University of Rwanda
RDB	Rwanda Development Board
TSS	Technical Secondary School
TVET	Technical Vocational Education and Training
VTC	Vocational Training Centers

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Executive Summary

This Report presents the findings of the skills survey of the Energy Sector Establishments in the Private Sector in Rwanda. The focus is on skills profiles, proficiencies, and gaps in the Energy Sector. The survey was commissioned by Rwanda Development Board as a national private sector skills survey targeting 8 priority sectors including ICT, Mining, Energy, Tourism, Manufacturing, Construction, Agriculture, Finance and Insurance. The survey was carried out in the five provinces in the country targeting large, medium, small and micro financial sector establishments in the Private Sector.

Principal Activities and Overall Labor Units in the Sector

The Energy sector in the private sector in Rwanda has 8 principal activities. The retail of water products accounted for 39% while production, transmission and distribution of electricity accounted for 16%; water collection, treatment and supply accounted for 13.2% and energy support services accounted for 7%. Other activities are sewage services, water collection, treatment & disposal.

The Energy establishments in the private sector had 1,668 labor units employed as Managers, Professionals (Engineers), Liberal Professionals, Technicians and Artisans.

The production, transmission and distribution sub-sector had a share of 24.8% labor units; retail of water products 20.4%, and water collection, treatment and supply 15.4% of the total labor units. Of the total employees women constituted 15.8% while expatriates accounted for 3.2%.

Skills Gaps: - The overall gap in energy establishments in the private sector was 408 in the short term, with the Liberal Professionals accounting for 40.9%, Technicians 34.8%, Artisans accounted for 11.3%, Managers 6.9% and the Scientific Professionals, mainly Engineers, accounted for 6.1% of the total skills gaps.

Supply of Skills by Training Institutions: - Currently, in Rwanda there are three categories of training institutions offering Energy courses which are HLIs, TSS and VTCs. It is estimated that between 2000 and 2011 these institutions enrolled 4,894 students. The enrolment has been dominated by HLIs at 67%, followed by TSS with 30%, and VTCs with 3%. Of the total 4,894 students enrolled, women constituted about 19%, while men were 81%.

The main training programs offered at KIST and NUR focus largely on preparing students for a BSc degree in Electrical & Electronic Engineering (Professionals). The programs from IPRC, TSS and VTCs prepare students for diploma and certificates in Electrical and Electronics Technology (Technicians and Artisans). The survey indicated that more Professionals (Graduates) are being produced in the energy sector than Technicians and Artisans - at the ratio of 3:1 annually. KIST alone enrolled 1,896 students including those enrolled on a part-time basis. The recently established IPRCs (Kicukiro) had an enrolment of 74 students in electrical technology in 2011.

There is a mismatch between the supply and demand of skills in the private sector. While training institutions in Rwanda tend to focus in the production of professionals, the private sector establishments require technicians and skilled artisans. There is urgent need to bridge the skills gaps to make the sector effective and efficient in

production in offering various services. To bridge the skills gaps in the Energy sector, the following recommendations are put forth.

a) Establishment Skills sector skills council that brings together employers, employee, training institutions and other stakeholders to address the skill shortage.
b) Enhance University-Industry Linkage-Initiate and enhance training institutions' partnerships and linkages
c) Mobilize funds for internships/attachments and innovations.
d) Enhancing qualitative skills among employees in the private establishment.
e) Launch and manage a national science congress competition to showcase talents and innovation in the energy sector
f) Develop a National Internship Policy.
g) Promote research, interest and skills development in renewable energy.
h) Promote and supporting more training programs for Energy Technicians.
i) Mobilize support for TSS and TVC.
j) Recruit motivating and Retaining Energy lecturers/trainers.

1.0 RWANDA ENERGY SECTOR

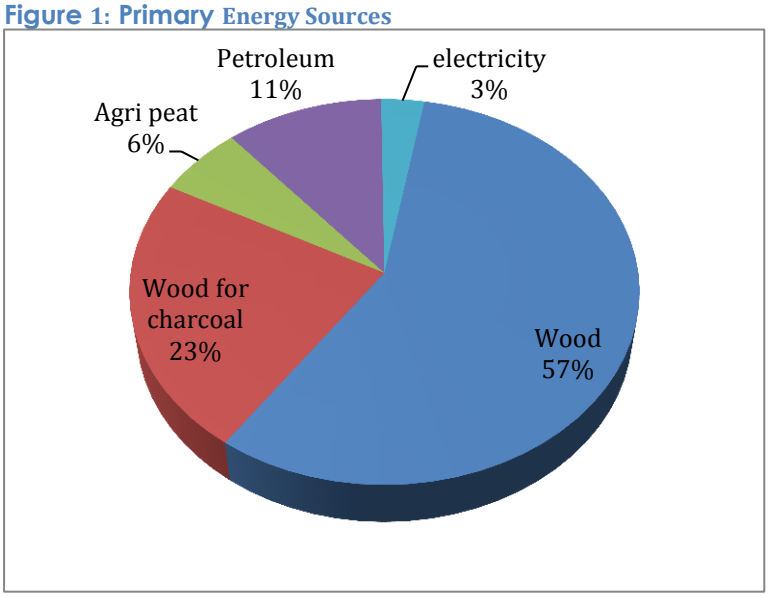
1.1 Sector Overview

The energy sector is key to Rwanda's development and modernization, thus the achievement of Vision 2020. Having enough, affordable, accessible and sustainable various sources of energy in Rwanda is strategic and is directly related to effective development of other priority sectors like ICT, Mining, Agriculture, Manufacturing and Construction and Finance.

By 2008, the total capacity of energy in Rwanda was 55 Mw. The target is to increase to 1,000 Mw by 2020. Industry and services (public and private) are currently the dominant users of electrical energy, accounting for over 60% of ELECTROGAZ sales, and are also major users of petroleum products. Over 75% of imported petroleum products are utilized in the transport sector. The electricity coverage of institutions providing social and administrative services was around 50 percent. There was also the establishment of the National Electrification Agency, which aims to increase affordability and access of power to rural households.

The Government of Rwanda (GoR) has developed a National Energy Policy and a National Energy strategy (Republic of Rwanda, 2009). The goal of the Energy Sub-sector is to ensure security of supplies by increasing domestic energy production from several sources including; hydro-electricity, methane gas, solar power, biomass and petroleum. The analysis of supply and demand of energy in Rwanda indicates that today approximately 86% of primary energy still comes from biomass, in the form of wood that is used directly as a fuel (57%) or is converted into charcoal (23%), together with smaller amounts of crop residues and peat (6%). Of the 14% of non-biomass primary energy[1], petroleum products account for 11% (used mainly in the transport sector) and electricity for approximately 3%. (Figure 1)

Figure 1: Primary Energy Sources



[1] Biomas Energy Strategy, 2008

The dominance of biomass energy in the sector is illustrated in the revenue it generates. The combined turnover of the wood and charcoal sectors (estimated at US$55 million and US$67 million or FRW 30 billion and FRW 36 billion respectively) was nearly double the electricity sales revenues of Electrogaz in 2007 (approximately US$65 million or FRW 35 billion).

GoR through the Ministry of Infrastructure has recognized and documented key challenges affecting the energy sector including increasing the production and access/use of energy. At present, the country has only about 55 MW of capacity, with per capita consumption of electricity being at a very low level of 20 kWh per capita per year. This compares with average per capita annual consumption of electricity in sub- Saharan Africa of 478 kWh, and for developing countries as a whole of 1,200 kWh per capita per annum[2].

The use of biomass energy has potentially serious environmental implications and will not be sustainable unless managed properly. About two thirds of the forest cover in the country has disappeared since the 1950s and although charcoal production is often blamed, there are many other factors such as land clearing for agriculture and habitation and the creation of tea plantations. Biomass energy will remain dominant for cooking and other household uses and in this regard it is imperative that forests and woodlots be more productively managed and charcoal more efficiently produced. Failure in this realm could result in further deforestation.

1.2 Key Energy Priorities and Energy

As articulated in the National Energy Policy and National Energy Strategy, 2009, the vision that guides future investment in the energy sector in Rwanda is to contribute effectively to the growth of the national economy and thereby improve the standard of living for the entire nation in a sustainable and environmentally sound manner. The mission of the energy sector is to create conditions for the provision of safe, reliable, efficient, cost-effective and environmentally appropriate energy services to households and to all economic sectors on a sustainable basis.

The goal of the Energy Sub-sector is to ensure security of supplies by increasing domestic energy production from several sources (hydro-electricity, methane gas, solar power, biomass and petroleum). To meet this goal, it aims to increase access to framework and institutional capacity of the energy sub-sector. Appropriate attention should be given to quality and continuity of electricity supply by improving the maintenance of generation and transmission equipment by fully trained staff.

The policy and strategy note that to achieve the rapid growth required in the energy sector, the private sector is expected to play a much greater role than in the past. The private sector has been integrated, as a major partner in the energy sector, at any and all levels of the energy supply industry, in particular: forestry, charcoal and peat projects; petroleum and geothermal exploration; petroleum products storage

[2] National Energy Policy and National Energy Strategy 2009

and distribution, methane projects -methane from Lake Kivu, urban landfill or other sources; large electricity generation projects; micro-hydro, solar PV and wind generation projects; small distribution grids; solar water heating; distribution and back-up service of household-level energy systems, including efficient and safe wood, charcoal, kerosene and LPG stoves and lights and energy efficiency initiatives.

The Ministry of Infrastructure, private sector, development partners and international contracted companies, guided by Rwanda National Energy Strategy 2008-2012, are collaborating in some key research and development projects in the energy sector. These include the following:

1. Biofuels: - Projects to producing biofuels from domestic resources. There are basically two main avenues which are currently being pursued:

- ***Ethanol,*** which can be used as a substitute for petrol or as a means of 'extending', imported petrol - this is derived from sugar or sugar-related by products.
- ***Biodiesel,*** which is produced from waste oils or from oil-rich crops such as oil palm, jatropha and pongamia.

2. Petroleum sub-sector: - Petroleum products used in Rwanda are currently all imported and this represents a considerable drain on Rwanda's foreign currency resources. The policy in the petroleum sector is:

- To ensure that ***oil exploration*** is carried out.
- Should oil or gas resources be identified, the necessary ***upstream developments*** necessary to exploit these resources will be actively pursued.
- The ***optimal degree of processing*** of crude will be carefully considered before any investment in refining capacity is considered.

3. Electricity sub-sector (additional hydroelectric, solar and wind power to the national grid)

The main policy aspects of the electricity sector are commitments in the following areas:

- Enhanced ***access*** to electricity, particularly in rural areas;
- reduction in the ***cost*** of electricity;
- ***diversification*** in sources of electricity supply;
- increased participation by the ***private sector*** in the electricity industry;
- enhanced ***regional cooperation*** in electricity to reduce overall costs and improve security of supply
- ***clarification of roles*** within public sector structures and development of ***skills*** in planning, procurement, and transactions' negotiation;
- development of the ***legal, institutional and financial framework*** for rapid development of the electricity sector.

4. New and renewable energies, including Methane Gas, Wind and Solar Energy

Government of Rwanda and private sector players are committed to exploit the available resource and develop a range of alternative energy sources, which hitherto have been relatively neglected. These include biomass alternatives (crop residues,

papyrus and typha), methane, peat, geothermal, solar and wind energy. The policy is

to:

- Proceed with further ***research and development*** of biogas, biofuels and technologies to utilize methane, peat, geothermal, solar and wind energy.
- Complement the technical side with investigations of ***the economic feasibility and social acceptability*** of using new and renewable forms of energy.
- Work with ***other countries and regional bodies*** so as to have research programs which complement one another, rather than duplicating efforts and wasting scarce resources available for these purposes.
- Provide economically justified ***feed-in tariffs*** (based on avoided costs of production to the utility but recognizing the potential availability of international credits for greenhouse gas reductions) or other mechanisms to give incentives and reduce risks for electricity production from renewable sources.
- Establish ***norms, codes of practice, guidelines and standards*** for new and renewable energy technologies.

Rwanda is pioneering research and development in methane extraction from Lake Kivu. Lake Kivu is estimated to contain 250 billion cubic meters of carbon dioxide and 55 billion cubic meters of methane gas, with a further 150 to 250 million cubic meters of methane being generated annually in the lake. The resource is shared equally between Rwanda and the Democratic Republic of the Congo (DRC).

The government-sponsored 4.5 MW methane gas pilot project in 2008, and the Rwandan Investment Group (RIG) developed another pilot project of 3.6 MW in 2009.Other private sector initiatives by several groups of local and foreign investors envisage projects of between 50 MW and 100 MW by each group, though the bigger projects may be developed in phases of 20-25 MW per phase.

With the above areas of focus in mind, what skills currently exist in the energy sector in the country? The following sections presents the survey and the findings on occupations, skills profiles and gaps in the private energy sector establishment in Rwanda.

2.0 CONTEXT OF THE SKILLS SURVERY

The Rwanda Development Board's (RDB) mandate is to promote private sector development though investment promotion. In order to attract the requisite investment, it's important to ensure that the country has the right quantity and quality do skills to support the emerging and growing industries. The Human Capital and Institutional Development (HCID) Department at RDB supports the private sector by developing mechanisms to ensure there is adequate and availability skills with the right quality. It is expected to address the human capital challenge both from an institutional and individual level, through sustainable interventions. Establishing and running such strategic interventions to fill skills gaps in the private sector requires evidence-based quantitative and qualitative data/information. HCID is committed to supporting interventions that would fill the potential gaps and reconcile both labor supply and demand in the private sector in Rwanda.

2.1 Rationale for the survey

Strategic and sustained investment in skills development requires credible and comprehensive labor market data and information in the private sector and training institutions. 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 (TVET and university institutions) and the labor market demand particularly in the priority sectors.

In addition, though RDB has a Labor 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 identifying the labor/skills challenges and opportunities the various sectors are facing/having. It is also not possible to conduct medium and long-term labor force forecasting for the various sub-sectors in the private sector. This is mainly because of lack of a series of cumulative credible data and limited use of robust methodological a approaches. This skills survey is a strategic start towards building a credible skills database for decision making and planning.

It is from the above context that RDB-HCID commissioned a national private sector skills survey targeting 8 priority sectors including ICT, Mining, Energy, Tourism, Manufacturing, Construction, Agriculture, Finance and Insurance. A regional consultancy firm OWN and Associates Limited, working with the HCID team, was commissioned to lead this strategic national skills survey in the private sector in Rwanda. The survey was launched in August 2011.

2.2 Objectives

This national skills survey targeted the Private Sector in Rwanda, with a focus on:

- Establishing a robust methodology for strengthening Labor Market Information System (LMIS) and conducting periodical labor market forecasting and manpower surveys.

- Collecting, collating and reconciling both labor supply and private sector labor demand: establishing sufficient quantitative and qualitative information to identify the potential skills gaps in the private sector.
- Providing RDB/HCID with comprehensive empirical data on the existing and/or projected human capacity gaps against which training /capacity development interventions and performance can be based, including sustainable and cost effective interventions such as internships, trainings, and scholarships.
- To conduct a SWOT analysis of respective private sector companies with respect to human capital covering individual, institutional and environment.
- Provide prioritized recommendations and an action plan that the government and other key stakeholders should undertake to address these gaps.

2.3 Design and Methodology

To carry out a comprehensive, credible and informative skills survey in the selected sub-sectors a rapid assessment methodology, applying qualitative and quantitative techniques was used. The survey was national and carried out on appropriately selected sectors in all the 5 provinces of the country, reflecting both the urban and rural settings. The research team worked with the National Institute of Statistics Rwanda (NISR) to get the right sampling framework and sample size for the skills survey. The NISR Establishment Census 2011 was used as a basis for the selection of the organisations to be visited during the study.

The key respondents during the survey were; employers (owners or/CEOs), employees, and representatives of academic departments of training institutions in Rwanda. The results of the "Establishment Census 2011" conducted by the Ministry of Public Service and Labor, Ministry Commerce and Industry, National Institute of Statistics Rwanda and the Private Sector Federation[3] were used as the framework to determine the sample sizes of the respective sectors for the National Skills Sector Survey.

Based on the Establishment Census 2011 data, NISR worked with the research core team and used a stratified sampling method to select the establishments for the survey across the country. The respondents were stratified using the following 3 criteria:

1. Sectorial activity,
2. Firm size,
3. Geographical location

The stratification by firm size divides the population of firms into a 4 strata as in the Establishment Census, 2011: i.e.

- Micro firms (1 Employee)
- Small Firms (2-3 Employees)

[3] *Republic of Rwanda. (June 2011). Establishment Census, 2011: Final Results. Kigali: Ministry of Public Service and Labor, Ministry of Commerce and Trade, National Institute of Statistics Rwanda, and Private Sector Federation.*

- Medium Firms (4-9Employees)
- Large Firms (10+Employees)

A geographical distribution is defined to reflect the distribution of the economic establishments across the country within the different provinces i.e. Kigali, Southern, Eastern, Northern and Western Provinces.

Sector activity was based on the eight (8) priority sector identified by RDB as part of the terms of reference.

2.4 Sampling framework

The sectors identified by RDB were categorized within the economic activities of the establishment census as shown in Table 2.1 below. Suing the formulae below the sample size was determined for each sector.

Using Yamane (1967:888) $n = \frac{N}{1 + N(e)^2}$

Where N is the population size

n- Sample size

e -level of precision: a precision of 5% was assumed for the skills sector surveys

Weights

To ensure that all sample estimates are reflective of the population parameters, weights for the different strata against the respective sample sizes have been tabulated. These have been reported in the respective sections. Weights have been computed using $w = n/N$, the reciprocal of which will be used to weight the sample results to get the overall population skills status magnitude. All weights have been incorporated in the databases.

Table 1: Sector Survey Sampling Framework

Sector*	Population**	Sample Size	Sample%
ICT (Information and Communication)	558	223	40
Energy	360	250	69
Mining	50	50	100
Construction	117	117	100
Tourism	33,305	476	1
Manufacturing	4,559	439	10
Agriculture	675	282	42
Finance & Insurance	970	330	34

This population is based on the NISR **Establishment Census, 2011 Report

2.5 Data collection

Through a collaborative process between the research core team, RDB and NSIR, a questionnaire was developed which had a core set of questions along with a series of sector specific modules which directly related to the footprints of each of the sectors. The core set of questions which examined generic recruitment issues, skills gaps, resources for training and future skills needs were drawn form to the international skill survey instruments.

For each of the sectors an individual set of questions (or modules) were developed which varied depending upon the priorities of that particular sector. The importance of such an approach was twofold. First, it allowed each of the sectors to gather specific workforce data on organizations which fell into their footprint. Second, it captured the duality of functions that employees often fulfill within private organizations and that would have otherwise not been captured through the more generic core questions.

Given the complexity of the questionnaire and the need to ensure that as many as possible establishments and training institutions within the sector were included in the research, focus groups and telephone interviews were deemed to be the most appropriate, manageable and cost effective method. The interviews were conducted by trained bilingual enumerators.

The number of respondents from the organizations and training institutions are shown in table 2. Experts from RDB HCID, sectoral department, and key stakeholders in each sector validated the survey instruments and were also involved in focus group discussion and/or interviews

Table 2: Sector Survey Respondents per Sector

Sector*	Establishments	Training institutions
ICT (Information and Communication)	211	31
Energy	243	31
Mining	41	31
Construction	83	33
Tourism	476	33
Manufacturing	439	33
Agriculture	310	19
Finance & Insurance	310	19

2.6 Report structure

While the surveys were conducted over three phases with at least 2 sectors being analyzed at a time, the reports have been developed separately for each of the eight sectors under review.

The following sections of this report present the **Energy sector** finding and recommendations.

The findings are divided into two parts.

Part 1 (Section 3) focuses on principal activities in the Energy establishments in Rwanda, as well as employment by categories of occupation (labor profiles), skills proficiency, skills gaps, and capacity building issues.

Part II (Section4) deals with supply of skills for the Energy sector (capacities of training institutions) including: courses offered, enrolment and output from HLIs, equipment/training facilities and academic staff.

Section 5 of the reports presents the implications of the findings and specific recommendations that need to be studied and implemented to bridge the skills gaps in the industry.

3.0 PART I: SKILLS INVENTORY IN THE ENERGY ESTABLISHMENTS

3.1 Energy Establishments by Principal Activities

A total of 243 establishments, representing 97% of the sample responded to the study, of which 39.1% of the establishments are located in Kigali City, 18.7% in Southern province, 17% in Eastern Province, 16.5% in Northern Province and 8.7% in Western Province (Table 3). The majority 83.8 per cent of the establishments were micro and small firms.

Table 3: Sample Characteristics of Energy Establishments

Region	%
Kigali	39.2
Northern	16.5
Western	8.7
Eastern	17.0
Southern	18.6
Total	100.0
Size	
Micro	66.2
Small	17.1
Medium	4.9
Large	11.4
Total	100.0

Table 4 presents the distribution of activities within the energy sector by principal activities. The retail of water products accounted for 39% while production, transmission and distribution of electricity accounted for 16%; water collection, treatment and supply accounted for 13.2% and energy support services accounted for 7%.

Table 4: Distribution of Establishments by Principal Activity

Principal Activity	Frequency	Percent
Production, transmission and distribution of Electricity	59	16.1
Manufacture and distribution of gaseous fuels	14	3.8
Energy Sector Support service activities	25	6.8
Water Collection, treatment and Supply	49	13.2
Sewage	6	1.7

Principal Activity	Frequency	Percent
Waste Collection, Treatment and Disposal Activities: Materials Recovery	7	1.8
Retail (selling/kiosk) of water products	144	38.9
Retail (Selling/Kiosk) of energy products	47	12.6
Other Energy related informal activities	19	5.1
Total	**370**	**100.0**

3.2 Employment by Sub-Sector and Firm Size

The sub-sectors in energy had a total work force of 1,668 of whom production, transmission and distribution sub-sector had a share of 24.8%; retail of water products 20.4% and water collection, treatment and supply 15.4%. The above subsectors were the major contributors in employment. Of the total employees, women constituted 15.8% while expatriates accounted for 3.2%. Table 5 gives employment data in absolute numbers.

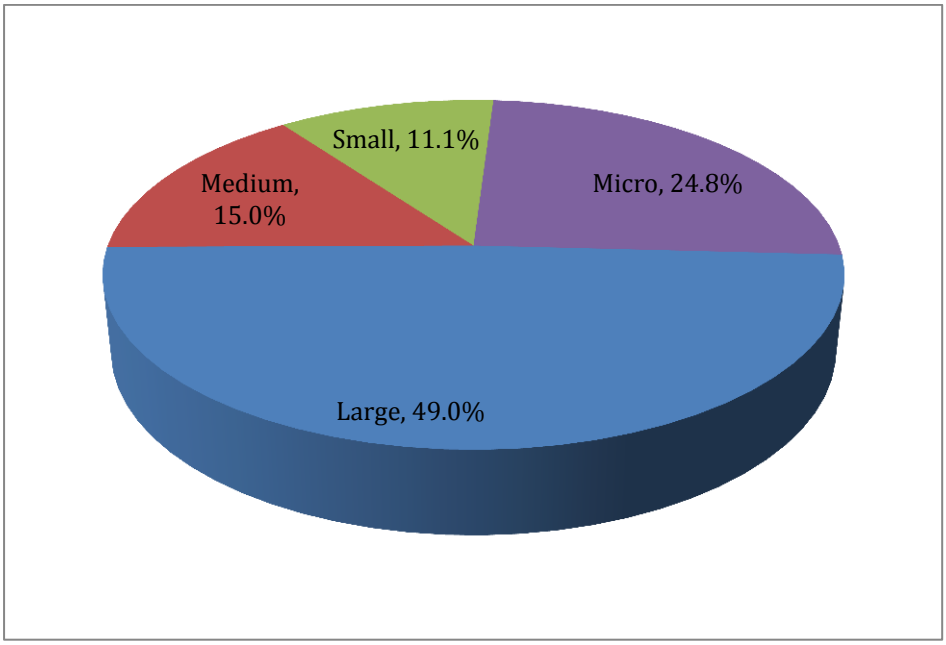
In all the sub-sectors except retail of water products large establishments were the main employers as is evident in Table 5. Overall large establishments accounted for 49.7% of total employment; micro 24.8%; medium 15.0% and small establishments 11.1% as depicted in Figure 5.2.

Table 5: Employment by Principal Activity by Firm Size

Sub-sector	Total Employment	Of whom Women	Of whom Expatriates
1. Production, transmission and distribution of electricity			
Large	316	51	7
Medium	9	1	-
Small	35	16	-
Micro	54	23	-
Sub total	**414**	**91**	**7**
2. Manufacture and Distribution of Gaseous Fuels			
Medium	65	-	-
Small	2	-	-
Micro	10	-	-
Sub total	**77**	-	-
3. Energy Sector Support Service Activities			
Large	191	19	10
Small	17	3	1
Micro	19	9	-
Sub total	**227**	**31**	**11**
4. Water Collection, Treatment and			

Sub-sector	Total Employment	Of whom Women	Of whom Expatriates
Supply			
Micro	65	8	3
Small	15	0	-
Medium	87	3	-
Large	108	8	1
Sub total	**257**	**37**	**4**
5. Sewage			
Large	26	5	-
Micro	8	3	-
Sub total	**34**	**8**	**-**
6. Water Treatment			
Large	63	2	-
Medium	24	4	5
Sub total	**87**	**6**	**5**
7. Retail of Water Products			
Large	70	12	14
Small	48	16	-
Micro	222	52	-
Sub- total	**340**	**80**	**14**
8. Retail of Energy Products			
Large	44	6	-
Medium	9	4	2
Small	22	5	-
Micro	35	4	-
Sub total	**110**	**19**	**2**
9. Other Energy Establishments			
Micro	20	-	14
Small	44	8	-
Medium	40	2	-
Sub- total	**104**	**10**	**14**
Grand Total	**1,668**	**264**	**53**

Figure 2: Distribution of Employment in Energy Sector by Size of Establishment



3.3 Distribution of Labor Force by Occupation

Classification of occupations by major groups is presented in Table 6[4]. Overall artisans were the majority in the energy sector accounting for 37.7% followed by technicians (21.3%) and managers (20.0%).

Table 6: Distribution of Employees by Major Classification

Classification	Existing Number	Percent
Managers	334	20.0
Energy Scientific professionals	119	7.2
Energy Technicians	355	21.3
Liberal professionals	231	13.8
Artisans	629	37.7
Total	1,668	100.0

Further in depth analysis for each occupation and the findings are presented as follows:

Managers: - Of the 334 managers 49 or 14.7% were women and 5 were expatriates.

[4] *Energy Scientists professionals are holders of degree and above. Technicians are holders of diploma and advanced certificates. Skilled Artisans are holders of certificates from technical and vocational training institutions.*

Scientific Professionals: - A breakdown of scientific professions indicated that out of 119 scientists, 43.7% were electrical engineers, 16.8% civil engineers, 15.1% mechanical engineers, 14.3% Environmental Protection Professional, and 1.7% environmental engineers. Analysis by gender show that 23.5% of the scientists were women and all of them were electrical engineers. The expatriates who accounted for 6.7.2% of the scientists were all electrical engineers. See Table 7.

Table 7: Distribution of Scientists by Occupation

Occupation	Existing Number	Women	Expatriates
Civil Engineers	20	0	0
Mechanical Engineers	18	0	0
Electrical/Electronic Engineers	52	24	8
Chemical Engineers	3	0	0
Environmental Engineers	2	0	0
Chemists	7	2	0
Environmental Protection Professionals	17	2	0
Total	119	28	8

Technicians: - In-depth analysis of technicians by occupation indicated that out of 355 technicians, electrical engineering technicians accounted for 38.6%, plumbers 14.4%, power production plant operators, 12.7% incinerator and water treatment plant operators 5.9% and chemical and physical land science technicians accounted for 4.2% (Table 8). Women employed as technicians accounted for 3.4% and were engaged as both electrical engineering technicians and plumbers. The expatriates accounted for 5.1% and all were electrical engineering technicians.

Table 8: Distribution of Technicians by Occupation

Occupation	Existing Number	Women	Expatriates
Physical and engineering science technicians	15	0	0
Chemical and physical science technicians	18	0	0
Civil Engineering Technicians	17	0	0
Electrical Engineering Technicians	137	6	18
Electronic Engineering Technicians	14	0	0
Mechanical Engineering Technicians	22	0	0
Chemical Engineering Technicians	10	0	0
Incinerator and Water Treatment Plant Operators	21	1	0
Power Production Plant Operators	45	0	0
Plumbers	51	5	0
Other Technicians	5	0	0
Total	**355**	**12**	**18**

Liberal Professionals: - Table 9 indicates that the Liberal professionals in the energy sub-sector were 231 of whom 34.2% were sales and marketing professionals, 25.5% finance professionals, 26.8% administration professionals and 5.6% ICT professionals. Women professionals accounted for approximately 28.6% with most of them being in finance. Expatriates accounted for 11.3% of the existing liberal professionals with majority (61.5%) being in sales and marketing.

Table 9: Distribution of Liberal Professionals by Occupation

Occupation	Existing Number	Women	Expatriates
Finance Professionals (Accountants, Financial analysts, Investment advisors)	59	26	1
Administration Professionals (management & org. analysts, HR)	62	21	6
Sales and Marketing Professionals	79	14	16
ICT Professionals	13	1	1
ICT Technicians	6	2	0
Other Liberal Professional (e.g. Lawyers , health workers, security, paralegals) – specify	12	2	2
Total	**231**	**66**	**26**

Artisans: - In this report artisans include support occupations plant operators and elementary occupations. Information collected show that there were 629 artisans of whom elementary occupations accounted for 38.6% followed by customer service occupations 26.1% and skilled artisans accounting for 22.6%. Women artisans accounted for 21.5% of the total artisans. Table 10 provides the details.

Table 10: Artisans by Occupation

Occupation	Existing Number	Women	Expatriates
Clerical Support Occupations (secretaries, clerks other office workers)	25	24	0
Customer service occupation (sales staff, retail cashiers, showroom attendants)	164	60	1
Skilled Craftsmen/Artisans/Tradesmen (electricians, mechanics, plumbers)	142	2	0
Plant Operators (incl. drivers, sorters, packers, drivers)	55	2	1
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, kitchen assistants)	243	45	0
Total	**629**	**133**	**2**

3.4 Distribution of Employment by size of Establishments and Sub-Sector

3.4.1 Production, transmission and Distribution of Electricity Sub-Sector

(a) Micro-Establishments

Table 11 shows that micro establishments had 64 employees with 29.7% being managers, 37.5% elementary workers and 14.1% electrical engineering technicians. Women accounted for 37.5% of the employees in the micro establishments, and again 37.5% of women worked as managers. There were no expatriates employed in the micro establishments.

Table 11: Distribution of Skills by Occupation in Micro Establishments

Occupations	Existing	Women
Managers	19	9
Electrical Engineering Technicians	9	3
Finance Professionals (Accountants, Financial analysts, Investment advisors)	3	0
Other Liberal Professionals	6	3
Clerical Support Occupations (secretaries, clerks other office workers)	3	6
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	24	3
Total	**64**	**24**

(b) Small Establishments: - The small establishments had 33 employees with 36.4% being managers and 33.3% elementary workers. Women accounted for 42.4% of the employee within the small establishments with 71.4% working as elementary workers and clerical support. There were no expatriates employed in the small establishments. Table 12 gives the details.

Table 12: Distribution by Occupation in Small Establishments

Occupation	Existing	Women
Managers	12	2
Finance Professionals (Accountants, Financial analysts, Investment advisors)	1	1
Clerical Support Occupations (secretaries, clerks other office workers)	6	4
Customer service occupation (sales staff, retail cashiers, showroom attendants)	1	1
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	2	0
Elementary occupations (unskilled workers,	11	6

messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)		
Total	**33**	**14**

(c) Medium Establishments: -Employees in medium establishments were 9 of whom 4 were electrical technicians; 4 were elementary occupations and one manager.

(d) Large establishments: - Table 13 indicates distribution of occupation in production, transmission and distribution sub-sector was 414 of whom 316 or 76.3% were in large establishments. Of the employees in large establishments 7.3% were managers; 32.6% were technicians and 13.6% were skilled craftsmen giving skills mix of one scientist to 39 technicians and 43 skilled artisans. Liberal professionals accounted for 12.9% of total employees in the subsector.

Table 13: Distribution of Skills in Production by Large Establishments

Occupations	Existing	Women	Expatriates
Managers	23	1	1
Mechanical Engineers	1	0	0
Physical and engineering science technicians	2	0	0
Chemical and physical science technicians	1	0	0
Civil Engineering Technicians	3	0	0
Electrical Engineering Technicians	21	0	0
Electronic Engineering Technicians	6	0	0
Mechanical Engineering Technicians	4	0	0
Chemical Engineering Technicians	2	0	0
Incinerator and Water Treatment Plant Operators	6	0	0
Power Production Plant Operators	27	0	0
Plumbers	26	2	0
Other Water Technicians	5	0	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	14	12	1
Administration Professionals (management & org. analysts, HR)	4	3	0
Sales and Marketing Professionals	4	1	0
ICT Professionals	8	1	1
Other Professionals	6	1	3
Business and Administration Associate Professionals (finance, HR, sales & marketing)	2	0	0
ICT Technicians	3	2	0
Clerical Support Occupations (secretaries, clerks other office workers)	3	3	0
Customer service occupation (sales staff, retail cashiers, showroom attendants)	20	12	1
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	43	0	0
Plant Operators (incl. drivers, sorters, packers, drivers)	29	0	0

Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	53	13	0
Total	**316**	**51**	**7**

3.4.2 Manufacture and distribution of gaseous fuels Sub-sector

The micro and small establishments in this sub-sector were run by 2 managers without any other cadre of staff. The medium establishments had 64 employees, 62.5% were in customer service occupation as presented in Table 14. There were no women and expatriates employees.

Table 14: Profiles by Occupation in Medium Establishments

Occupations	Existing employees
Managers	1
Electrical Engineering Technicians	1
Mechanical Engineering Technicians	2
Plumbers	1
Financial	4
Sales and Marketing Professionals	3
Customer service occupation (sales staff, retail cashiers, showroom attendants)	40
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	12
Total	**64**

3.4.3 Energy Sector Support service activities sub-sector

Total employment in the sub-sector was 227 employees of whom 84.1% were in large establishments; 7.5% in small and 8.4% in micro establishments. In the large establishments there were 4 (2.1%), managers; 29 (15.1%) engineers; 91 (47.6%) technicians, 57 (29.8%) liberal professionals and 10 (5.2%) skilled artisans as shown in Table 5.13 of the 191 employees in the large establishments 19 were women of whom 3 were electrical engineers and 11 in liberal professionals expatriates were 10 and all of them were sales and marketing professionals. See Table 15.

Table 15: Distribution of Skills by Occupation in Large Establishments

Occupations	Existing Number	Women	Expatriates
1. Managers	**4**	**0**	**0**
2. Energy Scientists Professionals			
Civil Engineers	2	0	0
Mechanical Engineers	6	0	0
Electrical Engineers	17	3	0
Electronic Engineers	2	0	0
Chemical Engineers	2	0	0
Sub-total Scientists	**29**	**3**	**0**

3. Technicians			
Electrical Engineering Technicians	71	0	0
Mechanical Engineering Technicians	16	0	0
Power Production Plant Operators	4	0	0
Sub-total Technicians	**91**	**0**	**0**
4. Liberal Professionals			
Finance Professionals (Accountants, Financial analysts, Investment advisors)	3	3	0
Administration Professionals (management &org. analysts, HR)	2	2	0
Sales and Marketing Professionals	6	6	10
ICT Professionals	2	0	0
Other Professionals (Lawyers, health workers)	44	0	0
Sub-total Technicians	**57**	**11**	**10**
5. Artisans			
Clerical Support Occupations (secretaries, clerks other office workers)	7	2	0
Customer service occupation (sales staff, retail cashiers, showroom attendants)	1	1	0
Plant Operators (incl. drivers, sorters, packers, drivers)	2	2	0
Sub-total Artisans	**10**	**5**	**0**
Overall Total	**191**	**19**	**10**

3.4.4 Water Collection, treatment and Supply subsector

There were 274 employees in this subsector with large firms having 38.7% of the employees followed by medium firms with 31.8% employees and small establishments had 5.5% employees. Women constituted 7.6% of the total employment. Details are as shown in Table 16.

Table 16: Distribution of Employees by size of Establishments

Size of Establishment	Existing	Women	Expatriates
Micro	66	9	3
Small	15	0	0
Medium	87	3	0
Large	106	9	1
Total	274	21	4

Micro Establishments: - Analysis by size show that out of 66 employees in micro establishments, managers constituted 25.8% of the employees; engineers 22.7% and liberal professionals 19.6%. Women accounted for 13.6% of the total employees while there were 3 expatriate managers as shown in Table 17.

Table 17: Skills Profiles by Occupation in Micro Establishments

Occupations	Existing	Women	Expatriates
Managers	17	2	3
Civil Engineers	3	0	0
Mechanical Engineers	8	0	0
Electrical /electronic Engineers	4	0	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	8	3	0
ICT Professionals	2	0	0
Liberal Professionals	3	0	0
Customer service occupation (sales staff, retail cashiers, showroom attendants)	3	0	0
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	18	4	0
Total	66	9	3

Small Establishments: - In the small establishments out of a total of 15 employees 26.7% were managers, 46.7% were engineers and 26.7% technicians. There were no women and expatriates employed.

Medium Establishments: - Table 18 gives employment data in medium enterprises. Analysis of the skills mix show the managers constituted 10..3% of the employees, engineers/chemists 25.2% and technicians 39.0% while skilled artisans accounted for 23%. There were only 3 women of whom one was a chemist and two were skilled artisans.

Table 18: Distribution of Skills by Occupation in Medium Establishments

Occupations	Existing	Women
Managers	9	0
Electrical Engineers	18	0
Environmental Engineers	1	0
Chemists	3	1
Physical and engineering science technicians	12	0
Civil Engineering Technicians	12	0
Incinerator and Water Treatment Plant Operators	1	0
Power Production Plant Operators	1	0
Plumbers	8	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	2	0
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	20	2
Total	**87**	**3**

Large Establishments Water Collection and Supply sub-sector: - Distribution of occupation in the large establishments of the sub- sector is presented in Table 3.17.

Managers' accounted for 4.7%, scientists 4.7%, technicians 19.6%, liberal professionals 4.7% and artisans 66.0%. The artisans who dominates the labor force constitute mainly skilled artisans, plant operators and elementary workers, for specific details, see table 19 below.

Table 19: Distribution of Occupation in Water Collection & Supply in Large Establishments

Occupations	Existing Numbers	Women	Expatriates
Managers	5	0	0
Chemical Engineers	1	0	0
Chemists	4	1	0
Physical and engineering science technicians	1	0	0
Electrical Engineering Technicians	3	0	0
Chemical Engineering Technicians	8	0	0
Incinerator and Water Treatment Plant Operators	5	1	0
Power Production Plant Operators	3	0	0
Plumbers	1	0	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	3	2	0
Administration Professionals (management & org. analysts, HR)	1	0	0
Sales and Marketing Professionals	1	0	1
Clerical Support Occupations (secretaries, clerks other office workers)	2	3	0
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	30	0	0
Plant Operators (incl. drivers, sorters, packers, drivers)	12	0	0
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	26	2	0
Total	**106**	**9**	**1**

3.4.5 Sewage Sub-sector

Sewage sub-sector had employees in micro and large establishments. In micro establishments there were 8 employees of whom 62.5% were managers and 37.5% were in elementary occupations. The large establishments had 27 employees of whom 18.5% were women as shown in Table 20. The employees were evenly spread in all occupations with water treatment plant operators and those in elementary occupations each contributing 18.5% of the total employees.

Table 20: Distribution of Skills by Occupation in Large Establishments

Occupations	Existing	women
Managers	2	0
Civil Engineers	1	0
Mechanical Engineers	1	0
Electrical Engineers	2	0
Environmental Engineers	1	0
Environmental Protection Professionals	1	0
Chemical and physical science technicians	2	0
Incinerator and Water Treatment Plant Operators	5	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	1	1
Sales and Marketing Professionals	1	1
Clerical Support Occupations (secretaries, clerks other office workers)	1	1
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	3	0
Plant Operators (incl. drivers, sorters, packers, drivers)	1	0
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	5	3
Total	**27**	**5**

3.4.6 Water Treatment sub-sector

In water treatment sub-sector there were 88 employees of whom 27.3% were in medium establishments and 72.7 in large establishments as shown in Tables 21 and 22. Of the employees in medium establishments 45.9% of the employees were in liberal professionals; 16.7% technicians and those in elementary occupations accounted for 25.0% with managers accounting for 8.3%. Women and expatriates accounted for 16.7% and 20.8% respectively.

Table 21: Distribution of Skills occupation in Water Treatment Medium Establishments

Occupations	Existing	women	Expatriates
Managers	2	1	0
Electrical Engineering Technicians	4	0	4
Finance Professionals (Accountants, Financial analysts, Investment advisors)	1	0	0
Administration Professionals (marketing &org. analysts, HR)	10	3	0
Plant Operators (incl. drivers, sorters, packers, drivers)	1	0	1
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	6	0	0
Total	**24**	**4**	**5**

In the large establishments managers accounted for 7.8%, technicians namely power production plant operators with other technicians accounting for 42.8%, elementary workers accounted for 34.4% of the labor force. Women accounted for 3.1% and they were all employed as finance professionals. Table 3.20 refers.

Table 22: Distribution of Skills by occupation in Water Treatment Large Establishments

Occupation	Existing	Women
Managers	5	0
Power Production Plant Operators	13	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	8	2
Administration Professionals (management & org. analysts, HR)	2	0
Other liberal associate professionals	14	0
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	22	0
Total	**64**	**2**

3.4.7 Retail of Water Products sub-sector

There were 341 employees involved in Retail of water products, 64.8% of whom worked in micro establishments, 14.7% worked in small establishments and 20.5% worked in large establishments. Women accounted for 22.9% of the total labor force whereas expatriates accounted for 4.1% of the labor force.

(a) Micro Establishments: - The micro establishments are the main employers employing 65% of the principal activity's labor force. Managers were the main employees in micro establishments accounting for 53.4% of the labor force, customer services occupations accounted for 26.7%, unskilled workers 13.1%. Women accounted for 23.4% with 72.5% of the women working as sales staff. There were no expatriates employed. This is presented in Table 23.

Table 23: Distribution of Skills by occupation in Micro Establishments

Occupations	Existing	Women
Managers	118	9
Electrical Engineering Technicians	3	0
Plumbers	7	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	3	0
Administration Professionals (management &org. analysts, HR)	3	0
Customer service occupation (sales staff, retail cashiers, showroom attendants)	59	37
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	29	5

Total	**221**	**51**

(b) Small Establishments: - In small establishments (Table 24) there were 50 employees with the managers accounting for 42%, technicians 26.0% and artisans accounted for 32%. All the artisans work as plumbers, and 20.8% worked as sales staff. Women accounted for 33.3% of the total labor force in the small establishments. Of women employees, 46.7% were managers. There were no expatriates employed in the small establishments.

Table 24: Distribution of Skills by Occupation in Small Establishments

Occupations	Existing	Women
Managers	21	7
Plumbers	13	2
Clerical Support Occupations (secretaries, clerks other office workers)	4	4
Customer service occupation (sales staff, retail cashiers, showroom attendants)	10	2
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	2	0
Total	**50**	**15**

Large Establishments in Water Retail (Kiosks): - Large establishments employed 75 staff of whom the managers accounted for 4%; scientific professionals 34.7% of the labor force, consisting of 24.0% working as environmental protection professionals and 10.7% as electrical engineers. Technicians accounted for 18.5% with 61.5% working as electronic engineering technicians. Artisans accounted for 37.3% of the total labor force in the large establishments, while women accounted for 14.7% and they were approximately evenly distributed between electrical engineers, environmental protection professions, finance professionals and elementary workers. Expatriates accounted for 12% with nearly all of them working as electrical engineers. Table 25 provides the details.

Table 25: Distribution of Skills by Occupation in Large Establishments

Occupations	Existing	women	Expatriates
Managers	3	0	0
Electrical Engineers	8	3	8
Environmental Protection Professionals	18	2	0
Electronic Engineering Technicians	8	0	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	2	2	0
Administration Professionals (management & org. analysts, HR)	8	2	1
Customer service occupation (sales staff, retail cashiers, showroom attendants)	2	0	0
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	6	0	0
Plant Operators (incl. drivers, sorters, packers,	9	0	0

drivers)			
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	11	2	0
Total	**75**	**11**	**9**

3.4.8 Retail of Energy Products

The retail of energy products sub-sector had 110 employees of whom 31.8% worked in micro establishments, 20% in small establishments, 8% in medium establishments and 40% in large establishments. Women accounted for 17% of the total labor force.

In micro establishments there were 35 employees with managers accounting for 60%, and custom service occupation accounting for 28.6%. Women accounted for 11% of the total labor force and there were no expatriates.

As for small establishments, there were 22 employees of whom 22.7% were women. Managers accounted for 40.9% of the workforce with skilled craftsmen accounting for 45.4%. Medium establishments had only 9 employees, of whom 44.4% were women and 22.2% were expatriates. All the managers and sales and marketing professionals were women.

The large establishments had 44 employees of whom 13.6% were managers 9.1% incinerator & water plant operators and 45.5% skilled artisans as shown in Table 26 Women accounted for 13.6% of the total labor force in the large establishments.

Table 26: Distribution of Skills by Occupation in Retail of Energy Products in Large Establishments

Occupations	Existing	Women
Managers	**6**	**2**
Incinerator and Water Treatment Plant Operators	4	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	2	0
Customer service occupation (sales staff, retail cashiers, showroom attendants)	8	4
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	20	0
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	4	0
Total	44	6

3.4.9 Other Informal Energy Establishments

This sub-sector had 20 employees in micro establishments, 44 in small and 40 in medium, giving total employment of 104. In the micro establishments there were only 6 managers and 14 technicians.

In the small establishments with 44 employees, the managers accounted for 16%, technicians 43.2%, artisans 40.9%. As for medium enterprises with 39 employees,

scientists accounted for 38.5%, technicians 30.8%, liberal professionals 23.1% and artisans 10.3%. Table 27 gives the details.

Table 27: Distribution of Skills by Occupation in Medium Establishments

Occupations	Existing	Women
Managers	1	0
Civil Engineers	13	0
Electrical Engineers	2	0
Chemical and physical science technicians	8	0
Electrical Engineering Technicians	1	0
Plumbers	1	0
Finance Professionals (Accountants, Financial analysts, Investment advisors)	4	0
Administration Professionals (management & org. analysts, HR)	5	0
Clerical Support Occupations (secretaries, clerks other office workers)	3	1
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	1	0
Total	**39**	**2**

3.5 Proficiency and Competency of the Employees in the Energy Sector

3.5.1 Proficiency in Professional and Technical Skills

Employers gave their rating on employees' proficiency in core skills as per the jobs assigned to them. Out of 1668 employees in energy sector, 1338 or 82.6% were rated as proficient and 17.4% were rated not proficient.

Table 5.26 indicates managers rating of employees' proficiency by occupation revealed that 7.0% of the managers were not proficient. Table 28 indicates the proficiency of scientific professionals. Overall 53.8% of the employees were proficient with all civil engineers and chemists having the highest ratings. Electronic engineers and environmental protection were all not proficient.

Table 28: Scientific Professionals' Proficiency

Occupation	Existing	Proficient Number	Percent Proficient
Civil Engineers	20	20	100.0
Mechanical Engineers	18	10	55.6
Electrical Engineers	47	25	53.2
Electronic Engineers	5	0	0.0
Chemical Engineers	3	1	33.3
Environmental Engineers	2	1	50.0
Chemists	7	7	100.0
Environmental Protection Professionals	17	0	0.0
Total	**119**	**64**	**53.8**

Technicians Proficiency: - Out of 355 technicians, 68.2% were reported proficient by the employers. The skill areas with the least proficiency were reported to be electronic engineering technicians with a proficiency of 14.3%, mechanical engineering technicians 18.2% and chemical technicians with a proficiency of 38.9% as shown in Table 29.

Table 29: Technicians' Proficiency

Occupation	Existing	Proficient No	Percent
Physical and engineering science technicians	15	13	86.7
Chemical and physical science technicians	18	7	38.9
Civil Engineering Technicians	17	12	70.6
Electrical Engineering Technicians	137	104	75.9
Electronic Engineering Technicians	14	2	14.3
Mechanical Engineering Technicians	22	4	18.2
Chemical Engineering Technicians	10	8	80.0
Incinerator and Water Treatment Plant Operators	21	21	100.0
Power Production Plant Operators	45	27	60.0
Plumbers	56	44	76.5
Total	355	242	68.2

Liberal Professional Proficiency: - Liberal proficiency had on average the lowest ranking in proficiency at 39.4% as indicated in Table 30. The skill areas of the least proficiency were identified as other liberal professionals, lawyers, sales and marketing professionals and finance professionals.

Table 30: Liberal Professionals' Proficiency

Occupation	**Existing**	**Proficient No**	Percent
Finance Professionals (Accountants, Financial analysts, Investment advisors)	59	41	69.5
Administration Professionals (management & org. analysts, HR)	62	19	30.6
Sales and Marketing Professionals	79	5	6.3
ICT Professionals	13	13	100.0
Business and Administration Associate Professionals (finance, HR, sales & marketing)	6	6	100.0
ICT Technicians	6	4	66.7
Other Liberal Professional (e.g. health workers, security, paralegals)	6	3	50.0
Total	**231**	**91**	**39.4**

Artisans Proficiency: - The overall proficiency of the artisans was reported to be 92.6% with clerical support occupations rendered to be the least proficient in the sector. The proportion was as low as 52%, included secretaries, clerks and other office workers. Of the Customer service occupations namely sales staff, retail cashiers approximately 20% were considered non proficient. The details are presented in Table 31

Table 31: Artisans' Proficiency

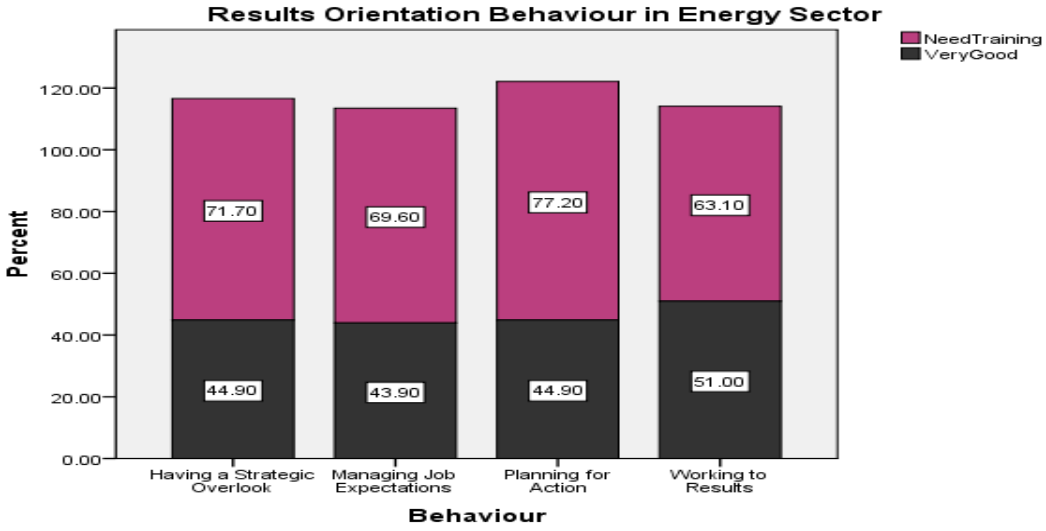
Occupation	Existing	Proficient No	Percent
Clerical Support Occupations (secretaries, clerks other office workers)	25	13	52
Customer service occupation (sales staff, retail cashiers, showroom attendants)	164	130	79.3
Skilled Craftsmen/Artisans/Tradesmen (electricians, carpenters, masons, motor mechanics, plumbers)	142	142	100
Plant Operators (incl. drivers, sorters, packers, drivers)	55	55	100
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	243	234	100
Total	**629**	**574**	**92.6**

3.6 Competency in Qualitative (Soft) Skills

Employees in the Energy sector were asked to assess their competencies in various qualitative 'soft' skills'. The employees who responded to the questionnaire were equally frank and indicated their competencies in various skills and expressed their desire to have training (See Figures 2-6).

The majority of employees, about 70 per cent, would like to be trained in result oriented behavior. And about 80 per cent would like to be trained in managing change

Figure 3: Results Orientation Skills in Energy Sector



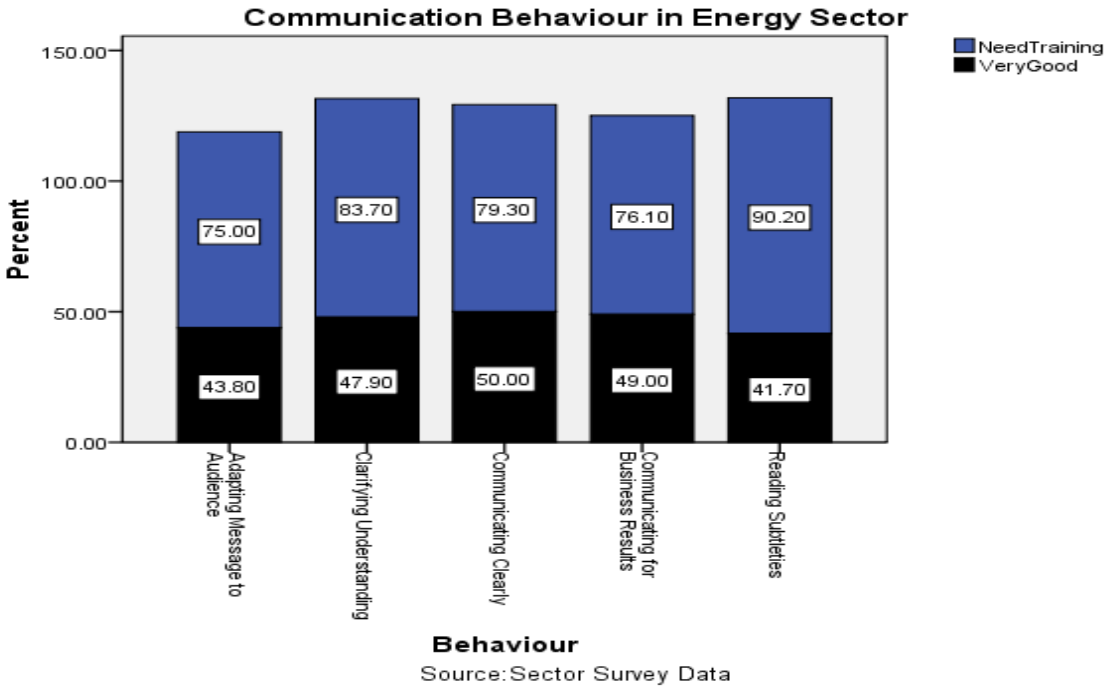
Source: Sector Survey Data

The proportion of employees in the sector who would like to be trained in problem solving, communication, and leadership is also very high.

Figure 4: Managing Change Skills in Energy Sector

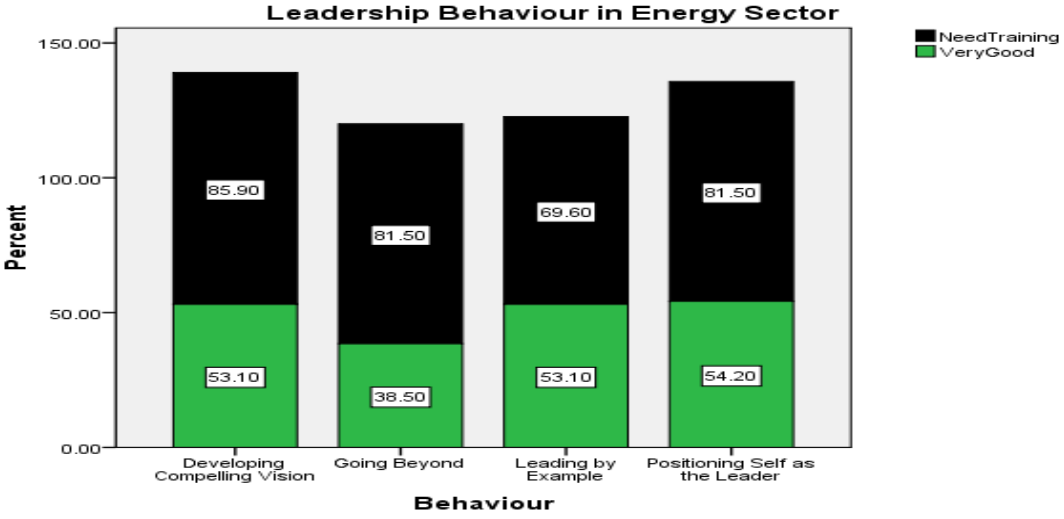
Figure 5: Problem Solving Skills in Energy Sector

Figure 6: Communication Skills in Energy



Source:Sector Survey Data

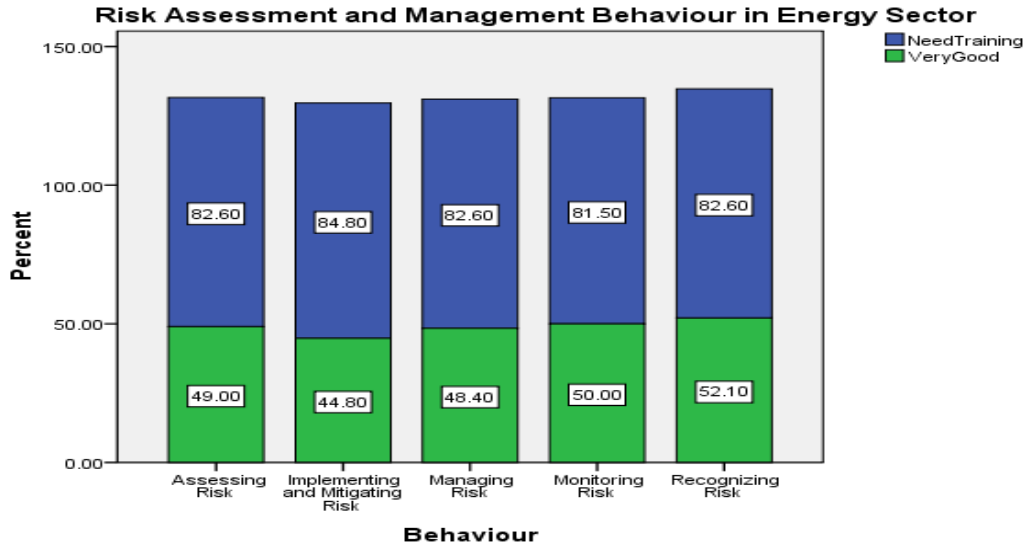
Figure 7: Leadership Skills in the Energy Sector



Source:Sector Survey Data

Just like in the mining sector, the proportion of employees in the energy sector who would like to be trained in risk assessment and management is also very high, indicated by over 80 per cent of those who responded to the questionnaire. This is explained by the fact that the energy sector has more risks to human beings and as a business. Such risks need to be effectively minimized and managed, thus a high need for training.

Figure 8: Risk Assessment &Management Skills in Energy Sector



Source:Sector Survey Data

3.7 Skills Mismatch and Training in energy Sector

Skills mismatch in the Energy Sector was analyzed based on the information provided by the employees on whether they were assigned the right job according to their qualifications. Table 32 indicates those who were not given the right job according to their qualification constituted 21.5% while 78.1% highly agreed/agreed that they were given the jobs in line with their qualification. Further analysis indicates that occupations with mismatch in the energy sector were customer attendants, 74.5%; electricians 10.9% and water technicians 9.1%

Table 32: Mismatch Proportion

Grading	Frequency	Percent
Highly Agree	1,065	65.4
Agree	201	12.3
Disagree	304	18.7
Highly Disagree	44	2.7
Didn't mention	14	0.9
Total	1,628	100

3.7.1 Training and Staff Development by Establishment

Training by existing establishments was not significantly part of the establishments' agenda in the energy sector, with only 10.4% of 369 establishments reporting to have trained in the 12 months prior to survey. The total number of trained employees was 698 accounting for 43.1% of the total employed lab units. On the Job specific training accounted for 68.7%, customer service 15.4% and IT User skills 4.6%.

Amongst all the existing establishments only 4.5% reported to have had a training budget as part of their establishments' budgets. This however amounted to 0.5% of the total budgets of these establishments

The main reasons given for not offering training by those who responded to the question was affordability, 27.1% reported inability to afford as the main reason for not training whereas 8.2% reported that they couldn't find relevant training that was needed and 7.2% stated that they had adequate skills. A large proportion of 54.2% of the establishments did not respond while 3.3% did not see the need for training because of high staff turnover.

3.7.2 Private Sector (Establishments') –Training Institutions Linkage

From the survey 89% of the establishments in energy sector reported that they don't take in interns, with only 11% accommodating interns in their work environments. The establishments that accommodated interns in the 12 months prior to the study had a total number of 215 interns with 36.7% being university students and 34.4% TVET students.

None of the existing establishments ever had a knowledge transfer partnership relationship with the academic institutions. However the establishments reported that the potential for acquiring new knowledge and technology exist. This is mainly from equipment suppliers, own research and development programs, engagement of local consultants and working with universities (Table 33).

Table 33: Potential Mechanisms of Acquiring New Knowledge & Technology

Acquisition Mechanisms	Important	Not important	Unknown
Own Research and Development	29.9	20.1	50.1
Parent Company/Joint Venture partners	21.8	20	58.3
Equipment suppliers	39.6	11.1	49.3
Foreign consultants	16.5	26.3	57.1
Local consultants	35.2	10.5	54.3
Foreign academic institutions	15.3	25.1	59.5
Rwanda academic institutions	16	25.5	58.4

3.8 Skills Gaps in Energy Sector

Out of 243 establishments covered, 3.3% or 12 establishments reported having 31 vacancies. These were mainly for laboratory technicians (16) and sales personnel (13). Accountants and electrical engineers had one vacancy each. The hard to fill vacancies were 3 of which 2 were for engineers in equipment making and had taken 12 months and one for an accountant. The reasons identified for the hard to fill vacancies were an attractive pay for the engineer in equipment making and under qualification by applicants for the accountants

3.8.1 Overall Gaps of the Sector

The overall gap in the sector was 408, with the liberal professionals accounting for 40.9%, and technicians 34.8% and artisans accounted for 11.3% (Table 34). Other occupations with the gap were managers 6.9% and the scientific professionals 6.1% and mainly they were engineers.

Table 34: Overall Sector Gaps

Classification	Numbers	Percent
Managers	28	6.9
Energy Scientists Professional	25	6.1
Technicians	142	34.8
Liberal	167	40.9
Artisans	46	11.3
Total	408	100

3.8.2 Gaps by Occupation levels

a) **Scientists Professionals**

Table 35 indicates the skills gaps among Energy Scientists professionals.

Table 35: Energy Scientists Professionals Gap

Occupation	Gaps
Mechanical Engineers	8
Electrical Engineers	9
Electronic Engineers	5
Chemical Engineers	2
Environmental Engineers	1
Total	**25**

b) Energy Technicians

Table 36 presents the gap for technicians. The overall gap in absolute number was 142with the electrical engineering technicians accounting for 33.1%, mechanical technicians 12.7% and chemical technicians and Plumbers each accounting for 7.7%.

Table 36: Energy Technicians' Gap

Occupation	Gaps
Physical and engineering science technicians	2
Chemical and physical science technicians	11
Civil Engineering Technicians	5
Electrical Engineering Technicians	47
Electronic Engineering Technicians	12
Mechanical Engineering Technicians	18

Chemical Engineering Technicians	2
Power Production Plant Operators	18
Laboratory Technicians	16
Plumbers	11
Total	**142**

c) Liberal professionals

The gap of the liberal professionals was 167, with the sales and marketing professionals accounting for 59.3% personnel, this was followed by associate professionals who accounted for 24% labor units and Finance professionals accounted for 12%. The gap of artisans was 46 personnel with customer support occupations accounting for 74% and clerical support accounting 26%.

Table 37: Liberal professionals Gap

Occupation	Gaps
Finance Professionals (Accountants, Financial analysts, Investment advisors)	20
Administration Professionals (mgt &org. analysts, HR)	3
Sales and Marketing Professionals	99
Lawyers	2
ICT Professionals	1
ICT Technicians	2
Other Technical/Associate Professional (e.g. health workers, security, paralegals etc.) – specify	40
Total	**167**

d) Artisans

The gap of artisans is 46 personnel with customer support occupations accounting for 74% labour units and clerical support accounting for 26% labour units. For details see table 38 below

Table 38: Artisans Gap

Occupation	Gaps
Clerical Support Occupations (secretaries, clerks other office workers)	12
Customer service occupation (sales staff, retail cashiers, showroom attendants)	34
Total	**46**

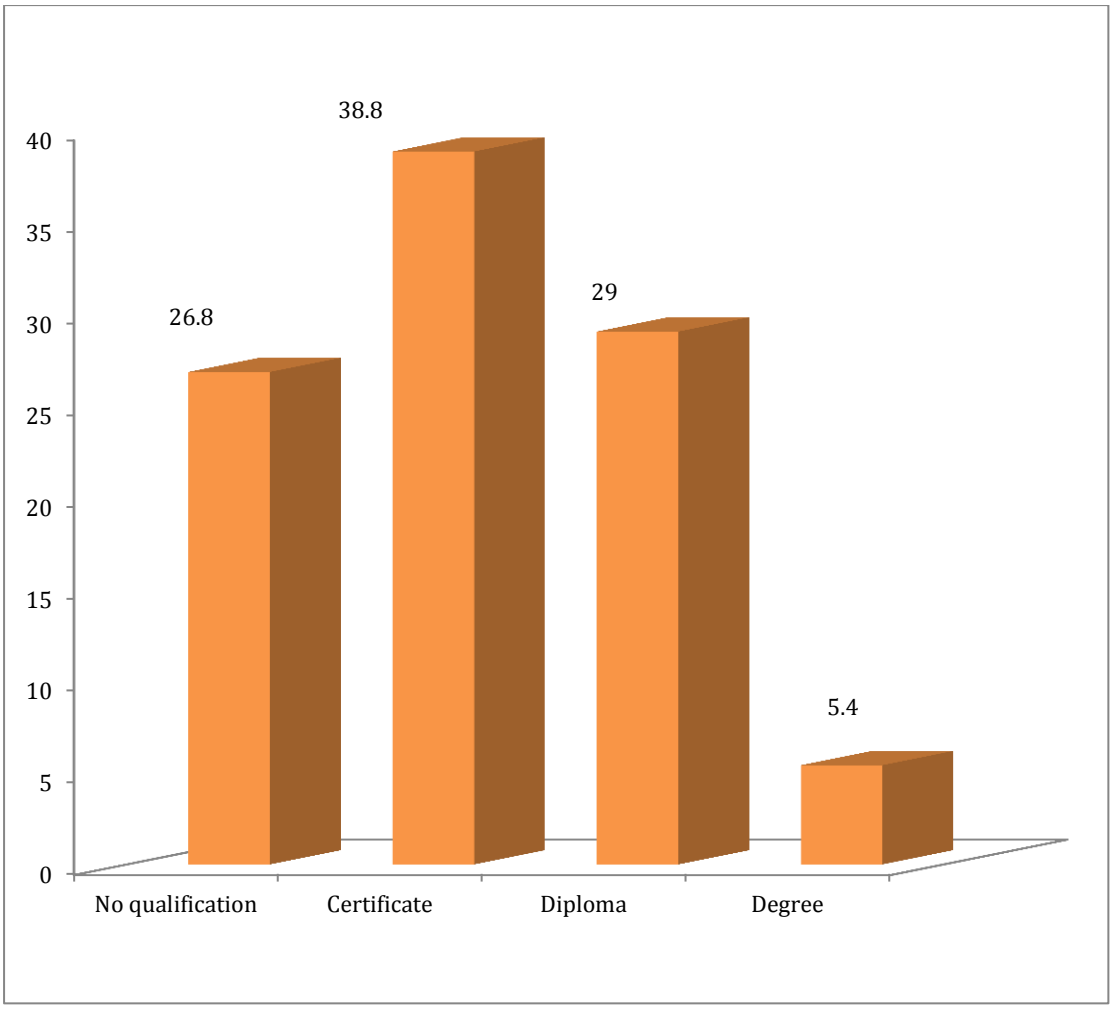
3.9 Employees by level of Education

Table 39 and Figure 8 show the actual job titles of employees in the energy sector who responded to the survey. The data show that on average 26.8% had no qualification; 38.8% had certificate level of education. Those with diploma and degrees constituted 29.0% and 5.4% respectively.

Table 39: Energy Employees Job Title & Qualifications

Energy Job Title	Professional Qualification			
	No qualification	Certificate	Diploma	Degree
Customer attendant	**59.2**	34.4	5.4	1.1
Electrical engineer				100.0
Electrician		45.9	54.1	
Electricity network technician			100.0	
Equipment maker		100.0		
Maintenance technician	16.7		66.7	16.7
Manager			20.0	80.0
Mechanic	16.7	50.0	16.7	16.7
Plumber	5.9	47.1	44.1	2.9
Water technician	5.0	50.0	35.0	10.0
Total	**26.8**	**38.8**	**29.0**	**5.4**

Figure 9: Distribution of Employees by Qualification in the Energy Sector



3.10 Earning in the Energy Sector

Information on earnings was inadequate as only 40% of the establishments responded while the other considered it confidential. A summary of the responses is presented in Table 40.

The highest earning of the sector are limited to managers and the professionals in the sector. The managers earn between RwF1, 000 and 900,000 with an average of 134,484. The scientists (Mechanical engineers, Electrical engineers and electronic Engineers) in this sector at the professional level earn between RWF150, 000 and 300,000 respectively. The technicians' earnings are between RWF86, 000 and 300,000 francs with an average of 170,000. The liberal staff namely lawyers, accountants to mention but a few earn between 70,000RWF and 400,000RWF. The lowest earnings in the sector are realized by the elementary and artisans who earn between 5000 RWF and 200,000RWF with an average of 75,650RWF per month.

Table 40: Earnings by Occupation

Function/Occupation	Lowest (RWF)	Maximum (RWF)	Average (RWF)
MANAGEMENT			
Managers (senior management excluding supervisors	1,000	900,000	134,484
Energy/Water &Sanitation Industry Professionals (University Graduates and/or equivalent Internationally Certified)			
Mechanical Engineers	300,000	300,000	300,000
Electrical Engineers	150,000	350,000	270,000
Electronic Engineers	300,000	-	-
Environmental Protection Professionals	400,000	450,000	400,000
Energy/Water& Sanitation Technicians/Associate Professionals			
Chemical and physical science technicians	130000	300,000	193,333
Electrical Engineering Technicians	100,000	300,000	180,714
Mechanical Engineering Technicians	150,000	200,000	190,000
Incinerator and Water Treatment Plant Operators	175,000	250,000	215,000
Power Production Plant Operators	86,000	200,000	234,000
Liberal Professionals			
Finance Professionals (Accountants, Financial analysts, Investment advisors)	70,000	350,000	206,470
Administration Professionals (management & org. analysts, HR)	150,000	300,000	210,909
Sales and Marketing Professionals	125,000	310,000	233,750
ICT Professionals	150,000	400,000	310,000
Artisans			
Clerical Support Occupations (secretaries, clerks other office workers)	50,000	190,000	143,000
Customer service occupation (sales staff, retail cashiers, showroom attendants)	15,000	100,000	36,222
Skilled Craftsmen/Artisans/Tradesmen	25,000	200,000	106,428

Function/Occupation	Lowest (RWF)	Maximum (RWF)	Average (RWF)
(electricians, carpenters, masons, motor mechanics, plumbers)			
Plant Operators (incl. drivers, sorters, packers, drivers)	40,000	150,000	81,642
Elementary occupations (unskilled workers, messengers, cleaners, gardeners, security guards, waiters, kitchen assistants)	5000	150,000	30,516

4.0 PART II: SUPPLY OF SKILLS – TRAINING INSTITUTIONS' CAPACITIES

4.1 Courses, Enrollment and Outputs

According to the National Energy Policy and Strategy in 2010, among the key areas of concern is that attention is to be paid to capacity building at all levels of the energy sector so that there are the human, computing and other resources necessary in the institutions for effective management.

4.1.1 Training Institutions

Currently, there are three categories of training institutions in Rwanda offering Energy courses. These are higher learning institutions (HLI's), Technical secondary schools (TSS) and Vocational training centers(VTC's) . It is estimated that between 2000 and 2011 these institutions enrolled 4,894 students. The enrolment has been dominated by HLIs at 67 per cent, followed by TSS with 30 per cent, and VTCs with 3 percent as shown in Table 4.1. Of the total enrolment of 4894 students, women constituted about 19 percent, while men were 81 percent.

4.1.2 Enrollment

The main training programs offered at KIST and NUR focus largely on preparing students for a BSc degree in Electrical and Electronic Engineering (professionals). The programs from IPRC, TSS and VTCs prepare students for diploma and certificates in electrical and electronics technology (technicians and artisans). The survey indicates that more professionals (graduates) are being produced in the energy sector than technicians and artisans by the Rwanda training centers, at the ratio of 3:1 annually. This trend that stretches over the last ten years is also reflected in Table 41. From the data that was available during the survey, KIST alone enrolled 1,896 students including those on part-time. The recently established IPRCs (Kicukiro) had an enrolment of 74 students in electrical technology in 2011.

Table 41: Enrolment by gender in energy in 2000-2011

Total number of enrollment in Energy by gender				
	INSTITUTION	MALE	FEMALE	Total
1	University	2,366	608	2,974
2	TSS	1,247	218	1,465
3	VTC	408	47	455
	Total	**4,021**	**873**	**4,894**

Table 42: Student enrolment in HLIs in the Energy Sector 2009-2011

Institution	Programme	2009			2010			2011			Grand Total
		M	F	T	M	F	T	M	F	T	
KIST	B Sc Electrical Engineering	451	114	**565**	472	134	**606**	433	140	**573**	**1744**
	B Sc Electrical Engineering (Part-time)	-	-	-	58	6	**66**	78	8	**86**	**152**
	Total			**565**			**672**			**659**	**1896**
NUR	Electrical and electronics Engineering	83	27	**110**	81	22	**103**	78	15	**93**	**306**
Grand total				**675**			**775**			**752**	**2,202**

4.1.3 Graduates in Energy Courses from HLIs

Table 43 below presents students who graduated from KIST and NUR in the energy sector at graduate levels between 2009 and 2011. Out of 339 graduates, NUR accounts for it accounted 71.4% of the graduates in electrical and power engineering and electronics and communication engineering, and KIST account for 28.6% of the graduates.

Table 43: Graduates in HLIs in the Energy Sector 2009-2011

Institution	Programme		2009			2010			2011		Total
		M	F	T	M	F	T	M	F	T	
KIST	B Sc Electrical Engineering	14	5	**19**	25	4	**29**	35	14	**49**	**97**
NUR	B Sc Electrical & Power Engineering	14	0	**14**	11	0	**11**	65	6	**71**	**96**
	B Sc Electronics & Communication Engineering	29	2	**31**	16	6	**22**	84	9	**93**	**146**
	Total										**339**

4.2 Infrastructure & training facilities

Forty one per cent of heads of departments who responded to the survey indicated that their training institutions have Energy laboratories, which they are using to train students, even though their numbers and facilities are not adequate in terms of student requirements. (Table 44)

Table 44: Availability of Energy Laboratory/Workshop by Institution

Existence of laboratories / workshops	Yes	No	Total
University Institutions	40.6%	59.1%	100.0%
IPRC	100.0%	-	100.0%
TSS and ETO	10.0%	90.0	100.0%
VTC	15.0%	85%	100.0%
Overall Percent	41.4%	58.6%	100.0%

Asked about the state of Energy laboratories, the heads of departments rated 30.0% and 65 per cent of the Energy labs as being s "excellent" and "good" respectively, while 5 per cent were rated "fair",. All categories of training institutions visited indicated that their energy laboratories and workshops were in good condition except universities as indicated in table 45.

Table 45: The State of Energy Course Training Workshops

State of Energy Workshops	Excellent	Good	Fair	Poor	Non-committal	Total
University Institutions	15.6%	30.0	54.4%	-	-	100.0 %
IPRC	33.3.%	66.7%	-	-	-	100.0 %
TSS and ETO	42.9%	42.9%	-	14.3%	-	100.0 %
VTC	20.0%	50.0%	20.0%		10.0%	100.0 %
Overall Percent	25.0%	45.0%	10.0%	5.0%	15.0%	100.0 %

Just like in training for ICT sector, as per international benchmarks, competence based technical training for professionals and technicians in the energy sector, requires that the student should have adequate supply of Standard Training Equipment/and machines to meet equipment-student ratio of 1:2 up to 1:4 between theory and practical application. Universities and IPRC with energy programs provided the most basic training equipment for the energy training programs. However, their quantity was inadequate in terms of equipment to student ratio.

On average, the present existing ratio is 1: 25 or 1: 30 and even more. And as a result of this, many of the available state-of-the-art equipment were shared by a big number of trainees if practical sessions are at all organized. Students therefore do not have enough time for effective hands on training. However, the biggest challenge facing TSS and VTC is lack of this Standard Training Equipment.

Figure 10: Standard Training Equipment for Power Generation Practical, Electrical Installation Tools & Measurement

The two examples below (Box 1 and Box 2) illustrate similarities and differences in the energy sector training in capacity, programs and facilities between institutions in Rwanda and others. From the two examples, the energy sector is quite wide, therefore requiring senior qualified academic and technical staff in the relevant areas. While the training institutions in Rwanda focus mainly on electrical, electronic and power engineering, the above programs go beyond these areas as energy and environment, solar, wind energy and biomass, geothermal energy, pollution control and others with study programs offered at undergraduate and postgraduate levels.

The programs are provided with matching facilities such as photovoltaic testing facilities, renewable/sustainable energy computer based simulation facilities, climate change weather file generation tools, building integrated PV arrays, monitoring facilities. In this regard, producing high quality energy professionals is really a very expensive undertaking.

Box 1: ENERGY TRAINING PROGRAMS AT STELLENBOSCH UNIVERSITY – SOUTH AFRICA.

DEPARTMENT OF SUSTAINABLE ENERGY

Academic staff with specialities in the following fields:

a) Solar Energy (Photovoltics and water heating)
b) Built Environment
c) Climate Change
d) Micro generation schemes
e) Wind Energy
f) Geothermal / gas turbine energy
g) Micro Hydropower
h) Biomass
i) fossil fuel (coal)
j) Pollution Control

Non administrative personnel

The following is an overview of key staff running the research programme

a) Vice rector research (prof) – 1 No.
b) Division for Research Development (31 No. Staff)

- Snr. and assist. Research and Innovation 2 No.
- Research Information and Strategy 7 No.
- Contract Research 6 No.
- International Funding and Capacity Building 7 No.
- Research Support 7 No.

c) Postgraduate and international office 34 No. Staff

- *Snr. Director*
- *Confucius Institute Stellenbosch University 2 No.*
- *Postgraduate & International enrollment 7 No.*
- *International Academic Networks 2 No*
- *IPSU, Exchanges, Study Abroad 11 No.*
- *Postgraduate funding 5 No.*
- *Welocmingcomitte 6 No..*

ACADEMIC PROGRAM:

Postgraduate Program

MSc's in Environmental Science and Sustainable Energy Technologies

with focus on the following areas

i) Energy, Environment and Buildings

This programme shall dwell with the interrelation between energy requirements, energy consumption, the environment we live in and the

buildings we use to offer solution to green building model as an end to energy conservation

ii) Electrical Power Engineering

The program shall focus on the following area

- Introduction to Energy Technologies
- Sustainable Energy Systems, Resources and Usage
- Power Systems Analysis
- Conventional Generation Technology
- Transmission and Distribution

iii) Energy Resources and Climate Change

The programme is to be offered in three distinctive modules specializing in:

- Bioenergy such as biogas, biofuels and any other renewable / recycled and other un-exploited biomass sources of energy (papyrus, typha, peat)
- Energy resources and
- the interaction between energy and the climate change agenda (carbon trading)

RESOURCES AND FACILITIES

- Building Integrated Photovoltic arrays
- Photovoltic Testing Facilities
- Accelerated Lifetime Testing Rig for Electric Connectors
- Renewable / sustainable energy Computer based simulation facility
- Hydropower - show water wheel and sedimentation models
- Geothermal / Methane
- Photovoltaic cells
- solar heaters
- wind energy generation
- Biofuels (biodiesel and ethanol)
- Biomass

Climate Change Weather File Generation Tools

- Tool compiled in house for generating regional climate change weather files for building performance simulation programs.

4.3 Academic staff

One of the biggest challenges facing all the training institutions visited is recruitment and retention of qualified academic staff, in the Energy sector in particular.

Training in the energy sector is dominated by the two leading public universities with an enrolment of 67 percent, while IPRCs, TSS and VTCs at 23 percent. Like the ICT sector, it faces the challenges of the quality of trainers, equipment/laboratories as well as staff student ratios. With regard to quality for example, one of the leading

university offers two Bachelor of Science degree programs, namely; Electrical Engineering and Electronics and Telecommunications Engineering, the latter being also offered as a part-time, evening programme with a total enrolment of 1,896 students. However, when it comes to staffing, it only has two members with doctoral degrees, one of whom is also an associate professor, 5 full-time and three part-time lecturers with Master's degrees and 13 assistant lecturers and tutorial fellows with Bachelor's degrees.

Table 46 indicates the situation of staff turnover in the training institutions visited. TSS and VTC are most affected due to low salaries and poor working environment. The high staff turnover can also be attributed to high demand of their specialized technical skills in the labor market.
Managements of universities and IPRC representatives indicated that senior qualified academic staffs in energy related programs are in high demand, especially in government agencies, with policy and regulatory mandate in the Energy sector. "The temptation of moving from university to such agencies is very high due to almost ten times salary difference."

Table 46: Status of Staff Turnover

Institution Type	Yes	No	Total
University and Institutions	27.3%	72.7%	100.0%
IPRC	16.7%	83.3%	100.0%
TSS and ETO	80.0%	20.0%	100.0%
Overall Percent	36.4%	63.6%	100.0%

Box 2: ENERGY TRAINING PROGRAMMES AT UNIVERSITY OF SOUTHAMPTON, UK

The school offers both undergraduate and postgraduate studies with emphasis on research on sustainable energy.
SERG (Sustainable Energy Research Group) established within the School of Civil Engineering and Environment undertakes studies in sustainable energy ranging from theoretical investigations o experimental research and field tests.

Core SERG team consists of 33 members who are faculty members at the UoS. The research team of various area of expertise are as follow
Photovoltaics- 3No. (2 Prof., 1 Doctorates)
Tidal Energy – 9 No. (3 Prof., 3 Dr., 3 MSc.)
Wave Energy – 8 No (2 Prof., 3 Drs., 3 MSc)
Built Environment – 7 No. (2 Prof. 3 Dr., 3 MSc)
Climate Change – 4 No. (1 Prof. 2 Dr., 1 MSc.)
Microgeneration – 4 No. (1 Prof. 4 Dr.)

Wind Energy - 5 No. (1 Prof., 3 Dr., 1 MSc.)
Micro Hydropower – 2 No. (Doctorate)
Pollution Control – 2No. *(1. Prof, 1.Doctorate)*

Undergraduate programme

UoS offers both Undergraduate and programme in the following fields of Energy sector
- B.Eng. Electrical Engineering
- B.Eng. Electromechanical Engineering
- M. Eng. Electrical Engineering
- M. Eng. Electromechanical Engineering

(M.Eng. Programme has same entry level as B.Eng. but runs for 4 years with emphasis on independent learning in years three and four and
Group design project in year four, to design and construct a product needed by industry)

Postgraduate Programme

MSc's in Environmental Science and Sustainable Energy Technologies
This is offered under Postgraduate programmes with the following options

Energy, Environment and Buildings

This programme aims to reflect the interrelation between energy requirements, energy consumption, the environment we live in and the buildings we use.

Electrical Power Engineering

The University of Southampton School of Electronics and Computer Science and Electrical Power Research Group will deliver the programme in Electrical Power Engineering. And shall focus on the following area

- Introduction to Energy Technologies
- Sustainable Energy Systems, Resources and Usage
- Power Systems Analysis
- Conventional Generation Technology
- Transmission and Distribution
- Energy Resources and Climate Change

This programme offers three distinctive modules specializing in bioenergy, energy resources and the interaction between energy and the climate change agenda

Building Integrated PV Arrays

A fully instrumented and configurable building integrated moncrystalline PV array of 7.2 kWp covering the south facade of Building 2 UoS
Facility for studies on multiple grids connected central and string inverters for analysis of mismatch losses in PV arrays including a range of inverters from 700 W to 5 kW.
Semi-transparent PV laminates in an array of 12.5 kWp on the atrium of the Professional Services Building

Photovoltaic Test Facilities

A 460 Wp, grid connected, fully instrumented and configurable roof tile mono-crystalline array.

Holographic Optical Element Test Facade

Test facade for performance analysis of light directing Holographic Optical Elements (HOE) elements.

Accelerated Lifetime Testing Rig for Electric Connectors

Life time testing rig for electrical reliability of connectors, including PV connectors.

Wave, Tidal and Hydropower Facilities

8m and 12.5m wave flumes with glass sides and floor, wave makers with active absorption.

21m and 14m tilting open channels, both with provision for studying sediment transport.

Water wheel test tank.

Marine Current Energy Converters

Developed testing procedures and modeling systems for Marine Current Energy Converters.

Prototypes of Marine Current Energy Converters.

Simulation Facilities

Various simulation tools for photovoltaic and solar thermal analysis as well as for system design. These tools are used to analyze PV performance.

Simulation tools for investigating thermal performance and lighting aspects in the built environment.

Performance and power simulation facilities for Marine Current Energy Converters.

Computer based modeling system of tidal currents.

In house micro-wind assessment tool.

Monitoring Facilities

High-resolution thermal imaging equipment.

Equipment for assessing indoor lighting performance.

High-speed velocity and turbulence measurement equipment for use in circulation water tanks.

Various environmental data analysis and data logging systems for the assessment of the indoor environment in buildings.

Climate Change Weather File Generation Tools

Tool compiled in house for generating UK climate change weather files for building performance simulation programs.

Tool compiled in house for generating worldwide climate change weather files for building performance simulation programs.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Implications of findings for Skills development

From the demand and supply side findings the skills gaps in the energy sector is dominated by liberal professionals 40.9% and technicians 34.8% whereas artisans, scientists and have a proportion of 11.3%, 6.1%, 6.9% respectively. The gap is concentrated in the large and medium enterprises. The implication is that there is need to graduate more professionals from the training institutions than technicians.

High student enrolment and a bulk of academic staff who are not fully qualified to teach at university level, does not reflect well on staff student ratios and therefore the quality of graduates for the energy sector in the country. The quality of the teaching staff is exacerbated by the state of infrastructure and equipment, which affect the quality of instruction and learning, in particular hands on lessons. Following admissions of relatively high numbers of students, most laboratories cannot adequately cope with such numbers of students. This contributes to overcrowding and continuous use of these facilities. It was noted that the electrical engineering disciplines lacked the necessary laboratories and state-of–the-art equipment as there has been no effort to rehabilitate or replace equipment provided when the institute was established.

The challenge with quality of the teaching staff, facilities and equipment the HLIs also pertains at the IPRCs, TSS and VTCs. Several official reports indicate that only 40 percent technical teachers are qualified to teach there. This underscore an urgent need for recruitment of new technical teachers coupled with training to upgrade the qualifications of many who are already in employment as well as addressing the problem or remuneration and related terms and conditions of service. There is also the need to ensure that teachers in technical institutions possess the required industrial exposure in order to offer effective practical skills. The number of technical teaching staff in many institutions is inadequate, considering that the teacher student ratio is already between 30:1 and 25:1 ratios as compared to the internationally recommended student/technical teacher ratio of 10:1 for technical education.

The area of facilities and equipment is also a major challenge. The physical facilities in most institutions have over the years experienced a significant dilapidation as a result of general neglect, vandalization and limited inspection and maintenance. In some cases the full range of physical facilities that ought to normally support such institutions are not in place. Such a situation applies to equipment as well. Most of the equipment has also over the years fallen into disuse and become obsolete.

The poor conditions of training in the institutions is worsened by the serious challenges in placing students for attachment due to competition from other institutions as well as a limited energy sector in the country which undoubtedly restricts hands-on preparation. Both students and the industries complain about the short duration of the attachment period which is inadequate to value to the training process.

5.2 Recommendations

Short Term Recommendations (1month -12 months)

1) **Establishment of Sectors Skills Councils (SSC's)**
   The Sector Skill Councils are national partnership organizations that will bring together all the stakeholders – industry, labour and the training providers, for the common purpose of workforce development within the industry sectors. The sectors will be key in developing qualifications standards to ensure that the quality of trainees in technical schools, higher learning institutions and professional development stages is relevant and globally competitive. The SSC's will also be the center mechanism for coordinating school to industry linkages that provide work based experiential learning for skills development.

2) **Enhancing University-Industry Linkage:**
   Creation and promotion of university-industry linkages for innovations and training should be initiated and supported. The government and energy sector stakeholders can mobilize funds for internships/attachments and innovations. Such funds should be accessed in a competitive manner by innovators and top-experts in ICT engineering, networking, programmers and cyber security experts in Rwanda. The facility should be used to mentor young innovators' curiosity and interest (as it happens in Uganda, Kenya, Egypt, South Africa, where private companies are funding training and incubation facilities at various training institutions mainly universities). The involvement of training institutions and the private sector in such a programme is critical.

3) **Enhancing Qualitative Skills among Employees in the Private Establishment:**
   Employees who responded to the survey indicated that they would like to be trained to enhance their capacities in 'soft' skills. Training programme should target the following: Communication skills, Leadership skills, Risk Management skills, Result Orientation skills, Business planning and development skills, and Innovations & Managing change skills.

4) **Initiating and Enhancing Training Institutions' Partnerships and Linkages**
   The survey established that there are very limited linkages between universities and Politechnics on one hand and Technical / Vocational institutions offering energy related courses. There is need to develop modalities of promoting partnerships and linkage among these training institutions. The training institutions should be linked and explore ways to establish incubation center and center for excellence in energy innovations – renewable energy in particular, and share the facilities and even teaching staff. Linkage programs will inspire trainees and make them learn from well-endowed universities and IPRCs.

5) **Launching and Managing a National Science Congress and Competition**
   Ministry of Education (MINEDUC), Local Government and industry players should organize National Science Congresses and Competitions from the districts to promote innovations and critical thinking in the energy sector and other related areas. The target should be both school primary and secondary students as well as young people in the SMEs establishment in ICT and Energy sectors. Each year

the congress should identify an innovative energy project from the district and fund it for further research and development. This is a perfect strategy of nurturing talent, innovation and knowledge transfer.

6) **Developing a National Internship Policy**
There are many uncoordinated internship/attachment programs in the public, private and civil society sectors. There is need for a focused Rwanda Internship Policy within the next 12 months. This will stream line internship programs and make students/trainees gain from them.

7) **Promoting research, interest and skills development in Renewable Energy**
The survey has established that there are some practical and viable energy projects at the national and district levels, biogas and solar energy. The support needed for educational tours and exchange programs nationally to expose and interest students and youths in SME in energy, water and sanitation programs and initiatives in the country cannot be over emphasized. Sector stakeholders should work with the Ministries of Natural Resources, Local government and Finance to promote the development and use of renewable energy like solar, biogas and wind.

5.9.2 Medium and Long Term Recommendations (13 months to 5 years)

1) **Promoting and supporting more training programs for Energy Technicians**
The training of personnel in the energy sector is heavily skewed towards the training of professionals (graduates) as opposed to the training of technicians and artisans, which the industry, SMEs in particular needs. There is need to increase the institutional capacities of IPRCs and VTC to train additional technicians and artisans.

2) **Mobilizing support for TSS and TVC**
Almost all the TSS and TVC visited have inadequate training equipment and facilities during the survey. There exist old and dilapidated workshops and laboratories for the Energy sector courses. There is need to support these training institutions, especially those located in the districts, with basic infrastructure and equipment. Each institution should have at least one state-of-the art equipped workshop/laboratory for them to offer meaningful skills development to many youths who long to become technicians or artisans in Energy Sector.

3) **Recruiting, motivating and Retaining Energy lecturers/trainers**
To ensure the production of high quality professionals (graduates) in the energy sector, the HLIs need to urgently address the challenge of the small numbers of qualified academic staff, especially at the doctoral and Master's levels as well as the intolerably high staff student ratios which impact on the quality of graduates being trained. The remuneration and working environment in all the training institutions need to be reviewed to make them attractive and motivating to qualified trainers from Rwanda and the region.

4) Enhancing partnerships and Attachment

Attachment/internship should be promoted as a means of skills development for ICT, Engineering and Energy sector students. There is urgent need to mobilize partners and resources to support many trainees, who are already enrolled in various institutions and have no enough funds and places to go for attachment. The following options should be considered:

- The Government should consider motivating private companies to participate in internship through industrial levies and/or tax rebates as it happens in Kenya.
- Establish and mobilize partners to establish Internship Fund. Establishments should apply for such funds on the basis of trainees they have offered internship.
- As is the practice in , Egypt, Tunisia and Ethiopia, identify top innovative and hardworking graduates and take them abroad for 4-6 months attachment in special specialized careers such as Electrical Engineering, energy projects engineering, carbon trading etc.