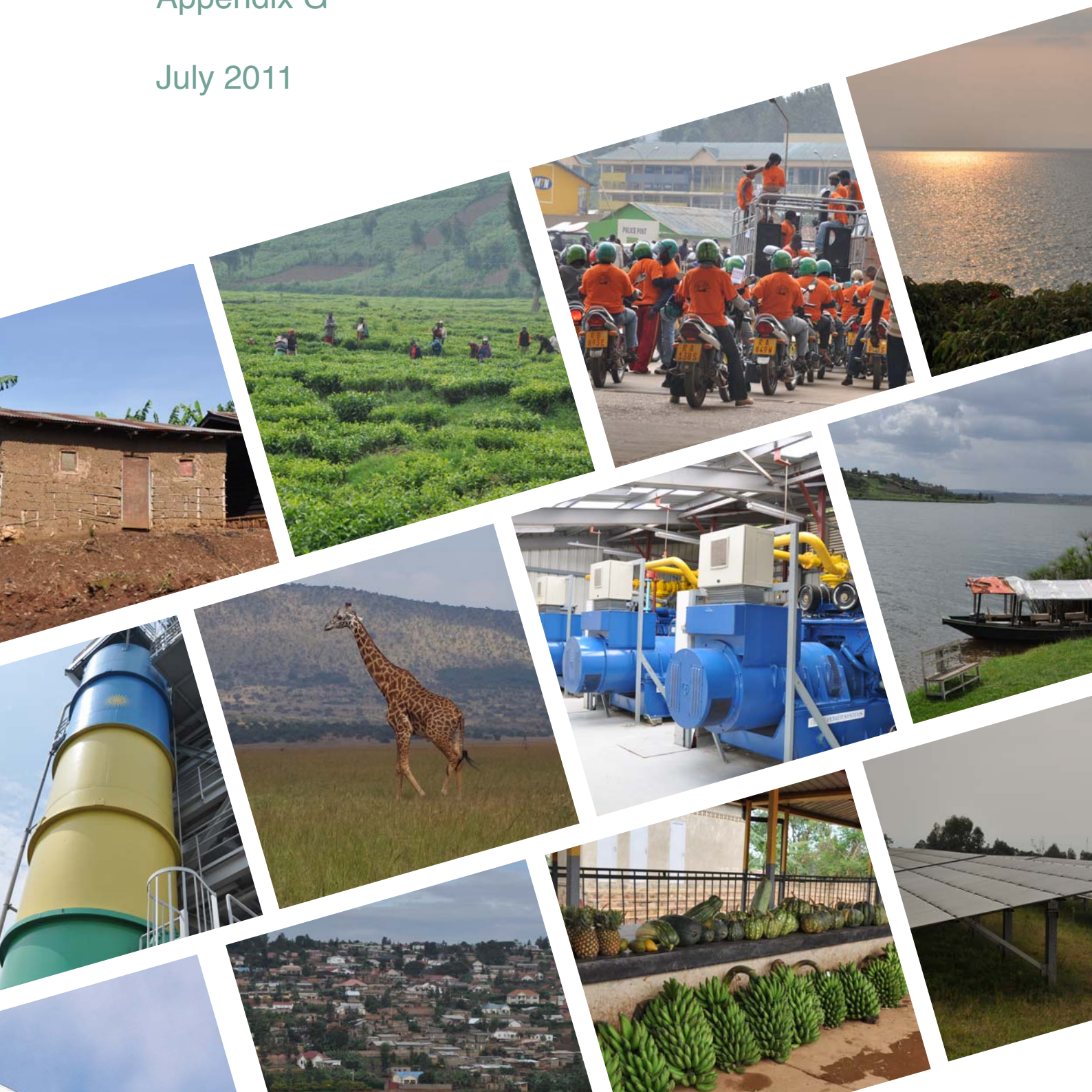
Intern Reports

Appendix G

July 2011



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Rwanda Private Sector Investment in Green Technologies

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Acronyms and Abbreviations

EWSA	Energy, Water and Sanitation Authority
KCS	Kigali Cleaning Services
MININFRA	Ministry of Infrastructure
RWF	Rwandan Franc
UNFCCC	United Nations Convention on Climate Change
USD	United States dollar
VAT	value-added tax
W	Watt

Introduction

Rwanda is putting great effort into environment protection, and has currently placed a special emphasis on mitigation and adaptation to climate change. The Rwandan inspiration and determination are embedded in Vision 2020. It includes 6 pillars, one of which is to have a private sector-led economy. In addition, Rwanda's first national communication to the United Nations Convention on Climate Change (UNFCCC) suggested among the strategies to reduce green house gas emission in energy sector: the disengagement of the Government for the profit of the private sector. For this reason, among others, the National Strategy on Climate Change and Low Carbon Development for Rwanda includes the perspective of the private sector. This study aims to reveal the challenges faced by private investors in green businesses, and government policies that could help to overcome those challenges.

Scope of the study

Case studies were conducted on private companies in Rwanda that are providing climate change mitigation and adaptation technologies. Climate change mitigation technologies, for the purpose of this study, are those that reduce energy consumption, or that convert renewable sources into heat or electricity, and which therefore lead to reduced emissions of greenhouse gases. The following technologies have been considered:

- Solar
- Micro hydro
- Improved cooking stoves
- Biogas
- Waste management
- Mechanically generated electricity

Methodology

Interviews were conducted with business owners and managers of seven companies operating in Rwanda. These interviews were informal with open questions focused on the interviewees experience and challenges in providing climate change mitigation and adaptation services, and elicited policy recommendations that the government could implement to help businesses overcome such challenges. Each interview is discussed in detail in the following section.

Company records, as well as a number of national development documents have been consulted to determine a baseline for the government's consideration of the private sector in policy formation.

Case Studies

4.1 COPED Ltd

In 1999, Kigali Cleaning Services (KCS) was founded by Paulin Buregeya, the current Chief Executive Officer of COPED Ltd. It started its operation as a sole proprietorship enterprise. In 2004, KCS' name was changed to Cooperative for Environment and Development (COPED) and was converted to a cooperative legal statute. In 2008, COPED's status changed again. It was registered as a Rwandan limited liability company (Ltd) under the name, Company for Environment and Development (COPED Ltd.)

COPED's vision is to lead the East and Central Africa market. It plans to establish a reference "Waste for Wealth" centre (W4W) that will partner with international organisations for effective and efficient implementation of different climate change initiatives.

COPED separates Bio-Organic Waste (collected in green containers), Recyclable Waste (in blue) and Non-Recyclable Waste (in yellow). It has two factories:

- ECOMAKE, which transforms dry biomass waste into briquettes
- ECOPLASTIC, which recycles plastic waste

Since 1st July waste categories have increased from three to five which include: organic waste, hazardous waste, recyclable waste, waste paper, non recyclable/disposable. In the near future, COPED will install composting centers that will convert wet bio-waste into organic fertilisers.

COPED's activities are limited to Kigali, but it plans to expand to other cities in the future.

4.2 Rural Energy Promotion (REPRO) SARL

REPRO SARL is a Rwandan private company with a focus on renewable energy and rural electrification. It has held an investment certificate since 2008. The company's activities involve production, promotion, distribution and retail of renewable energy products, as well as the

Box 1: Murunda Micro Hydro Power Plant

Location of the plant:

- Western Province, Rutsiro District, Murunda Sector, Rwishywa River

Technical Specifications:

- Grid connected
- Power: 96KW

Financing:

- Total cost: RWF 255million (USD 424 thousand)
  - 32% REPRO SARL's own contribution
  - 18% loan from BRD (Rwanda Development Bank) with a 14% interest rate during the pre-operational phase, rising to a 16 % interest rate once production operation commences,
  - 50% PSP Hydro grant

development of power generation projects through the construction of micro hydro power plants.

Under the Energizing Development Program (GIZ project), REPRO SARL developed and constructed the Murunda Micro Hydro Power Plant. It was the first ever privately initiated, owned and operated micro hydro plant in Rwanda (see Box 1).

4.3 Modern Technology Services, MTS Ltd

MTS sarl is a company founded in 2003. It is based in Rwanda, but has extended activities to Burundi and the Democratic Republic of Congo (DRC). Its principle activities are importation, retail, installation and maintenance of electrical and medical equipment.

It provides four main products:

- Service 1: Solar energy
- Service 2: Electric line
- Service 3: Generators
- Service 4: Medical equipments

MTS Ltd's domestic solar system costs an estimated RWF 1.5 million (USD 2500), and its institutional system costs between FRW 8 million and 27.5 million (USD 13 thousand - 46 thousand). The institutional systems range from 2000 watts to 3000 watts. When MTS installs a solar system, it provides a one year guarantee. Within that year, any problem with the system will be repaired for free.

4.4 BBOXX LTD

BBOXX is a for-profit spin-off company from a charity at Imperial College, e.quinox, which tackles the problem of rural electrification in Africa. e.quinox has been active in Rwanda since January 2009 and to-date has electrified over 300 households using its "energy kiosk" concept in collaboration with MINIFRA and the Belgium Technical Corporation.

The company developed the BB5, a portable battery box that can power AC and DC loads up to 80W and can be charged via a solar panel or a grid charger. The cost of the BB5 product in Rwanda is USD 46 (RWF 27,500) to the end consumer (2010 prices, which are currently being updated). A 2W LED light that goes with the product is USD 6, and a 10W solar panel to charge the box continuously throughout the day (and provide sufficient energy for 'typical' household use) costs approximately USD 38. BBOXX revealed that it is in the process of developing further products at a whole range of pricing levels, from USD 20 to 200, depending on the amount of energy the system can store, power it can produce, and usability.

4.5 Construction and Renewable Energy Technologies, CRET

CRET is a company involved in installation and maintenance of biogas. It has been operational since 2006. It provides biogas services to both domesticandinstitutions. In order to promote domestic biogas, the government has established a maximum price. A domestic biogas system costs between RWF 700,000 and 800 000 (USD 1,165 – 1,331), of which the Government provides RWF 300 000 (USD 500) through the national domestic biogas project (MININFRA). The remaining must be covered by the household. For institutional biogas there is no fixed price. It is negotiated.

4.6 TEKUTANGIJE Ltd

TEKUTANGIJE Ltd sells low carbon, energy efficient cooking stoves. The name TEKUTANGIJE was granted registered trademark status by RDB in April 2009. An image of the stove is provided in Figure 1. A number of the TEKUTANGIJE stove's features increase energy efficiency. A chimney installed at the level of the combustion chamber removes gases from the room that could otherwise have harmful health effects on the user. Doors to the combustion chamber allow the user to control air intake to maximize energy efficiency. Furthermore, a tank located inside of the combustion chamber can be used to heat water simultaneous to cooking.

A TEKUTANGIJE cooking stove for family use currently costs between RWF 300,000 to 400,000 (USD 500-665). According to the chief cook of lycée Notre Dame de Citeaux, one of the schools using TEKUTANGIJE, this technology allowed the school to save more than 30% of energy

Figure 1: TEKUTANGIJE cooking stove

consumption, and their kitchen is cleaner than before.

4.7 Nuru Energy

Nuru Energy provides an off-grid lighting alternative that is charged with a pedal generator, known as the POWERCycle. The POWERCycle provides approximate 60W of power, resulting in a charge of 375-500 minutes of light for every minute of gentle pedaling.

The company identifies and trains entrepreneurs in rural areas across the country, and provides them with a POWERCycle. It also links the entrepreneurs to a microfinance partner, Urwego Opportunity Bank, which extends a loan of 50 lights. Entrepreneurs sell the lights to customers for approximately RWF 3,750 (USD 6.25). Customers do not have their own POWERCycles, so they return every 5-7 days to the entrepreneurs to have their lights charged for a small fee of RWF 100 (USD 0.17). According to the company representative, the result is 85% savings for the customer over the cost of lighting with kerosene. Customers are also given the option to pay in installments, which make the upfront costs of Nuru Lights even more affordable. Entrepreneurs pay back the loan using the revenue from selling and recharging the lights, and receive another loan of 50 lights.

Findings

5.1 Common comments

Though the services provided by the companies in the case studies differ, they had some common declarations:

- **It is not a safe business**. Each company representative interviewed revealed that such businesses are not something that can be relied upon for everyday life. Owners must have another job or another business in a more stable industry.
- **Climate change mitigation services are expensive and are not among population's first priorities**. One interviewee said, "It is not like selling food or other basic needs, because in these services, however expensive they might be, customers will always be there."
- **There is no sound competition.** Lack of competition is likely the result of the different constraints mentioned above.

5.2 Specific challenges and suggestions

5.2.1 Solar

The main challenge revealed by solar companies is the affordability of solar products for private households.

They had the following policy recommendations:

- Clearer tax exemption rules for solar products
- Greater government-backed schemes to purchase small scale solar systems
  i.e. government microfinance loans

Lack of awareness of the benefits of solar systems was also mentioned, but it was stated that awareness would not help anything as long as affordability is still a problem.

5.2.2 Biogas

The Government has put much effort into biogas, and awareness is high. Compared to other renewable energies, biogas has more clients.

The main challenge stated for biogas is the fixed price, which according to CRET, results in low profit. They argue that in fixing the price, some issues have not been considered, such as marketing cost.

Institutions could offer biogas companies more profit, however their purchasing power is low compared to the cost of the product (institutional biogas costs between RWF 20 million and 30 million (USD 33-50 thousand). In addition, biogas is not available to institutions that do not keep livestock, as human waste alone cannot provide the necessary quantity of fuel. Once an institution wants biogas, it can negotiate and get support from the ministry (MININFRA).

The policy suggestions given by interviewees are the following:

- To make the price for domestic biogas more flexible.
- To put in place clear policies that support institutional biogas, similar to those supporting domestic biogas.

5.2.3 Waste management

The main challenge raised facing waste management companies is mindset. Most of the

population does not understand the benefits of waste management. In order for the population to purchase the service it must be very cheap – below the price of what is not possible due to the high investment required.

For waste management the following suggestions have been given:

- The government should mandate minimal waste services. Similar, for example, to how the government has made it an obligation for every car to be insured. Were the Government to mandate waste services, it must also put in place serious measures to control the industry, as well as penalties for non-compliant households.
- The Government should cover a given percentage of the cost for poor families.
- Equipment used should be made tax exempt, especially waste vehicles.

5.2.4 Micro hydro

The following challenges were raised for micro hydro companies:

- The cost of capital is high. With micro hydro dams being long-term projects requiring high investment the interest rates of 18% (in many banks) and 16% (BRD) are inhibiting to many developers.
- The price at which EWSA is buying electricity from micro hydro dams, according to the developers, it is very low.
- The costs of importing small quantities of components and equipment are very high.
- There is limited engineering capacity in Rwanda.

Policy suggestions given included the following:

- The Government should mobilize resources and create a credit line in a given bank (ex: BRD) at a low interest rate may be 10%.
- EWSA should increase the price paid for micro hydro electricity from FRW 60 to FRW 80 or 90/KWh.
- All equipment used should be exempt from taxes and import duties.

5.2.5 Improved cooking stoves

The main challenges stated for the company selling improved cooking stoves are the following:

- The low purchasing power of Rwandan population, especially in rural areas.
- Lack of skilled man power.
- High costs of raw materials.

The following policy recommendations were given:

- The government should hold demonstration events and provide marketing support to create awareness.
- Materials should be made exempt from taxes and import duties.

5.2.6 Nuru Energy

The Government, especially local government offices (District, Sector, Cell), have been very supportive of Nuru Energy's work in sensitizing the local population to the benefits of switching from kerosene to electric lighting systems. However, a company representative mentioned that there is still one challenge:

- Nuru Energy's two biggest competitors (solar and kerosene) have tax breaks. Solar is exempt from import duties, and kerosene is exempt from both import duties and value-added tax (VAT).

For this reason, Nuru Energy gave the following policy recommendation:

- To "level the playing field" by treating mechanical energy equal to solar and kerosene. Exempting the pedal generator and lights from import duties would allow Nuru Energy to sell products more cheaply to its customers.

Analysis and Conclusion

The private sector contribution to climate change mitigation and adaptation activities is indispensable, especially in renewable energy. Private companies can help to not only reduce green house gas emissions, but also increase non-farm employment which has been identified as one of the measures to adapt to climate change. The Government has done a lot to promote such investments, but more efforts are still needed to overcome existing challenges.

A number of suggestions have been given by operators; however some might be unfeasible or risky. For example, the public micro credit schemes, as recommended by the solar technology retailers, have generally been unsuccessful in other countries. Government-backed loan guarantees or grants to incentivise private microcredit has proven to be more effective alternatives.

Another potentially risky recommendation was to mandate that each household purchase waste management services. Eventually, mandatory waste management in cities will be necessary. At that point, it should be centrally-planned, possibly by the city council. The council would collect a "council tax" to pay for the service, and companies would bid for contracts to collect all of the waste in a given area in order to reduce overlap and increase efficiency. This would require significant investment in service provision, monitoring and enforcement, and would involve taxing low-income households, which could have detrimental social impacts. A more appropriate starting point would be to support waste management companies to earn money from economically valuable waste products through the recycling and reuse of plastics and organic waste for fertilizer and fuel. As the infrastructure is built up, and income-levels increase, we can transition to mandatory waste management.

General Recommendations

1. More communication between private investors and the ministries. Private investors seem to not be implicated enough in their respective ministries' action plans. Strong implication can help private investors to maximally benefit from the opportunities available, and, where needed, to orient their businesses towards country priorities.
2. Clear policy and strategy development based on country high priorities. The government should explain to the private sector why a given program is being promoted at a given time, rather than another. Clear policies would also prevent possible conflicts based on raw materials. For example, when two companies need organic waste – one for energy another for fertilizers- which company should be given priority?
3. Capacity building in green house gas emission calculations. The interviewed company representatives know that they reduce GHG emission, but they do not have the data necessary to access carbon markets. Government support to private companies in calculating carbon offsets could be instrumental in promoting carbon projects in Rwanda.

Table 1: Companies contacts

Company's name	Name and position of key contact	Contact details
Compagnie Pour l'Environment et Developpement /COPED Ltd	Paulin Buregeya CEO	Phone: +250(0)255 105795 Email:info@copedgroup.com Website:www.copedgroup.com
Renewable Energy Promotion/ REPRO s.a.r.l	Olivier Ngororabanga Project Manager	Phone:+250-252-587-284 Email:nolivier@reprorwanda.com Website:www.reprorwanda.com
Modern Technology Services/MTS Ltd	Ndirima Jean Bosco Commercial Director	Phone:+250 78 8595334 Email:mts@rwanda1.com Website:www.mts-world.com
BBOXX LTD	Christopher Baker-Brian Director of Research and Technology	Email:c.baker-brian@bboxx.co.uk Website:www.bboxx.co.uk
TEKUTANGIJE Ltd	Isidore Nzeyimana	Phone:+250 78 627050 Email:nzi25@yahoo.fr
Construction and renewable energy Technologies, CRET	Ndayisaba Edouard	Phone:+250 788302624 Email:cretdirector@gmail.com
Nuru Energy	Sloan Holzman Director of Partnerships	Phone:(250) 7893492342 Email:info@nurulight.com

Energy Research Centre Proposal

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Introduction

Current trends in climate change will bring greater weather extremes - storms, floods, droughts, heat waves, and cold waves with detrimental effects on human health, agriculture, and ecosystems.

Energy-related activities account for the majority of human-generated green-house gas emissions, the primary cause of climate change. According to the World Bank, between now and 2050, the demand for energy is projected to increase significantly, with the greatest increases occurring in developing countries. There is need for a change in government policies so that appropriate instruments are in place to facilitate investments in clean energy technologies. This calls for investment in Energy Research Centres for developing countries like Rwanda without which we could follow a carbon-intensive development path, similar to that of developed countries.

Justification

Our quality of life, standard of living and national security depend on energy. A strong, balanced energy research program, based on the most efficient use of our natural resources while minimizing our dependence on imported energy, is critical to the survival of Rwanda as a developing country. Our non-renewable energy resources are facing gradual depletion and even the existing methods of their use are polluting the environment.

Meeting the energy needs of developing countries like Rwanda in an environmentally sustainable manner is an urgent challenge. [Clean] energy makes it possible achieve sustainable growth and poverty reduction since the livelihoods and welfare of poor people in developing countries depend on the availability of energy services. Major improvements in the quality, quantity, and affordability of energy services in developing countries will be necessary to support countries' development objectives of job creation, health, and education. Since 2004, global oil prices have increased and this has further added to the challenge of ensuring affordable energy services, especially in the poorest countries of Sub-Saharan Africa.

The Rwanda Energy Research Centre will carry out world-class research into sustainable future energy systems. It will also serve as a link between Rwanda's and international energy research communities in addition to informing Rwanda's policy development and research policy for the energy sector.

Benefits

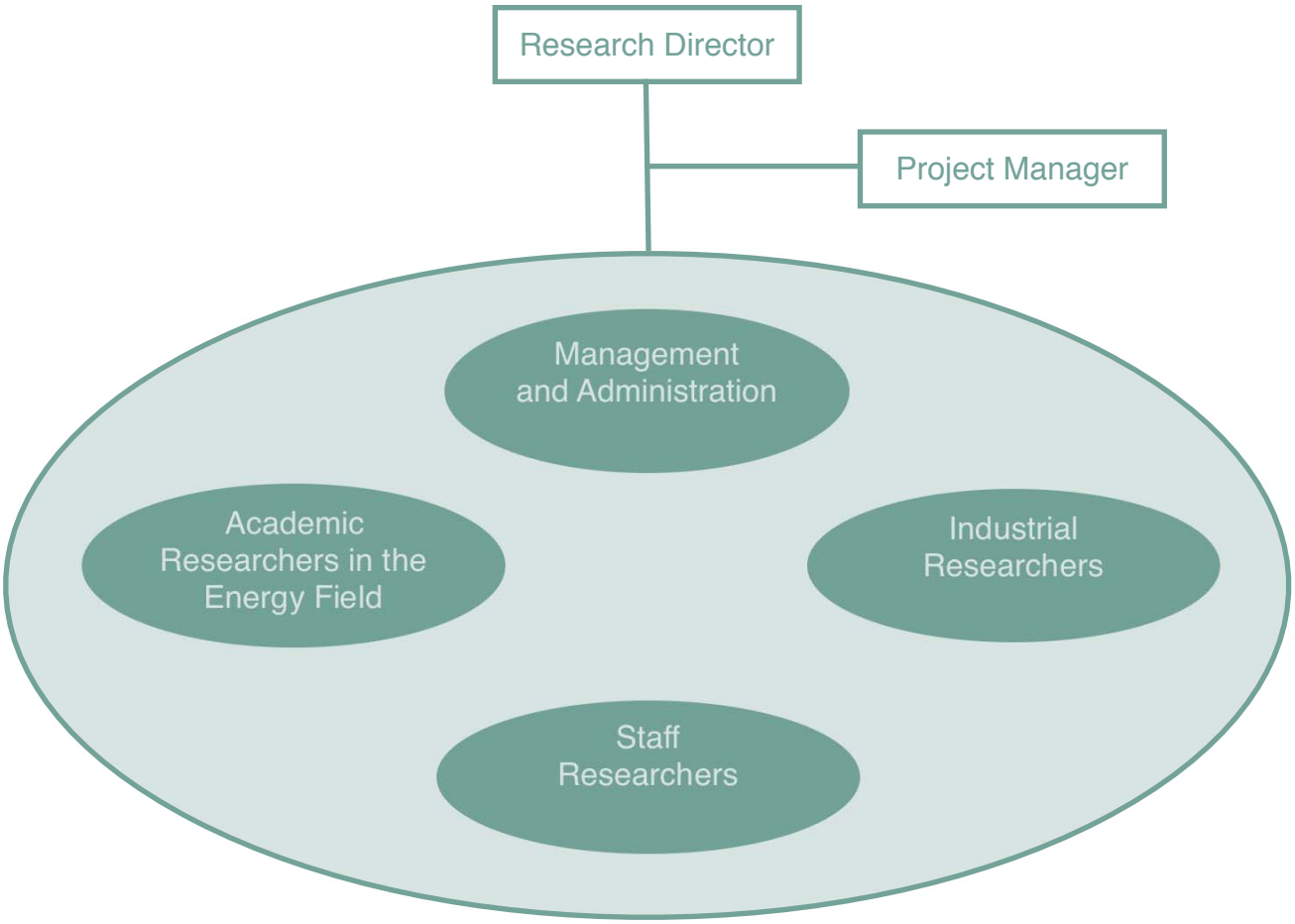
1. High levels of electricity generation and access to support a knowledge-based, service sector economy with high levels of growth.
2. Well-developed technical capacity at the local and national level through the center's R&D.
3. Energy security secured through research in a diverse range of renewable energy sources both domestic and regional, fostering an oil price resilient economy.
4. Research into a wide range of resources utilized that are not susceptible to climatic variations rendering the energy sector resilient to climate change.
5. In the medium and long term, new technologies are likely to become available and research will be done to investigate potential new technologies feasible for use in Rwanda. Smart grid technology feasibility will be investigated in order to utilize its energy efficiency potential.
6. Low cost electricity generated through utilization of low-cost renewable energy, energy efficiency and low levels of system losses.
7. The center will look at how to have a financially sustainable energy sector that is independent.
8. Smart grid technology feasibility will be investigated in order to utilize its energy efficiency potential by utilizing national grid and distributed local networks where each is most cost effective.
9. Research will also go into developing extreme weather resistant infrastructure, through robust planning system and development controls.
10. As a result of the center's work, Rwanda will become a regional hub of technical knowledge for renewable energy technologies and other forms of energy science.
11. The center will foster regional cooperation in energy use, research and development and link Rwanda to the world's state of the art energy research centers.
12. Providing a high level learning experience for post-graduate students and researchers in the area of energy systems.
13. Serving as a magnet for energy researchers and industrial partners from across the globe through the employment of a collaborative research methodology.

Key Research Areas

1. **Energy and the Environment:** To develop tools for assessing the environmental impact of energy exploitation/carbon abatement and to optimize opportunities for improved sustainability.
2. **Energy Demand:** The demand for energy worldwide is the driver of the whole energy system, influencing not only the total amount of energy used, but also the location, type of fuel and characteristics of the end use technology.
3. **Energy in the built environment**
4. **Integrated electricity system**
5. **Energy use in industry**
6. **Storage and transportation of fuels**
7. **Energy use in the home**
8. **Technology and Policy assessment:** This research area will be established to draw on the existing energy research to meet the demand from the industry, policymakers and other stakeholders for independent, authoritative and policy-relevant research that addresses key issues in the energy field.

Structure

The proposed structure for the energy reserach centre is shown in the figure below.



Rural Impacts of Climate Change and Low Carbon Growth in Rwanda: Transforming Rural Livelihoods and Energy Use

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Acronyms and Abbreviations

BTC	Belgium Technical Cooperation
CDM	Clean Development Mechanism
CFL	compact fluorescent lamps
CGIAR	Consultative Group on International Agricultural Research
EC	European Commission
EDPRS	Economic Development and Poverty Reduction Strategy
EPRER	Electrification des Populations Rurales par des Energies Renouvelables
EWSA	Energy, Water and Sanitation Authority
FAO	Food and Agrculture Organisation
GEF	Global Environment Facility
ICL	incandescent light
IREARPPP	Increase Rural Energy Access in Rwanda through Public and Private Partnership
kV	kilovolt
kW	kilowatt
LPG	liquefied petroleum gas
MDGs	Millennium Development Goals
MINECOFIN	Ministry of Finance and Economic Planning
MINEDUC	Ministry of Education
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MW	megawatt
NAPA	Nationally Appropriate Plans of Action
RWF	Rwandan Franc
UNDP	United Nations Development Programme
UNFCCC	United Nations Convention on Climate Change
USD	United States dollar
VAT	value-added tax
WHO	World Health Organization
WMO	World Meteorological Organization

Introduction

Climate change is expected to affect virtually every sector of society, including water resources, food production, energy use, transportation and commerce, recreation, and even national security. While some of these effects could be beneficial, particularly in the short term, many of the impacts could be costly, far-reaching, and damaging to local communities and society as a whole in the long-term"[1]

Climate change is becoming an economic, planning and finance issue, not an environment alone [2].Rwanda, through years has experienced periodic floods and droughts that cause major socio-economic impacts and reduce economic growth of the country. All of these changes will have effects on the global economy and the quality of life. The impacts of these events are economically significant. The study has estimated that the direct measurable economic costs of this event were $4 to $22 million (equivalent to around 0.1 – 0.6% of GDP) for two districts alone[2]. The total economic costs of the 2007 floods are therefore much larger and would increase further when other national level effects are considered. The future economic costs of climate change are very uncertain. However uncertainty is not a reason for inaction. In his NAPA, Ministry of Environment, Lands, Water and Natural Resources has set out recommendation regarding the energy use that are:

- Develop alternative sources of wood energy
- Rational utilisation of wood energy

The main objective is to reduce the pressure on forests done by rural and urban communities using wood energy. But the achievement of this objective requires that rural people who almost all use wood for energy have to be:

- Rational utilisation of wood energy
- Supplied with other sources of alternative energies instead of firewood and charcoal
- Sensitized on the utilization of alternative energies to safeguard the forests and environment in general[3].

These would lead to the achievement of the Vision 2020 objectives. In fact, Rwanda projects to increase the number of the population with an access to electricity shifting from 6% in 2000 to 35 % by 2020.Rwanda also argues that the consumption of wood will decrease from 94% in 2000 to 50% of national energy consumption[4].

In this paper, we focus on Rural Impacts of Climate Change and Low Carbon Growth in Rwanda: Transforming Rural Livelihoods and Energy Use.

Adaptation is essentially about individuals responding to climate risks. On finance, the focus is currently on the public sector. However, adaptation could be viewed as a social business, which means that the private sector could play a greater role.

1.1 Negative Impact of Climate Change in Rwanda

In Rwanda, negative effects linked with disturbances of climate system affected these two last decades different sectors and natural resources involved in socioeconomic development. In fact, a correlation exists between the increase in temperature and the humidity of the soil; the lowering of lake water levels and water flows, drying up of sources, agricultural productivity and appearance of paludism [3].

MINIRENA informs that in 1997, serious floods linked with El-Nino episode of 1997/98 destroyed a big number of agricultural plantations and ecosystems. According to the same source, the areas destroyed were occupying shallows and swamps of Nyabarongo and Akanyaru river basin. In 1999 to 2000, a prolonged drought seriously affected Bugesera, Umutara (Now Eastern Province) and Mayaga (North-West of Southern Province) regions. Also there is potentially large increase in the health burden of malaria in Rwanda. This arises because a large part of the rural population lives at higher elevations, where the disease is currently restricted by temperature. Whilst uncertain, climate change indicates potential increase in rural population at risk of malaria by 150% by the 2050s[2].

Table 1: Sensibility of human resources and groups in Rwanda

	Most frequent climate risks				
	Prolonged seasonal drought	Short drought during rainy season(dry spells)	Heavy rains	Short rains	Indicator of exposition(%)
Services rendered by Ecosystems					
Soil humidity	5	3	1	3	60
Water resources	5	2	1	4	60
Pastures	5	2	1	3	55
Timber/Fire wood	2	1	2	3	40
Means of Existence					
Food producing crop harvest	5	3	4	4	80
Industrial product(coffee,tea)	5	3	2	4	70
Animal	4	2	1	3	50
Charcoal	2	1	1	1	25
Rainfed Agriculture	5	3	2	3	65
Manpower	3	1	2	1	35
Mode of existence					
Farmers/home pilots	5	2	3	4	70
Pastoralists/Domestic level	5	2	1	3	55
Big farmers	4	1	2	2	45
Traders/Rural markets	4	1	3	3	55
Civil servant	3	1	2	2	40

1: Weak, 2: Relatively Weak, 3: Relatively High, 4: High, 5: Very High

Scale of Exposition: >70%: Very High Vulnerability, >55% High Vulnerability, >25% Relatively High Vulnerability

1.2 Influence of climate change on agricultural production

After the evolution realized until 2002 in banana, tubers, fruits and vegetable production, a low production,particularly for tubers, roots, cereals and leguminous was noticed. According to the MINECOFIN's department of statistics, the low performance of food production from 2002 is the result of irregular rainfalls and a dislocation of rainy seasons which took place. The leguminous production sensibly went down in 2004.This was due to heavy rains registered in high altitude regions, which are generally more productive.

1.3 Other negative consequences

Prolonged seasonal drought, recurrent drought on two or three successive years as well as low precipitations have an important impact of spatial area of 1000 km^2 leading to a loss of 1,000 lives, economic losses of RWF 1,000,000/capita among the affected population. The occurrence tendency of these events is very important and of high frequency.

Particularly intense rains coupled with short droughts (dryspells) alternating with low precipitations in rainy seasons also presents a recurring risk with localized impacts in an area of 100 km^2, a loss of 100 human lives and economic losses of RWF 100,000/capita among the affected populations. The occurrence tendency of these events is considered as average but of high frequency [3].

Energy in Rwanda

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, petroleum products account for 11% (used mainly in the transport sector) and electricity for approximately 3%[5]. The available electricity generation capacity in Rwanda by July 2009 was at 69MW and was produced from:

- Hydropower(home): 15%
- Regional hydropower: 15%
- Thermal power(home): 34%
- Thermal power(Rental): 13%
- Methane to power: 3%.

Biomass remains by far the largest source of energy used in the country especially for domestic cooking and it is likely that this will continue for some years to come. Projections show that biomass is expected to contribute to the source of energy at a percentage of 50% in 2020 [6].

The use of biomass energy has potentially serious environmental implications and will not be sustainable unless managed properly. More efficient production and use of biomass energy by households needs to be complemented by promoting other sources of energy. Are included biogas, peat, LPG, kerosene and of course electricity. Mains electricity is the most convenient

Table 2: Electricity Generation Capacity (MW)- by July 2009

Category	Name	Installed capacity(MW)	Available capacity (MW)
Hydropower	Ntaruka	11.5	7.25
	Mukungwa	12	12
	Gihira	1.8	0.7
	Gisenyi	1.2	0
Regional hydropower	Rusizi I	3.5	3.5
	Rusizi II	12	8
Thermal power	JabanaHFO	20.5	20.5
	Jabana Diesel	6.24	4.8
Rented Thermal Power	Gikondo Diesel	10	10
Solar Power	Kigali solar	0.25	0.25
Methane gas	KP1	4.2	1.8
Total		85.3	69.1

and useful form of energy for almost all of the key end-uses associated with the EDPRS strategy for national development. Internationally, there is a strong correlation between electricity consumption, economic performance and poverty reduction, so the challenge for Rwanda is to rapidly raise the level of electricity access and efficient usage of electrical energy [5].

2.1 Energy-Development-Environment links in Rwanda

Different forms of energy play an important role on human beings and have been considered symbols of development. Development agencies have shown that levels of wellbeing, progress and growth are associated with levels of consumption and energy demand [7].

According Vision 2020, Rwanda will have to produce enough energy to meet all economic and social development activities without further damage to the environment. Rural area will likely need a huge amount of energy to develop, either in farm or no.

Agriculture requires energy as an important input to production. Agriculture uses energy directly as fuel or electricity to operate machinery and equipment, to heat or cool buildings, and for lighting on the farm, and indirectly in the fertilizers and chemicals produced off the farm [8]

The increasing social and developmental pressures on the fragile ecosystem have implications for the pursuit of economic growth that is primary to successful alleviation of poverty in the

Table 3: Energy uses in Agricultural sector

Direct Use Energy	Fuel
Operating farm machinery and large trucks: - Field work(tractors,combines balers). - Input small vehicles	Diesel fuel
Operating small vehicles(cars and pick up trucks) - Farm management activities.	Gasoline
Operating small equipment: - Irrigation - Drying of grain or fruit - Heating for protection in groves and orchard - Crop flamers - Heating/cooling of cattle barn,pig or poultry brooder, green house,stock tanks,etc. - Animal waste treatment - Standby generators	Diesel fuel Natural Gas LP Gas Electricity
General farm overhead - Lighting for houses,sheds and barns - Power for farm household appliances	Diesel, gasoline, NG, LPG.
Custom operations - Field work(e.g combining) - Drying - Other	Electricity
Marketing - Transportation - Elevating	Diesel, Gasoline
Indirect use of energy	Fuel
Fertilizer (Nitrogen based,Phosphate,Potash)	Natural Gas
Pesticides (insecticides,herbicides,fungicides)	Petroleum or NG

country. It also has implication for the integrity of the ecosystems that underpins the prospects for sustainable development. It is in this context that environmental issues should be put at the top of the agenda in energy planning and decision-making.

2.2 Poverty-environment linkage

The key link between poor people and the environment is the extreme dependence of the poor on natural resources in their immediate environment. These resources are often all that stand between the poor and starvation [9]. The thinner and more depleted the resource base (eg little rain, polluted water, few trees, soil erosion), the more meager their livelihoods and the more insecure their food supply.

2.3 Poverty-energy linkages

The key links between the poor and energy have been described in terms of the quality and quantity of fuel used. Generally poor people use traditional fuels such as biomass, and do not have high-tech equipment (electric stoves, computers). 'Fuels of the poor' - biomass (wood, crop waste and dung) and to some extent kerosene and coal - are inefficient, expensive and hazardous to health [9].

- Inefficient: traditional fuels are far less efficient that modern ones, for example candles produceonly 1%, and kerosene wick lamps only 2% of the luminosity of electricity per kilowatt hour of energy used. Generally kerosene is considered to be 3-5 times more efficient than wood and Liquid Petroleum Gas (LPG) 5-10 times more efficient for cooking.
- Expensive: the poor spend a far greater proportion of their income on energy than the wealthy.

Whereas better-off household spend between 3-7% of their income on energy services, the poor spend 15-28% of their incomes on energy services.

- Unhealthy: Traditional fuels are unhealthy. The World Health Organization (WHO) is concerned about the high levels of Acute Respiratory Infections (ARIs) and eye infections caused by smoke inhalation by women and children while cooking over wood and dung fires. People with compromised immune systems (such as those with HIV/AIDS) are especially vulnerable.

The access to energy services facilitates economic development with the possibility of creating micro-firms, the development of maintenance activities beyond day light hours and local businesses which create employment. Modern energy can contribute directly to the reduction of poverty incrementing poor countries' productivity and extending the quality and offer of products.

2.4 Energy and general household welfare

It is particularly difficult to quantify the impact of energy use on poor households, and the likely benefits of different supply strategies.

Rural development in Uganda has been seen to be facilitated through improved access to energy (in this case solar lighting) where educational and health facilities are provided, and where agricultural production (e.g. fruit packing) may be done at night or in the early morning. Solar drying facilities have enabled commercialization of produce [10]. Also, in the majority of cases the electrification of households leads to slow but steady transition to electricity for all uses, and investment in the household – appliance purchase, upgrading, and an increase in the value of property [11].

Energy can support rural health, education, water supply, agriculture and general economic development, as well as facilitating government operations (electrification of government offices) and communications. Coordination is clearly important if rural development goals are to be furthered [12].

Modern energy services improve the lives of poor people in uncountable ways, reducing the time women and children spend in basic survival activities such as collecting wood and water, cooking, etc [13]. The modern forms of cooking protect women from the daily exposition to smoke,

refrigeration allow local hospitals to conserve basic medicines [14],sterilize equipments, which in turn reduces the mortality of infants and mothers and the occurrence of illnesses. With energy, pumped access to drinkable water improves. Clean water and food, in turn reduce hunger and improves quality of life [13].

Some important points that must be taken into account in the planning of energizing [15]:

- **Lack of knowledge** regarding energy alternatives.
- **Family size.** It could be that the amount of food required for a large family for a large family cannot be cooked in available stoves.
- **Food preferences.** It includes the types of food preferred by families and the consequences in terms of stove size and
- **Attitudes and believes**. The use of more efficient of sources energy will have a high social impact on families. The time spent by women collecting wood will also be reduced.

Although energy is an important support for economic development, effective strategies to realize growth require a greater focus on access to markets, appropriate finance, and capacity building than on energy provision. Again the need for coordination is apparent if this suite of interventions is to combine in an effective way.

Women and Climate Change

Although climate change will affect everyone worldwide, its impacts will be distributed differently between men and women as well as among regions, generations, and age classes [16]. In fact, neither the impacts of climate change on people nor the ways in which people respond to climate change are gender-neutral[17]. Gender inequality and climate change are inextricably linked. There are important gender differences in the implications of climate change for the lives of females and males of all ages, as the multiple environmental, physical, social and economic processes associated with climate change have differentiated impacts on them. Climate change can have disproportionate impacts on women's well-being. Through both direct and indirect risks, it can affect their livelihood opportunities, time availability, and overall life expectancy [16]. Women and girls often experience the most severe impacts of climate change and have less decision-making power and less access to and control over resources to face them. By exacerbating inequality overall, climate change slows progress toward gender equality and thus impedes efforts to achieve wider goals like poverty reduction and sustainable development.

Gender equality should be both a goal and condition for successful climate change adaptation and transitions to low-carbon pathways in developing countries.

By integrating gender responsive in strategies for mitigating for and adaptation to climate change , Women can help or hinder strategies related to energy use, deforestation, population, economic growth, and science and technology, among other things. Women are powerful agents of change whose leadership on climate change is critical. It is hence difficult or impossible to successfully have any achievement without mainstreaming gender in all climate change- related works. Moreover, when addressing global poverty, not taking both women and men, and girls and boys into account would mean neglecting a large part of the people whose well-being that was supposed to improve.

3.1 Women and climate change vulnerabilities

People's vulnerability to risks depends in large part on the assets they have available. Women, particularly poor women, face different vulnerabilities than men [16].

- Women and girls in developing countries are often the primary collectors, users, and managers of water. Decreases in water availability will jeopardize their families' livelihoods and increase their workloads, putting their capacity to attend school at risk.
- An analysis of 141 countries in the period 1981 to 2002 found that natural disasters (and their subsequent impacts) on average killed more women than men in societies where women's economic and social rights are not protected, or they killed women at a younger age than men.
- Women have less access to medical services than men, and their workloads increase when they have to spend more time caring for the sick.

3.2 Reducing women vulnerabilities on Climate change

Gender equality is both a goal and condition for successful climate change adaptation and transitions to low-carbon pathways in developing countries.

With an increasing understanding of climate change as a development issue not only requiring scientific but also social, political, economic and behavioural solutions, the need to ensure these solutions are gender-responsive should be self-evident.

We need to:

- Challenge these inequalities, both as a means to reducing negative impacts of climate change and creating more effective responses, and as an end in itself.
- Highlight the contributions women can make and are already making as agents in adapting to and mitigating climate change.

Agnes Otzelberger stated following strategies that can be useful [17]:

- Take a stronger lead on gender equality in the climate change arena,
- Create enabling organizational environments for effective gender mainstreaming
- Fill knowledge and best practice gaps in participatory ways that capture men's, women's and young people's ideas and knowledge,
- Improve the understanding of gendered impacts of climate change and of climate change policy and programme impacts
- Promote gender-responsive international climate negotiations
- Address the gender disconnect in project and programme cycles
- Promote equal access to decision-making processes and new opportunities created by responses to climate change
- Promote gender-responsiveness in emerging funds and policies for adaptation and low-carbon development.

Concrete actions should be undertaken. Ways to reduce climate-related risks for women include improving their access to skills, education, and knowledge; strengthening their ability to prepare for and manage disasters; supporting their political ability to demand access to risk-management instruments; and helping households gain greater access to credit, markets, and social security. Women could also be included in all levels of the design, implementation, and evaluation of afforestation, reforestation, and conservation projects that receive payments for environmental services, such as carbon sinks. And women should have access to commercial carbon funds, credits, and information that enable them to understand and decide which new resources and technologies meet their needs.

Climate Change in Rwanda

4.1 The energy resources and climate change in Rwanda

In Rwanda, the problem of energy caused a lot of damage to the environment consequently to the climate change. Our traditional reliance on fossil fuels is unsustainable: extracting, storing, transporting and burning of the local and global forest. In rural region, the population uses basically this kind of energy to prepare their food and for local industries like blacksmiths in Rwanda [18].

4.2 Rural people development and the climate change

Agricultural ecosystems, including forestry and fisheries, are the largest managed ecosystems in the world. Through the management of these ecosystems, rural people contribute to the provision of ecosystem services which secure life on earth and maintain the sustainability of biodiversity and humans' livelihoods. However, Human activities contribute to climate change. Because we burn fossil fuels to heat our homes, run our cars, produce electricity, and manufacture all sorts of products, we are adding more greenhouse gases to the atmosphere. By increasing the amount of these gases, we have enhanced the warming capability of the natural greenhouse effect. It is the human-induced enhanced greenhouse effect that causes environmental concern, because it has the potential to warm the planet at a rate that has never been experienced in human history [1]. The largest known contribution comes from the burning of fossil fuels, which releases carbon dioxide gas to the atmosphere [19].Changes in surface temperature, precipitation, weather variability and water levels, all of which are influenced by climate change, can have significant effects on the functioning of these services.

4.3 Mitigation of climate change as new opportunities for rural development

Today, effects of climate change have already been observed, and the rate of warming has increased in recent decades. For this reason, human-caused climate change represents a serious challenge,one that could require new approaches and ways of thinking to ensure the continued health, welfare, and productivity of society and the natural environment [1].

Climate change stops and undermines development, thus nullifying efforts to attain the Millenium Development Goals (MDGs), the Vision 2020, EDPRS and other efforts to development.Being one of the sources of climate change, rural areas can and should also contribute to mitigation. Examples of mitigation in rural areas may include bio-fuel generation from agricultural biomass or solar energy replacing power using fossil energy, afforestation and reforestation for carbon sequestration. Mitigation should also include the livestock sector.

As revealed in the study of the FAO,«the livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions, measured in CO2 equivalents. This is a higher share than transport» [20]. This is why efforts of mitigation should not let down the livestock, while the important source of climate change. Emission reduction through bio-energy investments has

expanded rapidly in recent years. As crude oil prices continue to rise, more such investments will become profitable. However, the production of biomass for bio-energy competes with the production of food or animal feed for scarce land and water. This may cause food prices to rise and poor net buyers of food can be hit hard. With further growth of bio-fuel production, this may develop into greater hunger problems that will need policy responses. To avoid this, crop intensification program that has been launched would be great opportunity for Rwanda to guarantee food security and strengthen the country's agricultural productivity.

Energy Use And Climate Change Adaptation

Adaptation involves taking action to minimize the negative impacts of climate change and taking advantage of new opportunities that may arise. Authorities, managers, planners, and policy makers need to account for the potential outcomes of climate change .Adaptation planning at the local and national levels can limit the damage caused by climate change, as well as the long-term costs of responding to climate-related impacts that are expected to grow in number and intensity in the decades to come. Those engaged in planning need to share information, plan together, and collaboratively modify existing policies and procedures to ensure efficient and effective solutions. The exchange of information, resources, best practices, and lessons learned across jurisdictional lines and among different groups of stakeholders is a key element of successful energy use adaptation planning.

The types of adaptation measures adopted will depend on the impact of climate change on particular regions and economic sectors. Adaptation should not be approached as a separate activity, isolated from other environmental and socioeconomic concerns that also impact on the development opportunities of the poor. Increasing our capacity to adapt reduces our vulnerability to the effects of climate change. However, we must start planning our adaptive responses now; by doing so, we may help to lessen some of the environmental, economic and social costs of climate change.

Improving energy can help reduce emissions, protecting the local and global environment; the efficient use of energy sources and good management can help in the sustainable use of the natural resources and the reduction of deforestation [13].

5.1 Government Commitments to Renewable Energy

The Energy Policy for Rwanda which was updated in November 2008 laid down the Government's commitment to the development and utilisation of renewable energy resources and technologies and energy efficiency promotion.

The vision of the energy sector 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. As stipulated in its Economic Development and Poverty Reduction Strategy (EDPRS) based on the Vision 2020, Rwanda intends to increase its access to electricity from the current 5% to at least 16% by the year 2012. It also plans to reduce the cost of electricity production mainly by diversifying its indigenous resources that are cheaper than oil products, promoting the Efficient Use of Energy and reducing losses in the power network system and Electrogaz (now EWSA, Energy,Water and Sanitation Authority) commercial losses. The preferred electricity generation sources will include Lake Kivu Methane gas, hydro, geothermal, solar, peat, etc.

5.2 Energy Efficiency

- Promotion of Compact Fluorescent Lamps (CFLs)
- Promotion of Solar Water Heaters
- Promotion of Inverters in Tea Factories
- Promotion of the use of Liquefied Petroleum Gas (LPGs)
- Promotion of Energy Audits in Industries
- Promotion of Good Domestic and place of work energy management

5.2.1 Compact Fluorescent lamps

The CFL distribution project has been implemented through several phases starting mid-2007 to now. A pilot phase (or phase 1) was completed in August-September 2007 with the distribution of 50,000 CFLs. A maximum of two CFLs were provided in exchange of incandescent lamps (ICLs). The second phase, started in September 2008, distributing 150,000 CFLs over the residential sector, up to 5 CFLs per household at a price of RWF200 (USD0.37) per bulb and in exchange of incandescent lamps. The third phase (200,000 CFLs) and the fourth phase (400,000 CFLs) will be implemented respectively by the middle of 2009 and the middle of 2010 [21].

What is impressive is that people now have understood the economic advantages of using CFL and have almost abandoned their incandescent tube lamps. This make benefits to family saving,also the EWSA's capacity of supplying electricity have surely increased,hence the number of customers too.

5.2.2 Solar Water Heating systems

Solar Water Heating systems allow the substitution of electricity, gas or fuel with solar energy for heating. The EDPRS target is to install at least 75 000 solar water-heaters in hotels, hospitals and households.This would save energy equivalent to 150 000 MWh per year. This energy is sufficient to supply annually 50,000 new electricity subscribers.

5.2.3 Promotion of use of Liquefied Petroleum Gas (LPGs)

Today, only a small number of households are using LPG (Liquefied Petroleum Gas) for cooking. LPG is one of the most efficient cooking energies for both households and Institutions. The targeted use of at least 5000 tonnes of LPGs per year would allow wood saving of 25,000 tons. These savings are equivalent to 25 000 MWh per year which could satisfy the power demand of 10,000 new subscribers in urban and semi urban areas.

5.2.4 Promotion of Energy Audits in Industries

Periodic energy audits of the industries will allow us to know the energy consumption of the industry and be able to recommend areas of saving by examining the whole industrial production chain. Sensitization campaigns on the efficient use of Energy in industries are being planned by MININFRA.

5.2.5 Good Domestic and work place electricity management

If the country has to promote the efficient use of energy, it has to go along with change in human behaviour. In our homes and offices we should turn off electrical lighting during day time when we can

Table 4: CFL Programme Phases

Phase	Number of CFLs	Indicative timeline of distribution
1	50000	Aug-Sept 2008
2	150000	Sept 2008-March 2009
3	200000	Mid 2009
4	400000	Mid 2010- early 2011, monthly recorded
Total	800000	

enjoy the sun light and turn off unnecessary lighting at night. Good house keeping should involve only using electrical lights when required, leaving them switched off at all other times.

5.3 Governmental and Community Initiatives

As mentioned above, Rwanda is committed to increase the energy available. This will underpin its commitment to realize the EDPRS, the Vision 2020 and the energy policy and strategies. Initiatives and actions have been taken and what is impressive is the awareness and involvement of the people. Here are some examples:

5.3.1 Hydropower

In Rwanda numerous rivers that flow down hills can be tapped to generate electricity. Currently, a total of 27.3 MW of electricity (Ntaruka: 11.5MW, Mukungwa: 12.5 MW, Gihira: 1.8 MW and Gisenyi: 1.2 MW) is being produced through hydropower.By 2009, many hydro power plants were under construction [22] namely:

Nyabarongo hydropower plant (27.5 MW)

This plant is located in Muhanga and Ngororero Districts. Currently the access roads are under construction; commissioning (coming into use) is expected to take place in 2013.

Rukarara hydropower plant (9.5 MW)

The plant is located in Nyamagabe district; the construction works are at 55% of completion. The commissioning is expected to take place in the first quarter of 2010

Eight Micro Hydro Power Projects

These Micro Hydro Power (MHP) are: Gashashi (200 KW), Janja (200 KW), Mukungwa-II (2.5 MW), Nyirabuhombohombo (500 KW), Nyabahanga (200 KW), Rugezi (2.2 MW), Nshilli-I (400 KW) and Ruhwa (200 KW). The completion date has been set for end of June 2010.

Micro Hydropower under UNIDO

These MHPP are Nyamyotsi I (100KW), Nyamyotsi II (100KW), Mutobo (200KW) and Agatobwe (200KW). The beneficiaries of this project include households, health centres, secondary schools, welding and carpentry workshops, battery charging points, small scale businesses and local administrative offices. The commissioning is expected to take place before the end of 2009.

Three MHPP under the Belgian Technical Cooperation

These MHPP Nkora, Cyimbili and Keya (Pfunda)

Contracts for civil works, Hydro-electro-mechanical equipment and for Medium/Low Voltage 30/0.4 KV lines for interconnections & distribution and for control & supervision have been signed; the commissioning was expected to take place before the end of 2010.

Private Sector Partnership (PSP) Hydro project/ GTZ

Three companies are undertaking the following three projects:

- REPRO (105 kW) located in Rutsiro district
- ENNY (250 kW) located in Nyaruguru District
- SOGEMR (400 kW) located in Gakenke District.

The commissioning was expected by September 2009 for REPRO MHPP, by November 2009 for ENNY MHPP and by the first quarter of 2010 for SOGEMR MHPP.

The following three companies have been required to clarify their situation in order to benefit from the support from GTZ/MININFRA. These MHPP are:

- SOGEMR (2200 kW, Mukungwa III, Gakenke)
- ENNY (200 kW, Maruruma, Nyaruguru)
- CORPOVAB (52 kW, Mpenge III, Musanze)

In addition to the ongoing projects above, by 2009 there were seven companies whose their proposals are under assessment:

- SEFIK (225 kW, Mpenge, Musanze)
- CALIMAX (150 kW, Gasumo, Musanze)

- EPR (99 kW, Mashyiga, Karongi)
- ESTP (210 kW, Nyakotsi, Gakenke)
- SONATUBES (90 kW, Mwese, Ngororero)
- AFRISET (105 kW, Kavumu, Gicumbi)
- GLC (330 kW, Mpenge I, Musanze)

EPRER/IREAPPP Projects

The Increase Rural Energy Access in Rwanda through Public and Private Partnership (IREARPPP) project is being implemented through program estimates in direct decentralized operations by the Ministry of Infrastructure (MININFRA) assisted by the European Commission (EC) and Belgium Technical Cooperation (BTC), whereas the Electrification des Populations Rurales par des Energies Renouvelables (EPRER) project aims to electrify remote areas with MHPP (Nyaruguru District, Southern Province) and solar power(65 Health Centres in 9 Districts: Nyamasheke, Nyaruguru, Burera, Gakenke, Rulindo, Bugesera, Kirehe, Gatsibo and Nyagatare).

These projects will concern the construction of 3 MHPP namely Ntaruka A (2 MW, Nshili II (500 kW) & Rukarara II (2 MW). The projects are under feasibility studies.

There are also two studies under EPRER/ IREAPPP:

- Study on the Development of Wind Atlas in Rwanda
- Study on Development of National Strategy Plan for the Maintenance of equipment used for production and distribution of renewable energy.

5.3.2 Biogas

The Ministry of Infrastructure is strongly engaged in the promotion of biogas. To date, 441 biogas installations built by the National Domestic Biogas Program (NDBP) are being used in rural households instead of firewood, and by 2011 at least 15,000 families will be using biogas for cooking and lighting. MININFRA in collaboration with MINEDUC has started a program for the construction of institutional biogas installations in schools, hospitals and other community institutions once funding has been secured [23].

5.4 Finance institutions

The finance of climate mitigation and adaptation in developing countries represents a key challenge in the negotiations on a post-2012 international climate agreement. Finance mechanisms are important because stabilizing the climate will require significant emissions reductions in both the developed and the developing worlds, and therefore large-scale investments in energy infrastructure [24].

Rwanda needs to build capacity for better risk management at all levels engaging the government, civil society, the private sector, communities, and individuals. The main dedicated sources of financing for mitigation at the global level include the Clean Development Mechanism (CDM) and various dedicated funds managed by the Global Environment Facility (GEF) and the World Bank. The Global Facility for Disaster Risk Reduction, is another source of financing for adaptation. In addition to these dedicated funds, most global multilateral development organizations and several bilateral agencies have started to emphasize climate change mitigation and adaptation in their regular operations, which is making available more funds for relevant activities. Similarly, many other international organizations—such as the Consultative Group on International Agricultural Research (CGIAR), World Health Organization (WHO), United Nations Development Programme (UNDP), and World Meteorological Organization (WMO) have or are developing programs mainly to finance climate change adaptation in the areas pertinent to their activities.

5.5 Energy subsidies

The US Energy Information Administration has defined an energy subsidy as any government action designed to influence energy market outcomes, whether through financial incentives, regulation, research and development or public enterprises. In a similar way, the IEA defines energy

subsidies as any government action that concerns primarily the energy sector that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers [25]. Energy subsidies take many different forms. Some have a direct impact on costs or prices, like grants and tax exemptions. Others affect prices or costs indirectly, such as regulations that skew the market in favor of a particular fuel or government-sponsored technology research and development.

Energy subsidies have important implications for climate change and sustainable development more generally through their effects on the level and composition of energy produced and used [25].

5.5.1 Economic, Social and Environmental Effects

A subsidy, by its very nature, involves a complex set of changes in economic resource allocation through its impact on costs or prices. These shifts inevitably have economic, social and environmental effects. Any subsidy can be justified if the gain in social welfare or environmental improvement that it brings exceeds the net economic cost. A good subsidy is one that enhances access to sustainable modern energy or has a positive impact on the environment, while sustaining incentives for efficient delivery and consumption.

Experience shows that subsidy programmes should be:

- Well-targeted – subsidies should go only to those who are meant and deserve to receive them and should not conflict with other instruments and goals;
- Efficient – subsidies should not undermine incentives for suppliers or consumers to provide or use a service efficiently, minimizing market distortion;
- Soundly based – subsidy programmes should be justified by a thorough analysis of the associated costs and benefits;
- Practical – the overall amount of a subsidy should be affordable and the administration of the subsidy programme should be a reasonable cost [25]. The policy challenges are many, including scaling up climate-related investment, leveraging private sector activity, and reforming the institutional framework of the CDM. Given the magnitude of the challenge, a mix of policy measures addressing carbon markets, ODA, and domestic sources of finance may be required.

Table 5: Types of Subsidies and their Impacts

Government intervention	Example	How the subsidies usually works		
		Lowers cost of production	Raises price to producer	Lowers price to consumer
Direct financial transfer	Grants to producers	•		
	Grants to consumers			•
	Low interest loans	•		
Preferential tax treatment	Rebates or exemption on loyalties,sales,taxes,producer levies and tariffs.	•		
	Tax credits	•		•
	Accelerated depreciation allowances on energy supply equipment	•		
Trade restrictions	Quotas,technical restrictions and trade embargoes		•	
Energy related services provided directly by government at less than full cost	Directed investment in energy infrastructure	•		
	Public research and development	•		
	Liability insurance and facility decommissioning cost	•		
Regulation of energy sector	Demand guarantees and mandated deployment rates	•	•	
	Price controls		•	•
	Market access restriction		•	

Conclusion

The main use of energy in rural areas is domestic and at 86%, the most widely used energy continues to be traditional, in spite of its negative impact on sustainable development and livelihoods. Renewable energies are a good alternative to solve the problem of rural energizing because they satisfy the objectives of economic and social development with positive and tangible effects in regional development and on employment with additional benefits on the environment. Planners and decision makers must put the issue of energy and climate change in their agenda. Mitigation and adaptations measures must be taken and according to the problem, its nature, its amplitude, the time, cost and feasibility. Climate change finance options and institutions are available. Rwanda will have to co-operate in order to have access on climate change funds available. Good policies and strategies will encourage donors to channel fund in the sector of energy which will lead to sustainable development and livelihoods of rural people, mostly poor with limited means to adapt to climate change impacts. The Public-private partnership seems to be very important and impressive in implementation of strategies of sustainably energizing the country. Rwanda has good will considering all the efforts done aiming to achieve it 2020 vision and EDPRS. Rural people must be aware of climate change impacts on their daily livelihoods, its consequences on present and on future generation hence be involved in all efforts aiming to preserve clean environment toward a responsible development.

References

1. U S Environmental Protection Agency, Climate Change Science Facts: Causes of climate. 2010.

2. Watkiss, P., et al., A Rapid Assessment of a National Energy and Low Carbon Path for Rwanda. 2009, DFID, SEI, Dew Point.

3. MINIRENA, NAPA, National Adaptation Programmes Of Action To Climate Change. 2006: Kigali.

4. MINECOFIN GoR, Rwanda Vision 2020. 2000, Ministry of Finance and Economic Planning,: Kigali.

5. MININFRA GoR, National Energy Policy and National Energy Strategy 2008-2012. 2009.

6. EUEI European Union Energy Initiative, Rwanda Biomass Energy Strategy: Volume 1 - Summary. 2009.

7. Dyner, I., C. Alvarez, and J. Cherni, Energy Contribution to Sustainable Rural Livelihoods in Developing Countries: A System Dynamics Approach. 2005.

8. CRS Catholic Relief Service, Annual Report. 2004.

9. Sustainable Energy Africa, Mainstreaming environment in energy Strategies to address Poverty in Rwanda. 2006.

10. Sengendo, M.C., Photovoltaic Project for Rural Electrification - Uganda. ENERGIA News, 2001. 4(3): p. 14-15.

11. Annecke et al., An assessment of PNES customer satisfaction and the contribution of electricity to the quality of life households in Khayelitsha, South Africa 2005.

12. Borchers, M. and W. Annecke, Poverty-Environment-Energy linkages in Rwanda. 2006, Sustainable Energy Africa, Poverty Environment Initiative, Rwanda.

13. DFID, Energy for the Poor: Underpinning the Millennium Development Goals. 2002: London.

14. IEA, Energy and Poverty in World Energy Outlook. 2002, International Energy Agency.

15. North, P., The impact of Energy on Poverty, Arusha, Tanzania. 2002, University College London.

16. Aguilar, L., State Of The World, 2009. Women and climate change: Vulnerabilities and Adaptive Capacities 2009.

17. Otzelberger, A., Gender responsive strategies on climate change: Recent progress and ways forward for donors. 2011.

18. Kalisa, J., The effects of climate change in Rwandan region. 2006.

19. IPCC, Summary for Policymakers, in Climate Change,2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 2007, Cambridge University Press: Cambridge, UK and New York, USA. p. 996.

20. Limaye, D.R., Livestock's Long Shadow,farming systems in the greater horn of Africa, in Short-Term Dsm/Ee Program For Rwanda. 2006, FAO/LEAD

21. Electrogaz, Clean Development Mechanism Project Design Document Form (CDM-SSC-PDD). 2006: Kigali.

22. MININFRA. Hydro. 2011 [cited Accessed June 2011; Available from: http://mininfra.gov.rw/index.php?option=com_content&task=view&id=202&Itemid=341.

23. MININFRA. Biomass. 2011 [cited Accessed June 2011; Available from: http://mininfra.gov.rw/index.php?option=com_content&task=view&id=115&Itemid=143.

24. Harvard Project on International Climate Agreements, Climate Finance. 2009.

25. UNEP, Reforming Energy Subsidies: Opportunities to Contribute to the Climate Change Agenda. 2008.

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