BASELINE RENEWABLE ENERGY DATABASE FOR THE COMESA REGION



MARCH 2012

COMESA Secretariat, LUSAKA, ZAMBIA

TABLE OF CONTENTS

List of Acronyms....4
1 EXECUTIVE SUMMARY....6
1.1 Background....6
1.2 The Renewable Energy Industry in COMESA....6
1.3 Barriers to the Renewable Energy Technology Deployment....10
1.4 Drivers of investments in the Renewable Energy Sector....12
1.5 Recommendations....12
2 INTRODUCTION....15
3 THE COMESA RENEWABLE ENERGY POLICY FRAMEWORK....20
4 SPECIFIC TYPES OF RENEWABLE ENERGY....22
4.1 Hydro Power....22
4.2 Biomass....23
4.3 Solar Power....25
4.4 Wind Power....26
4.5 Geothermal Energy....27
4.6 Municipal Waste....28
4.7 Biofuels....29
5 COUNTRIES RENEWABLE ENERGY ANALYSIS....30
5.1 Burundi....32
5.2 Comoros....34
5.3 Democratic Republic of Congo....36
5.4 Djibouti....38
5.5 Egypt....40
5.6 Eritrea....42
5.7 Ethiopia....44
5.8 Kenya....46
5.9 Libya....48
5.10 Madagascar....50
5.11 Malawi....52
5.12 Mauritius....54
5.13 Rwanda....56
5.14 Seychelles....59
5.15 Sudan....61
5.16 Swaziland....63

5.17 Uganda 65
5.18 Zambia 67
5.19 Zimbabwe 69
6 COMESA INTEGRATED MARKET POTENTIAL FOR RE 71
6.1 Commercialisation in renewable energy in COMESA 72
6.2 Barriers to the renewable energy market development 74
6.3 Investment Opportunities in the Renewable Energy Sector 75
7 RECOMMENDATIONS 78
8 WAY FORWARD 82
Annexure 1 – Status of development of RE Policy in COMESA 88
Annexure 2 – Country Specific Report 91
Annexures 2 – List of COMESA RE Projects 280

List of Acronyms

ACP - Alternative Compliance Payment

AFUR - African Forum for Utility Regulators

BOO - Build, Own, Operate.

BOOT - Build, Own, Operate, Transfer

CDM - Clean Development Mechanisms

CEB - Central Electricity Board

CER - Certified Emission Reductions

COMESA - Common Market for Eastern and Southern Africa

CSP - Concentrating Solar Power

DNA - Designated National Authority

DOE - Department of Energy

DRG - Distributed Renewable Generation

EDF - Electricité De France

EE - Energy efficiency

EEPCO - Ethiopian Electricity Power Corporation

EU - European Union

EWSA - Energy, Water and Sanitation Authority

FIT-All - Feed-in Tariff Allowances

FITs - Feed-In Tariffs

GDP - Gross Domestic Product

GEF - Global Environment Facility

GHG - Greenhouse Gas

GO - Guarantees of Origin

GW - Gigawatts

GPRS - Growth and Poverty Reduction Strategy

IPPs - Independent Power Producers

LCOE - Levelized Cost of Electricity

LTES - Long Term Energy Strategy

MoE - Ministry of Energy

MNRE - Ministry of Natural Resources and Energy

MW - Megawatt

MWe - Megawatt Electric

MSW - Municipal Solid Waste

NAMAs - National Appropriate Mitigation Actions

NREA - New and Renewable Energy Authority

NAP - National Action Plan

NCCRS - National Climate Change Response Strategy

NGOs - Non Government Organisations

PPAs - Power Purchase Agreements

ProBEC - Program for Basic Energy and Conservation

PV - Photovoltaic

RAERESA - Regional Association of Energy Regulators for Eastern and South African

RE - Renewable Energy

RED - Renewable Energy Directive (of the European Union)

REEEP - Renewable Energy and Energy Efficiency Partnership

REF - Rural Electrification Fund

REFIT - Renewable Energy Feed-In-Tariff

RERA - Regional Electricity Regulators Association (of Southern Africa)

RETs - Renewable Energy Technologies

SAPP - Southern Africa Power Pool

SHPP - Small Hydro Power Plants

SREP - Scaling-Up Renewable Energy Program

TSO - Transmission System Operator

TWh - Terawatt-hour

USAID - United States Agency for international Development

VAT - Value Added Tax

WESM - Wholesale Electricity Spot Market

Wp - Peak Watts

We - Watt electric

1 EXECUTIVE SUMMARY

1.1 Background

The overall aim of the project is to "facilitate the widespread introduction of renewable energy projects in the region that are sustainable and contribute towards the availability of locally generated energy in COMESA". The project acknowledges that this starts with the understanding of the "as is" status of RE and using that as the basis of developing the desired "to be" roadmap for each country individual, and for the region collectively. The approach was to develop a baseline data for renewable energy projects in the COMESA Member States as well as review of the regulatory framework. This information will assist COMESA in understanding the baseline potential for diversifying the energy mix of the region.

This project was commissioned by COMESA Secretariat, with the USAID as its financial partner. All COMESA members, namely: Burundi, Comoros, Democratic Republic of Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia and Zimbabwe were targeted to participate in the project. The plan was for each country to submit a country report outlining the renewable developments in their country through a national consultant appointed by COMESA. Only nine countries were able to submit their national reports, thus causing a variance in the depth of detail and number of country reports covered in Annexure 2.

The approach that was followed in this study was:

i. Appoint national country consultants, whose primary task was to:
   - Collect the energy and renewable energy policies of their country;
   - Report on the country's known RE resources and the energy potential of the resources, the status of RE projects in their country and the future plans for RE implementation;
   - Outline the barriers to the expansion of RE in their country.

ii. Where possible, undertake country visits. During the study country visits were undertaken to Uganda, DRC and Malawi.

iii. Supplement the country reports with desktop research if required.

1.2 The Renewable Energy Industry in COMESA

The renewable energy industry development in COMESA member states takes place in the context of varying electrification rates. Egypt, Mauritius and Seychelles have the highest electrification rates (over 95%), while countries like the DRC, Malawi and Uganda have very

low electrification rates (below 10%). In all these countries renewable energy brings the opportunity to provide decentralised electricity to remote (commonly rural) areas which otherwise would have been too costly to supply from the conventional energy generation centres as it requires extensive extension of the transmission and distribution infrastructure.

A number of renewable energy small projects, particularly solar PV projects, were found to fall under the rural electrification programmes for most member states.

1.2.1 Hydro Power

Hydro power generation was found to be the largest source of renewable energy in the COMESA region. There is often a debate amongst energy scholars on whether large hydro power should or should not be included in renewable. It is clean and renewable – thus, for the purpose of this report all hydro power generating systems are treated as renewable energy.

The hydro power potential amongst COMESA member States in enormous and will remain the main source of renewable energy. It is argued that the DRC could potentially supply power to the entire region at fairly reasonable tariff from its hydro resources. Challenges such as the availability of funding and grid connectivity to the other countries prevent this great opportunity from being explored.

1.2.2 Biomass

The main commercial source of biomass electricity generation in the COMESA member states is bagasse (a residue from the crashing of sugar cane at the milling unit in sugar manufacturing and recently ethanol factories). Fuel wood is generally used for in-door heating purposes in rural areas, which has the potential to cause ill-health to users. Without monitoring and regulation, the harvesting of fuel wood could detrimental to deforestation and hence have negative consequences to the environment.

Almost all operational biomass energy is based on bagasse co-generation in sugar mills. Mauritius is the most advanced in this respect where close to 40% of the country's electricity generation is from bagasse. Similar plants exist in Malawi, Kenya, Sudan, Swaziland Zambia and Zimbabwe. As electricity tariffs in these countries increase, plants with access to bagasse are increasing their efficiencies and targeting supplying the national grid with their excess power.

1.2.3 Solar Energy

Due to the abundance of free solar energy resource in all the COMESA Member States and the demand electricity supply in remote areas, photovoltaic applications are on the increase. Solar PV systems are used for rural domestic and public institutions (clinics, schools) electrification, powering remote telecommunication equipment as well as for pumping water. Solar thermal is dominated by solar water heaters mostly used to heat water in remote public institutions (hospitals, government buildings) and hotels.

Some of the countries, such as Egypt have advanced the rolling out of solar technologies and have developed a local manufacturing industry thus creating jobs and at the same time serving a national need and promoting the use of RE. Mauritius has developed a grid code for small scale distributed generation for small independent power producers with a capacity below 50 kW. This will enable small generators to produce for own use and supply the grid with excess. The cap is the first 200 applications or 2 MW – whichever comes first. Other countries, such as Swaziland, have developed good policies that have not yet been implemented.

The main market for PV systems consists of:

1. Rural domestic electricity
2. Telecommunication
3. Water pumping in rural areas
4. Rural schools and public institutions
5. Rural clinics
6. Other: robots, navigational buoys, parking ticket dispensers, solar powered hearing aids, etc.

Solar water heaters are mostly used for hot water supply to households, clinics, hotels and remote government buildings. Local manufacturing capacity for these technologies has been developed in Egypt and Zimbabwe. These countries, together with imported units from Europe, Asia and South Africa supply most of the COMESA demand. SWH is the renewable energy with the potential for local manufacturing or sourcing from within the COMESA trading block. There is considerable potential for market growth for SWH, their price is gradually declining whereas electricity prices are increasing rapidly due to the requirement for new (and expensive) generation capacity. The growth is highly dependent on the energy policy of each COMESA Member State – market forces are yet able to stimulate or sustain growth because SHW still require some form of incentives to compete with conventional electricity.

1.2.4 Wind Energy

Wind energy favours coastal areas; whereas, most members of COMESA are land locked. This, however, does not rule out wind energy as an alternative source of energy. Even within land locked countries, there are pockets of good wind resources where small to medium wind energy plants can be installed. Egypt, for example, has an installed capacity of 522 MW wind farms (517 MW at the Zafarana Wind Farm alone) and Kenya commissioned a 5.1 MW wind energy plant in 2010, with plans to increase this farm to 11.8 MW.

The traditional market for wind energy has been mechanical water pumping. This market is declining with the advent of PV pumps and the extension of the grid to rural areas. A small market exist for wind turbine battery chargers (<5kW) for use in remote applications. Large wind turbines supplying the grid are still relatively expensive and complex to maintain. However, like in the case of solar, wind energy is increasingly getting attention and most COMESA countries have plans to at least research and identify suitable sites.

1.2.5 Geothermal Energy

The only country that has successfully developed geothermal energy is Kenya. Currently its installed capacity is about 200 MW. Other countries are still at planning stages to explore the availability of this resource and determine if it can be economically developed. The technology is complex and there is scarcity of information. Other RE sources tend to be more viable and most energy and policy instruments in COMESA highlight geothermal energy as the last resource to spend money on. The private sector has also not shown much interest due to scarcity of information.

1.2.6 Municipal Waste

Municipal biodegradable waste is a potential source of energy in large cities where sufficient landfill gas can be extracted. While acknowledged as a potential source of RE by most COMESA countries, very little (if at all) resources have been spent on developing projects in this area except for Mauritius where a 2MW landfill gas to energy has recently been commissioned.

1.2.7 Biofuels

Most of the COMESA member states south of the equator have suitable under utilized land. The market for biofuels – both ethanol and biodiesel – will increase rapidly in the next 10 years due to the EU 2020 mandate of 20% blending. The EU countries do not have the agricultural capacity to produce the required biofuels for meeting these blending targets. Most EU liquid fuels majors look to Africa to supplement European production. Within COMESA, a market can be created by enforcing blending mandates in the member states. This would create an impetus for biofuels production in the region which would lead to job creation and savings of foreign currency.

1.3 Barriers to the Renewable Energy Technology Deployment

The deployment of renewable energy technologies was found to be constrained by a number of factors including:

a. *The relatively high costs of renewable energy* – (with the exception of existing large hydro power generating plants) most renewable energy generation would be higher than conventional energy in the COMESA member states. Where there is an economic driver for RE deployment (e.g. for distributed electricity supply to remote areas), in most cases the end-user does not have the financial capacity to support the investment.

b. *The relatively high development/investment costs* – investment costs are increased by the lack of industry information and the time it takes to develop a project. The lack of basic information like renewable energy resource data, leads to high project development costs as a developer has to collect this data before an investment decision can be made. Institutional frameworks in COMESA countries also present a barrier for the deployment of RETs as the roles of the different industry institutions are normally not clear, leading to delays in permitting and licensing of projects.

c. *The small fragmented economies imply small markets* – energy demand in COMESA countries is low because of the size of the economies and without integration these countries are perceived as small fragmented markets that would not enable investors to capitalise on economies of scale. Countries like Egypt (and South Africa), because of their large energy demand, have managed to attract significant investment and deployment of RETs.

d. Other barriers includes:

i. The absence of a stand-alone renewable energy policy as well as focus on implementing the policy.
ii. The absence of coherent national and COMESA renewable energy investment framework.
iii. The general view amongst utilities in COMESA that PV is a second rate and pre-electrification technology.
iv. The low level of industrial development in COMESA.
v. The fact that currently in most Member States RE projects are mainly donor driven.
vi. Low technical know-how within government senior officials.
vii. The affordability challenge of the rural community – their income in most instances can hardly meet basic needs.
viii. The limited economic integration within the COMESA Member States – trade amongst the members is at foundation stages.
ix. The lack of information of the region's viability as a regional market for renewable energy technologies.
x. The lack of COMESA / Sub-Saharan Africa technical standards pertaining to renewable energy technologies.
xi. The high perceived investment risks.
xii. The credit worthiness of off takers.
xiii. Poor regulatory and institutional framework.
xiv. Absence of reliable information on renewable energy resource potentials
xv. Lack of financing for RETs

The barriers can be addressed by the establishment of a regional renewable energy policy and integration of the renewable energy market.

1.4 Drivers of investments in the Renewable Energy Sector

In spite of the above barriers, COMESA has parameters that still presents good investment opportunities in the RE sector.

Privatisation

The shift from monopolistic energy sector dominated by state utilities to a more open market approach in a number of COMESA Member States has opened up opportunities for IPPs. Most states have established independent Regulators whose role is to ensure the market is liberated and open to private sector participation. This is of interest to grid connected generation such as hydro power, wind energy and concentrated solar power.

Investment Incentives

Most COMESA member states now have a range of investment incentives in place. The nature of these investments is structured to stimulate economic activities in the following areas:

- The manufacturing industry;
- Job creation; and,
- Increased exports.

REFIT is considered an important incentive to stimulate large RE projects. However, currently it does lead to higher prices for the consumers and Regulators take time to formulate a viable REFIT program, leading to delays and even abandonment of private sector initiatives. Only a few COMESA member states have a REFIT regime, though most are considering it. The resistance tends to come from the consumers who are more interested in cheaper energy than cleaner energy.

Tax relief instruments as well as direct cash contribution from the national treasurer can also be used as investment incentives for RE. An appropriate PPA framework from the national utility (or with government support) can also act an incentive as it guarantees the investor or project developer predictable and dependable revenues.

1.5 Recommendations

Most factors influencing the RE market are related to the broader energy sector and economic development policy and can therefore not are dealt with in isolation. These factors include the development of a sound regulatory environment, transparent and functional systems for attracting and protecting long term private

sector investments and a competitive market for service delivery. A phased approach is therefore inevitable in addressing the widespread implantation of renewable energy systems / projects as these elements must be put in place. Only Egypt has most of the key systems in place, other member states are in the process of doing so. The current worldwide recession has halted the pace of implementing these systems.

Specific renewable energy initiatives were identified which will facilitate development in the RE sector, prevent future marginalization of RE and assist in ensuring their rightful integration into the mainstream infrastructure and service delivery programmes. Based on the data obtained, the following measures are recommended for the successful development of RE industries in the bloc and member states:

1. **Renewable Energy Resource Mapping** - most COMESA member states could not provide a renewable energy resource map for their countries. This makes it difficult for member states to design RE programmes for their countries and to target specific investors. For the potential RE investor, the unavailability of a resource map increases project development costs and delays investment decisions.

2. **Development of a Comprehensive Renewable Energy Policy** - Annexure 1 shows that all COMESA member states do not have a standalone RE policy but rather the country's renewable energy policy is articulated in the energy policy.

   A comprehensive RE policy should, at the least, cover the following parameters:

   a. *RE resource potential*
   b. *National objectives*
   c. *RE targets*
   d. *Financing of RE*
   e. *Cost recovery mechanism*
   f. *Licensing, Off-take Arrangements and/or Procurement Processes*
   g. *Institutional framework*

   Promulgating comprehensive RE policies will unlock the RE potential of most countries and bring the RE projects under development in the countries to commercial operation.

3. **Develop Large Scale Renewable Energy Programmes** – once the RE resource is known, it may be possible for the member states or the bloc to design large scale

RE programmes that could bring economies of scale to enable manufacturing capacity and reduce the cost of RE production.

The last two chapters of this report elaborate on these recommendations and suggest an action list to implement.

2 INTRODUCTION

The energy sector is every important to every country's economy as it fuels economic growth and development. In many countries, the electricity sector started off as a vertically integrated sector with a state owned utility owning the generation, transmission and distribution assets. The generation assets were centralised, large scale generation plants requiring extensive transmission infrastructure to wheel the electricity to the load centres or points of consumption. In recent times, many countries have unbundled their utilities and have also increased private sector participation in electricity generation, transmission or distribution.

Previously, a country's electricity generation mix was determined primarily by the financial least cost option. As evidence of electricity supply risks surfaced from economies dominated by a single energy resource (e.g., in 2008 Ethiopia, which is hydro dominated, suffered severe electricity generation shortfalls due to prolonged drought conditions), countries started to acknowledge the need to diversify their electricity generation mix. Recently, the negative effects of greenhouse gas emissions from the use of fossil fuels for electricity generation have been highlighted leading to a worldwide concerted effort to increase electricity generation from environmentally benign technologies and resources. Renewable energy resources like solar, wind and hydro have the potential to diversify the electricity generation mix of a country while reducing its greenhouse gas emission footprint.

Installed renewable capacity has grown rapidly over the past decade around the world. While the growth has been mainly in developed nations, it is encouraging that developing countries have also embraced RE, as an integral part of this growth. In response to economic growth and projected high demand for energy, over US$150 billion was invested in RE in 2009[1]. In 2010, this increased to US$240 billion[2], with the US and Europe adding more electricity generation capacity from renewable resources than conventional energy resources like coal, gas and oil.

The purpose of this study is to assess the status of RE development in COMESA member states, identify barriers for RE deployment in the COMESA trading bloc and make recommendations for regulatory framework harmonisation to create an enabling environment for the deployment of RE. The report will serve as a baseline for both renewable energy policies and projects in COMESA member states.

[1] REN21 Renewables 2010 Global Status Report
[2] Bloomberg New Energy Finance, 2011

2.1 Climate Change

Of the many problems facing the world in the 21st century, climate change and the dwindling supply of low-cost energy are two of the largest. RE has the potential to sole both.

Climate change is a long-term shift in the climate of a specific location, region or planet. This shift is measured by changes in featured associated with average weather patterns such as temperature, wind patterns and precipitation. What most people don't know is that a change in the variability of climate is also considered climate change, even if the average weather remains the same.

Global warming (as well as global cooling) refers specifically to any change in the global surface temperature. An increase in average global temperature will also cause the circulation of the atmosphere to change, resulting in some areas of the world warming more, other less or even cooling.

A natural system known as the "greenhouse effect" regulates the earth temperature. Earth is heated by sunlight. Most of the sun's energy passes through the atmosphere to warm the earth surface, oceans and the atmosphere. However, in order to keep the earth's energy in balance, the warmed earth also emits heat back to space as infrared radiation.

As this energy radiates upwards, most is absorbed by clouds and the molecules of greenhouse gases in the lower atmosphere. These radiate the energy in all directions, some back toward the surface and some upwards where molecules higher up can absorb the energy again. This process of absorption and emission is repeated until finally the energy escapes from the earth.

However, because much of the energy has been recycled downward, surface temperature become much warmer than if the greenhouses were absent from the atmosphere. This natural process is known as the greenhouse effect. Without greenhouse gases, the Earth's temperature would be – 19 degrees Celsius instead of the current +14 degrees Celsius – i.e., 33 degrees Celsius cooler.

2.2 Benefits of Renewable Energy

COMESA member countries understand the potential benefits of RE including:

- the opportunity to beneficiate local resources e.g. hydro resource, biomass
- the advantages for distributed generation which can reduce cost of electricity supply to remote areas

- contribution to economic growth through introduction of new industries, technologies and skills
- diversifying the countries' electricity generation mix
- reducing the countries' greenhouse gas emission (carbon) footprint.

In many African states, electrification rates are very low and the impediment to electrification is the cost of the transmission infrastructure from the point of electricity generation to remote villages. Renewable energy technologies are an opportunity to have small decentralised generation where small demand centres can have access to modern energy.

2.3 Limitations of Renewable Energy Technologies

Renewable energy technologies are not without their limitations. The intermittent nature of wind and solar energy, the seasonality of run-of the river water supply for small hydro, means that these technologies cannot be relied on to provide base-load electricity. Complimentary electricity storage technologies for renewable energy tend to increase the cost of electricity supply.

2.4 Market failures for renewable energy deployment

If renewable energy can increase the security of electricity supply through diversification of the electricity mix while at the same time reducing the greenhouse gas emissions, why is there no explosion of renewable energy development in Africa where renewable energy resources are abundant and there is an acute shortage of electricity?

Renewable energy technologies face three main market failures or barriers for deployment:

a. Tariff gap

Even though capital costs for RE technologies have been on a downward trend, they remain relatively higher than those of conventional technologies per installed energy capacity. With the RE generator operating at below 50% capacity factors, RE technologies tend to require higher tariffs than conventional energy generators to be financially viable.

With the introduction of penalties for carbon emitters (e.g. carbon tax) in many countries, the conventional electricity generation tariff will soon drastically

increase while the cost of RE technologies continues to drop as more research is done and technology efficiencies increase. It is predicated that in countries introducing carbon taxes, grid parity for renewable energy technologies will be achieved in the next 5-10 years.

b. Enabling regulatory framework for renewable energy off-take

National utilities are focused on base-load electricity generation from conventional resources. RE deployment is usually at a small scale and most valuable to a market that cannot afford to pay for it (e.g. a remote village). The RE developer therefore does not have access to a secure cost recovery mechanism or framework. Utilities cite the lack of a regulatory framework for them to enter into a long term power purchase agreement (PPA) with RE developers. The renewable energy developer ends up not being able to raise the required project funding in the absence of a secure long term PPA with a credible off-taker.

c. Relatively high development costs

RE developers face high development costs at the beginning of the project to verify the RE resource, obtain environmental permits and approval for the project, obtaining permits and licenses for the electricity generation and finalising the business case for funders. All these costs are normally incurred at risk as the RE off-take is not guaranteed.

COMESA has developed and adopted a Model Energy Policy Framework which is guided by the COMESA Treaty, provisions on energy. The COMESA Energy Programme is used to facilitate energy policy and regulatory harmonization. Most COMESA member states are signatories to the Kyoto Protocol – an indication of their willingness to contribute to green-house-gas emissions reduction. The Clean Development Mechanism of the Kyoto Protocol is a mechanism through which emission reduction projects, like RE projects, implemented in developing economies can trade the emission reduced (certified emission reductions or CERs) with the developed countries. The CDM in many instances has led to successful implementation of RE projects by turning marginal projects into economically viable projects through the second revenue stream from the trading of the CERs. Between 2002 and 2008 renewable energy projects in developing countries were due to receive US$95 billion for their CERs.

The CDM hangs in the balance as the Kyoto Protocol comes to an end in 2012 with no new agreement concluded to date or the extension of this agreement confirmed. On the positive side though, the 15th conference of the parties (COP15) in Denmark saw developed

countries pledge up to US$ 100 billion up to 2020 for funding and technical support for carbon emission reduction projects, including renewable energy, in developing countries.

In harmonising the renewable energy policies of member states, it is important for COMESA to develop guidelines that will address the three market failures identified above. The baseline of RE projects collated in this report should serve as a source of information for the opportunities that RE presents as well as identifying barriers for meaningful implementation of RE.

It is important for COMESA to bear in mind that renewable energy implementation is not limited to the electricity sector but is also applicable to the liquid fuels sector as well. The greening of the liquid fuels sector is commonly achieved with biofuels (bioethanol and biodiesel) which requires large agricultural activities. The European Union has set itself a target of 20% biofuels in its liquid fuels but due to the EU's limited agricultural potential, it is looking to Africa as a source of the biofuel. The biofuels sector therefore presents another opportunity for renewable energy development in COMESA member states though its policy has to be carefully developed as unregulated biofuels production can have unintended negative consequences on food production and land tenure.

This report focused on developing a baseline for renewable energy for electricity generation. It is structured into 8 chapters:

CHAPTER	TITLE
1	Executive Summary
2	Introduction
3	The COMESA Renewable Energy Policy Framework
4	Specific Types of Renewable Energy
5	Member States Renewable Energy Analysis
6	COMESA Integrated Market Potential for Renewable Energy
7	Recommendations
8	Way Forward
Annexure 1	Status of development of RE Policy in COMESA member states
Annexure 2	Country Specific Report
Annexure 3	List of Renewable Energy Projects

3 THE COMESA RENEWABLE ENERGY POLICY FRAMEWORK

The main thrust of the COMESA Model Energy Policy Framework is to provide the COMESA member States with harmonized guidelines that would facilitate energy policy harmonization in the COMESA region in efforts to improve efficiency and increased investment. The models covers all energy types, including renewable energy. The model encourages the establishment of independent Regulators whose objectives will mainly centre on the following:

(i) To promote investment and develop the modern energy resources including their infrastructure;

(ii) to promote competition; and

(iii) to ensure that entry of new players is not inhibited.

Main Energy Policy Goal and Objectives

The main energy policy goal is to meet the energy needs, in an environmentally sustainable manner, through providing an adequate and reliable supply of energy, at least cost, to support: social and economic development and sustainable economic growth and also to improve the quality of life of the people.

The main energy policy objectives of this model energy policy framework include the following:

1. Improve Effectiveness and Efficiency of the Commercial Energy Supply Industries;
2. Improve the Security and Reliability of Energy Supply Systems;
3. Increase Access to Affordable and Modern Energy Services as a Contribution to Poverty Reduction;
4. Establish the Availability, Potential and Demand of the Various Energy Resources;
5. Stimulate Economic Development;
6. Improve Energy Sector Governance and Administration;
7. Manage Environmental, Safety, and Health Impacts of Energy Production and Utilization; and
8. Mitigate the Impact of High Energy Prices on Vulnerable Consumers.

Biomass and other Renewable Sources of Energy Sub-sector

Biomass **- t**he policy objective is to ensure sufficient and sustainable supplies of biomass to meet the demand while minimizing to a very far extent the environmental impacts associated with biomass industry.

The policy objectives of other **r**enewable sources of energy (hydro power, solar energy, wind energy, geothermal power and other possibilities) include the following:

a) to increase the contribution of other renewable sources of energy in the energy balance;
b) to utilize other renewable sources of energy for income and employment generation; and
c) to develop the use of other renewable sources of energy for both small and large-scale applications**.**

At present, most COMESA member states have established energy policies. None of the COMESA member states have a stand-alone energy policies. The development of the energy policies was in most instances done with the financial and technical assistance of the World Bank or other international organizations. Thus, the policies do cover the important elements that must be addresses in an energy policy and cover the key RE issues raised in the COMESA model. While most countries have developed the policy and the plans outlining what needs to be done, very few have made the final decision on how the policy is to be implemented. Where the decision has been made, member states generally struggle with the implementation and end up putting aspects of the implementation on hold.

Comoros have not yet developed an energy policy; they have requested technical assistance from the COMESA Secretariat based on the COMESA Model. On the other extreme, Egypt Kenya and Mauritius have set targets and are working towards the targets. Kenya has the advantage of being part of the six nations selected for the Scaling-UP of Renewable Energy Program for low income countries pilot project – i.e., it is getting external financial and technical support on its RE projects.

4 SPECIFIC TYPES OF RENEWABLE ENERGY

4.1 Hydro Power

Hydropower is power that is derived from the force or energy of moving water, which may be harnessed for useful purposes – mainly that of generation of electric power. Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. The power extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. This height difference is called the head. The amount of potential energy in water is proportional to the head. A large pipe (the "penstock") delivers water to the turbine.

The pumped-storage method produces electricity to supply high peak demands by moving water between reservoirs at different elevations. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir.

Run-of-the-river hydroelectric stations are those with small or no reservoir capacity, so that the water coming from upstream must be used for generation at that moment, or must be allowed to bypass the dam.

The hydro power potential of the COMESA member states can supply enough power to the all the member states at reasonable prices. The main obstacle is getting the investment as this project of highly capital intensive; however, the operating costs are low because the primary energy is almost free. Although there is significant potential for micro-hydro electricity generation in several COMESA Member States, the lack of available and verified data hampers the identification of those sites with the greatest implementation potential.

There is no formal international recognized definition of what constitute large versus small hydropower, generally speaking a large hydropower facility can be in the range 50-500 MW, medium hydropower ranges from 10 – 50 MW, while a small hydropower refers to plants lower than 10 MW. Some jurisdiction make several graded distinctions, such as “mini” for hydropower that is between 100 kW and 1 MW, “micro” for hydropower between 5 and 100 kW and “Pico” for less than 5 kW. Table 1 below shows the number of hydro power projects in some of the COMESA member states where data is available.

Table4. 1: Number of Hydropower Station in COMESA countries (see Annexure 2 for details)

COUNTRY	NUMBER OF HYDRO POWER PROJECTS[3]			
	Large > 50 MW	Medium:20-50 MW	Small: 1-20MW	Micro: <1 MW
BURUNDI	0	0	2	0
COMOROS	0	0	1	0
DRC	3	2	1	0
DJIBOUTI[4]	0	0	0	0
EGYPT	4	6	10	2
ERITREA	0	0	0	0
ETHIOPIA	11	1	1	6
KENYA	0	6	4	0
LIBYA	0	0	0	0
MADAGASCAR	5	3	24	33
MALAWI	0	0	4	0
MAURITIUS	0	1	3	5
RWANDA	2	2	8	14
SEYCHELLES	0	0	0	0
SUDAN	1	0	2	0
SWAZILAND	0	1	2	0
UGANDA	1	0	0	0
ZAMBIA	4	1	1	0
ZIMBABWE	0	0	0	10

Source: National Country Reports.

4.2 Biomass

In the first sense, biomass is plant matter used to generate electricity with steam turbines & gasifiers or produce heat, usually by direct combustion. Examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. In the second sense, biomass includes plant or animal matter that can be converted into fibres or other industrial chemicals, including biofuels. Industrial biomass can be grown from numerous types of plants, including miscanthus, switch grass, hemp, corn, poplar, willow, sorghum, sugarcane, and a variety of tree species, ranging from eucalyptus to oil palm (palm oil).

Some of the advantages of biomass include:

[3] In all section 4 table, projects refers to operational plants of facilities that are at advanced stages of construction.
[4] Djibouti's 116 MW installed capacity is dependent on diesel and heavy fuel oil

i. It use can be adjusted to meet demand.
ii. Unlike wind and solar, it does not have intermittency problems.
iii. It can be applied at a variety of different scales.

One of the most important issues in biomass is ensuring that it is truly an environmentally sound, renewable energy source. Biomass is often used by the less affluent members of society, where wood and charcoals are readily accessible. Biomass can be seen as contributing to deforestation. It is envisaged that biomass sources of energy will remain the mainstay of energy provision for low-income house hold in COMESA for decades. Although the importance of biomass as both a *modern* and a *traditional* energy source is widely acknowledged, there is very little investment in biomass electricity generation plants in the COMESA Member States. The sugar industry is however increasing its co-generations component and is selling the excess power to the national grid.

Table 4.2: Number of Projects in COMESA countries

COUNTRY	NUMBER OF BIOMASS PROJECTS	Installed Capacity (MW)
BURUNDI	0	0
COMOROS	0	0
DRC	2	10
DJIBOUTI	0	0
EGYPT	0	0
ETHIOPIA	4	120[5]
ERITREA	0	0
KENYA	1	26
LIBYA	0	0
MADAGASCAR	23	2.1
MALAWI	0	0
MAURITIUS	6	155
RWANDA	0	0
SEYCHELLES	0	0
SUDAN	3	55
SWAZILAND	1	25
UGANDA	0[6]	0
ZAMBIA	2	46
ZIMBABWE	2	40

Source: National Country Reports.

[5] To be commissioned in 2012
[6] used primarily for off-grid electrification for rural communities, as well as for solar cooking, and providing water heating and power to public buildings

4.3 Solar Power

Solar power is the conversion of sunlight into electricity, either directly using photovoltaic , or indirectly using concentrated solar power. Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic convert light into electric current using the photoelectric effect.

Commercial concentrated solar power plants were first developed in the 1980s, and the 354 MW SEGS CSP installation is the largest solar power plant in the world and is located in the Mojave Desert of California. Other large CSP plants include the Solnova Solar Power Station (150 MW) and the Andasol solar power station (100 MW), both in Spain. The 97 MW Sarnia Photovoltaic Power Plant in Canada, is the world's largest photovoltaic plant.

Solar energy constitutes a major renewable energy resource available throughout COMESA. All Member States are well endowed with sunshine throughout the year and a solar radiation average over twice that of Europe making the COMESA solar power resource one of the most intense in the World. This has great potential for short to medium term exploration, even at current levels of technological development and cost, for such applications such as small-scale remote area power supplies, community water pumping, SHW, and passive solar housing design.

In terms of commercial market growth considerations, and related increase in access to potential end-uses, solar energy offers considerable prospects. Two applications are of particular interest, namely the utilization of PV for household electrification and SHW for domestic, commercial and industrial use. The largest application of PV systems is in the field of rural service provision. The systems provide a means of accelerating household electrification and enabling essential services such as lighting and refrigeration to be delivered to rural schools, clinics and community centres.

Table 4.3: Number of Solar Power Facilities in COMESA countries[7]

COUNTRY	NUMBER OF SOLAR PROJECTS	Installed Capacity (MW)
BURUNDI	O	0
COMOROS	0	0
DRC	0	0
DJIBOUTI	0	0
EGYPT	2[8]	150

[7] Excludes small PV systems
[8] Excludes 400 000 Solar Water Heaters

COUNTRY	NUMBER OF SOLAR PROJECTS	Installed Capacity (MW)
ETHIOPIA	0	0
ERITREA	0[9]	0
KENYA	0	0
LIBYA	1	1.865
MADAGASCAR	10	1.4
MALAWI	7 000[10]	0.7
MAURITIUS	1	(small projects totalling 2 MW)
RWANDA	1	0.25
SEYCHELLES	0	0
SUDAN	0[11]	0
SWAZILAND	0	0
UGANDA	0	0
ZAMBIA	0	0
ZIMBABWE	0[12]	0

Source: National Country Reports.

4.4 Wind Power

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions during operation. A large wind farm may consist of several hundred individual wind turbines which are connected to the electric power transmission network.

Though for electricity for about 2 centuries, wind power has become possible on a large scale only since about 1980s, when technology advanced sufficiently to make large wind turbines cost-effective. At the end of 2010, worldwide nameplate capacity of wind-powered generators was 197 GW. Energy production was 430 TWh, which is about 2.5% of worldwide electricity usage.

Within COMESA there are some areas that have very good wind potential, primary coastal areas or exposed escarpments, though several countries have sufficient wind inland to enable small-scale applications such as windmills. In comparison to production by fossil fuels, wind-farm generation energy is at least at factor 3 more expensive.

[9] Currently used in public schools and public buildings – total capacity not quantified
[10] Solar home systems
[11] 45 000 households on PV
[12] Over 10 000 PV systems and 200 000 SWH

Table 4.4: Number of Wind Power Units in COMESA countries

COUNTRY	NUMBER OF WIND PROJECTS	Installed capacity (MW)
BURUNDI	0	o
COMOROS	0	0
DRC	0	0
DJIBOUTI	0	0
EGYPT	2	567
ETHIOPIA	7	120[13]
ERITREA	0	9
KENYA	5	385.5
LIBYA	0	0
MADAGASCAR	6	0.16
MALAWI	0	0
MAURITIUS	4	1.28
RWANDA	0	0
SEYCHELLES	1	6[5]
SUDAN	0	0
SWAZILAND	0	0
UGANDA	0	0
ZAMBIA	1	0.2
ZIMBABWE	0	0

4.5 Geothermal Energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet, from radioactive decay of minerals and from volcanic activity. The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface.

Typically resources with temperature greater than 150 degrees Celsius are used for electricity generation. Worldwide, about 10,715 MW of geothermal power is online in 24 countries. An additional 28 GW of direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agricultural applications.

Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries.

[13] Installed capacity of one of the wind projects to be commissioned in 2012

Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

Table 4.5: Number of Geothermal Plants in COMESA countries

COUNTRY	NUMBER OF GEOTHERMAL PROJECTS	Installed Capacity (MW)
BURUNDI	0	0
COMOROS	0	0
DRC	0	0
DJIBOUTI	0	0
EGYPT	0	0
ETHIOPIA	1	7.3
ERITREA	0	0
KENYA	7	516.5
LIBYA	0	0
MADAGASCAR	0	0
MALAWI	0	0
MAURITIUS	0	0
SEYCHELLES	0	0
RWANDA	0	0
SUDAN	0	0
SWAZILAND	0	0
UGANDA	1	-
ZAMBIA	1	0.2
ZIMBABWE	0	0

Source: National Country Reports.

4.6 Municipal Waste

Municipal biodegradable waste is a potential source of energy in large cities where sufficient landfill gas can be extracted. While acknowledged as a potential source of RE by most COMESA countries, very little (if at all) resources have been spent on developing projects in this area except for Mauritius where a 2MW landfill gas to energy has recently been commissioned.

4.7 Biofuels

Bio-ethanol

Bioethanol demand is expected to increase 3 times in the next decade, largely driven by the EU market. EU regulations require member states to achieve 20% blending by 2020. This is a huge market, most EU member states do not have suitable land to grow the feedstock for biofuels and look to Africa as one of the suppliers of this market. Within COMESA member states, moves are underway to introduce ethanol blending into the fuel pool.

It makes economic sense and is environmentally friendly to introduce fuel grade ethanol into the fuel pool. Most fuel is refined from feedstock, namely crude oil that comes outside the region. For smaller economies, crude refining is not economically viable, leading to imports of the final product – i.e., refined fuel. COMESA members, particularly those South of the equator have vast unutilized land that is suitable for growing ethanol feedstock – sugar cane, sweet sorghum, wheat etc. Ethanol production facilities are labour intensive because of the large agriculture component.

Other uses of bio-ethanol are industrial chemicals and beverage manufacturing. Biofuels can also be used for lighting and cooking in households.

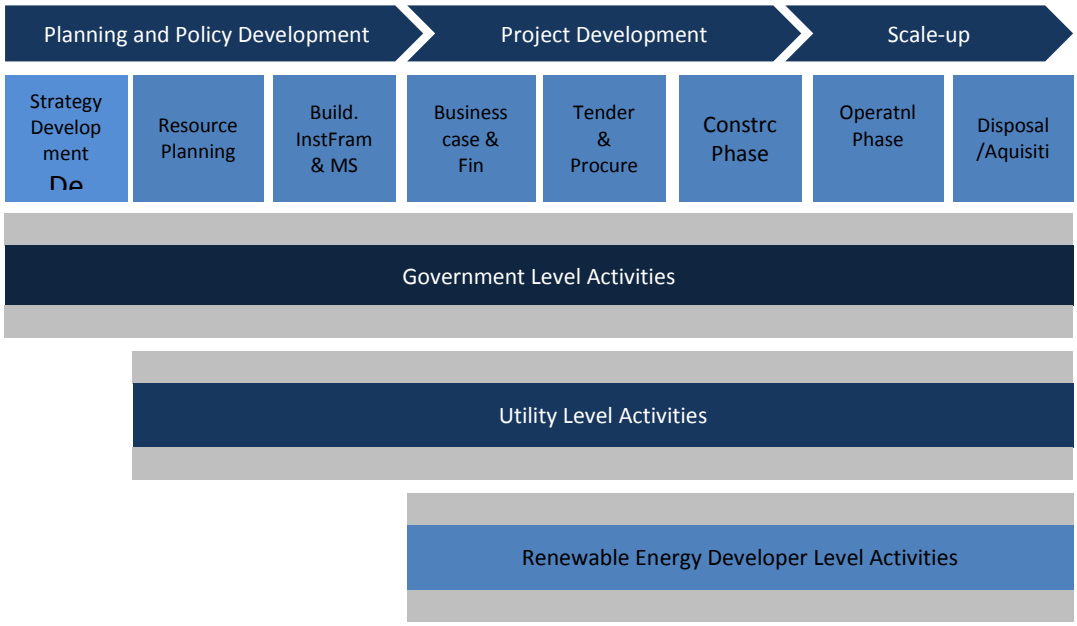
Bio-diesel

Bio-diesel can be produced from virtually any oil crops including seeds from soya bean, sunflower, peanut, cotton, avocado, Croton, Jatropha, castor and coconut palm as well as animal fats. It can also be made waste vegetable oils. In same vain as ethanol, the market is within COMESA member states and the EU.

5 COUNTRIES RENEWABLE ENERGY ANALYSIS

The Renewable Energy Life Cycle Model shown below is used by as the basis for the country analysis. It proposes that, at a high level, the development of renewable energy capacity in countries can be broken down into three key stages as shown in Figure 5.1.

Figure 5.1 Renewable Energy Life Cycle Model Overview



These three stages are:

1. **Planning and Policy Development:** Governments seek to create the right enabling conditions to encourage the development of renewable energy projects.

2. **Project / Programme Development:** With a more supportive business environment in place as a result of a wider government programme, the private sector begins to explore the development of projects, aided by government and national utility activities.

3. **Scaling-up:** Appropriate enabling conditions are in place at a country level. Government level programmes are established and projects have been successfully developed and are at a point where they can be commissioned and connected to the electricity grid to supply electricity.

The model also proposes three broad categories of stakeholder that are key along this life cycle. In practice, there will be a diverse set of other stakeholders and organizations that are involved. However, these are normally reliant in different ways on these three primary stakeholders.

- Country Governments (including the relevant ministries, agencies, etc. responsible for aspects of renewable energy)
- National Utility (responsible for the grid infrastructure)
- Renewable energy project developers (usually private sector).

5.1 Long-Term Planning

The first challenge relates to long-term planning. Ambitious targets for RE generation are normally set in response to international trends and commitments in international forums such as COPE. However, there is a risk that the credibility of these targets (once set) will be undermined without meaningful mechanisms for delivery as part of an overall strategic framework. Although Ministries pave the way for individual or flagship projects, this does not necessarily lead to programmes of work or the development of a wider market.

Long-term planning also needs to be supported by a number of other aspects to be credible. This includes the following:

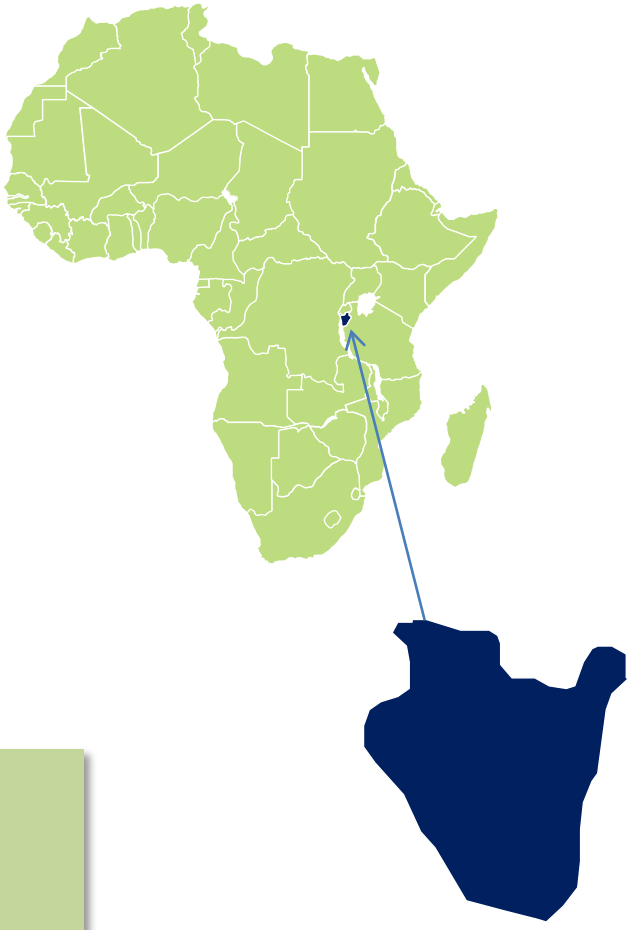
Renewable resource data – updated and consolidated resource maps need to be accessible as part of a national strategy. The investigation reveals that such data is not always readily available amongst most COMESA member States. Private investors require such data for purpose of trying to optimally site projects. For most countries, detailed data assessments are yet to be done.

Transparency of Electricity Pricing – Renewables have the potential to provide a surge of power at peak time, and so may be profitable under differentiated pricing. Peak tariffs should be made publicly available in order to support the development of business cases. Also, REFIT and other incentives must be long-term and publicly available.

Standardization of power purchase agreements – Inconsistent contracts for project development are not conducive to the creation of a true market for renewables. This situation can be compounded if regulators are new to their role and not yet familiar with many of the RE market intricacies.

Consistency – There is always a risk of publicly made promises not being kept, with frequent changes in Energy Ministry Leadership and legislation or where the policy horizon matches the election cycle. Constant amendments to legislation and/or Regulations create confusion for projects in transition and require regulatory steps to be repeated to obtain the latest permits.

5.1 Burundi



Capital City: Bujumbura
Size: 27 816 km2
Population: 8.5 million
GDP: US$ 1.796 billion

Peak Demand: 44 MW
Installed capacity: 34 MW
Share of RE in generation mix: 95%

Electrification rate: 1.8%
Utility: REGIDESO & SINELAC
Energy Regulator: Ministry of Energy

Renewable Energy Resources:
Hydro Power (Potential 1 700 MW)
Solar (Potential 5 kWh/ m2/day)
Wind (Potential No Data MW)
Biomass (Potential No Data MW)
Biofuels - None



Burundi’s Renewable Energy Analysis

Energy Policy Framework

Burundi’s Poverty Reduction Strategy (2006) identifies the severe shortfall in electricity supply as a major constraint for development. It recognises the need to undertake urgent actions (including the rehabilitation of existing power plants and the construction of new facilities) to ensure an adequate power supply, and endorses the government’s plan to undertake a rural electrification program by extending the grid and connecting villages, as well as disseminating information on alternative energy sources which are affordable for low-income households.

Market Applications of Renewable Energy Technologies

Hydro Power

Burundi’s theoretical hydropower capacity is 1,700 MW, however, roughly 300 MW is seen as economically viable, and only 32 MW has been exploited.

Biomass

Biogas is a form of energy adapted well to the needs for Burundi. The current government plan is to produce energy by means of digesters. Fuel-wood accounts for the vast majority of Burundi's energy consumption. However, potential wood consumption in the country is forecast to require production of 180,000 hectares, which surpasses the current forest coverage of 174,000 hectares, suggesting the need for reduction of consumption and re-forestation programs.

Solar Energy

Average solar insolation stands at 4-5 kWh/ m2/day. Solar energy is being investigated and utilised as a means of off-grid electrification for rural areas. Institutions such as the Solar Electric Light Fund have also invested in small solar systems for public buildings, such as health centres.

Wind Energy

Data on wind patterns has been recorded by the Institute for Agronomic Sciences of Burundi primarily for agricultural purposes; give a mean wind speed between 4 and 6 m/s. More potential sites probably exist in the higher elevations. Pilot private-sector schemes are currently operational.

Geothermal

Resources have been identified, but there is little available data to assess commercial viability, the last geothermal study of the region having been conducted in 1968.

RE Incentives

There is no legislation covering financial support for RE.

5.2 Comoros





Capital City: Moroni
Size: 2 236 km2
Population: 752 438
GDP: US$ 581.5 million

Peak Demand: 18.57 MW
Installed capacity: 19.74 MW
Share of renewables in generation mix: 0 %

Electrification rate: 46 %
Utility: MAMWE
Energy Regulator: Ministry

Renewable Energy Resources:
Hydro Power (Potential – 1 MW)
Solar (Potential – 5 kWh/m2/day)
Wind (Potential - No Data)
Biomass (Potential – Very Small)
Biofuel Potential - None

Comoros' Renewable Energy Analysis

Energy Policy Framework

No regulatory framework for sustainable energy exists on the islands. The government is planning to implement a new regulatory framework for the electricity sector, in conjunction with the privatisation of MAMWE.

Market Applications of Renewable Energy Technologies

Hydro Power

The Comoros Islands have approximately 1 MW of installed hydro-electric capacity. While it is recognised that the country has further hydro-electric potential, additional studies are needed.

Biomass

Oilseed plants such as coconut, sesame, peanut and Jatropha curcas (Barbados nut tree) grow in the Comoros. Studies could examine the use of Jatropha oil instead of diesel to power motors for vanilla preparation, and aromatic plant distillation and to replace kerosene in lighting.

Solar Energy

The most viable option for the Comoros Islands is solar (photovoltaic) energy, as the Union receives eight hours of sunshine daily (2,880 hours/year) and, on average, 5.0 kWh/m2/day. Once used only as a backup for mail and telecommunications, civil aviation and police, in 1995, solar energy became available on a wider scale through World Bank funding for ENERCOM, a Comorian corporation, which has implemented some 100 installations on the three islands, yielding 10,000 WP for domestic and professional partners

Wind Energy

In 1985, two Kenyan Kijito wind turbines were installed in Ngazidja to drive groundwater pumps. One was installed on the eastern coast at Mtsangadju ya Dimani and the other on the northern coast at Wella. A wind generator requires average annual wind speeds of at least 3 m/s, and data has shown that the island winds do not always reach this speed.

Geothermal

Geologically, the Comoros should have the potential to meet all its energy demands from its volcanic activity, many experts believe. The Australian Sinclair Knight Merz (SKM) and New Zealand-based Gafo Energy are joining forces to map the Comorian potential for geothermal energy on three Comoros islands; Grand Comore, Moheli and Anjouan. Gafo will operate the power installations if potentials are as expected.

Barriers

- Very small country
- No Energy policy

RE Incentives

Currently, the country does not have a REFIT tariff regime or any other incentives.

5.3 Democratic Republic of Congo





Capital City: Kinshasa
Size: 2 344 858 km2
Population: 71 712 867
GDP: $23.12 billion

Peak Demand: 1 736MW
Installed capacity: 2 589.82 MW
Share of renewables in generation mix: 95 %

Electrification rate: 9%
Utility: Societe nationale d'electicite
Energy Regulator: Ministry of Energy

Renewable Energy Resources:
Hydro Power (Potential 100 000 MW)
Solar (Potential 5 kWh/m2/day)
Wind (Potential No Data)
Biomass (Potential No Data, high usage in rural areas)
Biofuels Potential - Good



DRC's Renewable Energy Analysis

Energy Policy Framework

Renewable energy issues in DRC are addressed in the general national energy policy formulated in the "Document de Politique du secteur de l'électricité en République Démocratique du Congo"of May 2009.

Market Applications of Renewable Energy Technologies

Hydro Power

The DRC has a huge hydro-electrical potential estimated at 100,000 MW of which 44 % is concentrated in the Inga site. The actual level of development on aforementioned site is of 1,775 MW with 351 MW in Inga 1 and 1424 MW in Inga 2.

Biomass

There are 1.250 million tons from 122 million hectare of equatorial forest. Biomass (wood of fire and charcoal) provides 95 % of energy consumption while other forms of energy contribute at the rate of only 3% for electricity and 2% for the oil products.

Solar Energy

The DRC is in a very high level sun belt where values are between 3.25 and 6.0 kWh/m2/day3,250 and 6,000 Wattpeak/ m²/s. This makes installation of photovoltaic systems as well as use of thermal solar systems, viable throughout the DRC. Currently there are 836 solar systems, with a total power of 83 kW, located in Equateur (167), Katanga (159), Nord-Kivu (170), the two Kasaï provinces (170), and Bas-Congo (170). There is also the 148 Caritas network system, with a total power of 6.31 kW.

Wind

In some areas, wind speed is equal to or greater than 1.4 m/s, (1.5 m/s at Matadi, 1.7 m/s at à Gimbi and 1.8 m/s at Kalemie and Goma). However, wind energy is not used in DRC, with the exception of a few pilot facilities.

Geothermal

There is huge geothermal potential in the east of DRC consisting of volcanoes and active geothermal sites, but this is hardly exploited. Hot spring temperatures range from 35 to 90ºC.

Barriers

- Low income levels of potential market group and inability to access financial support.
- Low Capacity in commercial RE sector.
- Low awareness of RE opportunities on all levels.
- Weak industrial capacity.

RE Incentives

Currently, the country does not have a REFIT tariff or any other incentives.

5.4 Djibouti



Capital City: Djibouti
Size: 23 200km2
Population: 879 100
GDP: US$ 242 million

Peak Demand: 160 MW
Installed capacity: 116 MW
Share of renewables in generation mix: 0%

Electrification rate: 50%
Utility: Electricite de Djibouti
Energy Regulator: Ministry of Energy

Renewable Energy Resources:
Hydro Power (Potential 0 MW)
Solar (Potential 5.5 kWh/m2)
Wind (Potential 50 MW)
Biomass (Potential 0 MW)
Biofuels Potential - none



Djibouti's Renewable Energy Analysis

Energy Policy Framework

Renewable energy issues in DRC are addressed in the general national energy policy formulated in the "Document de Politique du secteur de l'électricité en République Démocratique du Congo"of May 2009.

Market Applications of Renewable Energy Technologies

Hydro Power

No potential for hydropower.

Biomass

With the majority of the country being semi-desert, the potential for large-scale power production from biomass is expected to be of limited feasibility. However, no formal assessment has yet been made into the country's biomass potential.

S*olar Energy*

Djibouti's location on the Horn of Africa is ideal for solar energy. Average daily insolation is 5.5-6.5 kWh/m2 over the whole country., The Japanese government has recently extended a grant for the installation of solar panels at the Djibouti Centre for Research and Studies, the state scientific institution.

Wind

Studies conducted in the 1980s indicated that average wind speeds across Djibouti peak at 4 m/s, indicating a moderate potential for wind energy. Government studies in 2002 concluded that Goubet, at the entrance to the Gulf of Tadjourah, has the potential for a 50 MW wind farm.

Geothermal

In 2001, the American Geothermal Development Associates (GDA) completed a feasibility study for a 30 MW geothermal power plant in the Lake Assal region, west of the capital. Icelandic company, is now poised to implement it, and the plant is expected to begin production in 2012, replacing some of the electricity currently generated using diesel.

Barriers

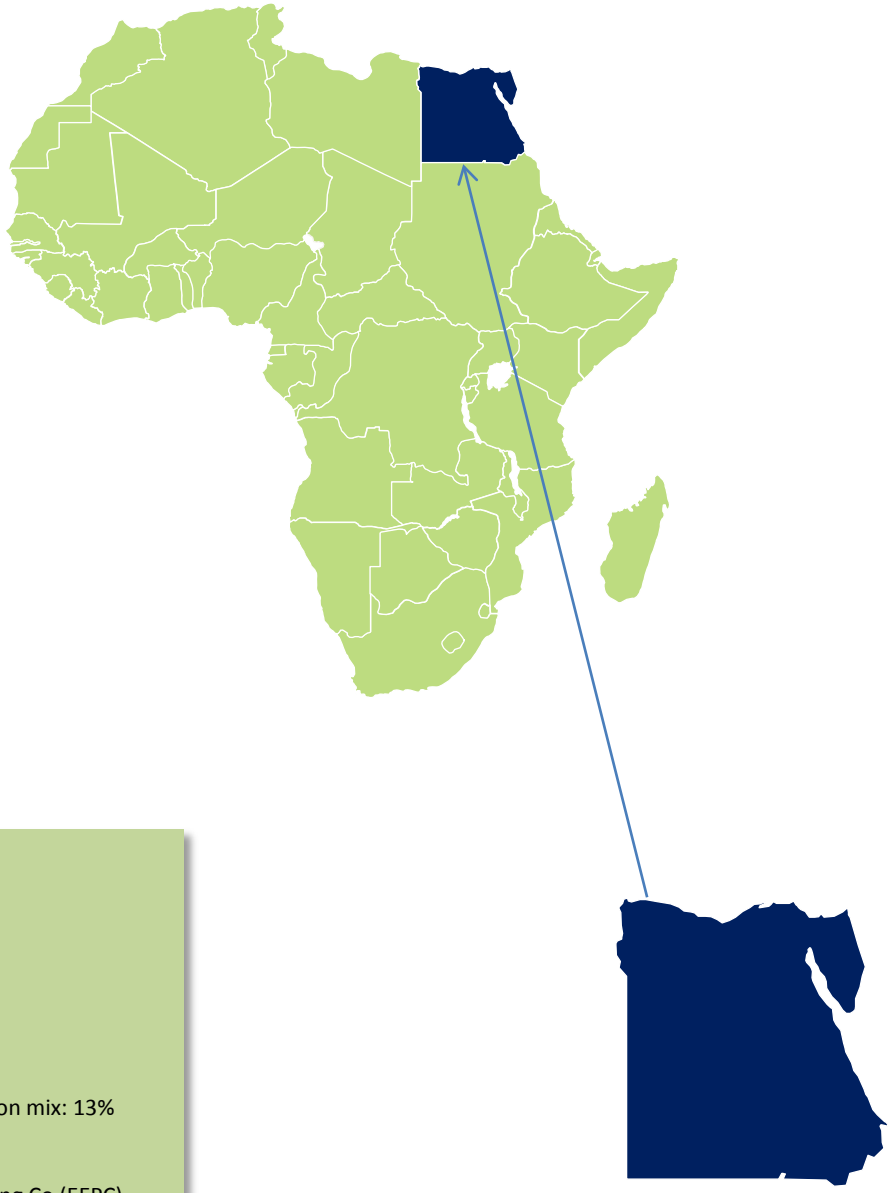
Low income levels of potential market group and inability to access financial support.
Low Capacity in commercial RE sector.

.

RE Incentives

Currently, the country does not have a REFIT tariff or any other incentives.

5.5 Egypt



Capital City: Cairo
Size: 1 002 450 km2
Population: 80 Million
GDP: US $ 471.2 Billion

Peak Demand:
Installed capacity: 22 583MW
Share of renewables in generation mix: 13%

Electrification rate 99.4%
Utility: Egyptian Electricity Holding Co (EEPC)
Energy Regulator: EEUCPRA

Renewable Energy Resources:
Hydro Power (Potential 2 842 MW)
Solar (Potential 73,656 TWh/year)
Wind (Potential 310 MW)
Biomass (Potential 1 000 MW)
Biofuels Potential - Low



Egypt's Renewable Energy Analysis

Energy Policy Framework

The Egyptian energy policy and electricity market structure meets most of the COMESA Model Energy Policy Framework requirements. The main challenge is meeting its clean energy targets because fossil fuels are still the key fuel for energy production. Egypt net exports of energy have been declining in recent years.

Market Applications of Renewable Energy Technologies

Hydro Power

Approximately 11.2% of Egypt's power comes from hydropower facilities, the first of which was built in 1960. The Aswan Dam was constructed to control the Nile water discharge for irrigation.

Biomass

About 23 MW of power is currently generated from the gasification of sewage sludge from the waste water treatment plant at EL-Gabal El-Asfer.

Solar Energy

Currently, there are ten SWH manufacturing companies. Over 400 SWH have been manufactured and installed in Egypt; 1 000 SHW were imported. The total capacity of PV systems in Egypt is around 10 MW, for lighting, water pumping, wireless communications, cooling and commercial advertisements on highways.

Wind Energy

The Zafarana Wind Farm produces 517 MW and the Wind Farms in Hurghada produces 5 MW. In future, NREA plans to implement wind projects with total capacities of 2 370 MW as part of its strategy to promote wind energy.

Challenges & Barriers

- Introducing market reform to improve efficiency and quality of supply as well as enable sufficient flow of investments into the power sector.
- Ensuring security of supply through the following governmental actions:
- Ensuring adequate legislative support
- Financial support - The draft electricity law establishes a renewable energy fund.

RE Incentives

Incentive consist NREA Incentives (soft financing), competitive bids (PPAs) and REFIT.

5.6 Eritrea



Capital City: Asmara
Size: 117 400 km2
Population: 5.2 million
GDP: US$ 1.873 million

Peak Demand: 167 MW
Installed capacity: 167 MW
Share of renewables in generation mix:0%

Electrification rate:32 %
Utility: Eritrea Electricity Corporation
Energy Regulator: Electricity Regulatory Commission

Renewable Energy Resources:
Hydro Power (Potential 2 600 MW)
Solar (Potential 6.0 kWh/m2/day)
Wind (Potential 2.4 MW)
Biomass (Potential 0 MW)
Biofuels production - None



Eritrea's Renewable Energy Analysis

Energy Policy Framework

To demonstrate its commitment to promoting sustainable energy, the Ministry of Energy and Mines, in consultation with the Ministry of National Development, has targeted in its long-term program (up to 2015) energy development initiatives as a vehicle to improve poverty alleviation, education, water and environment sustainability, with particular attention to the development of alternative energy resources a primary objective.

Market Applications of Renewable Energy Technologies

Hydro Power

Three potential hydropower sites have been studied (Ad Dankers, 1997), which include Tekeze river (~ 23000 GWh per year), Anseba river (~120 GWh per year), and Setit river (~ 240 GWh per year). Other potential sites for micro and mini hydropower have yet to be studied.

Biomass

There are many indications of potential for modern biomass energy usage in certain locations in Eritrea: A)The Alighider Farm Estate has the potential to supply raw materials (cotton and sorghum stalks, elephant grass, banana leaves etc.) for briquette production for at least 15 plants, b) Biogas plants could be installed in the Elabered Agro-industry, and other smaller dairy farms, c) Biogas could be generated from cactus trees, d)Energy recovery from municipal solid and liquid wastes is possible, e) Energy crops, such as Salicornia (being developed by SeaWater Farms, a biofuels company), could generate electricity for local uses or for the central grid.

Solar Energy

Eritrea has a very high potential for solar energy, with an average insolation of 5.0-6.5 kWh/m2/day. Possible uses include solar PV, water heaters and sterilisers, crop dryers and tobacco curing, desalination, cooling and refrigeration, and electricity generation. Solar is currently utilised for electricity in public buildings such as schools and hospitals.

Wind

A recent Global Environment Facility (GEF) sponsored feasibility study for wind energy on the southern coast shows that a 2.4 MW wind park in Assab and many off-grid stand-alone wind systems, wind-diesel or wind-solar hybrid systems are feasible and potentially economic. Wind pumps for irrigation, or for watering villages and their livestock have very good potential in the vast majority of Eritrea.

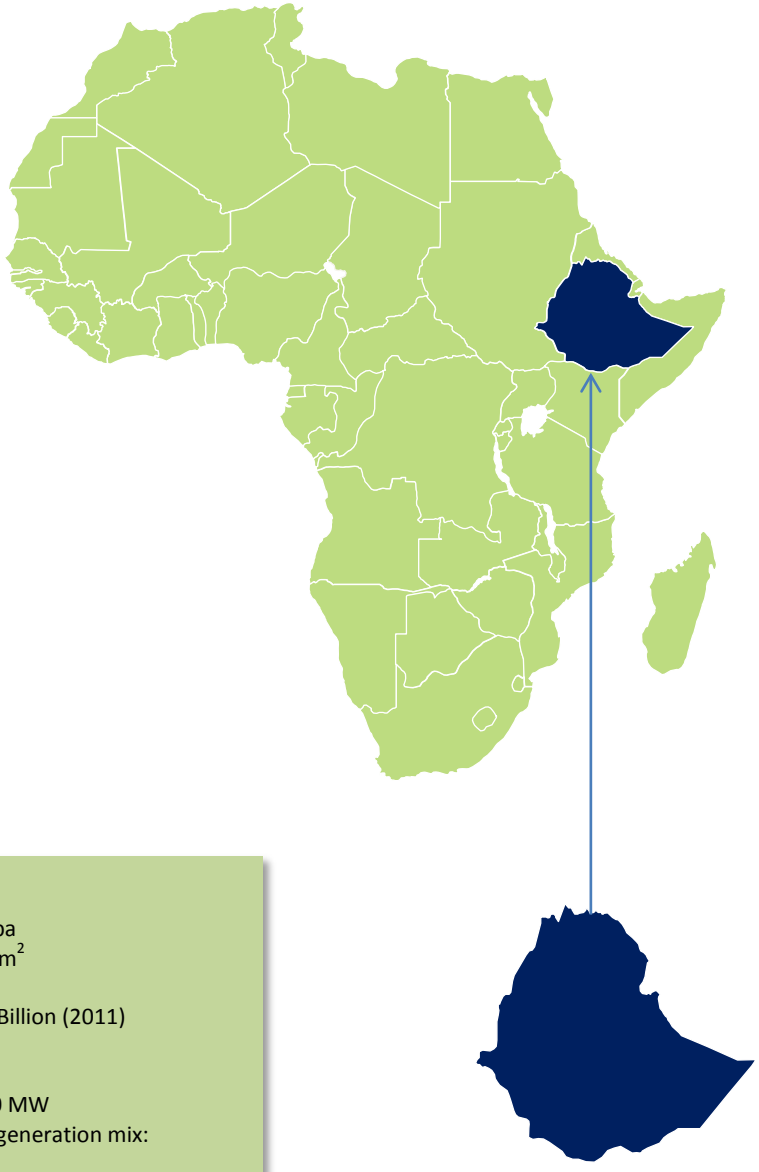
Geothermal

The most favourable location for geothermal energy in Eritrea is the Alid volcanic area, about 120 km south of Massawa, identified by the United Nations Development Programme in 1973. Further investigations were conducted in 1996, which identified at least 11 geothermal areas in the area. Additional exploration is required to prove the capacity of the resource, and the Eritrean Ministry of Mines is seeking funding for this purpose. If successful, a 5 MW pilot geothermal power plant has been proposed.

RE Incentives

Currently, the country does not have a REFIT tariff or any other incentives.

5.7 Ethiopia



Capital City: Addis Ababa
Size: 1104 300 km^2
Population: 80 Million
GDP: US$ 86.12 Billion (2011)

Peak Demand:
Installed capacity: 2 060 MW
Share of renewables in generation mix: more than 90%

Electrification rate: 41%
Utility: Ethiopian Electricity Power Corporation (EEPCo)
Energy Regulator: Ethiopian Electric Agency

Renewable Energy Resources:
Hydro Power (Potential 45,000 MW)
Solar (Potential 6 kWh/m2)
Wind (Potential 57,000 MW)
Biomass (Potential – sustainable yield of 36 million tons of biomass per year)



Ethiopia's Renewable Energy Analysis

Energy Policy Framework

Renewable energy issues in Ethiopia are addressed in the general national energy policy formulated of 1994. The main themes of the energy policy are: 1) Indigenous resources development where hydropower is recommended, 2) Development and utilization of alternative environmentally sound energy resources, 3) Promotion of energy efficiency and conservation measures for economic and environmental reasons. 4) Creation of mass awareness on energy issues.

Market Applications of Renewable Energy Technologies

Hydro Power

Hydro energy is in the focus of the government actions for energy supply in Ethiopia. Over 95 % of the electrical energy comes from water power plants. Ethiopia has a comparatively mild and rainy climate

Biomass

Just like centuries ago, the energetic use of biomass is very common in Ethiopia. Biomass energy provides for more than 90% of the total energy supplied in Ethiopia.

Solar Energy

Total installed capacity for PV systems in Ethiopia is estimated to be some 5 MW, 60% of it installed for rural telecom applications, 20% for water pumping and another 20% for solar home systems. The total number of solar water heating systems installed in Ethiopia is about 5 000 units, mostly installed for domestic water heating but also in commercial institutions (mainly hotels).

Wind Energy

Wind energy is considered the second most important potential source for power generation in Ethiopia after hydropower. The total area classified to have excellent wind class [areas with wind speeds in excess of 7.5 m/s at 50 masl] is estimated to be 11,500 km^2 with potential to generate 57,000 MW of power.

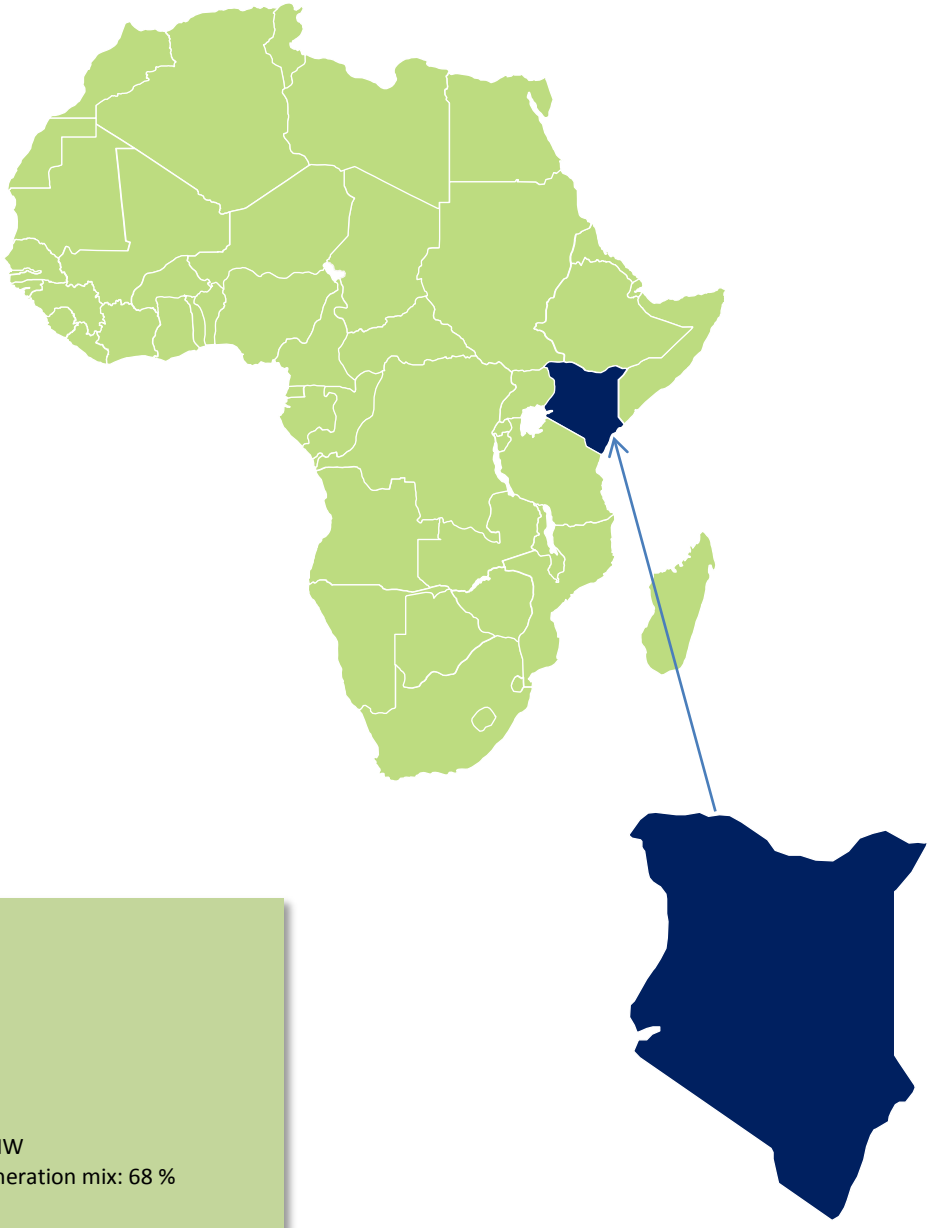
Challenges & Barriers

a) Investment requirements for large hydropower plants are high.
b) Changing climate is impacting flows in rivers.
c) Local capacity for design, plan, and construction of hydropower not adequate.
d) Clarity for delineation of grid and off-grid areas in power sector plans has constrained the development of small hydropower.
e) Resource information for small hydropower plants is not readily available
f) the high cost of biogas digesters.
g) Lack of trained technical capacity for the renewable energy systems development.
h) Inadequate information, particularly feasibility studies for geothermal power development.

RE Incentives

Ethiopia does not have meaningful renewable energy incentives at the moment.

5.8 Kenya



Capital City: Nairobi
Size: 581 312km2
Population: 41 Million
GDP: US$ 25 Billion

Peak Demand: 1 100 MW
Installed capacity: 1 232 MW
Share of renewables in generation mix: 68 %

Electrification rate: 22.7%
Utility: KPLC and KenGen
Energy Regulator: ERC

Renewable Energy Resources:
Hydro Power (Potential 707 MW)
Solar (Potential 5.5 kWh/m2/day)
Wind (Potential 390 MW)
Biomass (Potential 120 MW)
Biofuels Production – Good.



Kenya's Renewable Energy Analysis

Energy Policy Framework

A new national energy policy for Kenya was developed in 2004. Entitled 'Sessional Paper Number 4 of 2004 on Energy', the policy laid down the framework upon which quality, cost-effective, affordable, adequate and sustainable energy services are to be availed to the economy over the period 2004-2024.

Market Applications of Renewable Energy Technologies

Hydro Power

Currently the total installed hydro power capacity in Kenya is 764 MW. KenGen, a state corporation owns 761MW of this capacity. Most of the hydro power potential is uneconomical for development.

Biomass

Until recently, Bagasse co-generation has widely been used in the sugar mills to generate power and process steam for own use. One sugar mill has put up a 36 MW cogeneration plant that is supplying 26 MW to the national grid under a feed-in tariffs arrangement.

Solar Energy

PV was introduced in Kenya in the early 80's for the generation of electricity for use in remote areas far from the grid for household and other uses. Even though PV technology is proven and mature, no grid-connect or high capacity stand-alone PV installations have so far been installed in Kenya. The total number of installed solar water heating systems is estimated to be 140,000.

Wind Energy

Exploitation of Wind power in Kenya has just began with the commissioning of a 5.1MW wind power station (WPS) by KenGen in year 2010. The expansion of this WPS is planned to increase the capacity to 11.8 MW. KenGen is about to commence the construction of another 13.6MW WPS at the same site.

Geothermal Energy

The exploitation of geothermal resources in Kenya started over 30 years ago. In year 2000, an IPP got a concession to develop another site within the Olkaria prospect. However, only 198 MWe has been developed to date.

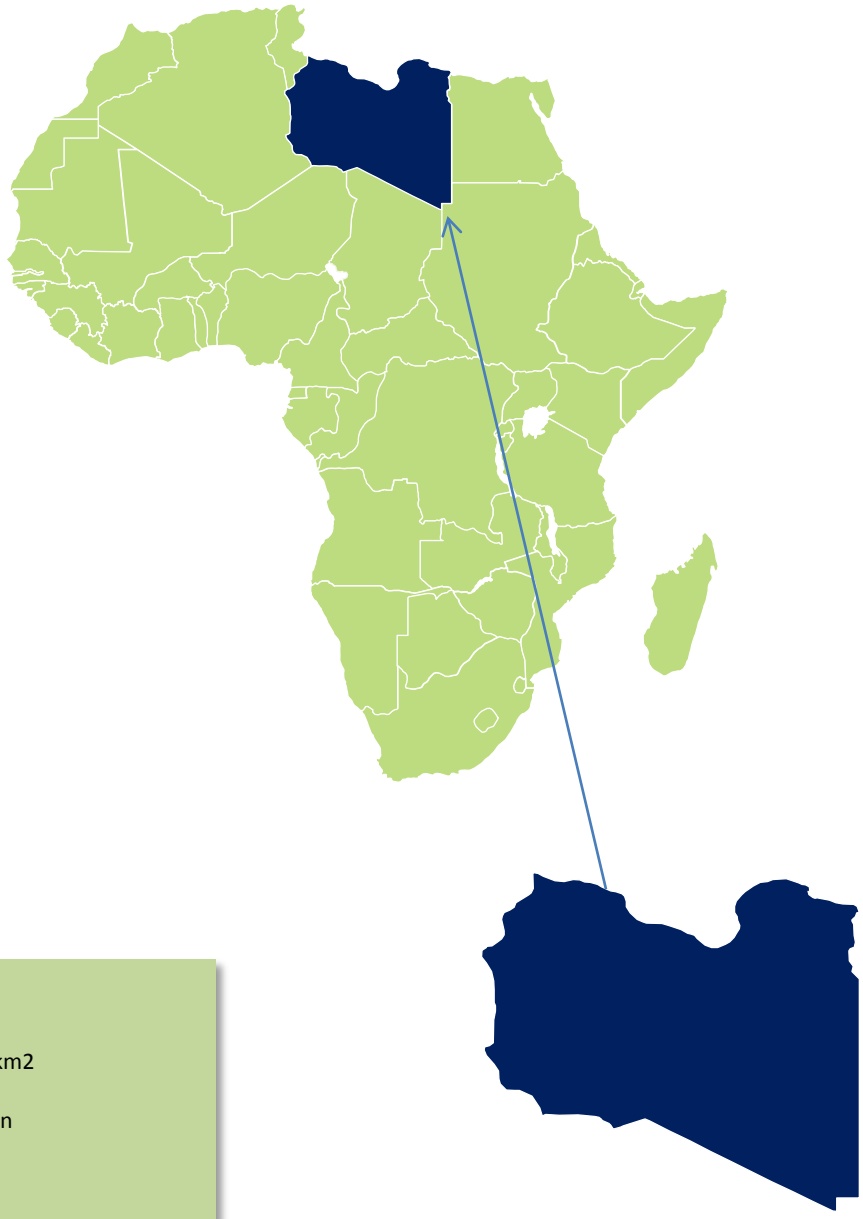
Challenges & Barriers

- High development costs due to lack of adequate, suitable and accurate data.
- Lack of appropriate policy, legal, regulatory and institutional frameworks.

RE Incentives

Kenya has various incentives including REFIT. Some of the incentives are donor funded.

5.9 Libya



Capital City: Tripoli
Size: 1.8 million km2
Population: 6.59 million
GDP: US$ 62 billion

Peak Demand: No data
Installed capacity: No data
Share of renewables in generation mix: 0 %

Electrification rate: 97 %
Utility: General Electricity Company of Libya
Energy Regulator: The Energy Council

Renewable Energy Resources:
Hydro Power (Potential 0 MW)
Solar (Potential 7.5 kWh/m2/day)
Wind (Potential 150 MW)
Biomass (Potential 2 TWh/year)
Bio-fuels Potential - None



Libya's Renewable Energy Analysis

Energy Policy Framework

The Renewable Energy Authority of Libya (REAOL) has created a RE roadmap up to 2030, that has been approved by the former Ministry of Electricity and Energy. Long-term plans are to cover 25% of Libya's energy supply by renewable energies by the year 2025, rising to 30% by 2030. Intermediate targets are 6% by 2015 and 10% by 2020.

Market Applications of Renewable Energy Technologies

Hydro Power

Libya, compared to its other North African neighbours, has a poorly-developed hydropower sub-sector. This is primarily due to the lack of availability of resources in the country for the development of the energy source. There are currently no plans for the exploitation of hydropower in the country. Plans to develop a hydropower installation on the Great Man-Made River Project have not yet come to fruition.

Biomass

The estimated biomass potential in the country is 2 TWh/year. Whilst this potential may be suitable for individual residences to exploit for personal power generation, it is deemed to be unsuitable for large-scale electricity generation.

Solar Energy

The solar regime in Libya is excellent; the daily solar radiation on the horizontal plane reaches 7.5 kWh/m2, with 3000-3500 hours of sunshine a year. There are few conflicts of land use; 88% of Libyan land area is considered desert, and much of this is relatively flat. There is some compromise between access to water, which is available at the coast where the solar regime is less favourable against inland sites with excellent solar characteristics, but far from water.

1,865 kWp of PV capacity were installed in Libya in 2006. The amount is increasing significantly; in particular, decentralised electricity generation in rural areas is being encouraged. PV systems are also used in agriculture to supply water pumps with electricity instead of using diesel

Wind Energy

The wind regime is also good. The average wind speed is between 6-7.5 m/s. There are several attractive prospects along the Libyan coast; one such site is at Dernah, where the average wind speed is around 7.5 m/s. A German-Danish consortium was contracted in 2000 by the national power utility to design and construct a 25 MW pilot wind farm. Several appropriate sites were identified and masts were installed to monitor wind conditions over 12 months. Technical specifications for all the components of the pilot wind farm and tender documents for a turn-key installation of the 25 MW facility were prepared. Bids were submitted, but the project was then, for all intents and purposes, abandoned.

B*iofuel*

Libya does not have biofuels projects – planned or implemented.

RE Incentives

There is no legislation covering financial support for RE, and addressing the issue of the additional costs of renewable energy compared to the least cost alternative should be investigated.

5.10 Madagascar

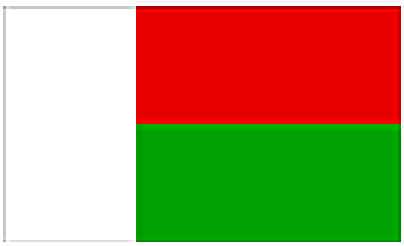


Capital City: Antananarivo
Size: 587 039 km2
Population: 22 million
GDP: US$ 8.4 billion

Peak Demand : 250 MW
Installed capacity: 233 MW
RE : 130 MW
Thermal : 100 MW
Share of renewables in generation mix: 60 %

Electrification rate: 19%
Utility: JIRAMA
Energy Regulator: ORE

Renewable Energy Resources:
Hydro Power (Potential 7 800 MW)
Solar (Potential 5.5 kWh/m2/day MW)
Wind (Potential 1.2 MW)
Biomass (Potential – No Data)



Madagascar's Renewable Energy Analysis

Energy Policy Framework

A new national energy policy for Madagascar was introduced by the Law n° 98-032 on January 20, 1999. Dedicated to the Reform of the Electricity Sector, the purpose of this Law is to allow new operators to act within the sector in order to, on the one hand, relay Malagasy Government in the country's electric infrastructure funding and, on the other hand, promote the efficiency, and the quality of the service offered to the users by the rule of competition.

Market Applications of Renewable Energy Technologies

Hydro Power

Currently the total installed hydro power capacity in Madagascar is 128 MW. JIRAMA, a state-owned utility owns 105 MW of this capacity. Two IPPs operate 23 MW as total of hydro installed capacity, supplying JIRAMA's generation system.

For rural electrification, some private micro-hydro plants are operational, but the total installed capacity is less than 0.5 MW by now.

Biomass

In Madagascar, biomass energy generation is mainly based on rice husks, coffee husks, woody biomass and similar agricultural residues. Since 2009, 40 kW of installed capacity co-generation rice husks has been operational by a private operator for Anjiajia village. Another one is commissioned (60 kW) in Bejofo village. Five sugar industries use bagass for co-generation for their own energy needs.

Solar Energy

The total installed capacity of PV currently operational is only about 9 kW for two little villages Benenitra and Ramena, though Madagascar has a huge potential.

Wind Energy

Since 2007, three private operators have implemented hybrid system thermal/wind power generation in five villages for about 150 kW total installed capacity.

Biofuel

Jatropha curcas, cotton and sugar cane are the three plants which are the most considered actually by investors in Madagascar. Jatropha and cotton are used to produce biodiesel; sugar cane is used to produce ethanol. Jatropha is already spread out in the country either through endemic plantation and large-scale human plantation.

Challenges & Barriers

- High development costs due to lack of adequate, suitable and accurate data.
- Usual Donors are not yet satisfied with the financial reliability of the projects

RE Incentives

The most important incentives are state subsidies granted through FNE (National Electricity Fund). According to the National Financial Law 2011, the importation of electric supplies and/or engines dedicated to RE generation is VAT free. Moreover, an alleviation of customs duties has been applied to the same supplies, in order to promote RE and ease energy access.

5.11 Malawi



Capital City: Lilongwe
Size: 118 484 km2
Population: 15 million
GDP: US$ 13.51 billion

Peak Demand: 344 MW
Installed capacity: 285 MW
Share of renewables in generation mix: 94 %

Electrification rate: 9 %
Utility: ESCOM
Energy Regulator: Malawi Energy Regulator Authority

Renewable Energy Resources:
Hydro Power (Potential 900 MW)
Solar (Potential 5.5 kWh/m2/day)
Wind (Potential 25 MW)
Biomass (Potential No Data)
Biofuels Potential - Good



Malawi's Renewable Energy Analysis

Energy Policy Framework

Currently, Malawi does not have a standalone Renewable Energy Policy. Renewable energy issues are covered in the National Energy Policy. The Energy Policy was enacted in 2003 and is reviewed and revised every 5 years. The Energy policy is influenced by national development plan. The Electricity act was revised to enable the participation of various actors in the electricity sector and the sector is regulated by the Malawi Energy Regulatory Authority.

Market Applications of Renewable Energy Technologies

Hydro Power

Malawi's electricity is generated from hydropower stations cascaded along Shire River which has of late been greatly affected by problems resulting from the degradation of the physical environment.

Biomass

In 2009, a small-scale underground biogas plant has been established by the Test & Training Centre in Renewable Energy Technologies (TCRET) at Mzuzu University, one of the public universities in Malawi. By the end of the project in 2011, there will be 12 biogas digesters.

Solar Energy

There are about 5 000 standalone solar systems (solar home systems) in the country generating a total of about 700KW of electricity. Solar Cookers International has rated Malawi as the 20th country in the world in terms of solar cooking potential. The estimated number of people in Malawi with fuel scarcity in 2020 is 2,700,000.

Wind Energy

MNREE through Department of Energy is implementing village electrification project on pilot basis, using Wind/Solar hybrid systems. With large lakeshore area with Mwera winds, Malawi has exceptional wind resources. Researchers have found that Malawi could meet all their electricity demands from wind power through 2030. Construction of the first wind farm in Malawi will start early 2010 close to Chilunguzi Farm; Mwasinja Village -T.A Nkosini Ntakataka- Dedza. The wind farm is scheduled to be completed by end of 2010.

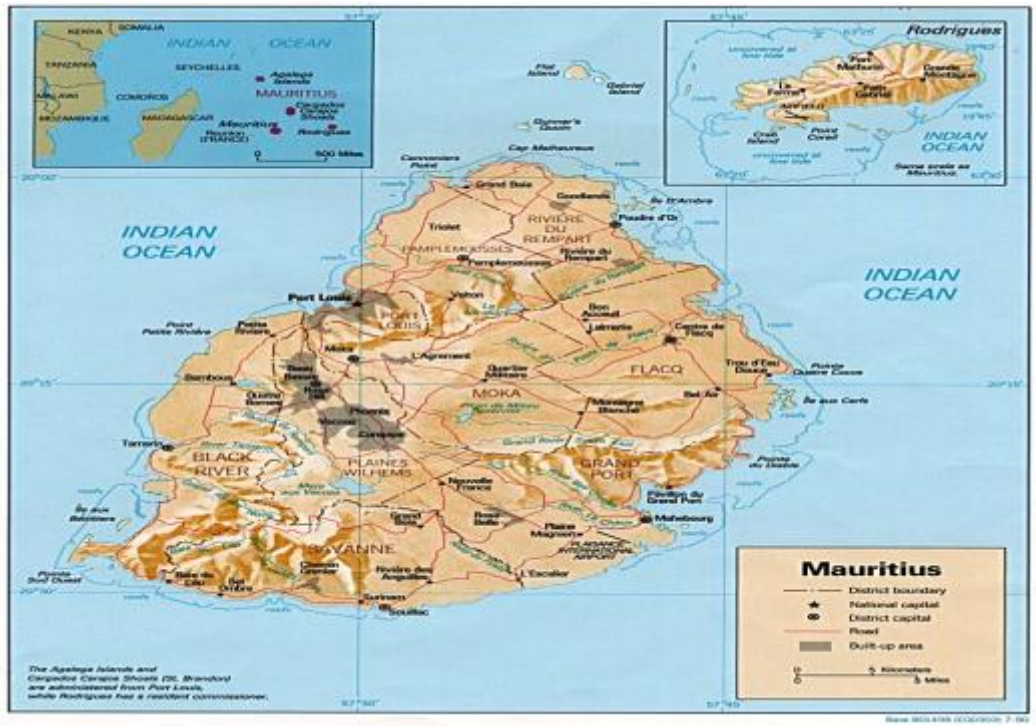
Barriers

- Low income levels of potential market group and inability to access financial support.
- Low Capacity in commercial RE sector
- Low awareness of RE opportunities on all levels
- Weak industrial capacity

RE Incentives

Currently, the country does not have a REFIT tariff or any other incentives.

5.12 Mauritius



Capital City: Port Louis
Size: 2 150 km2
Population: 1.27 million
GDP: US $10 billion

Peak Demand: 405 MW
Installed capacity: 650 MW
Share of renewables in generation mix: 20 %

Electrification rate: 100%
Utility: Central Electricity board
Energy Regulator: Central Electricity Board

Renewable Energy Resources
Hydro Power (59 MW):
Solar (Potential 5 kWh/m2/day)
Wind (Potential currently limited to 60 MW)
Biomass (155MW installed capacity)
Biofuels potential - Good



Mauritius's Renewable Energy Analysis

Energy Policy Framework

Currently, Mauritius does not have a standalone Renewable Energy Policy. The Long Term Energy Strategy 2009-2025 (updated in the Action Plan for the Energy Strategy 2011-2025) is the blue print for the development of renewable energy in the Republic Mauritius.

Renewable Energy Sub-Sector

Hydro Power

About 4% of Mauritius's- electricity is generated from hydropower stations. The Central Electricity Board operates 9 hydroelectric stations having a total installed capacity of 59MW. The full installed capacity can only be exploited in wet periods with heavy rainfall.

Biomass

Bagasse contributes the biggest share of the renewable energy in electricity generation (some 400 GWh/year presently). During crop season, the peak power output from the IPPs (when generating from bagasse only) sum up to about 155 MW.

Solar Energy

Despite enjoying more than 2900 hours of sunlight per year, grid connected PV systems are only recently coming online. The recently introduced Small Scale Distributed Generation scheme has allowed 2MW (of 50kW or less installations scattered throughout the island) to be connected to the grid.

Wind Energy

A study confirmed that there are potential sites on the two islands for the setting up of wind farms, with some areas having an annual average speed of 8.0 m/s at 30 m above ground level. The current capacity is limited to 60MW but expected to rise as installed capacity increases.

Barriers

- Overlapping responsibilities at institutional level
- There also need to be a resource map to clearly define to what extent renewable sources like geothermal and solar PV can be tapped into.
- The implementation of RE measures will requires heavy investment.
- Besides bagasse and hydro, there is limited understanding of the technicalities of other RE technologies.

RE Incentives

Mauritius has a number of RE incentives in place for RE initiatives.

5.13 Rwanda



Capital City: Kigali
Size: 226 338 km2
Population: 10,718,379 (Year 2011 projection)
GDP: US$ 6 000 m

Peak Demand: 87 MW
Installed capacity: 94.78 MW
Share of renewables in generation mix: 56.5%

Electrification rate: 14.25%
Utility: EWSA
Energy Regulator: RURA

Renewable Energy Resources:
Hydro Power (Potential 500 MW)
Solar (Potential 5.5 kWh/m2/day)
Wind (Potential no data MW)
Biomass (Potential no data MW)
Biofuels Potential - Yes



Rwanda's Renewable Energy Analysis

Energy Policy Framework

The "2004 Energy Policy Statement" of Rwanda was revised in 2007 and is entitled "National Energy Policy and National Energy Strategy 2008-2012". The Policy main objectives are to support national development through:

- Ensuring the availability of reliable and affordable energy supplies for all Rwandans.
- Encouraging the rational and efficient use of energy and
- Establishing environmentally sound and sustainable systems of energy production, procurement, transportation, distribution and end-use.

Market Applications of Renewable Energy Technologies

Hydro Power

The estimated installed capacity in 2011 is 94.78 MW while the available capacity is 85.25 MW. Hydroelectric power and thermal (Diesel and HFO) generation are still leading the power generation. The involvement of the private sector is still limited but promising in the micro-hydro power generation.

Solar Energy

Rwanda has a 250 kW solar installation (Kigali Solaire) and it is grid-connected. This project is owned by a German private operator called Stardwerke Mainz AG & the total project cost is estimated at 1,369,636 Euros (1,921,843 $). Electricity produced by Kigali Solaire is sold to EWSA at a fixed tariff of 0.07 US$/kWh. Solar water heaters are also being utilized especially in the capital city. Under the EDPRS (2008-2012), at least 20% of Rwandans will use hot water in their showers or bathrooms, solar water heating systems will be installed in at least 75,000 households and some hotels, health centres, schools, hospitals by 2012.

Wind Energy

A wind resource assessment has been undertaken and has shown that wind power resource in Rwanda is limited.

Geothermal Energy

Geo-scientific surveys have been conducted during the last three years and the potential is estimated at 310 MW. Exploitation of the resource will begin with a pilot project of 10 MW in the near future.

Biomass

A Co-generation plant is installed at one sugar factory (Kabuye Sugar Works) with a power production estimated at 2MW. Existing biogas projects are not focused on electricity generation but rather on producing gas for cooking purposes.

Electrical energy from Lake Kivu methane gas

Huge reserves of methane gas dissolved in the deep waters of Lake Kivu are currently being exploited at a pilot scale (designed capacity of 4.5 MW) for electrical power generation.

Challenges & Barriers

- Capital-intensive projects.
- Lack of a defined incentive regime for renewable energy resources
- Lack of technical know-how especially in monitoring renewable energy projects (starting from the design phase up to the implementation phase)

RE Incentives

- A detailed study of subsidy scheme for solar projects is still going on; however, solar panels and other equipment for solar PV & solar water heaters are tax-exempted.
- Development agencies such as GIZ and BTC are providing 50% of the total project costs to private operators in order to encourage private sector participation in the development of the micro hydropower sub-sector.
- A study on REFIT is being reviewed by the Regulator before its adoption and implementation.
- The GoR's subsidy scheme for domestic biogas plants is RWF 300,000/unit (more than $ 500); for institutional biogas plants, it is 40% of the total project costs.

5.14 Seychelles



Capital City: Victoria
Size: 455 km2
Population: 87 000
GDP: US$ 1.9 billion (ppp – 2010 est.)

Peak Demand: 50 MW
Installed capacity: 85,3 MW
Share of renewables in generation mix: 0%

Electrification rate: 99%
Utility: Public Utilities Corporation
Energy Regulator: Seychelles Energy Commission

Renewable Energy Resources:
Hydro Power (Potential 1.8 MW)
Solar (Potential 5.762 kWh/m^2/day)
Wind (Potential 3 – 9 m/s)
Biomass (Potential no data)
.



Seychelles' Renewable Energy Analysis

Energy Policy Framework

Seychelles has taken several steps in the past few years to consolidate its national energy laws, policies and programs, and to establish the development of renewable energy technologies in the country as a national priority. Among the recent steps in this direction have been: a) the establishment in 2009 of a Seychelles Energy Commission; b) the formulation of the Seychelles Energy Policy 2010-2030; c) the lifting of tariffs and tax on all renewable energy technology imports with endorsement from the Energy Commission; d) and various measures to promote energy conservation and renewable energy, including the removal of taxes on solar water heaters and other energy saving devices.

Market Applications of Renewable Energy Technologies

Hydro Power

Seychelles does not have hydro projects.

Biomass

Most of the work carried out in the past focused on gasification of biomass. The equipment used was all prototypes. Although some promising results were reported by the Technological Support Service Division (TSSD), there were technological failures which prevented the marketing and uptake by the local consumers.

Solar Energy

Most of the work in the field of solar energy in the past looked at thermal technologies and few projects exploring the production of electricity were carried out. The solar thermal projects included wood drying technologies and solar water heating.

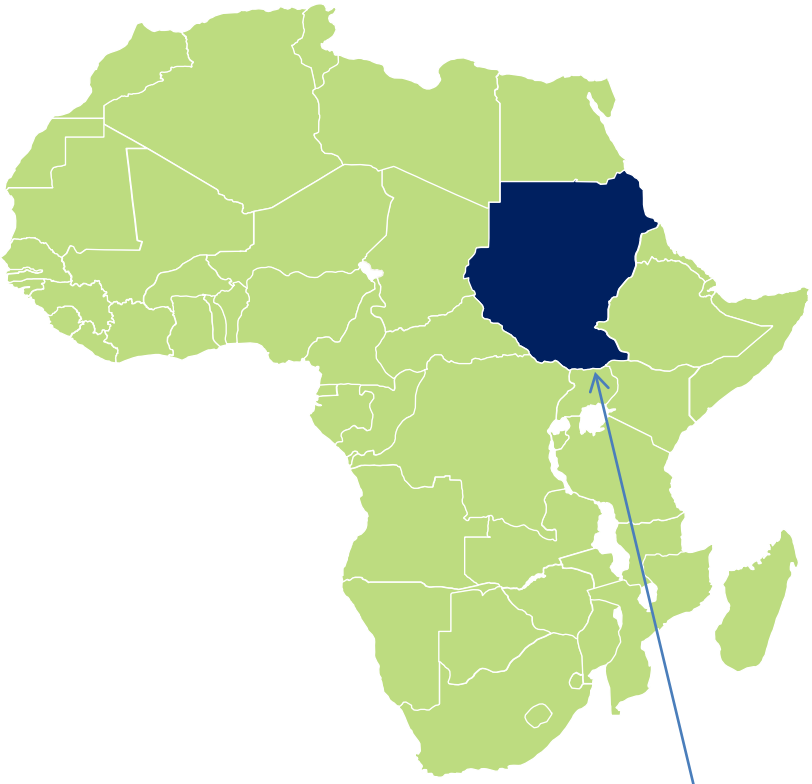
Wind Energy

Wind energy is currently one of the most competitive renewable energy technologies that exist. The wind regime is limited to around five to six months a year during the South East Monsoon period spanning from June to October. Studies on wind energy and its potential began in the 1980s. Two wind generators of 11kVA each were installed on the island of Ste Anne and connected to the grid. This was however a complete failure as one of the turbines was seriously damaged beyond repairs and the other was eventually taken out of service.

RE Incentives

Recent amendments to existing tax legislation have had a direct and beneficial impact on renewable energy in the country. Currently, imports of technologies for non-renewable energy production, such as diesel generators, are subject to a 15% tax rate under the Goods and Services Tax Act.

5.15 Sudan





Capital City: Khartoum
Size: 2,505,810 sq km (North & South)
Population: 45 Million
GDP: US$ 100 billion

Peak Demand:
Installed capacity: 1 235 MW
Share of renewables in generation mix: 24 %

Electrification rate: 30%
Utility: National Electricity Corporation
Energy Regulator: ERA

Renewable Energy Resources:
Hydro Power (Potential 4 920 MW)
Solar (Potential 6.1kWh/m2/day)
Wind (Potential No Data)
Biomass (Potential 55.5 MW)
Biofuels Potential – Good



Sudan's Renewable Energy Analysis

Energy Policy Framework

The government formulates its renewable energy policies by using a participatory process between relevant ministries and relevant stakeholders for each policy field – namely, electricity, petroleum and mining. It sets the direction for the development of the energy in order to meet the national development goals in a sustainable manner.

Market Applications of Renewable Energy Technologies

Hydro Power

Potential for hydropower is estimated at 4,920 MW. However, only 10% of the hydro-electric power is currently utilised. There are more than 200 suitable sites for the use of in-stream turbines along the Blue Nile and the main Nile. The total potential of mini-hydro can be considered to be 67 GWh/year for the southern region of the country.

Biomass

Biomass represents quite significant percentage of the Sudan Energy Balance. In 1995 biomass contributed 78% of the energy mix in the form of wood fuel i.e. Charcoal and firewood. The bulk of this is wood from the forest, which has led to massive deforestation.

Solar Energy

Average solar insolation in the country is roughly 6.1 kWh/ m2/day, indicating a high potential for solar energy use. A recent Global Environmental Facility (GEF), UNDP-funded project utilized PV to electrify 13 rural and peri-urban communities, with some 45,000 households in the country now using PV systems.

Wind Energy

Also the North States (Karema & Dongola areas) are also good sites. They have average annual wind speeds of 5 - 5.5 m/s. Khartoum and central states have annual average wind speeds of 4 - 4.5 m/s. West States have annual average wind speeds of 3 - 3.5 m/s. Wind energy in Sudan is currently used for pumping water from both deep & shallow wells to provide water for drinking and irrigation through the use of wind pumps.

Geothermal

Potential for hydropower is estimated at 4,920 MW. However, only 10% of the hydro-electric power is currently utilised. There are more than 200 suitable sites for the use of in-stream turbines along the Blue Nile and the main Nile. The total potential of mini-hydro can be considered to be 67 GWh/year for the southern region of the country.

Challenges & Barriers

- Lack of appropriate strategies and comprehensive level of government and the private sector to finance renewable energy projects.
- Absence of policies, legislation and laws for attracting investment in Sudan.
- Lack of regulation and institutional coordination at the level of Sudan for projects that aim to benefit from renewable energies.

RE Incentives

A number of financial incentives are available for the installation of renewable energy and conversion technologies.

5.16 Swaziland



Capital City: Mbabane
Size: 17 364 km2
Population: 1.2 million
GDP: US$ 3.5 billion

Peak Demand: 175 mw
Installed capacity: 60.1 MW
Share of renewables in generation mix:95 %

Electrification rate: 65 %
Utility: Swaziland Electricity Company
Energy Regulator: Swazi Energy Reg Authority

Renewable Energy Resources:
Hydro Power (Potential 70 MW)
Solar (Potential 6 kWh/m2/day)
Wind (Potential no data)
Biomass (Potential 200 MW)
Biofuels Potential – Good.



Swaziland's Renewable Energy Analysis

Energy Policy Framework

This National Energy Policy Implementation Strategy project commenced in July 2007 and was completed in October 2009. The government completed a comprehensive implementation strategy for the National Energy Policy, with the assistance of the European Union , under the European Union Energy Initiative on Poverty Alleviation and Economic Development, in partnership with European Union Partnership Dialogue Facility.

Market Applications of Renewable Energy Technologies

Hydro Power

Swaziland has three small hydro power stations, namely: 1) Edwaleni hydro power station; Ezulwini hydro power station; and, Maguga hydro power station. Some 77% of the power is imported primarily from South Africa.

Biomass

Swaziland has abundant sources of waste from agro-industries that could be used for power production. These industrial wastes include bagasse from processing sugar-cane and wood-waste from the timber processing industries. Ubombo Sugar Plant has recently commissioned a 30 MW co-generation plant that supplied the national grid. A pre-feasibility study for bagasse-fired power plant concluded that a 54 MW plant could be built at Simunye sugar factory and 85 MW plant at Mhlume sugar factory.

Solar Energy

Solar Energy has great potential for widespread use in Swaziland. Experience through Pilot Projects has demonstrated that careful planning and consultation when developing rural solar installations is very important. No large scale projects have been implemented to date.

Wind Energy

For maximum, cost-effective use to be made of renewable energy resources, a comprehensive knowledge of the resources is required. In Swaziland, there is a considerable lack of such resource data.

Challenges & Barriers

- High capital costs of hydro power stations.
- Zero CDM benefits because thermal energy is imported from South Africa.
- Limited local technical expertise in RE – particularly in the Regulator and Utility.
- Competition between thermal power generation versus RE in a very small market.

RE Incentives

Swaziland does not yet offer incentives for renewable energy. However, the research work done by the government on RE potential – particularly solar is a form of subsidised research.

5.17 Uganda



Capital City: Kampala
Size: 236,040 sq km
Population: 34.6 Million
GDP: US$ 17.1 Billion

Peak Demand: 350 MW
Installed capacity: 380 MW
Share of renewables in generation mix: 99 %

Electrification rate: 8 %
Utility: UEGCL / UETCL / UEDCL
Regulator: Electricity Regulatory Authority

Renewable Energy Resources:
Hydro (Potential 2000 MW)
Solar (Potential 6 kWh/m2/day)
Wind (Potential No Data)
Biomass (Potential 16 MW)
Biofuels potential – Good.



Uganda's Renewable Energy Analysis

Energy Policy Framework

Uganda is one of the few African countries with a clearly focussed renewable energy policy, which was published by the Ministry for Energy, Minerals and Development (MEMD) in 2007. Its objectives include increasing access to modern, affordable and reliable energy services as a contribution to poverty eradication. This comprises general public access to electricity and enhancing the modernisation of biomass conversion technologies. The overall policy goal is: "To increase the use of modern renewable energy, from the current 4% to 61% of the total energy consumption by the year 2017".

Market Applications of Renewable Energy Technologies

Hydro Power

Despite Uganda's vast hydropower potential, estimated at 3000 MW, less than 10% is currently exploited. Currently, a 250 MW hydropower project is under-way in the Jinja district of the country. Numerous other hydropower ventures are being investigated by both Ugandan and Japanese contractors, as well as the government.

Biomass

Bioenergy, apart from hydropower, is considered to be the second significant pillar to secure energy supply, particularly in rural areas. The transition from traditional biomass, which is often perceived as inefficient, to modern biomass and biofuel production and consumption is a main focal area of the government.

Solar Energy

Uganda has an average of 5-6 kWh /m2/day of solar insolation. Solar energy is currently used primarily for off-grid electrification for rural communities, as well as for solar cooking, and providing water heating and power to public buildings for example, hospitals.

Wind Energy

Wind speeds are estimated to average 3-3.5 m/s, indicating a moderate potential for wind power. Studies have concluded that whilst the wind resource is insufficient for large-scale power generation.

Geothermal

Uganda has an estimated geothermal resource potential of 450 MW, mainly located in the Western Rift valley part of the country. Feasibility studies are recommended to improve confidence in the resource and promote development.

Barriers

- Low income levels of potential market group and inability to access financial support.
- Low Capacity in commercial RE sector
- Low awareness of RE opportunities on all levels
- Weak industrial capacity

RE Incentives

Currently, the country does not have a REFIT tariff or any other incentives.

5.18 Zambia



Capital City: Lusaka
Size: 752,614 sq km
Population: 13.8 Million
GDP: US $ 20 Billion

Peak Demand: 2 062 MW
Installed capacity: 1 842 MW
Share of renewables in generation mix: 99.9 %

Electrification rate: 19 %
Utility: ZESCO Ltd
Energy Regulator: Energy Regulation Board

Renewable Energy Resources:

Hydro (Potential 6 000 MW
Wind (Potential 0 MW)
Solar (Potential 155 MW)
Biomass (Potential 30 MW)
Biofuels Potential - Good



Zambia's Renewable Energy Analysis

Energy Policy Framework

The 2008 National Energy Policy is the current energy policy for the country. It recognises solar, wind, micro-hydro (mini-hydro), biomass, and bio-fuels as renewable energy. The policy sets as its objective the increase in the utilisation of renewable energies by raising awareness, developing regulatory frameworks, improving technology and provision of fiscal incentives. A Bio-fuels Regulatory Framework is under consideration by the Government which was developed following a consultative process with relevant stakeholders.

Market Applications of Renewable Energy Technologies

Hydro Power

Hydro Power is the dominant source of electricity generation in Zambia – contributing over 99% of locally generated electricity. The Country is estimated to have over 6 000 MW of hydro power potential and less than 2 000 MW has been exploited thus far. Additional investment needs to be attracted to invest in hydro power generation.

Biomass

The Ministry of Energy and Water Development estimate that wood fuel accounts for 70% of the total national energy consumption. It further estimated that households accounted for about 88% of wood fuel consumed which is used for cooking and heating. Charcoal is the preferred form of biomass in the peri-urban and urban areas.

Solar Energy

Zambia has solar radiation of about 5kW h/m2/day which is suitable for generation of power with solar photo voltaic panels. Solar systems are primarily used by the state owned telecommunications company and the national radio and television broadcaster for their repeater stations and remote telephone exchanges. Solar systems became widely used in the early 1990s when smaller PV systems for domestics use were introduced in the country. The recently launched ZESCO Ltd Solar Geysers Project is planned to free the national grid of 150 MW. This project is in the procurement stage of phase of the project which aims to roll out 100,000 solar geysers for free to identified areas.

Wind Energy

The are no plans to introduce wind energy is Zambia's energy mix.

Challenges & Barriers

- Lack of clear Government targets for the renewable energy sector in a policy document.
- Lack of verifiable information on the available sources of renewable energy
- Lack of funding for research in the renewable energy sector.
- Absence of mandatory blending ratios is sited as the major hindrance to the development of the bio-fuels sector in the country.

RE Incentives

The Government has provided financial incentives for the solar sector by waving import duty on solar equipment in order to reduce the price of solar equipment.

5.19 Zimbabwe



Capital City: Harare
Size: 390 757 sq km
Population: 12.1 Million
GDP: US $ 4.4 Billion

Peak Demand:
Installed capacity:
Share of renewables in generation mix: 57 %

Electrification rate: 34 %
Utility: ***ZESA*** Holdings (Pvt) Ltd.
Energy Regulator: Zim Elec Reg Commission

Renewable Energy Resources:
Hydro Power (Potential 600 MW)
Solar (Potential 5.7 kWh/ m2/day)
Wind (Potential 0 MW)
Biomass (Potential 175 MW)
Biofuels Potential – Good.



Zimbabwe's Renewable Energy Analysis

Energy Policy Framework

The National Energy Policy was approved by Cabinet in 2010 and is meant to be reviewed soon to incorporate some emerging issues. Renewable energy, though not a stand-alone item in the NEP, has been an issue of national importance since independence in 1980.

Market Applications of Renewable Energy Technologies

Hydro Power

Renewable energy is dominated by small scale hydro power plants that are installed to supply energy to remote sites and rural homes. There is limited but growing use of larger systems for productive energy. Most systems were installed with grant funding from donors. Most of the small and micro-hydro installations in the country are in the Eastern Highlands.

Biomass

The sugar industry has traditionally produced electricity for own consumption. Currently the two sugar mills in the South Eastern part of the country employ 40 bar boilers to supply steam to a total 45 MW of power generation equipment. Each mill demands about 15MW during the milling season and can send about 5MW to the grid. A new sugarcane production and milling facility has just been constructed. The objective of the plant is to produce only anhydrous ethanol from cane and to use bagasse to produce electricity.

Solar Energy

There is no record of the total number of solar PV systems operating in Zimbabwe. The GEF PV Pilot Project installed 9 000 45 W equivalent systems. Private companies have continued to sell solar PV systems since then but at a lower rate. The Rural Electrification Agency uses solar for electrification of households and institutions. By end of 2010 they had installed 218 solar PV systems at rural sites. Currently there are over 200 000 households using electricity to heat water. If solar water heaters were used it is estimated that about 600 MW of peak power would be displaced from the grid.

Wind Energy

Average wind speeds have been estimated at 3.5 m/s. The NGO ZERO, a regional environmental initiative, has conducted feasibility studies, and financed production of a number of 1 and 4 kW wind turbines for off-grid purposes, as well as providing power to municipal buildings such as clinics.

Challenges & Barriers

- Economic - High initial investment plus high Operation and Maintenance cost.
- Poor access to technologies and poor skills to adopt and adapt technologies.
- Poor appreciation of linkage between individual and national development goals.
- Institutional and Policy/Regulatory - Subsidised conventional energy.

RE Incentives

The Government does not offer incentives for RE due to competing service deliver priorities.

6 COMESA INTEGRATED MARKET POTENTIAL FOR RE

From a RE market perspective COMESA can be split into a number of sub-groups according to political and economic links. The sub-groups are outlined below.

Group 1 : Egypt, Kenya, Libya, Swaziland

These countries have the most developed industrial infrastructure and the strongest potential and actual RE market. Government funding is being applied in combination with donor funds to implement basic service delivery. Egypt has the highest electrification rate and a growing RE technology industry. Though Libya's infrastructure has been destroyed by the recent civil war, the country has capital and oil reserves that should enable re-building of the infrastructure within a short period. Kenya receive substantial donor funding and is one of six countries selected for a RE development pilot project. Swaziland's has strong trade links with SA and as such is able to source its RE technology from South Africa. The energy distribution infrastructure is developed; rural electrification has been a major focus area.

Group 2: Burundi, Djibouti, Eritrea, Ethiopia, Malawi, Uganda, Sudan and Zambia

The economies of this countries started growing in the last decade and growth has since been slowed by the worldwide recession. Even though many renewable energy activities are still dependent on donor funded projects, there has been national initiatives to mobilise domestic capital to develop the RE sector. These countries are beginning to aggressively develop and implement infrastructure and basic service programmes. The liberalisation of the electricity sector has opened up opportunities for IPPs.

Group 3: DRC, Rwanda and Zimbabwe

Private sector participation in the economy was slow in beginning of the century in most sectors – RE sector included. There has been a turnaround in recent years – RE market development will benefit from increased private sector investment. Moreover, these counties have the advantage of vast mineral and natural resources.

Group 4: Comoros, Madagascar, Mauritius and Seychelles – The Islands

Remoteness from the mainland COMESA countries, combined with high levels of access to electricity and low fuel wood use, are distinguishing energy sector features. The energy sector of these islands is dependent on imported oil and co-generation in the sugar industry. Given the high costs of oil, Mauritius and Seychelles have focussed on the development and perfection of co-generation. The high cost of imported primary energy has incentivised these countries to look for RE solutions to their energy requirement.

6.1 Commercialisation in renewable energy in COMESA

The driving force behind the application of renewable energy in Europe and the rest of the developed world is the drive to clean up the environment and simultaneously diversify their sources of energy. During the past century and beyond, industrialized nation were the primary causes of the damage to the ozone layer. The impact has been felt everywhere in the world, and climate shift and become increasingly unfavourable for agricultural produce. The other drive for renewable energy is the need to reduce dependence of finite energy resources.

COMESA Member States differ in their energy mix – one hand Egypt is high on the usage of fossil fuels whereas on the other hand Zambia is almost entirely dependent on hydro power. Other countries such as Swaziland while locally they produce hydro power, they import most of their power from nations that primarily use fossil fuels for generation. Hydro power and baggage (in Mauritius, Kenya, Seychelles and Swaziland) based biomass (from sugar mills) are the only countries that are connected to the national grid; most of the sugar producing countries will follow soon. Connecting solar to the national grip is on the planning stages in some of the member states. Egypt and Kenya are the only countries that have connected wind power to the national grid.

In COMESA with its low level of access to non-biomass based energy carriers and particularly (connectivity averages 35%), RE is implemented as the least cost technology in supplying energy to remote areas and the poor sectors of the population, or to supply essential electricity to isolated areas. RE is still expansive, but a quicker and cheaper alternative to cover remote areas than expanding the utility's transmission and distribution network.

Hydro Power Market

There have been discussions on developing DRC, Zambia, etc. large hydro power potential, but the high capital costs and need to improve inter-connectivity among all the African pools have resulted in talk and intentions with implantation lagging behind. A number of small hydro power systems (<20 MW) were in installed in the last 3 decades and there are plans to install more.

With the opening up of the regional electricity market the opportunity to develop and run small IPPs has become commercially viable. This renaissance is also supported by the various international financing mechanisms aimed at reducing greenhouse gas emissions. Installed capacity is set to increase in the medium term as viable site are developed by IPPs or PPP with State owned utilities.

Biomass Market

Biomass through fuel wood or charcoal is the dominant household energy source in COMESA. Although there are a number of fuel wood related initiatives being implemented in the Member States, at present these offer little investment opportunities.

Other than fuel wood, the only other commercial option to biomass energy in COMESA is electricity and heat generation from the combustion of bagasse plants during the harvesting season. Mauritius is the most advanced in this respect where some 35% of their electricity generation is from bagasse plants. Similar plants exist in Kenya, Malawi, Sudan, Swaziland and Zimbabwe. The sugar mills in the latter countries have focussed on own use, Swaziland commissioned its new co-generation plant that supplies the local grid only a few months ago and it is planned that the two remaining sugar mills will follow suit. Also the sugar producing nations in COMESA have considerable potential for biomass based generation. Malawi and Swaziland could simulate Mauritius given their current total power demand versus vast sugar estates.

Solar Systems Market

Due to the abundance of solar energy is all COMESA Member States and the demand in remote areas for electricity supply, PV systems are dominant solar RE technology is COMESA. The market for PV system includes:

i. Telecommunications – PV panels are used for telecommunications applications such as microwave installations or telephone repeater stations. Unfortunately, with the exception of Egypt, the tendency is to import this system which robs the trading block of much needed jobs.

ii. Rural domestic electrification – this is the fastest growing sector for the PV market as member states fast track service delivery in rural communities.

iii. Clinics – rural clinic electrification is a common PV application in most countries.

iv. Water pumping – water pumping is a growing application as most mechanical wind pumps are replaced and new community water projects are implemented.

v. Other – other diverse applications of PV systems vary from navigational buoys, powering robots, parking tickets, hearing aids and so on.

Solar Water Systems is mostly used for hot water supply to households, clinics, hotels, remote government buildings and swimming pools. Due to the relatively low

electricity tariff in Sub-Sahara Africa, SWH have not been widely used. However, almost every country require new infrastructure and tariffs are increasing above the inflation rate, thus making SWH competitive.

Wind Energy Markets

The traditional application of wind energy has been mechanical water pumping. This market is declining with the increased use of PV systems. A small market exists for wind turbine battery chargers. Large wind turbines that are capable of connecting to the grid are now reliable and the capital costs are dropping gradually. For coastal based countries, such as Egypt, wind plants will form part of the energy mix in the near future.

Municipal Waste

Municipal biodegradable waste is a potential source of energy in large cities where sufficient landfill gas can be extracted. While acknowledged as a potential source of RE by most COMESA countries, very little (if at all) resources have been spent on developing projects in this area except for Mauritius where a 2MW landfill gas to energy has recently been commissioned.

6.2 Barriers to the renewable energy market development

The overall renewable energy market is constrained by a number of factors as highlighted below, these are:

1. The limited economic integration in COMESA – there is still much that can be done to improve economic integration and to support individual economies. This is process that COMESA needs to go through and requires both the public and private sector to unlock the obstacles to regional trade.

2. The low profile of RE technology in COMESA – compared to the impact and focus on the other energy sectors, such as grid electricity, liquid fuels and natural gas, RE technologies have a very low profile. This is partly due to lack of information of the potential and impact of RE as well as limited practical experience.

3. Low level of industrial development – the low level of industrialization limits the growth of technology driven market development. Technical support structures are needed for product development.

4. Absence of RE investment framework – the development of such a framework will facilitate market quantification and positioning of investments.

5. High perceived investment risk – the lack of information and preconceptions result in a high perceived risk.

6. Perceived barriers by investors – investors expect a similar type of investment climate in COMESA as they operate in, in their traditional markets. The absence of adequate incentives is seen as a high barrier to market development.

7. General utility view of PV as second rate and pre-electrification technology – the lack of information and preconceptions about the potential of RETs and particularly PV as a rural electrification technology has dampening effect on market development.

8. The lack of information on COMESA as a viable market for renewable energy – the general view is that the RE market is only viable through vast amount of grants which most Member States cannot afford. The exploitation of RET has so far focus on individual Member States.

9. A large number of the of RE project have been financed by donors. The donor financing is used to finance capital equipment, but without the government or community being able to manage and maintain the RE facility or even aware of the importance of doing so.

10. No COMESA technical standards – the lack of regionally accepted standards for hardware systems and components restricts the inter-regional trade.

6.3 Investment Opportunities in the Renewable Energy Sector

6.3.1 General

a) The strong positive growth experience prior to the recent worldwide recession has resulted in increased investment on infrastructure in a number of COMESA Member States. This has fuelled growth in the RE sector in rural electrification, telecommunications, and service sectors such as schools, clinics and other public buildings.

b) The shift from monopolistic energy sector dominated by State utilities to a more open market approach in a most COMESA member States has opened up opportunities for IPPs. Privatisation does lead to increased optimised invested and it is most likely to include foreign direct investment.

c) Most COMESA countries have a range of incentives in place, particularly for rural electrification.

6.3.2 Hydro Power Investment Opportunities

In general, governments or state owned utilities do not have the capital required to develop large or even small hydro schemes. There have competing priorities in an era of economic instability worldwide. At the same time, new investment on energy infrastructure is required as most countries are close or have reached their installed capacity limits.

Therefore, there is a potential for IPPs to invest in hydro power projects, either on their own or in partnership with the State.

6.3.3 Biomass Energy Investment Opportunities

The potential is in primarily two areas:

i. The sugar mills can change their power house and generate additional electricity and supply the national grid. The energy prices are sufficiently high to justify such investment.

ii. Biomass from sawmills and man-made forest rejects could be used for small (5-15 MW) power generating plants.

6.3.4 Solar Energy Investment Opportunities

The strong growth in the PV sector has created a significant market for solar. Investment exists in creating improved manufacturing capacity and cheaper PV systems. There is a need for service oriented companies that are able to design, implement and manage solar rural electrification projects.

6.3.5 Wind Energy Investment Opportunities

Sustainable market development largely depends on stronger government support in terms of incentives for clean energy. In order to stimulate considerations about setting up a manufacturing plant, both significant market potential and the possibility or its continued exploitation through implementation of relevant policy programmes and laws must be made available.

6.3.6 Municipal Waste

Most of the capital cities and major urban areas in COMESA generate substantial quantities of solid waste, most of it organic and generally referred to as municipal solid waste. The amount of waste and its content determines the viability of energy generation from MSW. Standard incineration plants generate about 0.6MW per ton. This illustrates that there is substantial potential available for energy generation

from municipal solid waste in urban areas even though not well studied in COMESA. Mauritius is perhaps the leader amongst COMESA member States in that it already generates 2 MW of electricity from municipal waste.

7 RECOMMENDATIONS

The status of the RE industry in COMESA member states is summarised in Annexure 1. It shows that with the exception of the use of large scale hydro and bagasse in Seychelles, many countries have no renewable energy in their electricity generation mix. The list of RE projects under development (Annexure 2) attest to the RE resource potential in the bloc but the slow pace of development of these projects suggests that there are barriers in the development of RE projects.

Based on the data obtained, the following measures are recommended for the successful development of RE industries in the bloc and member states:

7.1 Renewable Energy Resource Mapping

Most COMESA member states could not provide a renewable energy resource map for their countries. Without a resource map, it would be difficult for the bloc to develop strategies for supporting each other in the development of the industry. The resource map is also an important basis for developing the RE policy of each member state and the bloc.

7.2 Development of a Comprehensive Renewable Energy Policy

Annexure 1 shows that all COMESA member states do not have a standalone RE policy but rather the country's renewable energy policy is articulated in the energy policy. The limitations of not having an explicit RE policy are that the policy will tend to be very high level and not be comprehensive enough to articulate the objectives of the policy, set the targets and the implementation mechanism. The list of RE projects under implementation, with many of them in "development" or "planning" stage, attest to the limitations of the RE policies in the COMESA member states.

A comprehensive RE policy should, at the least, cover the following parameters:

a. *RE resource potential* – it is important that the policy indicates which RE resources it has, where and in what quantities. This gives policy makers and investors an idea of the industry potential. The more detailed the resource potential of a country is, the more likely it is for the country to attract private sector investment as resource mapping is one of the major costs of RE project development.

b. *National objectives* – it is important that the RE policy articulates the national objectives of the RE sector. Objectives could be diversifying the country's electricity generation mix, local economy development, new industry

development, job creation or reducing the country's carbon footprint. The national objective has implications on how the sector will be developed and how it will be funded, whether the RE generated will be exported or used domestically.

c. *RE targets* – a national RE policy needs to set the RE target for the country taking into account

- The RE resource potential of the country
- The impact on other resources e.g. land, water
- The cost to the economy

d. *Financing of RE* – with the exception of hydro, RE generation usually costs more than conventional energy generation. The RE policy must articulate how the additional cost will be funded. A number of financing instruments are at the policy makers' discretion e.g. Feed-in-tariff schemes, clean energy financing mechanisms (e.g. CDM), carbon tax from the other carbon emission sectors. It is important that the cost of the RE target be well understood and the policy maker makes an informed decision on affordability of the RE target against its potential benefits.

e. *Cost recovery mechanism* – the policy must articulate how the RE developer will be able to recover its dues. For example, if RE will be financed through a Feed-in-tariff (FiT), the FiT must still be collected by say the utility and passed to the RE developer. If the electricity industry is regulated, the regulator must pronounce on the FiT and the mechanism for its monitoring and transfer to RE developers. If the RE developer is the utility, its cost of generation will be impacted and the policy must articulate how this will be recovered e.g. tariff increase, carbon taxes, clean energy funds etc.

f. *Licensing, Off-take Arrangements and/or Procurement Processes* – in many countries an electricity generator needs to be licensed for generation. The transmission and distribution network in most instances belong to the utility. A RE policy therefore needs to address the licensing criteria, grid access conditions and if the state utility will the buyer of the RE then the procurement process needs to be outlined. The policy maker must bear in mind that the RE developer will require a long term off-take agreement (10-20 years in most cases) for the project to be bankable. If the RE developer is the utility, then these requirements of the policy might not be necessary.

g. *Institutional framework* – in many instances RE development stalls simply because the RE policy does not outline the institutional framework (including the role of each institution) that will enable the implementation of the policy.

h. Technology Transfer – The COMESA countries should share technology. This can be achieved through a COMESA data base.

i. Capacity Building – All players involved must get some form of capacity building. The point is elaborated in section 8.1.

Promulgating comprehensive RE policies will unlock the RE potential of most countries and bring the RE projects under development in the countries to commercial operation.

7.3 Catalysing Renewable Energy programmes through capacity building and regional cooperation

Other countries (e.g. China, India, and Spain) have developed new industries and manufacturing capabilities at the back of implementing RE projects. Such benefits can only accrue if the capacity being developed is large and warrants the establishment of manufacturing facilities. The electricity generation capacity and electricity demand of individual African countries is very small and the RE generation capacity cannot justify the establishment of manufacturing facilities. The implication of this is that African countries will continue to import technologies from other regions if the RE development is implemented in a fragmented manner.

COMESA should consider developing RE programmes straddling different countries for each renewable energy resource. The different programmes can attract clean energy technology funding, build manufacturing capacity in at least one country and ensure the industry has a meaningful economic impact in the bloc.

The harmonisation of RE policies is the first step towards the development of such a programme.

7.4 Development of a Renewable Energy Master Plan

As an extension to the policy framework, each member state should develop a Renewable Energy master plan, whose focus is to the implementation programmes guided by the policy. A RE master plan should also be developed by the COMESA as guideline as well as documents that captures the individual member states master plan. COMESA should assist the Member States develop their own Energy Master Plan.

7.5 Develop a Biofuels Industry

Biofuels offer an opportunity for growth in Africa due to the huge EU market. COMESA should help Member States with guidelines a development framework for the bio-fuels industry, hopefully with the same vigour and focus that Brazil gave to this industry many years ago. The market for biofuels is vast and growing rapidly. COMESA member states that have the suitable climate for growing ethanol and bio-diesel have an opportunity to attract foreign direct investment now when the EU is looking for suppliers of both ethanol and bio-diesel. Within COMESA, bio-fuels can economically replace fossil fuel [crude oil] which is often imported outside COMESA.

Commercial plants of biofuels require long term agreements for the land use and water. Land and water availability are essential for food security in a country. A biofuels strategy or policy therefore has to ensure that the biofuels industry is sustainable and does not negatively impact on food security. Some countries (like South Africa) have developed standalone biofuels policy and strategy in addition to the country's RE policy to ensure that monitoring is easy.

8 WAY FORWARD

The overall aim of this study has been to produce a baseline survey of the status and potential of renewable energy and draw conclusions as well as make recommendations on how the member states can develop the RE sector. The main objective is for COMESA Secretariat to facilitate the widespread introduction and application of innovative and appropriate renewable energy technologies by assessing the integrated member states potential for the introduction and application of RE technologies within COMESA. The analysis of the member states baseline survey, the observed barriers and the market opportunities for RE have clearly identified for the different RET in COMESA member states. The purpose of the action plan, is to capture the key actions necessary for the member states to harmonise and integrate the development of RE in COMESA. The action plan must be understood in the context of the recommendations listed in the previous section. Six priority areas have been identified for action, and these are:

8.1 Institutional Capacity Building

In order to increase the profile of the RE in COMESA, it is necessary to develop capacity in each member state in the understanding of the role that RE can play in the economy. Human resources should be developed, critical knowledge and know-how must be ensured in the three key drivers of energy, these being:

1. The Ministry responsible for energy – includes the specialist / engineer responsible for RE up to the administrative head of the Ministry. The ministry must balance the cost of RE development against competing community requirements for service delivery. These require proper and informed understanding of the long-term benefits of RE.

2. Regulator – it is assumed that all member states have or are working towards establishing an independent energy regulator. The energy regulator must possess the necessary skills to facilitate the development of RE. This includes management of issues such as feed-in-tariffs (and other incentives) for RETs in a manner that not only supports RE development but is sustainable for the country.

3. Utility – most utilities in COMESA are State Owned Enterprises. Their focus tends to be on traditional sources of energy. It is necessary that the utility views RE as part of their mandate and not competing technology that should only be provided by the private sector. Thus, there is a need for utilities to develop know-how on RE and find space in which they can work together with the private sector in developing RETs.

4. Practitioners – mainly these are private sector players doing the installation.

5. Consumers – dissemination of information on RE (particularly its low operational costs, its efficiency and ability to substitute grid electricity) to make the technology more acceptable to consumers.

6. National Standards Institutions – it is important that COMESA member states protect their markets from infiltration with sub-standard, poor quality and poor workmanship equipment. Such equipment ends up costing the consumer more and increase negative perception of RE technology amongst consumers.

Capacity building is an on-going process. It is costly, however, there is appetite amongst developed nations to sponsor capacity building in developing nations. COMESA could play a critical role in negotiating technical assistance from institutions such as the EU, USAID, etc. Capacity building will only work if it is undertaken with a view to implement the knowledge gained. Thus, while the details should focus at junior to middle management, it is important that senior officials from overall head of the energy department and the Ministry's administrative head are part of the capacity building. This is necessary because they make the implementation decision and will only buy into to RET initiatives if they have a broad view of the role of the importance of RE.

8.2 Renewable Energy Policy Framework Development

Traditionally, governments define their priorities and targets in a country policy and then develop strategies to implement the policy. Most of the member states have an energy policy with the few that do not have it showing the willingness to develop it. Policy development is not static and policies need to regularly reviewed to ensure the policy is still consistent with the economic development in general, and the energy sector in particular. Policy development is expensive and in a technical field such as energy, care has to be given that the appropriate benchmarking has been done. Fortunately, international organisations have assisted some of the smaller COMESA member states and seconded expertise to assist with the benchmarking. COMESA has developed the "COMERSA Model Energy Policy Framework", which should serve as a guide during policy review in order to foster harmonization of the key energy policy issues. Even though country needs are specific, the COMESA Framework may serve as a good as a guideline that can be adjusted for each country's unique local circumstances.

The COMESA Model Energy Policy Framework as well as all the member states energy policy, has Renewable Energy as one of the sections of the overall energy policy. In theory, if all the necessary key issues are addressed in the RE section, this strategy would adequately address the need for a RE policy. There is, however, growing realisation that when implementing the energy policy, like in all key performance indicator evaluation, if the bulk of the work has been done; the responsible person is

assumed to have achieved his target. Unfortunately, the tendency is to focus on the traditional energy industries and RE is given secondary attention.

Given the above, it is recommended that as the next phase of energy policy development, a RE policy framework should be developed by the COMESA secretariat to be used by the member states in a similar manner to the way the COMESA Energy policy framework has been disseminated and adapted by each country. In the previous section, the content of a RE policy are described and COMESA may use this as a guideline in developing their framework. This should assist ensure that:

- All member States have a RE policy in place.
- The RE policy for each member states is based on a single reference framework and therefore COMESA has an integrated RE framework.

The development of a biofuels industry has to take into account issues of food security, land tenor and water use. A commercial scale project may require long term land use and water supply agreements which important for food security. COMESA and each member stated must consider whether or not a biofuels policy (or strategy) should be part of the RE policy framework or stand alone.

8.3 Enhanced Renewable Energy Trade

In order to facilitate RETs trade amongst COMESA member states, it is essential to harmonise codes of practise and technical standards in line with global trends. Trade is hampered by the lack of uniform standards because member states cannot trade with countries using different standards. The private sector will only invest if there is a market for the good, thus smaller nations have limited opportunity to attract investors because their internal market is too small.

By harmonising the technical standards in COMESA economies of scale can be realised in manufacturing with positive effect on hardware supply cost and reliability. These will in turn positively affect end-user cost and reliability. One of the most effective steps required for achieving regional market integration is to make the different member states each other's RET product. This can only be done under the safeguard of acceptable technical standards across COMESA member states.

It is necessary to focus on those high profile products that are traded in COMESA such as PV systems and solar water heaters and facilitate the implementation of international RET hardware accreditation programmes. International initiatives such as the PV Global Accreditation programme should be integral inputs to this purpose. This will ensure that

the resultant standards does not limit trade just to COMESA, but also include markets outside COMESA – e.g., South Africa.

Power trade can only be enhanced if there is an integrated RE programme for the region clearly showing which country will focus on which technology and the timeline for the development of projects. Such projects can also be included in the regional power pools to ensure that there is sufficient demand for the clean power produced. It is therefore important that each country develops a RE master plan showing the targeted manufacturing capacity and technology as well as well projects to be developed. The country plans would then be integrated at the COMESA level to give the bloc's master plan.

The above requires a high degree of technology transfer amongst the member States. Harmonized technology and similar standards increase the market and regional trade on RETs.

8.4 Renewable Energy Investment Facility

It is evident that an appropriate framework for commercial energy investment in RET manufacturing capacity should be supported. To achieve this, an investment framework should be developed for supporting the RET's investment needs based on the programmes of national, regional and international financing organisations such as the African Development Bank, the World Bank and the International Financing Corporation.

Egypt is the only member state that has developed large manufacturing capacity, largely for its own market; and this is possible because of the size of the internal market. Other member states' RETs initiatives have focussed on how to deliver hardware and services to a largely poor, remote and rural base. These initiatives are now gaining momentum and a measure of success is being achieved in some member states. It is therefore important to look at what other factors need to be addressed in order to support and sustain the development of these emerging and growing markets. Emphasis should be placed on identifying and supporting hardware manufacturing and supply in order to facilitate member states synergies. The renewable energy sector's development and contribution to economic development and integration should be compared to other sectors such as transport and telecommunications.

8.5 Information Exchange Mechanisms

Information is critical for planning and decision making. If each country develops strategies and policy framework independent of other member states, integration will be impossible to achieve. A mechanism for information collection, collation and dissemination must be established. The COMESA HQ could ideally play this role through

the establishment of a central data base which is accessible to all the member states. Each member state would be required to appoint a contact point where the RE information can be sourced by the central co-coordinator of the COMESA RE data base.

RE should be addressed at member state level and the Regional power pool level for example by the mainstream RE projects at the Regional Pool master plan and priority project level and joint promotion level.

This recommended way forward is summarised in the responsibility matrix in the next page. It is important to recognise that the implementation of this way forward will require resources and therefore an underlying part of it is the sourcing of funds which might best be centralised at the COMESA Secretariat level.

8.6 Other Matters Discussed in the Validation Workshop

During the validation workshop, the attendees raised a number of issues most of which were addressed / incorporated in this report. Others would require further studies by COMESA, and these include:

a) ***RE Targets*** – COMESA should develop a program that will develop RE targets for each member state. Based on the RE resource map, this would involve identifying RE targets, estimating the cost of the RE versus conventional energy, accessing sustainability of existing and new projects, and drawing up the RE implementation roadmap.

b) ***Benchmarking of key Indicators*** – The benchmark of RE in COMESA shown in annexure 1 should be enhanced in future studies to clearly articulate:

- A reliable and detailed resource map indicating the potential for RE for each member state, , including location and ease of harvesting (i.e., estimate costs) the RE.
- Detailed electricity tariff structure of each member state, plus the financial details of the incentives for RE;
- The drivers of the electricity tariff structure must be explored with specific reference on how it impacts of the development and implementation of RETs.

c) ***RE Project*** – New RE projects should be identified, analysed and developed for the Investment Portfolio. Such projects should regard COMESA, amongst others, as the target market. This requires the harmonization of RETs in COMESA alluded to in the recommendation section of this report.

Way Forward Action/Responsibility Matrix

Programme	Responsibility	Date
1. Establishing a RE Fund 1.1 Funding for policy development 1.2 Funding for programme implementation	COMESA Secretariat	2012 – onwards
2 Institutional Capacity Building	Member States	2012 – onwards
3 Renewable Energy Policy Framework[14]	COMESA Secretariat	2012
4 Develop a RE manufacturers data base, inclusive for all member states.	COMESA Secretariat	2012
5 National RE Energy Policies 5.1 National RE resource map 5.2 National RE targets & programmes (or master plans) 5.3 National RE institutional framework 5.4 National RE policy 5.5 National Biofuels Policy/Strategy	Member States	2013 – 2014 2012 2013 2013 2013 – 2014 2013 – 2014
6 Implementing a COMESA Renewable Energy Programme 6.1 Developing the integrated regional RE programme showing country RET focus areas and projects for implementation 6.2 Developing a regional RE manufacturing roadmap 6.3 Establishing information exchange forums 6.4 Oversee the implementation of national programme and the regional programme	COMESA Secretariat	2013 - onwards

[14] The main purpose of the RE framework is to promote alignment of the RE framework amongst the member states.

Annexure 1 – Status of development of RE Policy in COMESA Member States

COUNTRY	Energy policy (incl. RE)	RE policy Stand-alone	RE Resource Potential	% RE in Electricity
Burundi	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 1 700 MW) Solar (Potential 5 kWh/ m2/day) Wind (Potential No Data MW) Biomass (Potential No Data MW) Biofuels – None	95 %
Comoros	X	x	**Renewable Energy Resources:** Hydro Power (Potential – 1 MW) Solar (Potential – 5 kWh/m2/day) Wind (Potential - No Data) Biomass (Potential – Very Small) Biofuel Potential – None	0 %
Democratic Republic of Congo	✓	X	Hydro Power (Potential 100 000 MW) Solar (Potential 5 kWh/m2/day) Wind (Potential No Data) Biomass (Potential No Data, high usage in rural areas) Biofuels Potential - Good	95 %
Djibouti	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 0 MW) Solar (Potential 5.5 kWh/m2) Wind (Potential 50 MW) Biomass (Potential 0 MW) Biofuels Potential - none	0 %
Egypt	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 2 842 MW) Solar (Potential 73,656 TWh/year) Wind (Potential 310 MW) Biomass (Potential 1 000 MW) Biofuels Potential – Low	13 %
Eritrea	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 2 600 MW) Solar (Potential 6.0 kWh/m2/day) Wind (Potential 2.4 MW) Biomass (Potential 0 MW) Biofuels production - None	0 %
Ethiopia	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 45 000 MW) Solar (Potential 6 kWh/m2) Wind (Potential 57,000 MW) Biomass (Contributes up to 90% of primary energy demand in the country) Biofuels production – Yes	98%
Kenya	✓		**Renewable Energy Resources:** Hydro Power (Potential 707 MW) Solar (Potential 5.5 kWh/m2/day)	68%

COUNTRY	Energy policy (incl. RE)	RE policy Stand-alone	RE Resource Potential	% RE in Electricity
		x	Wind (Potential 390 MW) Biomass (Potential 120 MW) Biofuels Production – Good.	
Libya	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 0 MW) Solar (Potential 7.5 kWh/m2/day) Wind (Potential 150 MW) Biomass (Potential 2 TWh/year) Bio-fuels Potential - None	0 %
Madagascar	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 7 800 MW) Solar (Potential 5.5 kWh/m2/day MW) Wind (Potential 1.2 MW) Biomass (Potential – No Data)	60 %
Malawi	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 900 MW) Solar (Potential 5.5 kWh/m2/day) Wind (Potential 25 MW) Biomass (Potential No Data) Biofuels Potential - Good	94%
Mauritius	✓	x	**Renewable Energy Resources** Hydro Power (59 MW installed): Solar (Potential 5 kWh/m^2/day) Wind (Potential currently limited to 60 MW) Biomass (155MW installed capacity) Biofuels potential - Good	20%
Rwanda	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 500 MW) Solar (Potential 5.5 kWh/m2/day) Wind (Potential no data MW) Biomass (Potential no data MW) Biofuels Potential - Yes	56.4%
Seychelles	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 1.8 MW) Solar (Potential 5.762 kWh/m2/day) Wind (Potential 3 – 9 m/s) Biomass (Potential no data) Biofuels (Potential no data)	0 %
Sudan	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 4 920 MW) Solar (Potential 6.1kWh/m2/day) Wind (Potential No Data) Biomass (Potential 55.5 MW) Biofuels Potential – Good	24 %
Swaziland	✓	X	**Renewable Energy Resources:** **Renewable Energy Resources:** Hydro Power (Potential 70 MW) Solar (Potential 6 kWh/m2/day) Wind (Potential no data) Biomass (Potential 200 MW) Biofuels Potential – Good.	95%

COUNTRY	Energy policy (incl. RE)	RE policy Stand-alone	RE Resource Potential	% RE in Electricity
Uganda	✓	X	**Renewable Energy Resources:** Hydro (Potential 2000 MW) Solar (Potential 6 kWh/m2/day) Wind (Potential No Data) Biomass (Potential 16 MW) Biofuels potential – Good.	99 %
Zambia	✓	X	**Renewable Energy Resources:** Hydro (Potential 6 000 MW Wind (Potential 0 MW) Solar (Potential 155 MW) Biomass (Potential 30 MW) Biofuels Potential - Good	99.9%
Zimbabwe	✓	X	**Renewable Energy Resources:** Hydro Power (Potential 600 MW) Solar (Potential 5.7 kWh/ m2/day) Wind (Potential 0 MW) Biomass (Potential 175 MW) Biofuels Potential – Good.	57 %

Annexure 2 – Country Specific Report

A2.1 Burundi

Functioning installed electricity capacity (2008): 32.9 MW

Hydro-electric: 95%
Thermal: approximately 5%
Total primary energy supply (2007): 176 ktoe

Biomass: 86%
Petroleum: 11%
Electricity: 3%

Over 90% of Burundi's energy requirements are met by the burning of wood, charcoal, or peat. Wood consumed mainly for cooking is and will be for a long time the main source of energy for rural households as well as in urban areas. The great majority of the population lives in rural areas and consumes primarily wood for fuel.

Reliance

Burundi has no indigenous sources of oil, natural gas or coal. It imports about 3,000 barrels of oil a day. There are no oil refining operations in the country. All refined oil products are imported from Kenya and Tanzania.

Extended Network

The distribution network is made up of a few isolated systems that enable transmission from the power plants of the Northern region, and a main interconnected grid linked with Rwanda and to the East DR Congo. The main grid is 362 km long and comprises of 110 kV, 70 kV and 35 kV lines. The electrification rate is just 1.8% of the population. The average electricity consumption barely exceeds 23 kWh/habitant/year.

Capacity Concerns

National electricity production has declined as a result of a lack of investment over the past 15 years, and the lack of rainfall, in conjunction with the country's dependence on hydropower. The sector is experiencing an energy deficit on the order of 10 MW, the result being load shedding and a slowdown in economic activity. There are power shortages, and electricity losses caused by an inadequate electricity infrastructure, and the need for better management of the distribution system.

The deficit of electricity in the country is estimated at approximately 25 MW in the dry season. However, this is likely to increase, taking into account the growth rate of the population, in particular of the urban population.

Renewable Energy Sources

Solar

Average solar insolation stands at 4-5 kWh/ m2/day. Solar energy is being investigated and utilised as a means of off-grid electrification for rural areas. Institutions such as the Solar Electric Light Fund have also invested in small solar systems for public buildings, such as health centres.

Wind

Data on wind patterns has been recorded by the Institute for Agronomic Sciences of Burundi (ISABU), primarily for agricultural purposes, give a mean wind speed between 4 and 6 m/s. More potential sites probably exist in the higher elevations. Pilot private-sector schemes are currently operational.

Biomass

Biogas is a form of energy adapted well to the needs for Burundi. The current government plan is to produce energy by means of digesters. Fuel-wood accounts for the vast majority of Burundi's energy consumption. However, potential wood consumption in the country is forecast to require production of 180,000 hectares, which surpasses the current forest coverage of 174,000 hectares, suggesting the need for reduction of consumption and re-forestation programs.

Geothermal

Resources have been identified, but there is little available data to assess commercial viability, the last geothermal study of the region having been conducted in 1968.

Hydropower

Burundi’s theoretical hydropower capacity is 1,700 MW, however, roughly 300 MW is seen as economically viable, and only 32 MW has been exploited.

Energy Efficiency

Burundi is one of the poorest nations in the world, with the significant upheaval having adversely affected the country's electricity networks. Distribution and technical losses amount to roughly 24%, and rehabilitation is necessary for a large proportion of the country's power generation infrastructure. Projects are currently under-way, financed by the World Bank, to aid Burundi in repairing the damage to the electricity network, as well as further extending it. The extensive use of traditional biomass is unsustainable in the long term.

Ownership: Electricity

The Burundian State promulgated, in August 2000, a law detailing the liberalization and regulation of the public utility of drinking water and electric power, allowing the private sector to contribute to the development of these sectors through Private Public Partnership (PPP).

The state-owned company Regie de Production et de Distribution d'eau et d'electrcite (REGIDESO) (the Water and Electricity Production and Distribution Authority) is in charge of production, transmission and distribution in urban areas. It is a public utility company, placed under the supervision of the Ministry of Energy and Mines. RIGIDESO mainly runs hydropower plants of high capacity.

Electricity is transmitted and distributed by REGIDESO, whilst the Societe Internationale des Pays des Grand Lacs (SINELAC), another state owned company responsible for development of indigenous and joint power ventures with neighbouring countries, generates and sells power to REGIDESCO.

Liquid fuels

The petroleum sector falls under the Ministry of Trade and Industry (www.commerceetindustrie.gov.bi) which supervises all imports.

Competition

REGIDESO is a vertically-integrated, state-owned institution. The company is the main producer of hydro-electric energy, as well as constructing and maintaining major electrical lines for the transmission, secondary transmission and distribution of energy.. DGHER, the authority responsible for rural electrification and water access, is a client of RIGIDESO, buying electricity from them and distributing it to rural customers. DGHER used to run its own power plants but now has just some micro plants , which are affected by high rates of unavailability.

Energy Framework: The Poverty Reduction Strategy Paper (PRSP)

Burundi's Poverty Reduction Strategy (2006) identifies the severe shortfall in electricity supply as a major constraint for development. It recognises the need to undertake urgent actions (including the rehabilitation of existing power plants and the construction of new facilities) to ensure an adequate power supply, and endorses the government's plan to undertake a rural electrification program by extending the grid and connecting villages, as well as disseminating information on alternative energy sources which are affordable for low-income households.

Moreover, to promote solar energy use and to reduce the high cost of acquiring solar equipment, the government plans the reduction or the suppression of the taxes which are

applied to photovoltaic panels. Nevertheless, solar systems have undergone a certain expansion due to diverse NGO initiatives to cover especially deprived sectors. For example, since 2006, more than 95 community organisations (centres of health, communal colleges and social centres) have been outfitted with solar photovoltaic installations.

Energy Debates

The government estimates that a very high priority must be given to the development of electricity, as an essential condition for development and a balanced economy, and for growth in all other sectors.

Energy Studies: Burundi Research Centre for Alternative Energies (CEBEA) undertook a rural solar electrification study in Burundi.

Assessment of the Current Status of the Energy Sector in Burundi – German Technical Assistance Regional Energy Advisory Platform Eastern Africa (GTZ-REAP-EA).

http://regionalenergy - net.com/images/Regional%20initiative%20report/Burundi%20Energy%20Study.pdf

Role Government: Ministry of Energy and Mines

The Ministry of Energy and Mines, by the means of the General Directorate of Water and Energy, formulates and implements energy policy. The responsibilities include:

- to plan, control and coordinate all programmes and activities of the energy sector;
- to promote exploration and exploitation of hydrocarbons while protecting the environment;
- to enhance access to modern energy services at least cost; and
- to elaborate laws and regulations for the best management of the sector.

Government Agencies: Centre d'Etudes Burundais des Energies Alternatives (CEBEA)

The Burundian Centre for Studies of Alternative Energies was created in 1982 to conduct applied research and disseminate knowledge of renewable energies, particularly solar, wind and biomass.

The Directorate General of Hydraulics and Rural Energies (DGHER)

The DGHER develops rural electrification projects. Since the hydroelectric power plants of DGHER are independent of the main power grid, an agreement between REGIDESO and DGHER becomes necessary when any of these hydropower plants gets connected to the grid for power transmission;

The Ministry of Communal Development and Craft Industry is mostly involved in the field of rural energies and water supply;

The Ministry of Trade, Industry and Tourism is involved with issues related to oil products;

The Ministry of Territorial Planning and Environment has authority over issues related to wood energy and the safeguard of the environment;
The National Commission for Water and Energy's (established by decree n 100/226 of 11/12/1989) main role is to coordinate the various programmes and policies.

Energy Procedure: Multi-Sectoral Water and Electricity Infrastructure Project (2008-2013)

Funded by The World Bank at a cost of $50 million, the project supports the Government of Burundi's efforts to (a) increase access to water supply services in peri-urban areas of Bujumbura; and (b) increase the reliability and quality of electricity services.

Interconnection of Electric Grids of Nile Equatorial Lakes Countries

The project consists of the construction and upgrading of 769 km of 220 kV and 110 kV power lines and 17 transformer stations to interconnect the electric grids of the Nile Basin Initiative Member countries (NBI), namely Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda.

Other Projects

Kabu 16 (20 MW) and Mpanda (10.4 MW) and two regional projects : Rusizi III (145 MW to be divided with Rwanda and the DRC) and Rusumo Falls (61 MW to be divided with Rwanda and Tanzania) are two further hydro-electric projects. Burundi also plans another national project: Jiji/Mulembwe/Siguvyaye in the south of Burundi rated for 100 MW or more, and on Ruvubu (Mumwendo site: 80 MW). It would have a cost of 750 million dollars and feasibility has not yet been established.

Energy Regulator

Burundi has started the process to establish a regulatory authority : the Agence Autonome de Régulation du Secteur de l'Eau et de l'Energie du Burundi. Meanwhile, the Electricity Department of the Ministry of Energy and Mines is responsible for the constitutional and organizational function for the electricity sector.

Degree Independence: The Ministry of Energy and Mines is directly subsidiary to the government of Burundi.

Regulatory Framework

The Ministry of Energy and Mines is responsible for policy and regulation of the energy and water sectors in Burundi. The Presidential decree No. 110/314 of 14th November 2007 defines the principle objectives of the Ministry of Water, Energy and Mines, as well as governance of upstream petroleum activities.

Regulatory Roles

The Ministry is responsible for the elaboration of laws and regulations for the best management of the sector.

Energy Role Regulation

The Ministry of Energy and Mines is the sole regulating body for the energy and water sectors in Burundi. No other government department takes an active role in energy policy or regulation.

Regulatory Barriers

Expansion of electricity services to the population is a vital first step in development, along with t an institutional framework for electrification or dedicated energy regulation.

A2.2 - COMOROS

1 Renewable Energy Regulatory Framework

Currently, the country does not have a national or local policy framework on energy or RE national policy on renewable energy. There also no regulations pertaining to renewable energy in Comoros.

2 Overview of RE in the Comoros

The Comoros is filled with vast renewable energy resources. However, energy scarcity is a serious obstacle to economic and human development in most parts of the country. The potential of energy efficiency and renewable energy to multiply the use of fossil energy from economic growth is largely untapped in the Comoros. The exploitation of this potential is important in the context of industrial productivity and competitiveness. A transition to modern energy services based on renewable energy to help break the cycle of deprivation and energy of underdevelopment in the region is needed.

Objective of the Project

The project objective is to convert significantly Comoros and local renewable energy in the context of greater energy independence and universal access to energy Comorians. The completion of the project activities will include contributing to a decrease in domestic consumption of fossil fuels, the preservation of global resources by a reasonable use of fossil fuels, and improved air quality at the global level, to through reduced emissions of carbon dioxide from fossil fuels.

We will discuss adopting a mixed strategy to reduce the need on the one hand, stabilize the supply for users, develop various energy sources that can meet different needs while promoting various resources available to the Comoros as:

- hydroelectricity by installing micro turbines when the potential is sufficient, which requires environmental protection measures to maintain the upstream water potential of the stream in question;
- wind, by setting up wind farm capable of ensuring the supply of an optimal size of communities
- biomass (agricultural waste recovery, increased energy efficiency of traditional fuels, egg improving the carbonization process for the production of coal,

reducing the need for coal and other fuels by spreading the use of improved stoves

- The biogas-from animal waste (EU production)
- passive solar / thermal (solar power is expensive): the development of solar power, solar ovens for domestic use and for processing of certain products, dryers, water heaters for hotels
- Geothermal.

3 Current Status of Renewable Energy.

The current situation of renewable energy is based on hydropower and solar and wind installations in the islands. Solar projects, wind, hydro and geothermal are studies to improve the energy capacity in the Comoros.

4 Future Plans

No plan so far in the country on renewable energy. For the recommendation is to take a national political.

5 Mandates for change

View that is no energy policy, or regulation there is not a change of mandate. Renewable energy targets are to convert the Comoros significantly to renewable energy and local perspectives in greater energy independence and universal access to energy Comorians. The completion of the project activities will include contributing to a decrease in domestic consumption of fossil fuels, the preservation of global resources by a reasonable use of fossil fuels and reduced emissions of carbon dioxide from fossil fuels. There is no mandate cannot speak ACCESS to other markets

6 Challenges , constraints and barriers

The major constraints to wider adoption and scaling of the use of renewable energy in Comoros are as follows:

- Lake of awareness of renewable energy
- High initial costs in the development of renewable energy system;
- the inadequacy of local research and development capabilities and acceptability of the end user
- A lack of demonstration projects to encourage more widespread interest in the private sector;

- Inadequate assistance of financial institutions, and
- Gap in the regulatory and policy framework.

Recommendations to overcome the challenges is to expand communication to promote renewable energy through the development of information tools on renewable energy and energy potentials of the country

7 Historic Electricity Cost

- Previous 5-year generation costs and forecast for the next 5 years.
- Previous 5-year wholesale costs and forecast for the next 5 years.
- Previous 5-year average retail costs and forecast for the next 5 years (may also report the separate retail customer categories and include their percentage consumption of the segment to total sales base).

8 Carbon Tax

The Comoros is among the countries signatory to the Kyoto Protocol.
There are no plan is developed today to introduce a carbon tax.
The contact details of the country's designated national authority (DNA). :
Name: Sharaff-dine; mobile phone: +269 3320849

9. Lessons learned and observations

After this work we found that countries with sustainable energy potential that could meet the energy needs, however, we note the lack of policy, strategy and regulations on renewable energy that exists in the country.

10 Conclusion

Despite sunshine (5000 Wh/m^2) identical throughout the territory, the mitigation scenarios must be analyzed in light of the specificities of each island and development costs of various alternatives. Moheli has the greatest wind energy potential; the island is often swept by winds of moderate strength, power to install a wind turbine area. In terms of Grande Comoros, a development of solar energy could be considered.

A mitigation scenario based on the use of geothermal energy in Grande Comoros could not materialize before 2020. The realization of a geothermal plant requires prior comprehensive studies of potential deposits. However, it should now undertake the research work, as in the case of conclusive data, it would be possible to generate

geothermal energy from 2020. A geothermal field would be enough to satisfy half of the estimated needs for 2020 in Grande Comoros. In the end, the realization of a hydroelectric project on the rivers of the island of Anjouan would meet the total demand for electricity in the island, and decrease of 38,000 tons of CO2 emissions over the period 2011 - 2020, representing a decrease of 90%.

In general, the state should, with the support of its partners, continue to encourage people to use alternative energy by introducing additional incentives and a policy of investment in the clean energy sector.

A2.3 DEMORATIC REPLUBLIC OF CONGO

1 Renewable Energy Regulatory Framework

National Energy Policy

Renewable energy issues in DRC are addressed in the general national energy policy formulated in the "Document de Politique du secteur de l'électricité en République Démocratique du Congo"of May 2009. The main themes of the energy policy are:

The national vision in electricity is to progressively provide the populations with dependable energy by exploiting all available energy resources, primarily hydroelectricity and increased focus on rural electrification.

The objectives is to progressively and in a balanced manner provide electricity to households, public institutions and industry; also, to simultaneously improve the supply electricity with respect to reliability, price and protection of environmental ecosystem.

Specific objectives are:

i. To increase the electrification rate and cover the whole country by 2025.
ii. The restructuring of SNEL in order to make the electricity sector one of the pillars of growth of the Congolese economy.
iii. The exportation of a part of energy production by means of interconnected network, and regional integration from energy pools and from sub-regional organization and to use the incomes of exportation of energy to develop other national facilities.
iv. The promotion of all renewable sources of energy other than hydroelectricity, with notably rational use of wood fuels.
v. The gradual replacement of diesel electricity generation systems in the autonomous centres with thermal generation.

Strategies adopted for the implementation of the policy of electricity development are:

i. The reform of the regulation and institutional frame work.
ii. Set national standards and codes through electricity project initiated by the DRC Ministry of Energy in September, 2008.
iii. The standards and codes project includes the Authority of Regulation of the electricity sector, the Agency of National Electrification and the National Fund of Electrification

iv. The transformation of the Administration of Energy objectives to reinforce the institutional and administrative capacities of this one.

v. The development of the different sources of energy and particularly the implementation of Inga's hydroelectrical site which represents a major opportunity for national economy growth though electricity exports.

vi. A strong campaign to mobilize funds for the development of Inga to its full potential so that it can supply power to power pools.

vii. The rehabilitation of the existent power station and building of new facilities of production, transport and distribution.

viii. The creation of a management structure for the development of the site of Inga and ensure a leading role by the government through the Ministry of Energy.

ix. The Energy from Inga 3 and Grand Inga will serve to reduce energy deficit of the country, to feed national industries in high consumption of electricity, to cover request in exportation and to promote its income, country electrification and other plans of socio economic development.

x. To promote regional cooperation and integration in energy issues, notably as part of CEEAC with PEAC, SADC with SAPP, CEPGL with EGL and SINELAC.

2 Renewable Energy Resources

2.1 Hydro Power

In spite of huge hydro-electrical potential of the DRC, estimated at 100 000 MW which 44 % is concentrated only in the Inga's site. The actual level of development on aforementioned site is 1 775 MW with 351 MW at Inga 1 and 1 424 MW at Inga 2. It will also be necessary to exploit the 215 hydro-electrical sites identified across the country as well as the other renewable forms of energy with objective to improve the electricity rate of service from 9 % to 19 % based on project skyline 2015.

2.2 Biomass

There are 1.250 million tons from 122 millions hectare of equatorial forest. Biomass (wood of fire and charcoal) provides 95 % of energy consumption while other forms of energy contribute at the rate of only 3% for electricity and 2% for the oil products.

2.3 Solar Energy

The estimated solar radiation is between3.50 and 6.75 kWh/m2/day. The solar energy industry has is yet to be developed.

2.4 Wind Energy

DRC has a restricted wind potential. Several on-going or accomplished studies are aimed at determining the average velocity of wind about 2.3 and 6.5 km/h.

2.5 Geothermal Energy

DRC has not yet assessed its geothermal potential. Nevertheless, several geothermal sites were identified in the eastern part of the country especially in the western branch of the African Rift Valley.

3.6 Municipal Waste

Annual municipal waste generation in Kinshasa only is estimated at about 803,000 tons. These are collected by PNA (Clean up National Programme) and can be disposed in a central deposit sites and can be available for energy recovery.

A2.4 DJIBOUTI

Total installed electricity capacity (2007): 116 MW

Diesel/Heavy fuel oils: 100%

Total primary energy supply (2007): 145.2 ktoe

Traditional biomass fuels, petroleum products and electricity have a significant share in the country's energy mix. 250 GWh of electricity were produced in 2006.

Peak production capacity is substantially lower than the installed capacity, as power generation is provided by ageing diesel and HFO engines. The city of Djibouti is the principal power market. Over the long term, electricity demand has been increasing at a rate of 3% to 5% per year. The maximum energy demand for 2025 has been forecast to be 810 GWh/yr.

Reliance

Djibouti has no indigenous sources of oil, natural gas, hydropower or coal. Oil consumption and imports are 13,000 barrels per day, most of which comes from Saudi Arabia. There is no oil refinery in the country, and as a result, all refined petroleum products including gasoline, jet fuel and kerosene are imported. An oil refinery is expected to be completed in 2011. Much of the output will be exported.

Extended Network

The national electrification rate in 2003 was 49.5%, and the electrification rate in urban areas was estimated to be 57% in 2006. The government expects 60% of the entire population to have access to electricity in 2015.

Capacity Concerns

Electricity production in Djibouti comes at a high cost, but service delivery is poor. Despite energy tariffs amongst the highest in Africa, and four times higher than in neighbouring Ethiopia, the national utility runs net operating losses, which have increased with the recent surge in oil prices. At the root of these problems is the dependence on imported oil, aggravated by large arrears from the public sector; and obsolete equipment. Cost recovery is also hampered by large technical and non-technical losses (for example, illegal connections), respectively estimated at 10% and 6% of production. The financial situation of the company has resulted in insufficient maintenance and investment, and inadequate service, with frequent power cuts at peak times.

70% of the population live in the capital of Djibouti-Ville, and another 13% in secondary towns, kerosene is in high demand for household needs such as cooking, but the volatility in petroleum products prices makes it very expensive.

Renewable Energy

Solar

Djibouti's location on the Horn of Africa is ideal for solar energy. Average daily insolation is 5.5-6.5 kWh/m2 over the whole country., The Japanese government has recently extended a grant for the installation of solar panels at the Djibouti Centre for Research and Studies, the state scientific institution.

Wind

Studies conducted in the 1980s indicated that average wind speeds across Djibouti peak at 4 m/s, indicating a moderate potential for wind energy. Government studies in 2002 concluded that Goubet, at the entrance to the Gulf of Tadjourah, has the potential for a 50 MW wind farm.

Biomass

With the majority of the country being semidesert, the potential for large-scale power production from biomass is expected to be of limited feasibility. However, no formal assessment has yet been made into the country's biomass potential.

Geothermal

In 2001, the American Geothermal Development Associates (GDA) completed a feasibility study for a 30 MW geothermal power plant in the Lake Assal region, west of the capital. EDD aimed to execute the $115 million plant using a Build-Own-Operate (BOO) model. With financing for the project finally put in place in 2008, Reykjavik Energy Invest (REI), an Icelandic company, is now poised to implement it, and the plant is expected to begin production in 2012, replacing some of the electricity currently generated using diesel.

Energy Efficiency: With distribution and transmission losses in the region of 16%, the potential for efficiency improvements in the electrical power sector are evident. The promotion of energy efficiency in the residential sector has also been identified Predominant use of traditional biomass resources for domestic purposes is regarded as inefficient and potentially harmful. The World Bank has made recommendations to the government of Djibouti to promote the use of bottled LPG as an alternative, as well as improved home energy efficiency.

Ownership: Electricity

Electricité de Djibouti (EDD, http://www.edd.dj/), a state-owned enterprise, has the monopoly on the generation, distribution and marketing of electricity in the departments of Ali-Sabieh, Arta, Dikhil, Djibouti, Obock and Tadjourah, while the rest of the country is covered by private firms. In 2004, a total of 38,856 subscribers were connected to the grid. The EDD is unable to satisfy all domestic demand.

Liquid fuels

The public limited company, Société internationale des hydrocarbures de Djibouti (Djibouti International Hydrocarbons Company) (SIHD), a state-owned enterprise, and two other companies (Shell and Total) share the import market and, where applicable, the export, exploitation, processing, storage and marketing of hydrocarbons and their by-products.

Competition EDD is a vertically-integrated, state-owned company, responsible for the generation, transmission, distribution and sale of electricity in Djibouti, and has the primary responsibility for the development of geothermal resources for power generation.

The SIHD is responsible for the import, export, processing and operation of hydrocarbon resources and products in Djibouti. The SIHD is state-owned, and fully integrated in its operations. Co-operation between the SIHD and public/private sector partners is encouraged in the establishing law No 65/AN/99.

***Energy Framework: The government's goals are to**:*

- improve efficiency and financial performance of the electricity utility through loss reduction measures;
- address key service delivery constraints through rehabilitation and extension of networks, and administrative improvements; and
- explore new resources for power generation (for example, renewable energy and interconnection with Ethiopia).

Energy Debates:

In May 2010, Djibouti received a US$30 million loan for its 75 MW thermal electricity plant with the option to later expand to 300 MW. The loan was provided by the Kuwait Fund and the Saudi Fund, with an additional $80 million being provided by the Islamic Development Bank and OPEC.

The government is in the process of replacing the majority of rural diesel water-pumps with sustainably-powered equivalents.

Energy Studies: Ethiopia-Djibouti Power Interconnection Project

Ethiopia's power system is predominantly hydroelectric based and production costs are low. However, Djibouti's power system depends on oil, whose cost depends mainly on the price of imported petroleum. As a result, the unit cost of power production in Djibouti is about 4 times higher than in Ethiopia. In the spirit of regional cooperation, and given the huge advantage for Djibouti, in using hydropower from Ethiopia, rather than indigenous, high cost thermal power, in November 2002 the countries signed an agreement to implement the interconnection project.

In 2005 the African Development Fund (ADF) approved loans of US$30.4 million and US$25.6 million to Ethiopia and Djibouti respectively. Djibouti is also a member of the League of Arab States and the African Union.

Role Government: Ministry of Energy and Natural Resources

EDD is the state-owned electric utility and is under the jurisdiction of the Ministry of Energy and Natural Resources, which is in charge of developing and implementing sectoral policies for energy, water and mineral resources. The SIHD is also under the jurisdiction of the ministry.

Government Agencies: Centre des Etudes et de Recherche de Djibouti (CERD)

The CERD is the national institute responsible for monitoring and carrying out scientific and technical work in Djibouti. It is a semi-autonomous government agency that reports directly to the Office of the President. CERD provides technical support to EDD for geothermal exploration and the development of renewable resources.

Energy Procedure: In 2009, the UNEP in conjunction with the Global Environmental Facility (GEF) and the World Bank, launched the proposal for: Regional (Djibouti, Eritrea, Ethiopia, Kenya, Tanzania, Uganda); African Rift Geothermal Development Facility (ARgeo) which is a program of financial, policy and technical instruments for the promotion of geothermal energy development in these six countries.

DJ-Power Access and Diversification (2005-2013):

Funded by the World Bank, the project's original objectives (PDOs) were to:

- increase access of under-served populations to electricity services, through investments in distribution, and electricity connections in Balbala (an area of the capital, Djibouti-Ville);
- increase reliability of electricity services by introducing a pilot wind farm of an estimated capacity of 3.5 to 4.5 MW near Arta, West of Djibouti-Ville; and

- improve the efficiency of the electric utility, through technical assistance, including an electricity tariff study, an electricity loss reduction study, and a commercial management study for the electricity and water sectors.

By the end of 2008, delayed progress in implementing the wind component coincided with a cash crisis at EDD. In the absence of proportionate electricity price adjustments, this crisis, brought on by record international oil prices, led to unsustainable government budget transfers to cover the costs of fuel, and to the risk of defaults by EDD in its payments to oil suppliers. As an emergency measure, in order to avoid the interruption of the operation of EDD's generation plants, the World Bank agreed that savings from the wind component (US$4.9 million) be channelled into the purchase of heavy fuel oil and supplied to EDD. The planned tariff study was cancelled as the AfDB had completed such a study in December 2008. The PDOs of the Projects were therefore revised as follows:

- to increase electricity access;
- to ensure the emergency reliability of power generation; and
- to provide some diagnostic tools for improving the efficiency of the power utility.

Energy Regulator: The Ministry of Energy and Natural Resources has the responsibility for regulating the electricity and oil sectors in Djibouti.

Degree Independence:

The Ministry is a government department, with funding being directly allocated from the national budget, and is hence, not independent. The Minister of Energy is appointed by the Prime Minister.

Regulatory Framework:

Act No.97/AN/00/4 on the re-organisation of the Ministry of Energy and Natural Resources dictates the new structure of the Ministry, to include a General Secretariat, in addition to 3 Directorates, for administrative and legal affairs, energy issues, and natural resources.

Regulatory Roles:

The Ministry is responsible for all policy and regulatory mechanisms relating to the electricity and oil sectors in the country, including the operational management of the national utilities.

Energy Role Regulation:

The Directorate of Energy within the Ministry is responsible for the development and promotion of renewable energies, the investigation of energy issues, the monitoring of compliance to regulations pertaining to the electricity and oil sectors, the award of and withdrawal of licenses for market activities, and the collection and analysis of data for the preparation of a national energy policy.

Regulatory Barriers:

The establishment of clear development goals for the sector, including enabling legislation and policies pertaining to the promotion of new and renewable energy sources, would assist the development of RE in the country.

A2.5 EGYPT

1 Renewable Energy Regulatory Framework

The Egyptian energy policy and electricity market structure meets most of the COMESA Model Energy Policy Framework requirements. The main challenge is meeting its clean energy targets because fossil fuels are still the key fuel for energy production. Egypt net exports of energy have been declining in recent years. The

significant reductions of net export in crude oil and petroleum products has been partly offset by the increasing exports of natural gas.

The polices that have been adopted to support renewable energy include:

i. The main policies that could be supported either the production or the demand for wind could be one of the following:
ii. Quantitative Polices as green certificate and competitive bidding
iii. In addition to other supplementary policies as:
iv. Financial policies such as soft loans and governmental purchases
v. Taxes and custom incentives either related to production or consumption
vi. Contractual as power purchase agreement

Energy Efficiency is one of the major concerns of the energy sector, particularly the electricity sector. The draft electricity law addresses these concerns were by issuing energy efficiency related codes and through the formulation of a number of ad hoc energy committees at Ministerial level as well as at NGO level. A typical example of this is the energy committee by the Federation of Egyptian Industries, and the Egyptian Energy Saving Council for Industry.

2 National Energy Policy with Reference to COMESA

The Energy Policy of Egypt embraces most of the issues addressed in the COMESA model energy policy framework.

3 Renewable Energy Strategy

Egypt has set a target of 20% renewable energy in the electrical energy mix. Hydro installed capacity currently contributes 10% and is expected to drop to below 6% by the year 2020. This implies that 14% of the renewable energy must come from other sources by 2020. This is equivalent to installed capacity of 7 200 MW. The renewable energy strategy priority states that wind energy should contribute 12% of the

targeted 14% of the renewable energy mix in the year 2020 for the following reasons:

i. There is a high potential of wind energy in many sites with a high capacity factor.
ii. The local experience in wind energy dates back to the 80's - the current installed wind energy capacity is 405 MW.
iii. The potential for an increasing share of local manufacturing of wind energy equipment which increase to 30-70%[15].
iv. Wind generation costs are getting closer to oil and gas generation costs.

Renewable energy laws and legislations

The new electricity law has adopted three mechanisms for power generation from renewable sources, these mechanisms are:

1. Plants shall be built by NREA
2. Competitive Bidding
3. Feed-in-Tariff

PROGRAM SIZE	2 200 MW	2 500 MW	2 500 MW
Single Wind Farm Size	Large (100-400 MW)	Large ten Modules each (250 MW)	Medium and Small below 50 Mw
Developer	NREA	Private (most probably international)	Private (focus on local)
Finances	Governmental and soft financing from international development agencies	Commercial finance	Commercial finance
Tariff Setting	Proposed by Egypt era and approved by the cabinet of ministers	According to the bid outcome	proposed by Egypt era and approved by cabinet of ministers
Contracting	20 years	Long term PPA mostly for 20 years	15 years
Off taker	Grid		Grid or distribution system
O/M	NREA	Developer	Developer

[15] Sourced from the latest report issued by IMC in cooperation with Cairo University.

Construction Responsibility	NREA through EPC	Developer	Developer

4 Status of Renewable Energy Development and Future Plans

4.1 Hydro Power

Approximately 11.2% of Egypt's power comes from hydropower facilities, the first of which was built in 1960. This facility, the Aswan Dam, was constructed to control the Nile water discharge for irrigation. In 1967, the 2.1 GW High Dam hydropower plant was commissioned, followed by the commissioning of the Aswan 2 power plant in 1985, the commissioning of the Isna hydropower plant in 1993 and that of Naga-Hamadi in 2008. An additional 32 MW hydro power station is currently under construction and will be commissioned in 2016. The project is known as the New Assult Barrage Hydro Power plant. The total installed hydro power is 2 800 MW.

4. 2 Biomass

About 23 MW of power is currently generated from the gasification of sewage sludge from the waste water treatment plant at EL-Gabal El-Asfer.

There is a high potential projects for power generation based on gasification or direct combustion of organic solid wastes or agricultural waste. These are under various stages of development or consideration; potentially, about 1000 MW could be generated from agriculture waste

4.3 Solar Energy

Solar Thermal Water Heaters

In the 1980s, the Ministry of Electricity and Energy imported 1 000 solar flat plate solar water heaters with different capacities. They were installed in different places in order to initiate the market for solar water heaters and to increase the national awareness of the benefits and advantages of solar heaters. At the same time, first private company for manufacturing of solar water heaters was been established. Currently, there are ten SWH manufacturing companies. Over 400 SWH have been manufactured and installed in Egypt.

Disseminating Solar Heaters Project in Hotels located in Red Sea and Sinai

The aim of this project is support the financing and the dissemination of solar heaters in hotels and resorts in Red Sea and Sinai governments. The subsidy is 25%

of the total system cost including the operation and maintenance services for 4 years. So far the list of water heaters suppliers has been identified and published. The total subsidy budget is currently US$ 500 000.

Kuraymat 140 MW Integrated Solar Combined Cycle Power Plant

The project site at Kuraymat, which locates nearly 90 km South Cairo .It, is based on parabolic trough technology integrated with combined cycle power plant using natural gas as a fuel with a capacity of 140 MW including solar share of 20 MW. Total cost is 340 Million Dollar. The project is considered as one of 3 similar projects are being implemented in Africa (Morocco, Algeria, Egypt), which mainly depending on integrating solar field with combined cycle.

Photovoltaic Systems

The total capacity of PV systems in Egypt is around 10 MW, for lighting, water pumping, wireless communications, cooling and commercial advertisements on highways.

Future projects in the_5th year plan (2012 - 2017) includes

- The proposed Concentrator Solar Power project with capacity of 100 MW in Kom Ombo city to be a model for governmental projects.
- Photovoltaic plants with total capacity of 20 MW.

4.4 Wind Energy

Wind Farms in Hurghada – 5 MW

Hurghada wind farm operates since 1993, it includes (42) wind turbines with different technologies, German, Danish, and American. Wind turbines have single, double and triple blades. The percentage of local manufacturing reached about 40% (blades, towers, mechanical and electrical works) and the capacity of wind turbines ranges between 100 to 300 kW. The total production of the power plant in 2009/2010 reached around 7 GWh saving about 1.5 thousand tons of oil equivalents and reduce the emission of approximately 4000 tons of carbon dioxide.

Zafarana Wind Farm – 517 MW

This wind farm has been implemented in several stages (60, 80, 85, 80, 120 MW) starting in 2001, through the governmental co-operation protocols with Germany, Denmark, Spain and Japan. 120 MW wind farm in Zafarana has been completed in August 2010 before the end of the contractual terms. The wind farm is implemented in co-operation with Denmark. The total capacities reached 517 MW. It is expected that the total capacities in Zafarana would reach 545 MW after the completion of 120 MW farms that implemented through co-operation with Japan.

Future Projects

- NREA plans to implement wind projects with total capacities of 2370 MW as part of its strategy to promote wind energy.

- The proposed 120 MW wind in co-operation with "Italgen" Company. The project EIA was completed in April 2010. The land use agreement is currently under preparation.

- Solar energy can benefit from the recently adopted European directive (2009/28/EC), which enables European countries to build renewable plants in a third country, providing that electricity will be physically exported to Europe. There are currently two regional solar initiatives that Egypt will be able to participate in, the Mediterranean Solar Plan and Desertec, though both are inhibited by existing transmission capacity limitations.

4.5 Geothermal Energy

The country does not have geothermal energy plant or projects.

4.6 Other Possibilities

Municipal waste energy generation projects have not been prioritized.

5 Renewable Energy Incentives

5.1 Incentives

NREA Incentives

Soft financing is be provided with the aim to develop RE projects. The existing installed capacity is 400 MW. The plan is to add another 200 MW every year until 2200 MW is reached. after 2014 includes both soft financing and partnership with other governmental entities.

Competitive Bids

The grid will issue tenders requesting supply of RE power in blocks of 250 MW that will total 2500 MW. The private sector will be offered viable long term power purchase agreement with the grid operator. This may be increased by 750 MW if the feed-in-tariff program does not meet its target.

Feed-In-Tariffs

The target for the FIT incentive is to reach 2500 MW. Its target are small to medium Wind Energy developers. The FIT will be set for 15 years and the tariffs will be based on the wind speed and capacity. International experience has shown that feed-in tariff are more attractive for smaller wind RE projects investors like farmers, cooperatives and private investors.

5.2 Clean Development Mechanism and Carbon Tax

Egypt is a signatory of the Kyoto Protocol, which the country signed in 1997 and ratified in 2005. About 405 MW of the planned Wind Power Projects qualify for CDM financial support.

6 Challenges, Constraints and Barriers to Renewable Energy Development

Egypt has successfully managed to secure electricity supply to 99.03 % of its population. The electrical peak demand increased by an average of 7% over the last decade, it increased by more than 12% in the year 2007/2008. It reached 23 300 MW in August 2010. To meet the increase in demand an average annual expansion in generation and transmission as well as distribution of 2 000 MW is needed over the next 20 years.

The potential of adding more hydro-generation is limited. In 2006/2007 Installed renewable sources (mainly wind) reached 230 MW, which is 1.1% of the installed capacity and only 0.3% of the generated electricity. Electricity purchased from internal generation and cogeneration units in industry in 2006/2007 represents only 0.07% of the total electrical energy generated.

The clean power sector strategy should overcome such challenges by:

a) Introducing market reform to improve efficiency and quality of supply as well as enable sufficient flow of investments into the power sector. The objective is to "establish a fully competitive electricity market, where electricity generation, transmission and distribution activities are fully unbundled". The proposed market will adopt bilateral contracts with a balancing and settlement mechanism. Efficiency increase and service enhancement are sought by virtue of introducing competition, freedom of electricity supplier choice, and third party access.
b) Ensuring security of supply through the following governmental actions:
    - The government has declared a program which targets building several nuclear power plants.
    - Meet the set target of 20% RE by the year 2020. This energy will be mainly generated from wind energy.
    - The support of cogeneration and generation from secondary sources through adopting feed-in tariff as well as take or pay contracts.

.

c) Ensuring adequate legislative support - a new draft electricity law has been prepared by the Ministry of Electricity and Energy with the cooperation of the electricity sector stakeholders.
d) Financial support - The draft electricity law establishes a renewable energy fund For the transmission company to purchase renewable energy from the investors through the competitive bidding and feed in tariff mechanisms.

7 Lessons Learned, Observation, and Conclusion

As stated above, Egypt has several challenges in the energy sector as a whole subject. But it is also clear that renewable energy and energy efficiency represents a major part of the solution to these problems. It is also clear and worthy to mention that Egypt is committed to implementing a meaningful and government supported RE and EE strategy. This strategy is strongly biased towards wind energy, there is a potential to investigate and include as part of the solution other renewable energy resources such as biomass and geothermal.

There is also a need for human resources development to address skills shortages in renewable energy, energy efficiency and even the potential electricity market. Customer awareness is a big challenge to the development of such a market. It is through the customers that real investments opportunities are realised in all of the energy fields.

A2.6 ERITREA

Total installed electricity capacity (2007): 167 MW

Diesel/HFO: 100%
Total primary energy supply (2007): 721 ktoe
Biomass: 73.5%
Petroleum products: 26.5%

Domestic generation comes mainly from two oil-fired plants that produced 267 GWh in 2006. Another 2 GWh came from solar energy. Total consumption was 220 GWh, with distribution losses of 37 GWh (13.75%). Eritrea's annual electricity consumption per capita is 67 kWh. The main source of energy for lighting is kerosene, which is burnt through wick lamps.

Energy Framework

To demonstrate its commitment to promoting sustainable energy, the Ministry of Energy and Mines, in consultation with the Ministry of National Development, has targeted in its long-term program (up to 2015) energy development initiatives as a vehicle to improve poverty alleviation, education, water and environment sustainability, with particular attention to the development of alternative energy resources a primary objective. Emphasis is not only on the adequacy and affordability of energy, but also on qualitative aspects, including flexibility, efficiency, sustainability and usage convenience. The issues of social equity, quality of service, energy conservation, environmental protection and safety are critical. So is the issue of ensuring energy security, as the country is heavily dependent on imported fuels. These goals imply major investment in additional capacity in power generation, improvement in EE and in sector management. The policy will be implemented in eight priority areas:

Reliance

There are no indigenous sources of oil, natural gas, coal and hydropower. Oil imports and consumption are 5,000 barrels per day (bpd). In 2005, oil imports accounted for 35% of the total national energy supply. The only oil refinery was located at the Red Sea port of Assab. It had a capacity of 18,000 bpd. In 1997, it was closed because of high operating and maintenance costs. As a result, all refined products, including jet fuel and gasoline, are imported.

Extended Network: Approximately 20% of the population have access to electricity.

The Eritrean Electricity Corporation (EEC) runs two types of grid systems, the Inter-Connected System (ICS) around the Asmara-Massawa regions; and the Self-Contained System (SCS) around Assab and other areas, such as Adi Keih, Barentu, Agordat and Tessenei. Total peak capacity of the two systems is 119 MW, of which 10 MW is in the SCS. The ICS is currently over-capacity with the commissioning of the Hirgigo 88 MW plant in 2002, along with the Belesa Power Plant. The Belesa plant runs at low efficiency, due to aged generating equipment. Lack of maintenance, and high voltage drops in the distribution system also contribute to losses.

Capacity Concerns:

Eritrea is facing acute shortages of modern energy services, especially in rural areas, and the country is generally characterised by low energy consumption levels. In order to facilitate the economic development of Eritrea, further development of the electricity sector is necessary.

The use of biomass for cooking, using generally inefficient appliances such as the mogogo, has led to unsustainable energy supplies, especially the traditional biomass, and is contributing to carbon emissions. Deforestation is resulting from overuse of biomass for fuel. Without alternatives, the pressure on Eritrea's limited forest resources would increase.

The over-reliance on imported fossil fuels does not only divert scarce financial resources from other socio-developmental areas, but further contributes to environmental emissions and energy related health problems.

Renewable Energy

Solar

Eritrea has a very high potential for solar energy, with an average insolation of 5.0-6.5 kWh/m2/day. Possible uses include solar PV, water heaters and sterilisers, crop dryers and tobacco curing, desalination, cooling and refrigeration, and electricity generation. Solar is currently utilised for electricity in public buildings such as schools and hospitals.

Wind

A recent Global Environment Facility (GEF) sponsored feasibility study for wind energy on the southern coast shows that a 2.4 MW wind park in Assab and many off-grid stand-alone wind systems, wind-diesel or wind-solar hybrid systems are feasible and potentially economic. Wind pumps for irrigation, or for watering villages and their livestock have very good potential in the vast majority of Eritrea.

Biomass

There are many indications of potential for modern biomass energy usage in certain locations in Eritrea:

- The Alighider Farm Estate has the potential to supply raw materials (cotton and sorghum stalks, elephant grass, banana leaves etc.) for briquette production for at least 15 plants, each with a capacity of 4000 tons per year. Briquettes are a replacement for fuelwood and charcoal. Agricultural waste could generate electricity thermally,
- Biogas plants could be installed in the Elabered Agro-industry, and other smaller dairy farms,
- Biogas could be generated from cactus trees,
- Energy recovery from municipal solid and liquid wastes is possible,
- Energy crops, such as Salicornia (being developed by SeaWater Farms, a biofuels company), could generate electricity for local uses or for the central grid.

Geothermal

The most favourable location for geothermal energy in Eritrea is the Alid volcanic area, about 120 km south of Massawa, identified by the United Nations Development Programme in 1973. Further investigations were conducted in 1996, which identified at least 11 geothermal areas in the area. Additional exploration is required to prove the capacity of the resource, and the Eritrean Ministry of Mines is seeking funding for this purpose. If successful, a 5 MW pilot geothermal power plant has been proposed.

Hydropower

Three potential hydropower sites have been studied (Ad Dankers, 1997), which include Tekeze river (~ 23000 GWh per year), Anseba river (~120 GWh per year), and Setit river (~ 240 GWh per year). Other potential sites for micro and mini hydropower have yet to be studied.

Energy Efficiency:

The 3-stone fire, a traditional method of stove construction, predominantly used in Eritrea for cooking, needs to be abandoned as soon as possible because of its low energy efficiency (circa 10%). Instead, energy efficient biomass stoves should be introduced for the household sector, especially in rural areas where the dependency on biomass will remain for many years. Further, EE cooking practices need to be stimulated, for example the pre-soaking of grains, the use of lidded receptacles, and using solar energy for pre-heating. An improvement in EE also needs to be worked on for other cooking stoves (those using

kerosene, LPG, or electricity). Special attention must be given to disseminating EE stoves in order to ensure that what has been developed is also going to be put to use. Significant entrepreneurial potential exists in this regard. A great potential exists to improve EE in all industries, but particularly in the most energy-intensive ones –steel, glass, ceramic and cement.

Ownership: Electricity

The Eritrea Electric Corporation (EEC) is a public utility that operates two systems, namely the ICS which covers 89% of its business and the SCS, accounting for the 11%. The total generating capacity is over 160 MW, of which the EEC accounts for around 116 MW, with the remainder from either public institutions like the Assan Port Administration, small municipalities in remote towns, or entrepreneurs with smaller generators.

Ownership: Liquid fuels

Offshore oil exploration has taken place, but no commercial deposits have been discovered. Companies which have explored for oil are ENI (Italy), Anadarko Petroleum (US), Perenco (France) and CMS Oil and Gas (US). In October 2008, the government signed 2 agreements with the Defba Oil Share Company (a joint Chinese-Eritrean venture to explore for oil). Exxon Mobil, Shell and Total are involved in the marketing and distribution of petroleum products in the country. The Petroleum Company of Eritrea (PCE) is a public company, responsible for the wholesale of petroleum products in the country.

Competition - The Eritrean Electricity Corporation (EEC) is a vertically-integrated company, responsible for the generation, transmission and distribution of electricity.

In May 2004, the government made the first steps towards reforming the power sector. Electricity Proclamation No 141/2004 has the objective of promoting efficiency, safety, environmental protection and private sector involvement. Proclamation No 142/2004 for the Establishment of the Eritrea Electric Corporation has the purpose of commercialising the utility to give it more autonomy in its operations and to contribute to the development of Eritrea by providing efficient, dependable, cost-effective and environmentally safe production, transmission and distribution of electricity.

The oil market is primarily unbundled, with private firms involved in upstream and downstream activities in the country. The PCE is state-owned, and operates solely as a wholesaler.

- Energy reform measures,
- Investment promotion,

- Improvement of sector management capacity,
- Creation of a “right pricing” policy,
- Promotion of energy conservation and environmental protection at supply and end-user levels,
- Promotion of rural electrification,
- Promotion of regional co-operation in energy trade,
- Involvement in modern energy technology developments.

The current short and medium-term energy sector investment program consists of investments in refurbishing and expanding generating plants, in expanding the Rural Electrification Programme, and supporting green field investments in RE, including wind, solar and geothermal power applications.

Energy Debates

The government strategy to increase electricity generation includes RES in the form of wind and solar systems, with the ultimate aim of generating as much as 50% of the nation’s grid electricity from wind energy. Similarly, photovoltaic (PV) generation is being considered. Solar energy accounted for only 0.7% of the EEC's total production in 2006, despite Eritrea’s very high potential. Rural electrification requires further investment. The government’s restructuring of the EEC, and the development of a new energy policy, is aimed at attracting private sector participation. To this end, international and regional independent power producers (IPPs) and independent power distributors (IPDs) are being sought as investors in the projects.

Energy Studies

Eritrea is a member of the Common Market of East and Southern African States (COMESA), an organisation dedicated to promoting greater regional integration between member states, in an effort to stimulate the economies of all countries involved. The country is also a member of the African Union.

Analysis of Long-Range Clean Energy investment Scenarios for Eritrea, East Africa – Robert Van Buskirk, Lawrence Berkeley National Laboratory, US.

www.osti.gov/bridge/servlets/purl/886977-mP99Bh

Role Government: Ministry of Energy and Mines

Within the Ministry of Energy and Mines (www.moem.gov.er), the Department of Energy (DoE) is entrusted with the task of designing and refining policies, strategies and regulatory issues in the energy sector, approving the corresponding plans and programs formulated in

the sector, and supervising their implementation. The Department of Energy has three divisions:

- Energy Resource Management,
- Energy Resource Development, and
- The Renewable Energy Centre

In addition to the above there are two autonomous enterprises within the department. The Eritrea Electric Corporation (EEC) and the Petroleum Corporation of Eritrea (PCE) are governed by a board of directors, chaired by the Ministry of Energy and Mines.

Government Agencies: Energy Research and Training Centre (ERTC)

The ERTC was set up in 1995 to research and develop different RETs. Up to now, its role has been fundamental in the dissemination of information regarding RETs and their implementation throughout the country. For example, the ERTC coordinated the Eritrea Dissemination of Improved Stoves Program (DISP) to develop and disseminate an improved version of the mogogo stove. The DISP was initiated in 1996, with the first field-test taking place in 1999. Since the programme began, over 10,000 improved mogogo stoves have been disseminated, reaching about 1% of traditional stove users. The programme has made dramatic improvements to the mogogo stove and has experimented with wind and solar power. The ERTC is training women to build the stoves themselves and also providing a salary, in return for the further dissemination of training.

Energy Procedure: Wind Energy Application in Eritrea (2007-2011)

Being funded by the GEF, the UNDP and the government, this project aims to produce pilot projects in the wind rich areas (Assab, Edi, Gahro, Gizgiza, Rahaita, Berasole, Beylul and Dekamhare) and replicate the project in other parts of the country. The project is expected to improve rural livelihoods by providing access to sustainable energy services and contributing to the reduction of greenhouse gas emissions. The three immediate objectives are:

- To develop necessary personnel and institutional capacities to plan, install, operate and manage on- and off-grid wind systems, and increase awareness amongst decision makers in governmental and private institutions, both at the community and central level;
- To install a small wind farm in Assab and integrate the wind-generated electricity into an existing conventional electricity grid, thus demonstrating that on-grid wind energy is

feasible, and can be a least cost electricity supply possibility in Eritrea at high wind speed sites;

- To install eight small scale decentralised wind stand-alone and wind-diesel hybrid systems to demonstrate the t viability of off-grid wind energy systems.

Eritrea Power Distribution and Rural Electrification Project (2004-2010)

The World Bank funded the Eritrea Power Distribution and Rural Electrification Project at a cost of $57.2 million. This project was approved in 2004 and was extended until June 2010. The key components included rehabilitation and expansion of the electricity distribution system in Asmara, Eritrea's capital; rural electrification in four areas, and a program for power sector reform and the institutional capacity. In 2008, the World Bank approved additional financing for the project at a cost of US$17.5 million.

The main energy sector development policies of the Eritrean government have been aiming at:

- promoting economically and environmentally sound energy sector development through appropriate technology for energy production, conservation and usage optimisation;
- appropriate energy pricing structures that avoid all forms of subsidy;
- diversifying sources of energy to minimise the dependence on dwindling biomass energy resources and imported oil,promoting private capital participation in hydrocarbon exploration, and developing renewable energy resources potential;
- modernising and expanding the country's power generation and distribution system, and enabling private participation in energy development and the market;
- developing capacity through to competently manage the sector

Energy Regulator:

The Electricity Regulatory Commission (ERC) established by the Electricity Proclamation No.141/2004, is not yet fully functional, though Ministry of Energy and Mines personnel are occasionally assigned to carry out regulatory tasks.

Degree Independence:

According to the Electricity Proclamation No.141/2004, the Regulatory Committee shall have a chair-person, who, along with the other members shall be appointed by the President of the State of Eritrea. Two of whom shall be from the private sector. Funding for the organisation comes from governmental allocations, and operational levies.

Regulatory Framework:

The current regulatory framework promotes efficient, dependable, safe and economically sustainable electricity operations in Eritrea, as well as private sector and community participation in the sector.

Therefore, current policy gives IPPs the option of generating power using a variety of sources including wind, solar, geothermal, or other state-of-the-art conventional energy technologies. Importation or exportation of electricity leading to regional integration of power supply is subject to government approval; the distribution of power to rural communities is a priority.

Regulatory Roles:

- To promote efficiency, dependability, cost-effectiveness, safety and quality of services and fair competition, as well as private and community participation in electricity operations;
- supervise and ensure that electricity operations (the generation, transmission, distribution and sale of electricity) are carried out in accordance with the corresponding regulations;
- to study, review and determine electricity tariffs and related service charges;
- the initiation and performance of investigations into standards of quality of services, and to monitor standards of overall performance of permit holders;
- to protect the interests of customers, permit holders and the general public;
- to investigate complaints;
- to instruct parties in writing to adhere to and fulfil their obligations under this Proclamation within a reasonable time.

Energy Role Regulation

As the ERC is still a relatively young organisation, still yet to be fully established, the MOEM has an occasional role in regulating the electricity sector. No other government department takes an active role in energy regulation, as the MOEM is also responsible for the natural resources of the country, including all energy resources.

Regulatory Barriers:

Barriers pertaining to the lack of experience with wind energy increase the transaction costs for the initial development of wind energy systems. These include:

- The lack of experience inside the Eritrean private sector with regard to the private business opportunities wind park projects offer.
- Lack of adequate model contracts, on the basis of which private developers and the EEC can negotiate Power Purchasing Agreements (PPAs) and other necessary contracts for such kind of projects.

Other issues including:

- The lack of procedures and responsibilities for the development and the implementation of rural renewable energy projects.
- The lack of financing mechanisms that take into account the special features of RETs.

A2.7 ETHIOPIA

1 Renewable Energy Regulatory Framework

Renewable energy issues in Ethiopia are addressed in the general national energy policy formulated of 1994. The main themes of the energy policy are:

a. Indigenous resources development where hydropower is recommended as the principal source for electricity generation and agro-forestry for wood biomass.
b. Development and utilization of alternative environmentally sound energy resources for supply diversification and energy security.
c. Promotion of energy efficiency and conservation measures for economic and environmental reasons.
d. Creation of mass awareness on energy issues.

The energy policy of Ethiopia has identified the following ten (10) objectives:

i. To enhance and expand the development and utilization of hydrological resources for power generation with emphasis on mini hydropower development.
ii. To promote and strengthen the development and exploration for natural gas and oil.
iii. To expand and strengthen agro-forestry programs.
iv. To provide alternative energy sources for the household, industry, agriculture, transport and other sectors.
v. To introduce energy conservation and energy saving measures in all sectors.
vi. To ensure the compatibility of energy resources development and utilization with ecologically and environmentally sound practices.
vii. To promote self-reliance in the fields of technological and scientific development of energy resources.
viii. To ensure community participation, especially the participation of women, in all aspects of energy resources development and encourage the participation of the private sector in the development of the energy sector.
ix. To stage popularization campaign through mass media using various national languages to create awareness among the general public and decision makers regarding energy issues.
x. To create appropriate institutional and legal frameworks to handle all energy issues.

On the resource development side the policy gives top priority for hydropower development for the power sector and forestry for the biomass sector. On the demand side the focus was on improving energy efficiency in the household sector.

2 National Energy Policy with Reference to COMESA

The Ethiopian energy policy embraces most of the COMESA Energy Policy Framework. The country's energy situation differs vastly from industrialized nation in that Ethiopia is still highly dependent on biomass as its primary energy. Basically wood is processed to charcoal, is neither cultivated in a sustainable way nor is it used efficiently.

The development and implementation of the energy policy is beginning to yield positive results. The electrification of the country has increased greatly over the past few years and is now officially at 41%. However, this figure is based on the population living in the electrified area only. The installed generation capacity is expected to increase to 10,000 MW in the next ten years[16].

The Ethiopian Electricity Agency sets out rules and regulations for the market and is therefore also in charge of the electricity tariffs. The setting price of electricity is set by the regulators. Government policy dictates the need to keep these tariffs at the level to ensure that the low income families have access to electricity.

Renewables will remain important sources of energy in Ethiopia for at least the next two decades because of continued dependence on biomass for cooking and accelerated development of hydro, wind and geothermal energy for the power sector. The main issues for increased and sustainable use of renewables in Ethiopia are the following:

a) The policy and regulatory environment does not appear to provide adequate incentives for increased production and use for distributed (and off-grid) applications. Regulations for power feed into the grid are yet to be implemented. There is no clear demarcation for grid based power extension and potential off-grid services which impedes the private sector from investing in renewables to serve the off-grid population.
b) The capacity to develop and implement renewable energy programs and to develop the sector in general is inadequate. Renewables currently provide and will continue to provide largest share of the energy consumed in Ethiopia. Implementation capacity in the public sector (both at the federal and regional

[16] Growth and Transformation Plan, Ethiopia, 2011

government level) is not adequate to meet the challenge. Opportunities in growing institutional capability at the district level are yet to be exploited.

c) Capacity for local production of renewable energy products and services is inadequate. The local research and development capacity is also under developed. Ethiopia has a relatively large market for renewables but practically all renewable energy systems are imported. Some of the emerging small industries for renewable energy, such as for production of solar water heaters and wind pumps, have disappeared.
d) The role of different actors in the renewable energy value chain is not adequately understood and exploited. In particular the role of the private sector in RE product and service delivery is not appreciated. This is believed to have limited the outreach of renewables particularly in distributed renewable sin rural areas.
e) Quality management structure for renewable energy products and services is not in place; this impacts the long term acceptability and viability of RE. Low cost but low quality products actually work against the sustainable development of the renewable energy sector.
f) The technical market for renewables is high but the market size for them is relatively low. Bioenergy for thermal energy for cooking and baking and large hydropower on the rid are the least cost options for their particular applications. Other renewables are, however, relatively less competitive with conventional systems. This limits the market size for renewables which then hinders the sector attain the critical mass for the product and service infrastructure.
g) Renewables are relatively more capital intensive compared to conventional alternatives. Financing for producers and users is important to increase their wider adoption. However, adequate financing is difficult to secure from banks, partly due to the unfamiliarity of banks of the risks and benefits of renewables.
h) The low level of energy efficiency, particularly for biomass energy, is a threat for its continued use and the sustainability of resources. The large majority of residential and institutional consumers of biomass fuels still cooking and baking stoves which waste 90% or more of the energy supplied.
i) Heavy dependence on biomass energy has led to the over exploitation of the resource with serious consequences for the sustainability of forests, soil and water. Deteriorating access to wood fuels has resulted in increased use of crop residues and animal dung as fuel which would have better use as animal feed and soil fertilizers.

3 Renewable Energy Strategy

The Growth and Strategy Development Plan (GTP) of Ethiopia outlines the five years strategic plan of development for all sectors from 2011 to 2015. The strategic

direction for the energy sector during the five year period are development of renewable energy, expansion of energy infrastructure, and creation of an institutional capacity that can effectively and efficiently manage the energy sector development. Major targets for the energy sector are presented below:

i. Increase hydropower generation capacity from the current 2 000 MW to 10,000 MW by 2015;
ii. Increase coverage of electricity service from 41% to 75%;
iii. Improved cook stove distribution;
iv. Development of biofuels for household cooking fuel and transport fuel;
v. Alternative energy resources development which includes solar, wind and micro hydropower resources; and,
vi. Capacity building and awareness creation.

Ethiopia's renewable energy strategy is also found in the energy policy. The priorities of the Government on energy are:

i. To place high priority on hydro power resource development.
ii. To encourage energy mix – high emphases on the development of solar, wind, geothermal energy in a cost effective manner.
iii. To take appropriate policy measures to ensure transition from traditional energy fuels to modern energy fuels.
iv. To take due and close attention to ecological and environmental issues during the development of energy policies.
v. To set issues and publicise standards and codes which will ensure that energy is used efficiently.
vi. To develop human resources and establish competent energy institutions.
vii. To provide the private sector with the necessary support and incentives to participate in the development of energy projects. The majority of potential energy projects is Ethiopia are in the renewable energy sector.

4 Status of Renewable Energy Development and Future Plans

4.1 Hydro Power

Hydro energy is in the focus of the government actions for energy supply in Ethiopia. Up to 98% of the electrical energy comes from water power plants. The reasons for this are to be found in the climatic and geographic conditions of the country: Ethiopia has a comparatively mild and rainy climate. Especially during the mainly reason in July and August, a lot rainy climate. Especially during the main rainy season in July and August, a lot of rain falls on the Ethiopian highlands.

Besides this, one of the world's biggest rivers springs in Ethiopia: The beautiful Blue Nile arises close to the huge Tana Lake in the north west of the country. A big hydro power plant is operating with this stream. This plant is deactivate on weekends so that tourists can enjoy the impressive Nile Falls.

There are currently 11 hydro power plants with total installed capacity of 1 800 MW on the national grid. The short term plan to 2015 is to add 8 700 MW of capacity from large hydropower plants.

Besides large-scale hydro power plants, hydropower can also be generated from small mini to macro hydro plants which are designed to supply island networks in small villages. They can even be transportable so that traditional nomadic tribes can use them on their journeys.

The total hydropower potential of Ethiopia is estimated at 45,000 MW. However, only 5% of this potential has been developed so far. Although as much as 10% of the total hydropower resource of Ethiopia is estimated to be in small hydropower plants, fewer than twenty small hydropower sites have been developed so far. The majority of these have once been run by the national power utility but are now abandoned as the towns they served got connected to the national power grid.

The hydro power resource in Ethiopia are summarized below.

Hydropower *(IWMI, 2007)*

Total exploitable potential = 159TWh
Abbay basin: 79TWh
Omo-Gibe basin: 36TWh
Baro Akobo basin: 19TWh
Other basins: 25TWh



4.2 Biomass

Just like centuries ago, the energetic use of biomass is very common in Ethiopia. Biomass energy provides for more than 90% of the total energy supplied in Ethiopia. It is the main energy source for cooking for 95% of households (15 million households) in the country. The level of biomass energy consumption is high in Ethiopia where the average household consumes 3.5 tons of biomass fuel annually.

The main biomass energy sources used are wood and charcoal, crop residues, and cattle dung. The forest and woodland stock for Ethiopia is estimated at 732 million tons with mean an annual yield of 36 million tons. Annual crop production now stands at some 20 million tons of grain with potential to supply 40 million tons of residues annually. Ethiopia has 53 million heads of cattle which produce some 35 million tons of waste.

Biomass energy has important positive attributes: it is an indigenous resource that is produced and used locally. It is a potentially more accessible and affordable source of energy, particularly in rural areas. Biomass fuel supplies also engage tens of thousands of suppliers thus serving as a source of income for the poor. However, the current methods of producing and using biomass energy also have serious negative environmental and social impact, such as:

a) available biomass resources can no longer meet requirements and access problems are exhibited in the majority of districts in Ethiopia;

b) biomass energy production contributes to local environmental degradation including exacerbating deforestation, soil erosion, and water quality degradation;

c) biomass energy used at the household level contributes to indoor air pollution and health problems; and,

d) exploiting biomass resources beyond replacement levels contributes to greenhouse gas emission.

Like in other countries in the equatorial belt, the export oriented cultivation of energy plants for bio-fuels is booming in Ethiopia. Because of its mild and sunny climate, Ethiopia has a great potential for growing sugarcane.

4.3 Solar Energy

Energy from the sun offers probably the best potential for a decentralised energy generation in Ethiopia. Solar radiation can be used for example to run water pumping systems for villages, to operate lighting systems for households, to heat water cooking, to dry straw, to use telecommunication systems and even to refrigerate for example medicine in health centres. An assessment study in 2002, revealed that the average solar radiation reaching the ground for Ethiopia as a whole is 6 KWh/m^2/day.

Total installed capacity for PV systems in Ethiopia is estimated to be some 6.5 MW, 70% of it installed for rural telecom applications, 10% for water pumping and another 20% for solar home systems. The total number of solar water heating systems installed in Ethiopia is about 5 000 units, mostly installed for domestic water heating

but also in commercial institutions (mainly hotels). There are small scale projects that promote solar cooking for residential and institutional use such as for schools.

The strength of the solar radiation in Ethiopia is assumed to be amongst the highest category of the world. Consequently, the radiation could be the sole resource of energy for the country. Sun energy can contribute to a sustainable and decentralised energy mix for Ethiopia. But many solar energy technologies are still very expensive – especially for a low income countries like Ethiopia. Hence the use of photovoltaic systems are only worth to generate electricity for island net systems which cannot join the main grid.

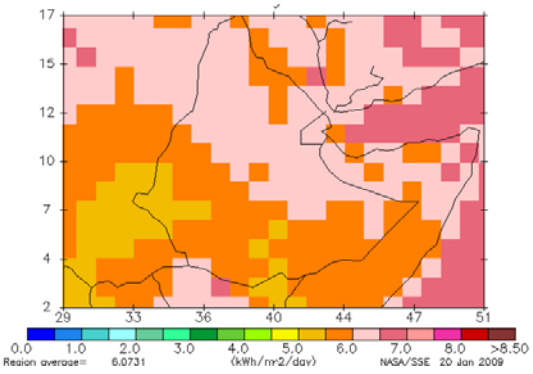
In contract to expensive PV systems, solar thermal systems are already affordable today. For example concentrator cookers can provide enough energy for cooking, which is basically the main basic energy need of Ethiopia's population. But these cookers require direct sun light; cooking is only possible when the sun is shining.

The solar energy resource in Ethiopia are summarized below.

1-50	50-200	200-300	300-400	400-500	500-600	600-800	> 800	Power Density in W/m^2

Solar energy (NASA)

More than half the area of Ethiopia receives 6kWh/m^2/day.



4.4 Wind Energy

Wind energy is considered the second most important potential source for power generation in Ethiopia after hydropower. The total area classified to have excellent wind class [areas with wind speeds in excess of 7.5 m/s at 50 masl] is estimated to be 11,500 km^2 with potential to generate 57 GW of power.

Seven wind power projects with combined capacity of 866 MW are in the short term plan for development in the next five years. Construction has started for two of these projects (170 MW). Wind energy is also used for rural potable water pumping and an

estimated 100 units are believed to be operational mainly in the central and southern parts of the country.

"When there is no hydro there is wind, when there is no wind there is hydro. A good match". This statement of a GTZ energy researcher about climate conditions in Ethiopia suggests that wind energy can provide an important contribution to a sustainable energy supply. But until today wind power does not have a mentionable share in Ethiopia's energy.

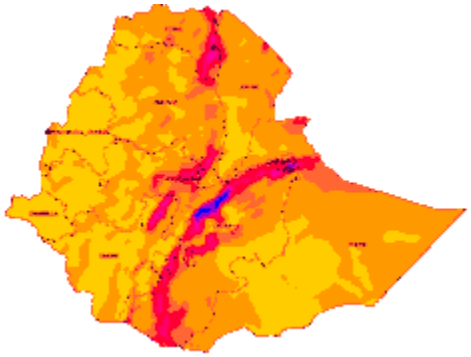
By World's standard, Ethiopia's wind resources are not considerable for electric power generation. Based on a feasibility study a few years ago, there are at least 7 suitable sites identified along the escarpments of the great rift valley in Ethiopia. Construction of wind farms has already started in two of the potential sites – the Ashegode wind farm in Tigray Region, and Adama wind farm in Oromia Region.

The wind energy resource in Ethiopia are summarized below.

Wind power (EREDPC, 2007)

Area with good to excellent wind classes = 33,771km^2

Wind class		Density 50magl (W/m^2)	Speed 50magl (m/s)	Area km^2	Potential GW[17]
Excellent	7	> 800	> 8.8	1,392	7
Excellent	6	600 – 800	8.0 – 8.8	3,646	18
Excellent	5	500 – 600	7.5 – 8.0	6,454	32
Good	4	400 – 500	7.0 – 7.5	22,279	111



4.5 Geothermal Energy

Geologically, Ethiopia has some potential for the energetic for geothermal energy. This is mainly due to the great African Rift Valley, which runs through the country. In the rift, there are active volcanoes and also several hot springs. Though the geological energy potential is excellent, it is difficult to develop this source of energy in Ethiopia. A major problem is that high-tech equipment like sonorous appliances and high-performance borers are required to access enough heat for the generation of electric power.

The total geothermal potential in Ethiopia is about 5 000 MW. Of this, studies have shown that only 515 MW can be harnessed. One small geothermal pilot project – with installed capacity of 7 MW - was commissioned in the mid 1990's. At the

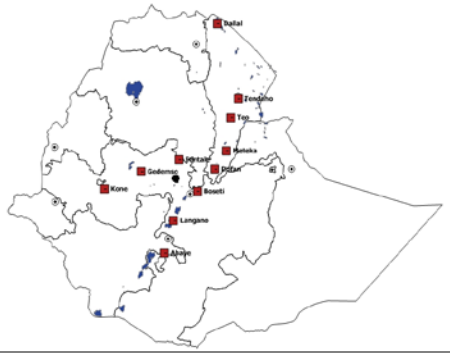
[17] The power production estimate is based on installed capacity of 5MW/km^2 for good and excellent wind classes (EREDPC, 2007).

moment it is generating power at a capacity of 3 MW. The current short term power development plan envisages the installation of a 80 MW geothermal plant before 2015.

The geothermal energy resource in Ethiopia are summarized below.

Geothermal (Ministry of Mines and Energy, 2010)

Total exploitable potential = 5000MW (700MWe)
Rift valley = 170MWe
Southern Afar = 120MWe
Central Afar = 260MWe
Denakil Depression = 150MWe



4.6 Other Possibilities

There is considerable energy potential in agricultural and municipal waste. Agricultural waste (crop residue and animal dung from small holder farmers) now provides a significant amount of household energy demand for cooking in rural areas (the current estimate is that about 8% of the total cooking energy demand in rural areas is met from crop residues). Residue from large commercial farms for coffee, sugar, cotton and oil seeds can provide a source of energy for the residential and other sectors.

Municipal solid waste generation from the seven largest cities in Ethiopia is estimated at some 420 000 tons per year, only 60% of which is actually collected and disposed in waste disposal sites. Municipal liquid sludge in the main cities is also considerable, although only in the larger cities is waste processed at central processing facilities. There are currently no energy conversion facilities from municipal waste in Ethiopia; however, projects are under development for energy recovery from waste disposal sites in Addis Ababa and a few other cities.

5 Renewable Energy Incentives

5.1 Incentives

Import duty tax exemption for renewable energy technologies is an incentive for increased use of the technologies. Ethiopia does not have yet introduced a feed-in tariff law for power generation from independent power producers However, this

could change given the drive for increased electricity generation and the potential for renewable energy discussed above.

5.2 Clean Development Mechanism and Carbon Tax

CDM does not improve the energy situation directly, but it can be a good incentive to attract private investors now that the CO_2market is expanding all over the world. Since hydro power, which does not emit CO_2 is the main source of energy resource in Ethiopia, CER is relatively low compared to countries where fossil electric power generation is the mainstream power source.

Ethiopia does not have a carbon tax regime.

6 Challenges, Constraints and Barriers to Renewable Energy Development

The main challenges for hydropower development in Ethiopia consist of the following:

a) Large hydropower plants are financially the least cost option for power generation in Ethiopia. However, hydropower is capital intensive and investment requirements for large hydropower plants are high (table above).

b) Changing climate is impacting flows in rivers and therefore energy availability from hydropower plants. This challenge may be mitigated by diversifying hydro generation into several basins and by supplementing hydropower with other renewable resources.

c) Local capacity for design, plan, and construction of hydropower plants is growing but it is still not adequate to meet requirements.

d) Clarity for delineation of grid and off-grid areas in power sector plans has constrained the development of small hydropower for off-grid applications. Relevant regulations for grid feed in tariffs are also not in place to ensure that off-grid small hydropower plants continue to generate revenue when areas they supply get connected to the grid.

e) Resource information for small hydropower plants are not readily available and this hampers plans for their development either as off-grid systems or for grid feed in (when feed in tariffs are in place).

The main challenges to wide scale dissemination of biomass energy technologies in Ethiopia are private sector engagement for production and marketing of

technologies, developing biomass energy technology appropriate for rural communities such as cook stoves and the high cost of technologies such as biogas digesters.

The challenge for solar energy development and dissemination is primarily high initial cost of system, lack of trained technical capacity for system sizing, installation and after sales service, and undeveloped market.

The major challenge for the wind resource development is lack of information regarding resource potential. The wind resource potential information available in the country now is satellite derived data with little or no ground verification. This puts much of the resource information doubtful.

The challenges for geothermal development in Ethiopia include the following:

a) Inadequate information, particularly feasibility studies for power development. Available exploration studies have not provided adequate information for the purpose of feasibility assessment.
b) The cost of exploration and feasibility assessment for geothermal systems are high. Exploratory wells up to 2km deep have to be sunk and the cost for such exploration is high. There appears to be also considerable uncertainty in estimates for resources.
c) The relatively small size of systems, compared to hydro plants now under consideration, may make them less attractive for the power utility.
d) There is very limited experience in Ethiopia for development of geothermal plants. Only one plant has been commissioned so far; this plant was developed by an international company and local capacity is limited for construction and operation of geothermal power plants.

7 Lessons Learned, Observation, and Conclusion

The main lessons learned in hydropower project development in Ethiopia include the following:

a) The government is now undertaking an ambitious power development strategy which is predicated on large hydropower plants. The government has managed to bring together number of partners to finance these projects. *Commitment for development of the sector has helped the government secure financing from bilateral and international sources*.

b) *Consideration of regional power export (interchange) has opened the market for hydropower development in Ethiopia*. This is a good lesson for countries in the

region which may have limited market for power in their country but large resources that they can export regionally.

c) *Local capacity for design and construction of parts of hydropower plants has improved*.

i. Local companies are increasing their capacity for construction of hydropower plants. Some of the large civil, hydro mechanical and electro-mechanical construction companies in Ethiopia have taken part in civil construction (power houses), hydro mechanical part manufacture (penstocks) and electro-mechanical installation (turbines and generators). They have developed partnerships with foreign companies to realize this.
ii. Government agencies and private companies have increased their capacity for design and installation of micro hydropower plants.
iii. The government plans to produce major hydropower components locally including hydro turbines.
iv. Local private consulting companies have also improved their capacity for feasibility studies and design for large hydropower plants through their partnership with international engineering consulting firms.
v. Increasing capacity on the part of the national utility EEPCO to manage the construction and operation of large hydropower plants.

Other lessons learned are:

a) Using the private sector led dissemination strategy for improved cook stove and biogas technology is slow initially but ensures sustainable dissemination.

b) In recent years, development of solar PV market is increasing. Several government, NGO and donor driven projects have installed institutional system which help create awareness of the technology, built local technical capacity and jump start active participation of the private sector in developing the solar market.

c) Even though existing wind resource potential is not very accurate it indicates potential wind sites. Taking this information for preliminary identification of potential wind sites, further ground data should be collected before consideration of the site for power generation.

d) The main lesson from the one geothermal plant developed so far is the need for local capacity for effective operation and management of plants in Ethiopia. Ethiopia can also learn from experiences from the region, particularly from Kenya, where geothermal plant development has progressed much rapidly.

e) Current plans to develop the Addis Ababa landfill site will contribute to building local knowledge and will help facilitate the development of landfill gas projects in the other six cities.

f) Proposed development of the Addis Ababa landfill gas project through the Clean Development Mechanism (CDM) will ease the financing constraints for such projects for the other cities as well.

A2.8 KENYA

1 Renewable Energy Regulatory Framework

A new national energy policy for Kenya was developed in 2004. Entitled 'Sessional Paper Number 4 of 2004 on Energy', the policy laid down the framework upon which quality, cost-effective, affordable, adequate and sustainable energy services are to be availed to the economy over the period 2004-2024.

In the policy document, the Government undertook to:

i. Expand and upgrade the energy infrastructure;
ii. Ensure security of supply through diversification of sources and mixes in a cost effective manner;
iii. Promote energy efficiency and conservation;
iv. Enhance economic competitiveness and efficiency in energy production, supply and delivery;
v. Formulate enabling legal, regulatory and institutional frameworks;
vi. Promote public–private partnerships in the provision of clean energy services.

The policy document is elaborate and detailed. It covers both conventional and renewable energy. In this report, the emphases is on the renewable energy framework. On RE the policy commits the Government to:

a) Promote the development and widespread utilization of renewable energy technologies to widen access to clean, sustainable, affordable, reliable and secure energy services for national development while protecting the environment.
b) Encourage and promote private sector initiatives in the development and expansion of the renewable energy markets.
c) Allocate resources to complement self-help groups and private sector efforts in rural energy supplies.

This would be achieved by:

i. Designing incentive packages to promote private sector investments in renewable energy and other off-grid generation.
ii. Providing requisite support for research and development in emerging technologies like cogeneration and wind energy generation.
iii. Promoting cogeneration in the country's sugar belt through an attractive bulk tariff regime that recognizes the need to reduce oil based thermal generation.
iv. Encouraging and promoting private sector initiatives in the development and expansion of the renewable energy markets.

v. State financing and implementation of indigenous energy resources assessment and feasibility studies
vi. Formulation and enforcement of standards and codes of practice on renewable energy technologies to safeguard consumer interests.
vii. Allocation of resources to complement self-help groups and private sector efforts in rural energy supplies.

The policy expressly recognizes biomass, solar, wind, small hydropower, power alcohol, biogas and municipal solid waste energy as renewables and sets out specific objectives, activities and timelines for their implemented to promote them.

Legal and Regulatory Policy

The policy undertook to amend the then existing law, The Electric Power Act, 1997, to take the new developments on board and to make it more responsive to private sector participation in the provision of electricity services to incorporate the following provisions:

i. Enable renewable energy systems not exceeding 3MW or if operating in hybrid mode in which the oil-fired component does not exceed 30% of the
ii. Total capacity to operate in any area of the country without any license, irrespective of any other existing distribution license;
iii. Make it mandatory for a licensed public electricity supplier operating in an area where power generation is being undertaken by parties other than those with agreements or arrangements with such public electricity supplier to buy such power on terms approved by the Energy Regulatory Commission (ERC). Preferential treatment shall be given to electricity generated from renewable energy including bagasse and other biomass fuels.

The Government recognizes that other renewable energy sources: solar, wind, small hydros, co-generation, biogas and municipal waste energy; have potential for the creation of opportunities for income and employment generation. In order to encourage private sector participation in harnessing these sources of energy the Government would pursue the following policy instruments:

i) Continue to collect hydrological data and undertaking of pre-feasibility and feasibility studies on small hydro, wind regimes and solar insolation
ii) Promote feasibility studies on the utilization of municipal waste as a source of energy;

iii) Formulation and enforcement of standards and codes of practice on renewable technologies to safeguard consumer interests;

iv) Packaging and dissemination of information on renewable energy systems to create investor and consumer awareness on economic potential offered by these alternative sources of energy. This will include establishment of community based pilot projects where feasible to promote acceptance;

v) Amending the *Electric Power Act, 1997* to promote vertically integrated mini-grid systems for rural electrification using renewable energy technologies even in areas where licences have been issued to public electricity supplier.

vi) To amend building by-laws under Local Government Act to make it mandatory in urban areas to include hot water systems in building designs.

vii) Promote research and development and demonstration of the manufacture of cost effective renewable energy technologies;

viii) Promote development of appropriate local capacity for manufacture, installation, maintenance and operation of basic renewable technologies such as bio digesters, solar water heating systems and hydro turbines;

ix) Promoting development and widespread utilization for renewable energy technologies which are yet to reach commercialisation;

x) Allowing duty free importation of renewable energy hardware to promote widespread usage;

xi) Provide tax incentives to producers of renewable energy technologies and related accessories to promote their widespread use

xii) Provide fiscal incentives to financial institutions to provide credit facilities for periods of 7 years to consumers and entrepreneurs

xiii) Support community based water lifting and pumping, using renewable energy technologies through cost sharing arrangements and fiscal incentives. The level of Government contribution will be determined by the degree of socio-economic impact on the community subject to a maximum capital contribution of 80% by the beneficiaries; and,

xiv) Encouraging private sector, NGO's and other self-help groups to accelerate their efforts in tree planting, and environmental protection.

For Biomass, the policy objective is to ensure sufficient supplies to meet demand on a sustained basis while minimizing the environmental impacts associated with biomass energy consumption. The following instruments are to be used:

a) Formulate a national strategy for coordinating energy research ;
b) Increase support for R&D, including capacity building for technology transfer, support property rights and innovations;
c) Integrate biomass energy issues including research on biomass energy effects on climate, health, etc. into the formal education system;
d) License charcoal production to encourage its commercial production in a sustainable manner;
e) Promote private sector participation in biomass energy production, distribution and marketing by providing tax incentives to sustainable producers;
f) Increasing the rate of adoption of efficient charcoal stoves from 47% currently to 80% by 2010 and to 100% by 2020 in urban areas; and to 40% by 2010 and 60% respectively in rural areas;
g) Increasing the rate of adoption of efficient fuel wood stoves from 4% currently to 30% by 2020;
h) Promoting inter-fuel substitution;
i) Increasing the efficiency of the improved charcoal stove from the current 30 -35% to 45-50% by 2020;
j) Promote introduction of efficient charcoal kilns in charcoal producing areas;
k) Promotion of fast maturing trees for energy production;
l) Promotion growing of appropriate tree species for production of feedstock for manufacture of bio-diesel;
m) Encouraging the establishment of commercial woodlots including peri-urban plantations;
n) Offer training opportunities for artisans at the village level for the manufacture, installation and maintenance of renewable energy technologies including efficient cook stoves;
o) Promote cogeneration to generate 300MW by the year 2015 in the sugar;
p) industry and other commercial establishments where opportunities exist; and,
q) Undertake appropriate studies on co-generation.

2 National Energy Policy with Reference to COMESA

The main thrust of the COMESA Model Energy Policy Framework is to provide the COMESA member States with harmonized guidelines that would facilitate energy policy harmonization in the region in efforts to improve efficiency and increased investment. The Specific objective of the Model is to provide an outline of contents expected in National Energy Policy, which countries can then adopt and/or customize, therefore, harmonizing policies in the spirit of regional integration.

The aim of the analysis of the Kenya's energy policy with reference to COMESA model energy framework is therefore to determine the extent to which the Kenya energy policy is in harmony with the COMESA model.

The COMESA model energy policy framework emphasizes the importance of formulating an energy policy that ensures adequate, quality, reliable, secure, cost-effective and affordable supply of energy to achieve and sustain national socio-economic development. The Kenyan policy, in its vision and mission statements aims to promote equitable access to quality energy services provided at least cost by facilitating the provision of clean, sustainable, affordable, reliable and secure energy services for national development while protecting the environment. The main goal of the Kenyan policy is therefore in harmony with the COMESA model energy framework.

The COMESA model energy policy has eight main objectives. Policy instruments that are required to meet each of the main objectives are proposed. To determine to what extent the Kenyan policy is in harmony with the COMESA model, each of the main objectives of the COMESA model and the proposed instruments are provided. The Kenyan policy is then discussed in the context of each objective.

The COMESA model objective no. 1 is to improve effectiveness and efficiency of the commercial energy supply industries. This is in line with the two of Kenya's main policy objectives which are to provide sustainable quality energy services and promote energy efficiency. To achieve this objective, the COMESA model proposes policy instruments to restructure and reform energy markets to promote competition, efficient use of resources and regional cooperation to pool together resources to reduce energy costs. The instruments proposed in the Kenyan policy include new legal and regulatory framework to allow for market liberalization, private sector participation and power market pool.

The COMESA model energy policy objective no. 2 is to improve the security and reliability of energy supply systems. To achieve this, the policy instruments proposed include encouraging direct investment, maximizing the development and the utilization of indigenous energy resources and supporting research and development (R&D) through developing the necessary scientific and technological capacity. This COMESA policy objective is in tandem with another Kenya's main policy objective which is to enhance security of energy supply through expanding and upgrading of infrastructure, development of indigenous energy resources, diversification of sources and mixes and capacity building and support to R&D.

The COMESA model energy policy objective no. 3 is to increase access to affordable and modern energy services as a contribution to poverty reduction. Policy instruments required to meet the above objective include promotion of the use of low cost technologies, modern energy and end-use appliances, energy conservation and through appropriate fiscal and tariff-based incentives, subsidies, financing schemes and light-handed regulation. This is in line with another Kenya's main policy objective to improve access to affordable energy services. The policy instruments applied in the Kenya case are similar to the ones proposed here and include tax-free importation of power generation equipment, tax holidays, subsidies such as life-line tariffs and light-handed regulation as is the case in the removal of licensing for low capacity power generation.

The COMESA model energy policy objective no. 4 is to establish the availability, potential and demand of the various energy resources through the development of long term perspective of the options for demand/supply matching, identification of potential projects for investment, resource assessments, enhanced R&D and regional cooperation. This is similar to the Kenya's integrated energy planning and indigenous resources development and promotion policies in which the government undertakes to facilitate the establishment, maintenance and update of databases on the energy sector and annual updating of the 20-year least cost power development plan.

The COMESA model energy policy objective no.5 is to stimulate economic development. The policy instruments required to meet this objective include the application of appropriate fiscal and tariff-based incentives to attract investments in energy services, encouraging competition within the energy markets, ensuring energy adequacy and security, energy pricing and promoting regional trading in energy. This COMESA policy objective is similar to the Kenya's policy objective to utilize energy as tool to accelerate economic empowerment for urban and rural development. The Kenya's regional trade policy, fiscal and tariff based incentives, energy pricing are some of the mechanisms that have also been prescribed in the Kenyan policy.

The COMESA model energy policy objective no.6 is to improve energy sector governance and administration. The policy instruments required to meet this objective include creating clear and transparent legal, regulatory and institutional frameworks for the sector and developing new and appropriate policies. The Kenyan policy recognized this and provided for the establishment of an enabling environment for the provision of energy services by revising the legal, regulatory and institutional framework for the sector including establishing more institutions with specific and clear mandates.

The COMESA model energy policy objective no.7 is to manage environmental, safety, and health impacts of energy production and utilization. Policy instruments proposed include subjecting all projects to stringent Environmental Impact Assessment (EIA), awareness campaigns, promotion of environmental benign technologies, adopting integrated energy planning, promoting energy efficiency and conservation an setting targets. This is in tandem with one Kenya's policy objective to promote energy efficiency and conservation as well as prudent environmental, health and safety practices.

The last main COMESA model energy policy objective is to mitigate the impact of high energy prices on vulnerable consumers through subsidy mechanisms. Though not explicitly stated in the Kenyan policy, it is implied in the Kenya's energy pricing policy that requires that social equity be taken into account in determining energy prices to protect vulnerable goods. Indeed subsidy is currently applied on low electricity consumers and kerosene. It is also implied in another main policy objective which is to improve access to affordable energy services.

A closer look at the Kenyan and the COMESA energy policy frameworks shows that both were devised to address similar issues and challenge, which were identified in both documents.

In conclusion, the goals, main policy objectives and delivery mechanisms of the Kenya's energy policy framework with reference to COMESA model energy policy framework shows that the two are in great harmony.

3 Renewable Energy Strategy

Kenya has a National Climate Change Response Strategy, which has been designed to put in place actions to address challenges of climate change. These actions range from adaptation and mitigation measures in key sectors to necessary policy, legislative and institutional adjustments. Actions are underway to implement the actions identified in the NCCRS. There is also a Climate Change Co-ordinating unit in the office of the Prime Minister that ensures that policy development and implementation is effective and consistent across all Ministries.

The Government of Kenya is planning to establish the Green Energy Fund, which will address the issues of high upfront costs and human resources constrains in renewable energy development by providing concessional lending as well as capacity development support.

Kenya is one of six countries to benefit from the Scaling-UP of Renewable Energy Program for low income countries. The objective of SREP is to pilot and demonstrate the economic, social and environmental viability of low carbon development pathways in the energy sector by creating the new economic opportunities and increasing energy access through the use of renewable energy.

4 Status of Renewable Energy Development and Future Plans

4.1 Hydro Power

Current Status

Even though hydropower development commenced over 50 years ago, most of the hydro power potential described above is uneconomical for development. This is due to the topographical conditions of the sites, proximity to national grid and scale for development.

Currently the total installed hydro power capacity in Kenya is 764 MW. KenGen, a state corporation owns 761MW of this capacity. Most of the KenGen sites were construction decades ago and the main ones are listed in Table 2.2.

Table A4.2: Kengen's existing main hydroelectric power stations

	SITE NAME	INSTALLED CAPACITY (MW)	LOCATION
1	Kamburu	94	River Tana
2	Gitaru	225	River Tana
3	Kindaruma	40	River Tana
4	Masinga	40	River Tana
5	Kiambere	168	River Tana
6	Turkwel	106	Turkwel River
7	Sondu Miriu	60	Sondu River
8	SHP stations	28	various
TOTAL CAPACITY		761	

Potential

The country's hydroelectric power potential is spread across the country's five major drainage areas, namely: Lake Victoria drainage basin; Rift Valley region; Athi River Basin; Tana River Basin and Ewaso Ng'iro North River Basin.

The hydroelectric potential in Kenya is estimated to be about 6,000 MW. Half of this potential is medium to large hydro (>30MW) and the other half is classified as small hydro (<30MW) and is located on small rivers.

The un-exploited medium to large hydro power capacity is estimated to be 1500 MW.

A pre-feasibility study carried out in year 2006 by MOE confirmed an unexploited small hydro capacity of about 500 MW spread across the five drainage basins.

The MOE commenced a small hydro power resource assessment in 2006. This programme aims to identify suitable sites for small hydro power development. The programme is on-going and has identified 12 viable small hydro sites with a combined capacity of about 16MW. The GoK does not wish to develop the sites itself. The private sector and communities are encouraged to develop the viable sites under feed-in tariffs.

Future Plans

The hydro power plans are:

i) Undertake pre-investment studies on hydro power resources to define technical and financial viability. This is on-going.
ii) Install a total of 59 MW of new capacity. Details of the relevant projects are provided in Annexure A.

The publication of FITs policy has created a lot of interest in small hydro power developments. A number of investors have shown a lot of interest and have expressed interest to develop some sites and MoE has allowed them to proceed with studies.

4.2 Biomass

Current Status

Until recently, Bagasse co-generation has widely been used in the sugar mills to generate power and process steam for own use.

Recently however, one sugar mill has put up a 36MW cogeneration plant that is supplying 26MW to the national grid under a feed-in tariffs arrangement. The details of this project are provided in Annex F.

Six sugar mills have expressed interest in undertaking grid-connect co-generation projects to benefit from the FITs policy. These projects are at the feasibility study stages.

It is clear that even the established biomass potential has hardly been exploited mainly because there was no enabling environment to encourage investment until recently when feed-in tariffs policy came into being.

Potential

In this section biomass refers to agricultural wastes such as Bagasse, Rice Husks, Coffee Husks, Coconut Shells etc., and also animal wastes such as cow manure

There are six sugar cane milling factories serving the cane growing areas of Nyanza and Western provinces of Kenya. Based on a 2007 MoE pre-feasibility study, there is a potential to sustainably generate a combined total of 300MW from bagasse generated by the Factories.

Rice Husks, Coffee Husks, Coconut Shells and similar agricultural residues can also be converted into modern fuel, through thermal treatment. A few commercial scale opportunities may exist in centralized crop processing facilities such as in rice irrigation schemes and coffee milling. The potential has however not been established.

Future Plans

The only biomass future plans are those that are included in the energy policy:

i) Undertaking of a study to identify the most appropriate charcoal kiln technologies.
ii) Formulation of strategies for attaining the target of 300MW of co-generation capacity-by-2015 and incorporate the same in the least cost power development plan.
iii) Establish a pilot cogeneration investment programme.
iv) License charcoal trade to encourage sustainable production.
v) Implement a program for dissemination of improved charcoal kilns.
vi) Initiate programmes aimed at improved stove promotion and education.
vii) Launch medium term bagasse based cogeneration investment programme with a target of 150MW by 2010.
viii) Establish biomass energy technology databases
ix) Expand improved stoves and charcoal kiln programmes, to reduce the fuel wood deficit to 5 million metric tons by the year 2012.
x) Undertaking full cycle technology transfer from initiation to local adaptation and acceptance of specified technologies;

xi) Development of local expertise for energy consultancy services in renewable energy; and,

xii) Provision of charcoal kilns by the Government in charcoal producing areas at a fee to cover transportation costs. Use of these kilns will be made mandatory for all charcoal producers.

No major initiatives have been made towards implementing these biomass plans however.

4.3 Solar Energy

Current Status

Solar energy can be used for various applications including power generation, heating, cooling, drying and cooking. Traditional use of solar for drying is the most extensive in Kenya.

Two modern technologies for harnessing solar have made some headway in the country. These are photovoltaic and solar thermal.

PV was introduced in Kenya in the early 80's for the generation of electricity for use in remote areas far from the grid for household and other uses. Even though PV technology is proven and mature, no grid-connect or high capacity stand-alone PV installations have so far been installed in Kenya. The main barrier is cost. The local installation cost of stand-alone PV systems with battery storage, varies between US$12 and US$17 per Wp. There is however a vibrant solar home systems market and its estimated that a total of 12 MW has been installed to date.

The only significant PV electrification programme was initiated in year 2006 by MOE to provide basic power for lighting to schools and health centres in areas far from the national grid. To date this programme has benefited 280 public institutions. The total cost has been $10 million dollars and the total installed capacity is from this programme alone is 750 kWp

Solar thermal technologies can be used for various applications including electrical power generation, steam and hot water provision. At the local level, traditional uses aside, solar thermal has mostly been used for the provision of low temperature water for sanitary use in domestic and commercial premises. No large scale solar thermal installation programmes have been undertaken in Kenya. Only domestic small capacity (2-8 m^2 of collector area) systems are marketed in Kenya. It is estimated that a total of 5000m^2 of collector area is installed annually in the whole

country. The total number of installed solar water heating systems is estimated to be 140,000.

Potential

Kenya lies on the equator, between -5 degrees to the south and 5 degrees to the north. There is no major difference between the lengths of day and night and experiences no major seasonal weather variations. This also means that the solar radiation is available and well distributed across the country all year round with no major seasonal variations.

The annual average irradiation across the country ranges between 4 and 7 kWh/m²/day. The average national mean is 5.5 kWh/m²/day. The irradiation is highest in the drier north and north eastern Kenya. It is lowest in Mt. Kenya region and other highlands but still good. The national distribution is shown in Figure ?.

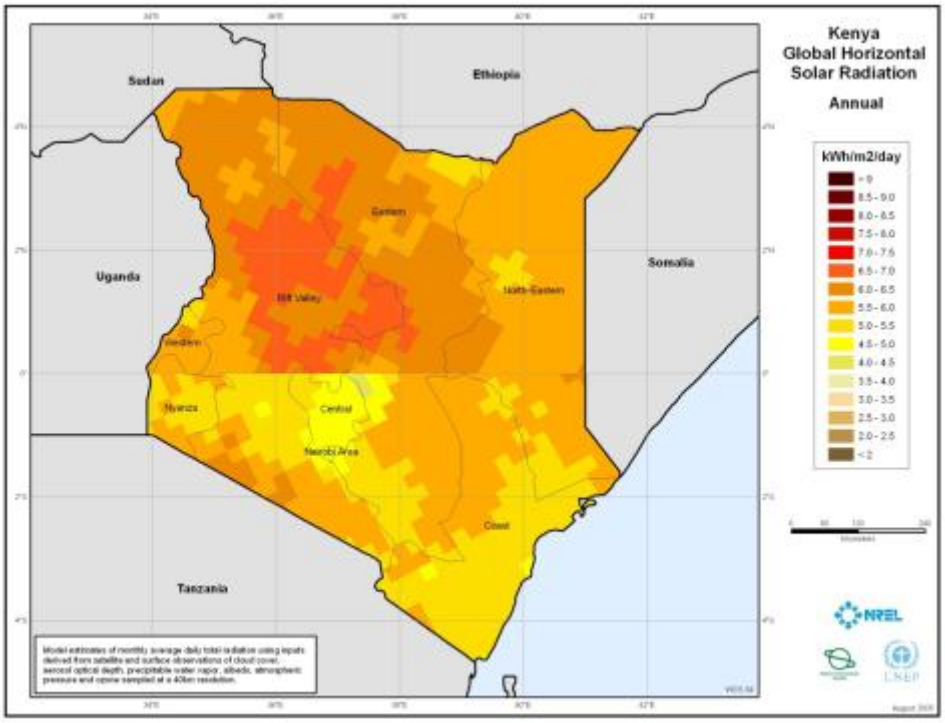


Figure A4.1: Calculated Average Global Horizontal Solar Radiation distribution in Kenya, 1985-1991[18]

In conclusion, solar energy potential in Kenya is enormous. However, only small scale exploitation is taking place, mainly because the technologies are relatively expensive

[18] **Source: Rural Electrification Master Plan, 2009**

and some such as concentrated solar power are not fully developed or commercialized.

Future Plans

The solar energy development plans are:

i) Make it mandatory to install solar water heating in domestic and commercial premises where medium temperature hot water is required.

Continue and expand the on-going PV electrification of schools and public institutions in off-grid areas.

4.4 Wind Energy

Current Status

Exploitation of Wind power in Kenya has just began with the commissioning of a 5.1MW wind power station (WPS) by KenGen in year 2010. The expansion of this WPS is planned to increase the capacity to 11.8 MW. KenGen is about to commence the construction of another13.6MW WPS at the same site.

Some developers have carried out feasibility studies at some sites and found wind power projects viable. Two projects with an installed capacity totalling 360MW are at an advanced stage of development with PPAs (Power Purchase Agreements) having been concluded. The developers are currently raising the requisite investment capital. These projects are included in Annexure B.

Two years ago, the MoE commenced a wind resource assessment programme for the country. Wind data loggers, at 40m heights are being installed at selected sites in the country to gather wind data that shall be used to identify suitable sites for wind power development.

Potential

The first authoritative wind energy resource mapping study in Kenya was carried out in year 2001 by the Ministry of Energy. The study resulted in the production of the first indicative wind atlas for Kenya.

According to the study, the areas that are potentially suitable for wind energy application are dispersed throughout out the country. The resources are spatially distributed to different areas depending on the local terrain features, climatic and seasonal factors. As a result mean wind energy can vary considerably over short distances, especially in areas of hilly, mountainous terrain and along the coast and the plains. The wind atlas developed based on synoptic weather data was therefore useful in identifying promising regions for further studies to establish the viability of wind energy exploitation.

A recent simulation by Solar and Wind Resource Assessment project (SWERA) corroborated the MOE wind atlas and more accurately located areas of high wind energy potential.

In general north eastern, western, south western and coastal regions of Kenya have potentially suitable wind energy. The wind resource distribution in Kenya is shown in Figure 1.

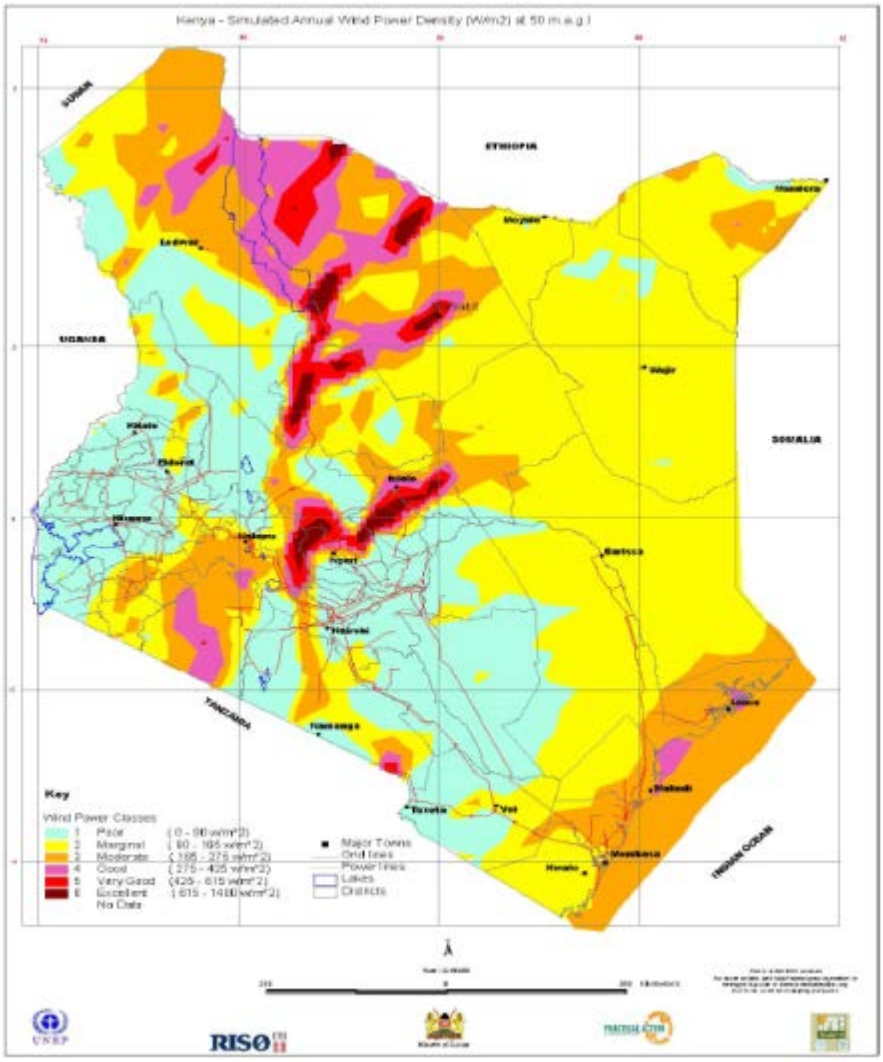


Figure A4.2: Wind Resource Distribution in Kenya *(Source: Rural electrification Master Plan, 2009*)

The MOE study estimated that 6.5% of the country has good-to-excellent wind regimes suitable for wind power generation. This proportion of the land area has mean annual wind speeds of above 6 m/s equivalent to power density of about 500W/m2. This implies that the country has a good wind power potential.

Future Plans

The wind energy development plans are:

i) Undertake wind resource assessment. This is on-going.
ii) Install a total of 380 MW of new capacity.

The publication of FITs policy has created a lot of interest in wind power developments. A number of investors have shown a lot of interest and have expressed interest to develop some sites and MOE has allowed them to proceed with studies.

4.5 Geothermal Energy

Current status

The exploitation of geothermal resources in Kenya started over 30 years ago even though the potential has not been in doubt. In year 2000, an IPP got a concession to develop another site within the Olkaria prospect. However, only 198 MWe has been developed to date. The existing geothermal power stations are shown in Table 2.3.

SITE NAME	INSTALLED CAPACITY (MW)	DEVELOPER
Olkaria I	45	KenGen
Olkaria II	105	KenGen
Olkaria III	48	Orpower 4 Inc.
Total Capacity	**198**	

Table A4.3: Existing Geothermal power stations in Kenya

The details of the above projects together with others at different stages of development are provided in Annexure C.

In 2009, the government set up GDC, a state corporation, whose mandate is to develop steam fields to reduce upstream geothermal power development risks so as to promote rapid development of geothermal electric power. This corporation is currently engaged in exploration and production drilling activities.

Potential

Geothermal resources in Kenya are concentrated along the Rift Valley with more than 14 fields extending from Lake Magadi to Lake Turkana. The resource distribution across the country is shown in Figure 3.

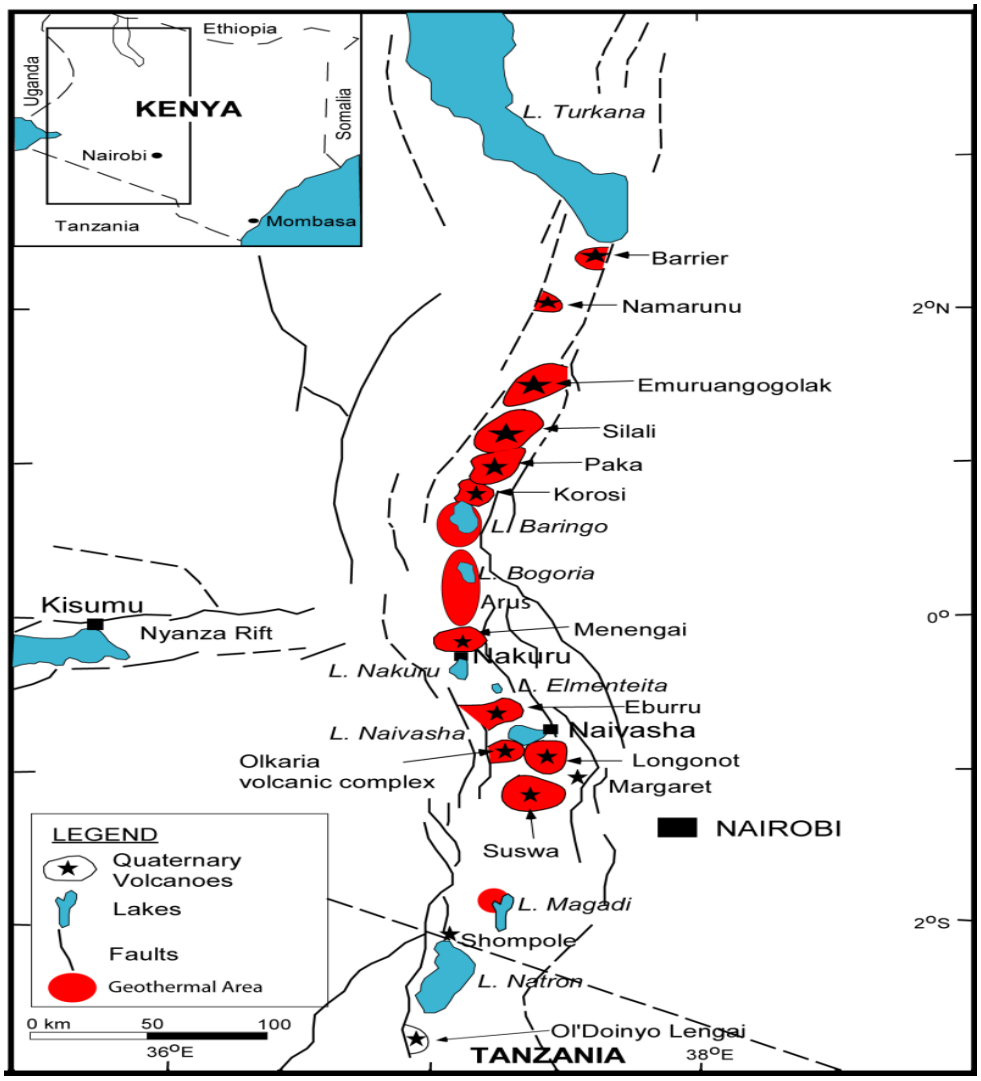


Figure A4.3 : Kenya Geothermal potential sites

The Olkaria geothermal prospect has been most studied. Recently however, other prospects namely Suswa, Longonot and Menengai have been fairly studied and the potential is estimated to be a minimum of 600, 700 and 800 MW respectively.

For a long time, the geothermal power generation potential has been estimated to be 3,000 MW. Recently, this estimate has been revised to about 10,000MW.

Future Plans

The Geothermal power development plans are:

i) Undertake geothermal resource assessments to define additional resource base in support of new geothermal power plants. This is on-going.
ii) Install a total of 315 MW of new capacity. Details of the relevant projects are provided in Annexure C.

Recently more private investors have shown interest in Geothermal and are actively seeking concessions.

4.6 Other Possibilities

Current Status

Currently no efforts have been expended towards exploitation of MSW energy potential. The waste is dumped at designated dumpsites and incinerated.

Potential

All major urban centres in Kenya generate substantial quantities of solid waste, most of it organic, and generally referred to as municipal solid waste (MSW). For example, Nairobi, Mombasa, Kisumu, and Nakuru generate an 2500, 700, 500, and 500 tons of MSW per day.

The amount of waste and its content determines the viability of energy generation from MSW. Standard incineration plants generate about 0.6MW per ton. This illustrates that there is substantial potential available for energy generation from municipal solid waste in urban areas even though not well studied.

5 Renewable Energy Incentives

5.1 Incentives

Kenya has a broad and all encompassing policy on renewable energy. The policy was first developed in 2004 and revised in 2006. The Policy and accompanying strategies are good as they support the introduction of incentive packages, including tax and feed-in tariffs. The implementation of the policies and strategies that have been in operation for close to six years now and the supporting law for 3 years has however been slow. The existing incentives are listed below:

1) An enabling law, the Energy Act No.12 of 2006, was legislated and operationalized in 2007. This is crucial incentive to investors as they now know their legal entitlements and protection
2) New focused institutions, with focused mandates were established as outlined in section 2.3.12. This will accelerate the development of the sector.
3) Resource assessment and/or feasibility studies are being undertaken on wind power, bio-gas, co-generation, small hydro power and Bio-ethanol. This is a major incentive since both the private and public investors will have access to reliable data and information on which to base their investment decisions.

4) Bio-ethanol development strategy has been prepared and plans for the re-introduction of automotive fuel blending with ethanol have been finalized. This is an incentive to farmers and private sector to invest in bioethanol production.
5) Bio-diesel development strategy has been developed. This will guide the development of bio-diesel market in Kenya.
6) Solar PV projects are under implementation. This serves to promote the technology and also provide basic electricity to public institutions in remote areas.
7) Feed-in Tariffs policy and regulations have been introduced. As a result, two RE IPPs (one geothermal and the other biomass co-generation) are currently selling power to the national grid under the FITs.
8) Tax free importation of renewable energy hardware such as solar panels.
9) Tax free importation of renewable energy equipment for power generation.
10) Removal of licensing requirement for power projects of less than 3MW capacity. A permit is required for a plant with a capacity between 1MW and 3 MW but no permit is required for capacities of less than 1MW.

The Feed-in Tariffs that have been introduced are contained in a document entitled 'Feed-In-Tariffs Policy and Regulations, revised edition 2010. The summary is presented in Table 2.1

RE Technology	Plant Output Capacity (MW)	Maximum Firm Power Tariff $/Kwh)	Maximum Non-Firm Power Tariff ($/KW)
Geothermal	0-70	0.085	-
Wind	0.5 - 100	0.12	**0.12**
Biomass	0.5 - 100	0.08	**0.06**
Small Hydro	0.5 – 0.99	0.12	**0.10**
	1 – 5	0.10	**0.08**
	5.1 – 10	0.08	**0.06**
Biogas	0.5 – 40	0.08	**0.06**
Solar	**0.5 – 10**	**0.20**	**0.10**

Table A4.4 Summary of Kenya's Feed-in Tariffs for Renewable Energy Generated Electricity[19]

[19] Source: Ministry of Energy

5.2 Clean Development Mechanism and Carbon Tax

Carbon taxes are one of the policy measures that can be used to encourage RE development by discouraging the use of fossil fuels. In this policy measure, a tax is imposed on the use of fossil fuels in proportion to their carbon content.

The Kenyan government has not imposed any Carbon Tax and there are no immediate plans to do it. The country however encourages projects development using the CDM mechanisms. Kenya is a signatory to the Kyoto Protocol. The national designated authority is NEMA and its contact details are:

The National Environment Management Authority
Popo road, off Mombasa road
P.O. Box 67839-00200
Nairobi, Kenya
Tel: (+254 20) 6005522 / 6005526/7
Fax: (+254 20) 6008997
Email: dgnema@nema.co.ke
Website: www.nema.go.ke

6 Challenges, Constraints and Barriers to Renewable Energy Development

There exist substantial renewable energy resources in Kenya. Solar, Wind, biomass, small hydro and geothermal resources are abundant and they would more than meet, and continue to meet for a long time, the demand for modern fuels in the country if they would be fully developed.

However, there are challenges and barriers that need to be addressed. These barriers and constraints have extensively been covered in the national energy policy. They were indeed the basis of the formulation of the said policy. It is not intended to reproduce then in this report and only a summary is provided. The details can be obtained in the energy policy document, Annexure J.

In Kenya, renewable energy development faces a number of barriers. These barriers include:

a) High development costs due to lack of adequate, suitable and accurate, site specific data.
b) High capital costs.
c) Lack of appropriate policy, legal, regulatory and institutional frameworks
d) Lack of financing schemes – traditional lenders are not familiar with the technology hence aren't able to assess the risks.
e) Intermittent nature of RE resources such as wind and solar makes their power less attractive to Utilities

f) Lack of local technical capacity

g) Un-proven and non-commercialized harnessing technologies in some cases.

It is for the above reason that world over RE development has been supported by Governments using a variety of strategies and incentive packages.

In Kenya, the policies and strategies described in Section 2.3 were developed to address the above barriers. Even though some progress has been made in the implementation of the said policies and strategies, only the policy and legal frameworks can be said to have been addressed substantially. What has been achieved is described in Section 2.3.12. The other identified barriers remain.

Even with appropriate policies and strategies in place, implementing them faces a number of challenges. In the Kenyan case, the major challenges faced in implementing the undoubtedly good policies are briefly discussed here.

Mobilization of Adequate Financial Resources

Renewable energy resources are site specific and require long duration and detailed studies to determine their economic and technical viability. This leads to high development costs. Even when the studies show that a RE project is viable, its implementation requires high initial investment capital. Mobilization of adequate financial resources, both public and private is a major challenge.

Budgetary allocations compete with other national priorities such as education, health, mainstream energy supply etc. The scope for budgetary allocation is therefore limited in poor countries like Kenya. It is however noted that the budgetary allocation for geothermal development has been increased substantially in the last two years.

Foreign governments and multilateral agencies do provide some funding but their priority is not renewable energy.

The private sector, being profit driven is not likely to invest in RE development work. It will normally come into the picture once a project has been identified and viability established. Kenya's unpredictable political environment also discourages private investors as their perception of political risk is that it is very high.

Resource mobilization is therefore a major limitation. It is the main reason why policy strategies that require substantial financial resources such as fiscal incentives and detailed feasibility studies are not being addressed timely.

It is recommended that the Government gradually increases financial allocation to RE in its budget and also mobilize RE development financial resources from development partners.

Technical Capacity Development

Renewable energy development studies require specialized knowledge and skills to undertake. Implementation of RE projects requires equipment that is not available locally. This means there is no significant local technical capacity for implementing RE projects.

Development of adequate technical skills takes a long time and requires financial resources. Furthermore market liberalization conditions may not favour local manufacture. These two requires a deliberate policy action by the Government.

The short courses MOE sends some of its technical personnel are not adequate. In any case, these are too few and do not address the wider market capacity deficiencies.

It is recommended that the Government identifies the skills gaps and establish a training programme for RE.

Lack of Financing Schemes

Traditional lenders such as banks are not familiar with RE technologies and hence aren't able to assess the associated risks. Consequently they do not extend financing to renewable energy projects.

This is a major constraint because project finance is a major drive of infrastructure development.

A deliberate government action to build capacity for financing institutions and also share risks with them is recommended.

Costs and Intermittent Nature of RE supplies

RE Power is generally more costly to generate hence not competitive in most cases. It is also intermittent and poses a significant risk to utilities in terms of its management and planning. Consequently utilities are not interested in it.

Deliberate Government actions such as feed-in tariffs and renewable energy portfolio standards are some of the drivers for RE development.

It is recommended that renewable energy mandates be established for Kenya now that feed–in tariffs are in place.

7 Lessons Learned, Observation, and Conclusion

Renewable energy resources in Kenya are substantial. However only large hydro power sites have been substantially exploited to a level where it contributes over 50% of the country's electricity.

Kenya has a comprehensive and progressive renewable energy policy framework and associated instruments for renewable energy development. Its implementation faces a number challenges most to do with limited financial and technical capacity.

The main lesson learnt here is that renewable energy policies in themselves, though necessary must be backed up with a commitment to mobilize adequate financial and technical resources in a timely manner for their implementation

A.2.9 Libya

Total installed electricity capacity (2006): 5,438 MW
Total primary energy supply (2007): 17,823 ktoe

Oil and products: 69.4%
Natural gas: 29.6%
Comb. renew. and waste: ~1%

Libya does not have a large population, extensive agricultural potential or a well-established industrial base like other North African countries such as Algeria, Egypt, Morocco or Tunisia. The country does, however, have abundant energy resources. Given the country's small population, 6.2 million in 2008, and its large oil and gas reserves, Libya's energy situation resembles that of the small oil-exporting Gulf countries more than that of its North African neighbours.

Electric power is produced from 30 power stations, which are largely oil-fuelled steam turbines, although there are a handful of gas-fired plants, and some turbines have been converted to gas to increase oil capacity available for export and other uses. The peak load in 2006 was 4005 MW, with a comfortable buffer between capacity and demand.

Reliance

Libya imports certain oil products such as gasoline due to its outdated refining sector. However, Libya is a net exporter of energy sources by a vast margin. Total crude oil exports in 2007 were 71,142 ktoe, with 4,223 ktoe of refined products being exported in the same year. Natural gas exports in the same period were 8,152 ktoe. With the country holding the largest crude oil reserves in Africa, the domestic oil market is likely to remain export-focused for the foreseeable future.

Extended Network

The electrification of Libya reached almost 100% of the population as of the year 2005. The Libyan grid is connected to Algeria, Egypt and Tunisia, which have further connections to other networks in Turkey and Morocco with onward links to Europe. The national power utility has indicated that power links with these countries may be developed further.

Libya's power grid consists of roughly 12,000 km of 220 kV transmission lines, with 21,000 km of 66 kV and 30 kV lines, and 32,000 km of 11 kV distribution lines.

Capacity Concerns

Almost 80% of the electricity consumed is based on oil. An important goal is to alleviate the dominance of oil-based power production by constructing new natural-gas fired power plants. This would, at the same time, serve the objective to renew the national power

generation infrastructure. In 2003, about two-thirds of the installed power generating capacity was more than 20 years old. Hence, the efficiency of the already installed power plants is far below the OECD standard. In 2006, the average conversion efficiency of Libyan thermal power plants was less than 29% compared to 36-40% in most industrialised countries. Blackouts in the summer of 2004, mainly due to ageing and faulty generators, led to the current drive to further increase capacity.

Renewable Energy:

Hydropower

Libya, compared to its other North African neighbours, has a poorly-developed hydropower sub-sector. This is primarily due to the lack of availability of resources in the country for the development of the energy source. There are currently no plans for the exploitation of hydropower in the country. Plans to develop a hydropower installation on the Great Man-Made River Project have not yet come to fruition.

Biomass

The estimated biomass potential in the country is 2 TWh/year. Whilst this potential may be suitable for individual residences to exploit for personal power generation, it is deemed to be unsuitable for large-scale electricity generation.

Solar

The solar regime in Libya is excellent; the daily solar radiation on the horizontal plane reaches 7.5 kWh/m2, with 3000-3500 hours of sunshine a year. There are few conflicts of land use; 88% of Libyan land area is considered desert, and much of this is relatively flat. There is some compromise between access to water, which is available at the coast where the solar regime is less favourable against inland sites with excellent solar characteristics, but far from water.

1,865 kWp of PV capacity were installed in Libya in 2006. The amount is increasing significantly; in particular, decentralised electricity generation in rural areas is being encouraged. PV systems are also used in agriculture to supply water pumps with electricity instead of using diesel.

Wind

The wind regime is also good. The average wind speed is between 6-7.5 m/s. There are several attractive prospects along the Libyan coast; one such site is at Dernah, where the average wind speed is around 7.5 m/s. A German-Danish consortium was contracted in 2000 by the national power utility to design and construct a 25 MW pilot wind farm. Several

appropriate sites were identified and masts were installed to monitor wind conditions over 12 months. Technical specifications for all the components of the pilot wind farm and tender documents for a turn-key installation of the 25 MW facility were prepared. Bids were submitted, but the project was then, for all intents and purposes, abandoned.

Geothermal

Whilst the potential for large-scale geothermal power generation has not yet been analysed in Libya, studies have been conducted into the potential for Underground Thermal Energy Storage (UTES), whereby excess heat is stored in an underground circulating pipe system.

Energy Efficiency:

There is little evidence of any strategy or targets for energy efficiency in Libya and analytical work on the possible potential is lacking. An old study indicated that the potential efficiency savings could amount to 20% over the period 1998 to 2020. Improvements in electricity use could reduce the need for electricity generation by 2,160 MW in 2020.

Ownership: Electricity

The General Electricity Company of Libya (GECOL, www.gecol.ly), the state-owned electricity company, is responsible for power generation, transmission and distribution in Libya. The company owns 100% of the long-range transmission grid and 90% of the distribution grid. GECOL's power plants produced 25.5 TWh in 2007.

Liquid fuels and gas:

Libya's oil sector is dominated by the National Oil Corporation (NOC, www.en.noclibya.com.ly). It has a monopoly on all oil fields and manages investments in the oil industry through Exploration and Production Sharing Agreements (EPSA). National refining capacity totals 378,000 barrels per day, being provided by five domestic oil refineries, owned by NOC. All refineries are in urgent need of upgrading and maintenance.

NOC is also responsible for natural gas production, and has a monopoly on all new discoveries. As of 2008, Libya had proven natural gas reserves of 1.3 billion toe. This amount increased significantly over the last 20 years since large investments were undertaken to investigate new deposits.

Competition - There have been previous attempts to liberalise the sector, and a draft law was prepared that provided for the legal unbundling of GECOL into companies for generation and transmission, along with several distribution companies. This law was never submitted to the legislature. The law also would have created a regulatory agency and allowed for the participation of private power producers in generation; it would also have

allowed operation and maintenance contracts with private contractors. Such industrial reform would have been helpful for RE, as it would create a clear legal framework for IPPs under which a power purchase agreement might be signed with the transmission company.

However, as the situation currently stands, the electricity market in Libya is entirely under the purview of GECOL, the state-owned, vertically-integrated national utility. The monopoly that the NOC holds over the up- and down-stream oil industries is also total.

Energy Framework

The Renewable Energy Authority of Libya (REAOL) has created a RE roadmap up to 2030, that has been approved by the former Ministry of Electricity and Energy. Long-term plans are to cover 25% of Libya's energy supply by renewable energies by the year 2025, rising to 30% by 2030. Intermediate targets are 6% by 2015 and 10% by 2020.

There is no formal government procedure for ensuring that physical development of infrastructure and buildings follows an energy efficient and sustainable path. The Libyan "Five Points Company for Construction and Touristic Investment" has announced that it will sign a contract with the Gulf Finance House to build an "Intelligent Energy City" in Libya, at a cost of US$5 billion. Libyan institutions will bear 40% of the cost, and the Gulf Finance House, 60%. The project will contain centres for databases, environmental assessment and RE, in addition to special compounds for oil and natural gas producing companies, energy sector services and manufacturing industries. Whether this development will actually occur in the present financial climate is uncertain. The lack of concern for EE in transport and spatial planning is another factor to be considered in the country's future energy planning.

Energy Debates

There is no energy efficiency law in Libya. Some considerations regarding energy efficiency were included in a previous draft electricity law, but this law never reached the statute book and was withdrawn when the Ministry of Energy was disbanded. It is understood that a new law on energy efficiency is in preparation, but its contents are as yet uncertain.

Energy Studies

Libya is member of the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE), formally established in 2008 as an independent regional think tank, based in Cairo, dedicated to the promotion of RE and EE, comprising 10 North African countries. In addition, the RCREEE encourages the participation of the private sector in order to promote the growth of a regional industry of RE and EE. In the current start-up phase the Centre is financed by Denmark (DANIDA), Germany (Federal Ministry of Economic Cooperation and Development), the European Union and Egypt.

Libya is also a member of the Arab Maghreb Union, and is hence involved in COMELEC, the regional power project, aiming at increasing inter-connection between the Maghreb states, as well as further development of inter-connections with Europe for the purposes of power trading.

Role Government: Energy Council

The current institutional setting is not favourable for sustainable long-term policies and strategies. In 2008, the Ministry of Electricity and Energy was disbanded, and its responsibilities shifted to the Energy Council. Formally established by the Prime Ministerial Decision of September 8th 2009; the Council is chaired by the Prime Minister, and is comprised of the Ministers of Industry and Economic Development, Planning and Finance, and Municipalities together with the Chairmen of the Environmental General Authority, REAOL, GECOL, the NOC, the Atomic Authority, the Solar Energy Research Centre, the Libyan Bank and the National Security Council. The Ministry of Transport is a notable omission.

The Energy Council has the mandate to organise the broad range of all energy matters. It serves as a mechanism of decision making in areas where inter-Ministerial cooperation is vital, for example strategy and pricing. It also performs tasks that would normally be done by a Ministry of Energy; for example structuring of the sector, investment management, and the provision of information. Lastly it micro-manages the operating entities, creating conflicts of function, risks of confusion and delays. Generally, the policy-making process lacks transparency and inter-institutional communication structures.

Government Agencies: Renewable Energy Authority of Libya (REAOL)

REAOL was established in 2007 as a management, research and planning agency for the introduction of renewable energy. The authority has been provided with US$487 million of funding for the period until 2012. REAOL's current target is to achieve a 10% share of energy from renewable sources in the energy mix by 2020, from today's negligible levels.

REAOL was originally a solar research centre within GECOL. GECOL was asked by the government to develop proposals for concrete projects concerning renewable energy, and so the research centre was upgraded to a Department within GECOL. Subsequently the Department was separated from GECOL and became a dedicated agency depending on the Ministry of Electricity. Soon afterwards the Ministry of Electricity was suppressed and REAOL (along with other agencies such as GECOL) was transferred to the direct supervision of the General Peoples' Committee for Electricity, Water and Gas.

Centre for Solar Energy Studies (CSES)

CSES is based in Tripoli, and performs studies and research programs in the field of solar energy, and promotes use of both PV and solar thermal technology within the country. Its

main objectives are to promote and perform solar desalination projects, as well as the research and development of solar water heating technology in the country. The organisation works closely with GECOL in the promotion of PV technology, in particular.

Energy Procedure

The present National Plan covers the period from 2008-2012. It contains a chapter on RE, and provides for operating funds for REAOL. However, no investments are foreseen other than a wind plant at Dernah. Preparations for the next Plan have not yet begun, so there is scope for strengthening the RE component in the next period. Budgets for entities funded through the Plan are allocated annually. This makes long-term planning very difficult.

A new draft electricity law has now been prepared, which is understood to be similar to the Egyptian law. It contains explicit provisions for RE and EE, but it appears that these two topics may be removed from the draft and treated later in special purpose laws. The strategy will purportedly restructure REAOL to take care of EE as well as RE, and will distribute any physical assets of REAOL into a separate company, to avoid conflicts of interest between regulatory and commercial functions.

REAOL has prepared a medium-term plan (2008-2012) to promote RE in Libya and to meet these targets. The Plan addresses projects in solar and wind and stimulating local manufacture of equipment for RE. This plan comprises several wind farms with a total proposed capacity of marginally less than 1000 MW, including:

- the Dernah wind farm (120 MW in two stages);,
- the Al Maqrun wind farm (240 MW in two stages),
- Western region farms at Meslata, Tarhunah and Asabap (250 MW),
- South Eastern region wind farms at Gallo, Almasarra, and Alkofra, Tazrbo (120 MW),
- South Western region wind farms at Aliofra, Sabha, and Gatt, Ashwairef (120 MW).
- The solar component includes PV and solar thermal technology:

Three large-scale PV plants connected to the grid at Aljofra, Green Mountain, Sabha (5-10 MW each),

- Extending the use of PV technologies in remote areas (2 MW),
- 1000 PV roof top systems for residential areas (3 MW),
- A feasibility study for a CSP plant in unspecified location (100 MW),
- The development of a joint venture with local and foreign investors for the manufacture of solar water heaters for the local and export markets (40,000 units / year),
- The development of a joint venture with local and
- Foreign investors for the assembly of PV systems (50 MW).

However, these RE targets and strategy do not seem to be fully shared by all involved parties, despite the approval of the target by the Cabinet. The lack of consensus means that REAOL's programs and targets may not be realised on the time-scale envisaged.

Regulatory Framework

There is no legislation covering financial support for RE, and addressing the issue of the additional costs of renewable energy compared to the least cost alternative should be investigated. Furthermore, there is no clear legislative basis for the participation of private capital in the power sector. Current drafts of the electricity law are hypothesised to contain measures for the promotion and financing of RE and EE, but no definite measures are currently in place.

Regulatory Roles

The Energy Council is responsible for all activities in the energy sector, including regulatory functions for both the oil and electricity sub-sectors. Previously, under the former Ministry of Energy, tariff and standards setting was the responsibility of the respective national utilities. Since the establishment of the Energy Council, responsibility for these activities has been transferred directly to the government, and current trends appear to suggest a more state-oriented regulatory approach for the future.

Energy Role Regulation: The tasks of the Council include:

- To prepare and suggest policies and strategies for the energy sector, and to promote coordination among stakeholders,
- To develop the energy sector structure,
- The establishment of policy to manage demand,
- To establish a strategy for pricing,
- To collect available information
- The evaluation of sources of energy, especially solar,
- Energy forecasting,
- To establish procedures for investment in the energy sector,
- Approval of contracts with foreign companies.

Energy Regulator: There is no regulatory agency in the country. The Energy Council is responsible for all operations in the sector, including such regulatory measures as are necessary for the sector's operation.

Degree Independence: The Energy Council is comprised entirely of government agencies, chaired by the Prime Minister. Funding for the council and its constituent members comes directly from the national budget, and operating revenues of the involved government companies.

Regulatory Barriers:

Each entity has its own policy and moves in different directions. It is obviously important to coordinate activity according to a common and agreed strategy.

A.2.10 Madagascar

1 Renewable Energy Regulatory Framework

A new national energy policy for Madagascar was introduced by the Law n° 98-032 on January 20, 1999. Entitled 'The Reform of the Electricity Sector', the purpose of this reform is to allow new operators to act within the sector in order to, on the one hand, relay Malagasy Government in the financing of the electric infrastructure of the country and, on the other hand, promote the efficiency, and the quality of the service offered to the users by the the rule of competition.

According to this Law, the Government commits to:

vii. Liberalize the electricity sector;
viii. Ensure security of private investments;
ix. Ensure transparency on tariff setting;
x. Preserve the environment.

The Law is detailed. It covers both conventional and renewable energy. Within this legal framework, the Government has designed a "Technical Paper for Madagscar Energy Policy" in October, 2009. The contents of the Technical Paper are :

d) The Global objective is Ensuring Energy Supply:
   - in sufficient quantity,
   - of good quality, and
   - at a least cost.

e) Global program : Promotion Of Local Energy Resources & Infrastructure Development

f) Specific objectives :

   - strengthening good governance & securing private investments
   - improving electricity access
   - satisfying durably woodfuel needs
   - improving the use of local energy resources
   - enhancing energy sector development support

For each specific objective, this would be achieved by related program/actions :

viii. Specific objective 1. Strengthening Good Governance & Securing Private Investments

Programs / Actions:

- Plans and Policies Updating
- Institutional reforms
- Legal reform

ix. Specific objective 2. Improving Electricity Access

PROGRAMS / ACTIONS

- Increasing generation, transmission and distribution capacities of Electric Power
  - * Hydro Power stations
  - * Thermal Power stations
  - * Reinforcement of Transmission grid systems and Distribution

- Extending electrification to rural and suburban areas, as well as in the high economic potentialities zones
  - * Promotion of Renewable Energies: H ydro, solar (village), wind, thermal biomass
  - * Thermal Diesel
  - * Extension of the interconnection

x. Specific objective 3. ***SATISFYING DURABLY WOODFUEL NEEDS***

PROGRAMS / ACTIONS

- Improving the production and the use of woodfuel
  - * Reforestation focused on energy goals
  - * Promotion of the improved carbonization techniques
  - * Diffusion of improved stoves and solar cookers
  - * Development of alternative energies

xi. Specific objective 4. Improving The Use Of Local Energy Resources

PROGRAMS / ACTIONS

- *Promoting new technologies and techniques*
  - * Biogas
  - * Biofuel and Biocarburant:
  - * Solar and wind

- *Promoting NON-RENEWABLE energy resources*
  - * Coal fired power station

xii. Specific objective 5 Enhancing Energy Sector Development Support

PROGRAMS / ACTIONS

- *Supporting all the stakeholders implied in the sector*
  - * Synergy between Energy and Environment sectors
  - * Funds allowance for various programs

Legal and Regulatory Policy

In 1999, the Government of Madagascar finalised the institutional framework and promulgated a law N° 98-032, which introduced reforms in the electricity sector. Since that year, "JIRAMA" the state-owned utility has had competition in electricity supply. The main provisions of this framework are to open the economy to private investment and to facilitate the participation of national and foreign investors to all activities of energy supply from renewable sources, in particular for grid-connected hydro-power, small hydro-power for rural electrification, plantation of energy crops and transformation to bio-fuels, solar energy for rural energy supply, wind power.

This Law implemented the Electricity regulatory body, called "Office de Regulation de l'Electricite" (O.R.E). The ORE's responsibilities include (i) to design and to publish the electricity regulated prices and to supervise their correct application, (ii) to supervise the respect of the quality standards of service, (iii) to control and make the principles of competition be respected.

Besides, an agency, named "Agence de Developpement de l'Electrification Rurale" (A.D.E.R) was created with a view to promote rural electrification.

2 National Energy Policy with Reference to COMESA

The main thrust of the COMESA Model Energy Policy Framework is to provide the COMESA member States with harmonized guidelines that would facilitate energy policy harmonization in the region in efforts to improve efficiency and increased investment. The models cover all energy types, including renewable energy. An independent Regulator "Office de Regulation de l'Electricite" (ORE) is already implemented (by the law 98-032), whose objectives will mainly focussed on the following :

- To promote investment and develop the modern energy resources including their infrastructures ;
- to promote competition ;
- to incitate and facilitate that entry of new investors is encouraged.

Main Energy Policy Goal and Objectives

The main energy policy goal is to meet the energy needs, in an environmentally sustainable manner, through providing an adequate and reliable supply of energy, at

least cost, to support: social and economic development and sustainable economic growth and also to improve the quality of life of the people.

The main energy policy objectives of this model energy policy framework include the following:

9. Improve Effectiveness and Efficiency of the Commercial Energy Supply Industries;
10. Improve the Security and Reliability of Energy Supply Systems (implementation of technical and quality standards) ;
11. Increase access to affordable and Modern Energy Services as a contribution to Poverty Reduction ;
12. Establish the Availability, Potential and Demand of the Various Energy Resources ;
13. Stimulate Economic Development ;
14. Encourage and secure private investments ;
15. Improve Energy Sector Governance and Administration;
16. Manage Environmental, Safety, and Health Impacts of Energy Production and Utilization ;
17. Mitigate the Impact of High Energy Prices on Vulnerable Consumers : implementation of social block tariffs.

Biomass and other Renewable Sources of Energy Sub-sector

Biomass - **t**he policy objective is to ensure sufficient and sustainable supplies of biomass to meet the demand while minimizing to a very far extent the environmental impacts associated with biomass industry.

The policy objectives of other **r**enewable sources of energy (hydro power, solar energy, wind energy, geothermal power and other possibilities) include the following:

d) to increase the contribution of other renewable sources of energy in the energy balance;
e) to utilize other renewable sources of energy for income and employment generation; and

f) to develop the use of other renewable sources of energy for both small and large-scale applications.

3 Renewable Energy Strategy

Madagascar has a high potential of RE in many sites with high capacity factor especially hydro potential (estimated at 7800 MW). In this regard, a Least Cost Expansion Plan based on hydro potential plants has been undertaken and annually updated. As a result, hydro implementation program has been designed for the JIRAMA's main grids.

With a view to meet national energy demand, the consideration of the other resources is on-going to complete this Plan. For rural areas, the "Agence de Développement de l'Electrification Rurale" (ADER), undertakes energy planning studies which consider all available local resources.

4 Status of Renewable Energy Development and Future Plans

4.1 Hydro Power

Current Status

The experience with hydro power in Madagascar plants dates back to the beginning of the 20th century. Currently the total installed hydro power capacity in Madagascar is 128 MW. JIRAMA utility owns 105.MW of this capacity. Two IPPs operate 23 MW as total of hydro installed capacity, supplying JIRAMA's generation system .

Most of the JIRAMA sites were construction decades ago and they are listed in Table A2.1. Table A2.2 shows IPP's hydroelectric power stations, and Table A2.3 hydroelectric power stations owned by private operators in rural electrification.

Table A2.1: JIRAMA's existing hydroelectric power stations

	SITE NAME	INSTALLED CAPACITY (MW)	LOCATION / RIVER
1	Andekaleka	58	Vohitra
2	Mandraka	24	Mantasoa (dam)
3	Antelomita	8	Ikopa
4	Volobe	7	Ivondro
5	Namorona	6	Namorona
6	Manandona	2	Manandona
7	Manandray	0,5	Fianarantsoa
TOTAL CAPACITY		**105 MW**	

Table A2.2: IPP's existing hydroelectric power stations

	SITE NAME	INSTALLED CAPACITY (MW)	OPERATOR
1	Sahanivotry	15	HYDELEC
2	Tsiazompaniry	5,2	Henri Fraise & Fils
3	Maroantsetra	2,6	HYDELEC
TOTAL CAPACITY		**23 MW**	

Table A2.3: Existing private hydroelectric power stations in Rural Electrification

	SITE NAME	INSTALLED CAPACITY (kW)	OPERATOR
1	Andriantsiazo	7,5	AIDER
2	Andriatsemboka	10	AIDER
3	Antetezambato	53	Coopérative ADITSARA
4	Ranotsara nord	20	VITASOA ENERGY
5	Ranomafana est	30	ELEC & EAU
6	Sahamadio	128	JIRAFI
7	Ankazomiriotra	120	POWER & WATER
8	Mangamila	80	ELEC & EAU
TOTAL CAPACITY		**440 kW**	

Potential

The theoretical hydropower potential of Madagascar has been estimated at 7,800 MW of installed capacity. A further estimation in terms of the economically exploitable potential has not been established so far.

Future Plans.

The hydro power plans are :

i) Undertaken pre-investment studies on hydro power resources to define technical and financial viability according to a Least Cost Expansion Plan for the main electric grid systems. This is on-going and updating.
ii) Details of the relevant projects are provided in Annexure .
iii) For rural areas, a master plan considers small hydro plants (see Annexure).

A number of investors including NGOs have shown a lot of interest and have expressed interest to develop some hydro power sites. MoE has allowed them to proceed with studies.

4.2 Biomass

Current Status

In Madagascar, biomass energy is mainly based on rice husks, coffee husks, woody biomass and similar agricultural residues. Since 2009, co-generation rice husks has been operational by a private operator for Anjiajia village. Another one is in construction in Bejofo village .

Potential

Rice Husks, Coffee Husks, Woody biomass and similar agricultural residues can be converted into modern fuel, through thermal treatment. The potential has however not been established.

Future Plans

The biomass future plans are those that are included in ongoing projects as pilot cogeneration investment programme .

BIOENERGELEC is the main project in collaboration with CIRAD, ADER. This project , funded by EU will be implemented in the six following villages : Ambohijanahary, Befeta, Didy, Ifarantsa, Mahaditra, Manerinerina

4.3 Solar Energy

Current Status

The total installed capacity of PV currently operational is only about 9 kW , though Madagascar has huge potential.

Solar energy can be used for various applications including power generation, heating, cooling, public lightning, drying and cooking.

Photovoltaic and solar thermal technologies are also used in Madagascar for domestical purposes. These are undertaken with NGO’s programs.

a. Solar thermal

There are two solar cookers available in Madagascar: the box cooker and the parabolic cooker. There are build in Madagascar by NGOs like ADES or SOLTEC (see experiences in Madagascar).

b. Photovoltaic

In most of the project already done or which are going to be realized, all the materials are imported (May, 2008). The project GREEN-MAD tried in the 90' to vulgarize the technology but it was a failure (see experiences in Madagascar section). The market of batteries is widely developed in Madagascar. However, VIRIO is the only local firm involved in the production and the recycling of batteries.

c. Experiences in Madagascar

Solar thermal

ADES is a NGO and a non-profit organization, producing solar cookers in Madagascar and encouraging the use of renewable energy. The association is involved in the construction, the production and the sale of solar box cookers in Toliary and Ejeda. Local craftsmen produce the box type solar cooker in the ADES workshop in Toliary and starting in April 2006 also in Ejeda in the South of Madagascar. ADES sells the solar cookers to the population at Ar 25 000, but the price is largely subsidize. Teaching the population thow using the solar cooker is an important part of ADES. Due to the favourable conditions of 350 sunny days per year the South is ideal for using solar energy. ADES therefore focuses its activities on the south of Madagascar, the Province of Toliary. In order to cover the whole south ADES is planning to build various regional and local centres for solar cooking within the next 8 to 10 years. Two regional centres are planned in Morondava and in Tolagnaro. Up to the present time the financing of two centres (investment and yearly operation) is possible through the fundraising activities of ADES in Switzerland. For further centres other financial sources have to be found.

SOLTEC is a professional center which helps the orphan or the families in difficulties. Each year, 140 young malagasy are trained in mechanics, metallic, woodworks, etc. They produce parabolic solar cookers and solar dryers. The price for a parabolic cooker is 190 000 Ar.

Photovoltaic

TENEMA is currently the leader on the PV market. It is a filial from TENESOL (TOTAL).

They have distribution centers in Toliary, Farafangana, Fianarantsoa and Manakara. According to rural electrification, they have implemeneted PV installation: 7840 Wc in Toliary region, 1200 Wc and 1300Wc in other regions. Furthermore, 60 schools and CSB have been electrified by 700 Wc solar systems. They installed the biggest unit of Madagascar in the Parc d'Ankarafantsika with 16 kW power capacities.

SOLARMAD is a little french-malagasy firm which produces and sales solar and wind power devices in rural area at a competitive price. It has begun in 2005 and is growing since then. Today, 10 peoples are employed. According to their surveys, it exists a demand for solar panel, mainly for those with low power capacity, under 50 W in order to use radio, cell phones, lamps and televisions. These low capacity solar devices are sale from Ar 15 000. Around, a 100 have been sale until now. The panels are produced in amorphous silicon which is the cheeper material available on the market. Its efficiency is low compared to its size but according to Solarmad it does not matter. Panels without frame and cabling are imported.

ADES is also involved in photovoltaic issues. They do demonstration of their products in their expositon center. Currently, they are analyzing the feasibility of a rural electrification project in Saint Augustin in the Tolearia region. Several photovoltaic solutions are going to be tested in order to choose the most adapted technology for vulgarization purpose. Units would be implemented by the end of 2008.

GREENMAD is a project led by GTZ and the energy ministry. Part of this project was in the 90' to develop the photovoltaic sector. They target the north-west side of the country given the sufficient solar radiation potential: 5500 Wh/m . Three of the four steps of the project have been handled: the region situation analysis (socio-eco, matching demand, etc.), demonstration projects in 6 CSB and 9 households and technology transfer to the private firm SOCIMEX (technicians and engineer have been trained). The third step was the commercialization of the solar kits. It did not happen because of the lack of involvement of SOCIMEX, the lack of profitability and the lack of the demand solvability. Indeed, studies have shown that PV installations were profitable only in 4.5% of the rural population (GREEN-MAD, 1992).

RONOSOA is a Malagasy firm working on PV issues since 2004. In 2006, they implemented PV installations in the Andranofeno village in the Analamanga region. Panels are mono-crystallite and are imported from Italia.

PEPSE is a project focusing on the rural electrification solution in 9 regions in the south of Madagascar: Amoron'I Mania, Atsimo Atsinana, Androy, Atsimo Andrefana,

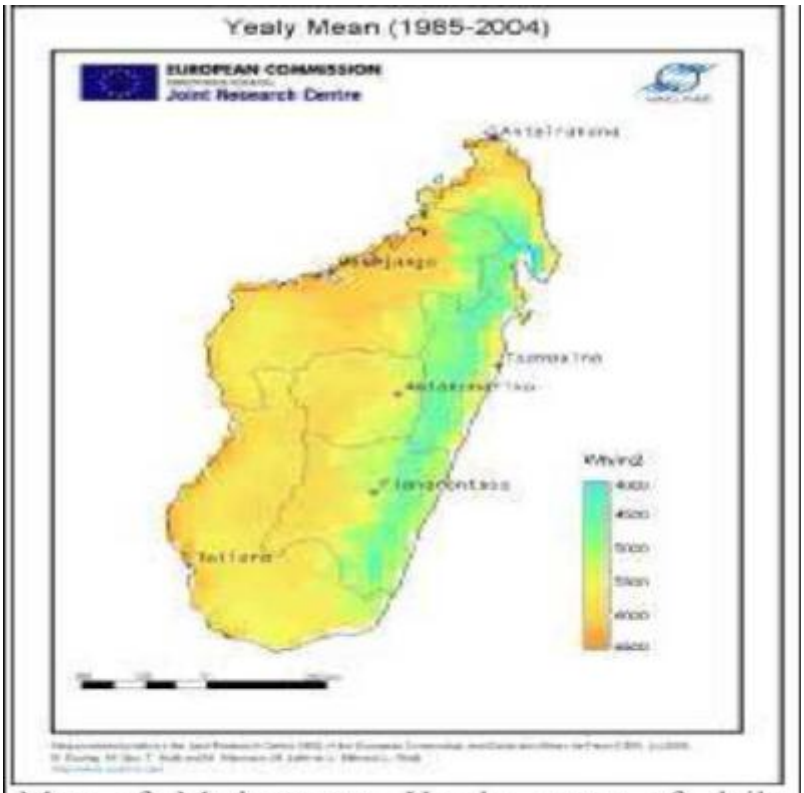
Haute Matsiatra, Menabe, Vatovavy fitovinany, Ihorombe and Anosy. Several indicators have been chosen to select the better sites. 73 villages in these 9 regions have been elected. 41 of them have the objective to produce electricity from solar central through a local grid. The table below details the information.

Potential

In Madagascar, sunshine is 750 W/m^2 as a maximum in sunny day. As a mean over the year, it is around 250 W/m2 meaning that the potential for Madagascar per year is 1950 KWh/m2 (Ischebeck, 2008).

Although other factors as temperature, weather, relative humidity, etc. affect the solar energy capacity, we focus here on the radiation repartition over the territory. Moreover, areas threaten by deforestation represent a good indicator for site selection. All this aspects need to be taken into account in a more detailed study.

Therefore, we study below maps which display the radiation reaching the ground in Madagascar. The quantity displayed is the irradiation for a day averaged over twenty years from 1985 to 2004. The radiation is expressed in Wh/m2. These maps are computed from observations made by meteorological satellites (European commission and l'Ecole des Mines, 2005).
According to the yearly mean data, Madagascar has an important potential in the region on the western side from Antsiranana to Taolagnaro and on the east cost. Solar radiations range from 4 000 to 6 500 Wh/m . The most interesting regions which have a radiation level up to 5 500 Wh/m^2 (yellow to the red color) are Diana, Sava, Sofia, Boeny, Melaky, Menabe, Astsimo andrefana, Androy, Anosy, Ihorombe, Haute Matsiatra, Amoron'I Mania, Vakinankaratra, Bongolava. In the eastern side, we find the cost of Atsimo atsinanana and of Vatovavy Fitovinany. However, these results have to be balanced given the influence of the factors like weather. Because, the rain comes from the east, he east cost is more exposed and present a higher rate of rainy day per year. Given to ADES and GREEN-MAD the Toliary, the Mahajanga and the Antsiranana province are the better sites for solar energy taking into account all the factors affecting the solar energy efficiency.



Map of Madagascar: Yearly mean of daily irradiation

In conclusion, solar energy potential in Madagascar is enormous. However, only small scale exploitation is taking place, mainly because the technologies are relatively expensive and some such as concentrated solar power are not fully developed or commercialized.

Future Plans

The solar energy development plans consist of continuing and expandind the on-going PV electrification of schools and public institutions in off-grid areas.

PEPSE solar central projects

Region	Village	Available power (kWc)	Population targeted	Estimated costs (million Ar)
Atsimo Atsinana	4	232	70 000	8 000
Amoron'I Mania	10	251	112 000	8 976

Atsimo Andrefana	5	206	128 000	9 254
Haute Matsiatra	7	135	98 000	6 229
Vatovavy Fitovinany	7	342	89 000	11 780
Irohombe	1	28	12 325	975
Menabe	7	195	82 000	7 036

4.4 Wind Energy

Current Status

Three private operator have implemented hybrid system thermal/wind power generation in five villages for about 150 kW total installed capacity.

Running projects

a. Mad'Eole

Mad'Eole sarl realized in June 2007 the electrification of the village of Sahasifotra in the region of Diana. 60 families representing 300 people are now electrified. The system is made of 3 Aerosmart wind turbines of 5 kW, lowered in case of cyclones. These wind turbines work with a battery and are accompanied by a diesel generator of 5 kW. Financing is taken into account by Mad'Eole at 70% and by ADER via the Fond National d'Electricite (30%).

The project led in Sahasifotra will be followed by 15 other projects in 15 different villages, all located in the region of Diana. In 2008, the villages of Ambolozokely and Ambolozobe are going to be electrified. They will be followed by 12 other villages during the 5 next years. The villages are chosen according to their wind regimes, their village structures, their economic potential and the engagements of the population.

b. Institut pour la Maîtrise de l'Energie (IME)

A wind turbine of 500 W was installed in the University of Antananarivo by the Institut pour la Maîtrise de l'Energie (IME) in collaboration with the Association Energie Efficiente Trans Europe Culture (AEETEC) of Strasbourg. Every part of the wind turbine was imported and the system was fabricated by the Ateliers Rasseta in Antananarivo for a total cost of 6 millions of Ariary.

c. ACORDS

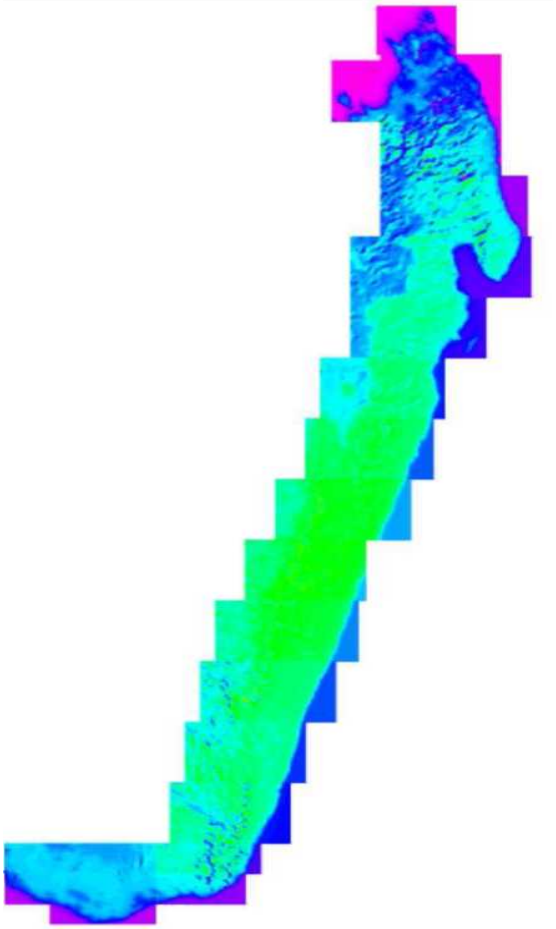
The village of Faux Cap (région) was recently electrified thanks to 3 wind turbines of 5 kW each accompanied by a diesel generator. A cold chain was also settled in the village thanks to the electricity produced by the wind turbines. This project was financed by the ADER and ACORDS (a European Union program). The wind turbines were imported from India and provided by Installation Electrique Technique (IET) a company based in Antananarivo.

Potential

In Madagascar, 3 kinds of winds are distinguished: the coastal winds and other locals wind, the Alizés and the cyclones. Whereas, the first types of winds have a daily variation, Alizés have a seasonal variation. Cyclones are individual phenomena occurring during the austral summer that is to say from December to March. Coastal and local winds and Alizés have a good potential for wind energy. Cyclones represent a danger for wind turbines. Central East Coast, with 1 to 5 cyclones per season, is the most vulnerable region of Madagascar to cyclones and, thus, can present an important barrier for rural wind energy development.

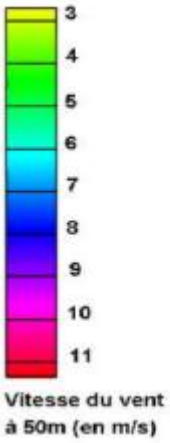
Generally, the North, the South and the East coast of Madagascar are said to be the windiest
regions of Madagascar. This generality is confirmed by every study on wind measurement all
over the country. In the beginning of the nineties, the German society DECON (Deutsche
Energy Consult) conducted wind measures in numerous points all over the country. 3 sites were considered interesting for developing wind energy equipment: Antsiranana, Vohemar and Taolagnarao. The Vergnet company published a wind atlas of Madagascar, covering the North, the East coast, the East region of Hauts Plateaux and the South. The maps result from satellite measures of the NASA and refer to the average speed of the wind at a height of 50 meters. This study of the wind resource shows that there is a great potential of wind energy resource: in the north of the country (Diana), many sites with wind speed higher than 8m/s were identified, in the middle part, the average wind speed in the range from coast stretch to more than 10km inland is between 6-6.5 m/s, and in the south part, the estimated wind speed exceeds 7.5m/s. Considering only the highest wind speed

sites (>7m/s at 50m) along the south and north coasts, Madagascar has more than



Source: Atlas Eolien de Vergnet

2000 Mw of potential. From this atlas, we can conclude that the highlands region is not interesting for the development of wind energy. This state of mind is based on the weak wind regime (about 4m/s) compared to a very good potential for hydraulic energy. The South and the North remain the regions where wind energy has the most important potential. The central east coast has also a good potential but cyclones can represent a barrier to wind energy development. These remarks concern average measures of wind power, it is possible that in very precise point of the West coast or of the highlands, wind speed is higher than in some points in the South, the North or the East Coast. For every eligible village to wind energy project a specific measure study should be conducted.



4.5 Biogas

Current status

There are three technologies used in Madagascar: scattered, continual and half continual. The continual system is the most common. Several digesters have been implemented as the continual fixe dome and the continual floating dome. Few digesters have been built in the mid-west regions, in Vakinankaratra and around Antananarivo. Today, the more appropriate technology for Madagascar seems to be the Borda fixe domes developed by GTZ/RFA because it is better adapted for local manufacturing since it uses bricks and a reduced amount of cement for masonry work.

Potential

In Madagascar, since the rural economy depends essentially on primary sector activities, there is a large potential for biogas production from animal wastes and agricultural residues.

Future Plans

4.6 Biofuel

Current Status

Jatropha curcas, cotton and sugar cane are the three plants which are the most considered actually by investors in Madagascar. Jatropha and cotton are used to produce biodiesel; sugar cane is used to produce ethanol.

Potential

Those plants could represent relevant potential for alternative rural energy development.

4.7 Wood fuel

Current Status

The forests cover in 2005 represents 9 million Ha or 15% of the territory. Half of this cover is humid forest, 30% is dry forest, 20 % is thorny forest and 3% is mangrove. Others kind of forest are marginal.The main plantations in Madagascar are pin and eucalyptus.

The deforestation rate in Madagascar is 0.55% per year on the period 2000-2005. It has decreased since the 90', the rate was 0.82% per year. Over the period, the distribution remains generally the same between the regions. Deforestation is observed all over the island

In order to limit the deforestation and to preserve the Malagasy biodiversity, the government established a national system of Protected Areas. First, there are the Protected Areas managed by the Système National d'Aires Protégées (SAPM). Then, there are the priority areas for the future expansion of the SAPM. There also Sites de Gestion Forestière Durable (SGFD), they represent forest areas controlled and managed in a sustainable way, from the remaining forests which can be exploited freely. The SGFD represent the forest managed in a sustainable way, while the remaining forests correspond to a potential of forest managed area.

Experiences and running projects

a. Cooking

Many initiatives have been launch to developed improved stoves in Madagascar. We present here the improved stove "fatana pipa" proposes by BIONERR because it seems well adapted to the rural needs. The stove is mainly composed by a heat-resistant clay fireplace, by a cover
protection in sheet metal and a chimney. Accessories can be added like a valve for air regulation.

The schemes below show how work a fatana pipa and present also the monetary saving using a fatana pipa.

- ***Electrification***

The CIRAD is currently implemented a DRE (Decentralized Rural Electrification) financed by the Energy Facility. It consists in implementing two DRE units in the east

of Madagascar. The units work with a vaporization system. Wood is the resource used to heat.

c. Forest management project

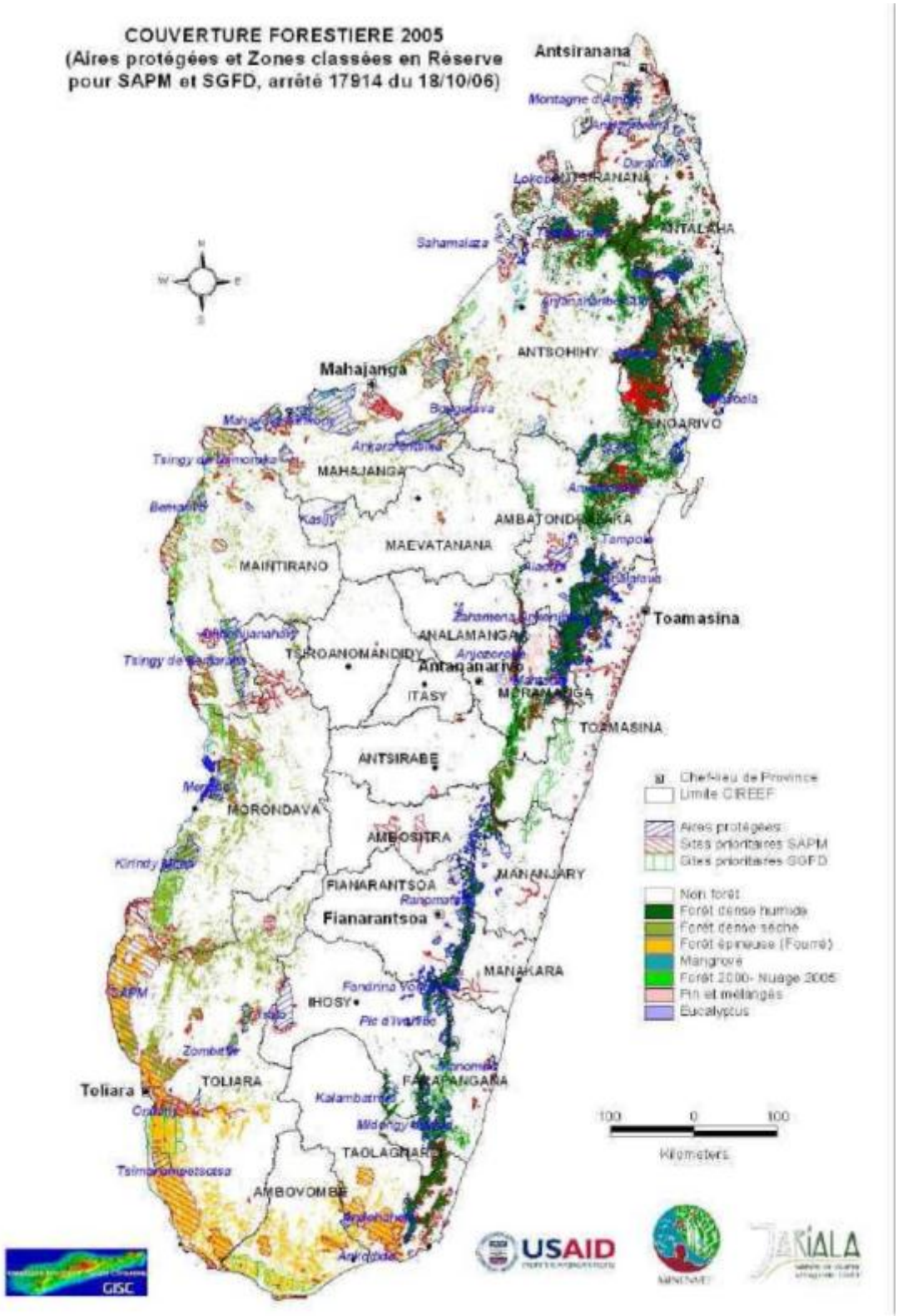
Many projects based on the wood energy field development have been implemented and are still running to reduce the overexploitation of the forest.

The project Greenmad (GTZ), for instance, has been implemented in the north with a significant success. The objective of the project was to develop an integrated management of the wood energy field from where the resource stands to the consumers. It has led to increase the management of the forest, to develop rural competences for carbonization issues and to strengthen the distribution chain to the urban consumer. Given the success, the project will be extended in the others regions of the country.

Other similar projects have been implemented or are still running such as the SEESO project (WWF, CNRIT - Energy Facility).

Potential

The energy wood field has to be developed. It could improve the forest quality and introduce forest maintenance. It offers also the possibility to develop the by-product market of the wood transformation industry. The field profitability could then be increased. Finally, involving the rural households in the field development may afford them additional revenue providing incentives to manage their forest in a sustainable way.



5 Renewable Energy Incentives

The most important incentives are state subsidies granted through FNE (National Electricity Fund).

According to the National Financial Law 2011, the importation of electric supplies and/or engines dedicated to RE generation is **VAT free**. Moreover, an alleviation of customs duties has been applied to the same supplies, in order to promote RE and ease energy access.

6 Challenges, Constraints and Barriers to Renewable Energy Development

Substantial renewable energy resources exist in Madagascar. Solar, Wind, biomass, hydro resources are abundant. They would more than meet the demand for modern fuels in the country if they would be fully developed.

In Madagascar, renewable energy development faces a number of barriers. These barriers include:

a) High development costs due to lack of adequate, suitable and accurate, site specific data.
b) High capital costs.
c) Lack of financing schemes – traditional lenders are not familiar with the technology hence aren't able to assess the risks.
d) Intermittent nature of RE resources such as wind and solar makes their power less attractive to Utilities
e) Lack of local technical capacity
f) Un-proven and non-commercialized harnessing technologies in some cases.

Mobilization of Adequate Financial Resources

Renewable energy resources are site specific and require long duration and detailed studies to determine their economic and technical viability. This leads to high development costs. Even when the studies show that a RE project is viable, its implementation requires high initial investment capital. Mobilization of adequate financial resources, both public and private is a major challenge.

Multilateral agencies do provide some funding but their priority is not renewable energy.

The private sector, being profit driven is not likely to invest in RE development work.

Resource mobilization is therefore a major limitation. It is the main reason why policy strategies that require substantial financial resources such as fiscal incentives and detailed feasibility studies are not being addressed timely.

Technical Capacity Development

Renewable energy development studies require specialized knowledge and skills to undertake. Implementation of RE projects requires equipment that is not available locally. This means there is no significant local technical capacity for implementing RE projects.

A training programme for RE is required.

Costs and Intermittent Nature of RE supplies

RE Power is generally more costly to generate hence not competitive in most cases. It is also intermittent and poses a significant risk to utilities in terms of its management and planning. Consequently utilities are not interested in it.

7 Observation, and Conclusion

Renewable energy resources in Madagascar are substantial. However only large hydro power sites have been substantially exploited to a level where it contributes over 50% of the country's electricity.

A2.11 MALAWI

1.0 RENEWABLE ENERGY REGULATORY FRAMEWORK

1.1 Renewable Energy Policy

Currently, Malawi does not have a standalone Renewable Energy Policy. Renewable energy issues are covered in the National Energy Policy which was formulated in 2003. However, there is a draft Renewable Energy Strategy. It should be mentioned that the lifespan of the National Energy Policy is 5 years hence the policy is due for review. This means that the draft Renewable Energy Strategy should also be reviewed to reflect changes that will be made in the revised energy policy. The policy will be revised next year i.e. 2012.

1.2 Renewable Energy Regulations

Malawi has Renewable Energy Regulations enacted in 2008. The regulations are on: prices and charges on renewable energy technologies (RETs); standards, code of practice and inspection of RETs; and purchase, sale and service agreements on RETs, among others. These regulations are enforced by the energy sector-wide regulator known as Malawi Energy Regulatory Authority (MERA). MERA is also responsible for licensing RET suppliers, retailers and installers. Currently, there are about 20 Government/ MERA - certified renewable energy companies in the country.

1.3 Role of Government in renewable energy

The role of Government (through its Ministry of Natural Resources, Energy and Environment - MNREE) in renewable energy is confined to providing policy guidelines, developing strategies and providing institutional and capacity building support for market priming. In the National Energy Policy (2003), institutional strengthening and capacity building has six key priorities:

a) establishment of National Sustainable and Renewable Energy Program as a semi-autonomous body under the overall supervision of the MNREE through its Department of Energy Affairs (DoE) to serve as a focal point for the implementation of renewable energy reform programme, particularly market priming.

b) strengthening research institutions to include renewable energy upstream development work initiating manufacturing and assembling capacity.

c) establishing a testing and training centre for RETs responsible for training and accrediting technicians, offering RETs testing and certification services in collaboration with MERA and the Malawi Bureau of Standards (MBS).

d) strengthening MBS to enable it to develop appropriate RET standards and a code of conduct.

e) undertaking public awareness campaigns to explain the efficacy of RETs and to inform the public of the new market arrangements by making used of print, electronic and motion picture media for the delivery of these messages, and

f) introducing courses in sustainable and renewable energy and environment into school curricula at primary, secondary and tertiary levels.

2.0 ELECTRICITY SUPPLY AND DEMAND SCENARIOS IN MALAWI

The supply and demand scenarios show a trend of significant capacity shortage the foreseeable future due to an increase in demand averaging 7% per annum. Currently, the system average peak load in around 295 MW, while the available capacity is around 255 MW which translates to power shortage of 14%. Load shedding and power outages are therefore used extensively to ration power.

The current installed capacity stands at 283.8 MW against a demand of 344MW. It is projected that electricity demand will be 598 MW in 2015, 874 MW in 2020 and 1,597 MW in 2030.

Malawi's electricity is generated from hydropower stations cascaded along Shire River which has of late been greatly affected by problems resulting from the degradation of the physical environment.

The country is currently not connected to power systems in neighboring countries however, this option is under consideration. There are plans to interconnect with Mozambique for purchase of at least 50MW.

3.0 ELECTRIFICATION RATE

The electrification rate in Malawi is at 9% which is probably the lowest in the region. In cognizance of this, the Government through DoE is implementing Malawi Rural Electrification Programme (MAREP) whose overall objective is to improve access to electricity for people in peri-urban and rural areas through grid and off-grid options. The grid option for MAREP involves the extension of low voltage power distribution lines (up to 66KV) to target areas identified under the MAREP Master Plan which was

developed in 2004 with technical assistance from the Japanese Government through JICA.

The Government recognizes that there are a number of sites which will be difficult and expensive to reach because they are remote or demand is very low hence the use of off-grid option. The off-grid options include solar systems, wind systems, mini-grid solar/wind hybrid systems and mini/micro hydro power plants, among others. The Government supports both public and private-sector driven programmes that will electrify areas not on the grid using off-grid options which are basically RETs. Thus RETs have a potential to reduce poverty through business and job creation, transform rural economies and improve productivity (notably in agriculture) in addition to mitigating climate change.

4.0 RENEWABLE ENERGY RESOURCE POTENTIAL

Malawi is well endowed with renewable energy resources which include good sunshine i.e. solar radiation of 21.1 MJ/$m^{2/}$day throughout the year for photo-voltaic (PV) and photo-thermal applications, reasonable wind speeds (averaging 3 -7 m/s) adequate for water pumping and electricity generation, a number of perennial rivers with hydro power potential of 900MW, a reasonably large population of domesticated animals for biogas applications and hot springs for geothermal power generation.

Although RETs are now widely commercially available and their prices are increasingly competitive, Malawi has not been able to fully utilize them. As a consequence, the role of RETs in the total energy balance in the country has remained insignificant (0.2%).

4.1 Barriers to development of RETs in Malawi

The slow up take of RETs in the country is attributed to the prevalence of a number of technical, economic, skills, institutional and socio-cultural barriers. Technical barriers include a lack of capacity in manufacturing, distribution, installation and maintenance of RETs. Financial barriers include high initial investment costs. Other important financial barriers are a lack of dedicated and affordable financing mechanism, a lack of financiers and suppliers knowledgeable about establishing dedicated financing mechanisms and appraising applications for credit, a lack of skills to develop business plans, a lack of knowledge about local, regional and international financial facilities for RETs, a lack of confidence in RETs and low returns on investment (for financiers) and the non-availability of loans (for end users).

Institutional barriers include lack of standards and regulatory framework, limited delivery modes, a small number of RET companies, a latent market and a small number of qualified technicians to undertake installations. Lack of a deliberate policy and strategy on RETs and lack of information about the efficacy of RETs among policy makers, NGOs and the public, have further contributed to the entrenchment of institutional barriers.

Socio-cultural barriers include gender insensitivity in the design and operation of some RETs and the acceptability of those technologies, which touch on cultural issues, such as the promotion of biogas using human wastes.

The Government has made some strides in addressing some of these issues in order to promote RETs as highlighted in the proceeding sections.

5.0 DEVELOPMENT ON RENEWABLE ENERGY TECHNOLOGIES

5.1 Solar photovoltaic and solar thermal technologies

Solar PV and solar thermal systems are being utilized in households, schools rural hospitals and other services. However, their contribution to the total energy balance is very insignificant owing to a number of factors as mentioned above notably high initial costs. To promote RETs in the country, especially solar PV and solar thermal, the Government waived duty on importation of solar gadgets by certified companies involved in renewable energy in order to reduce the initial cost. Lately, the Government has extended the duty-waiver status on importation of RET gadgets to all Malawians (not only certified companies).

There are about 5000 standalone solar systems (solar home systems) in the country generating a total of about 700KW of electricity.

5.2 Wind power technology

Malawi is endowed with wind energy which can be used for power generation averaging between 3-7m/s (the resource could be higher than this because these measurements were done at 4-meter height.) This resource has not been tapped significantly. In the medium term, there are plans to have 25MW of electricity generated from wind.

MNREE through DoE is implementing village electrification project on pilot basis, using Wind/Solar hybrid systems. Under this project, six (6) villages have been electrified using the technology. Fifty (50) households in each village have benefitted from the project. The electricity generated is used for lighting, powering

radios and TVs, water pumping and street lighting. The systems are centralized and use mini-grids. The total installed capacity for this project is 132 kW of which 90 kW is from wind.

However, large capacity wind turbines are required to be installed in order to increase electricity generation capacity in the country. Meanwhile, the Germany Government has pledged to construct a wind farm with a total installed capacity of 90 MW (about 32% of the current total installed capacity in the country). The electricity generated will be fed into the national grid. The Government intends to undertake feasibility studies for wind mapping in the short term to enable potential investors have detailed information for all potential wind power generation sites.

To develop renewable energy more especially wind power, Malawi needs to first of all locate, quantify and ascertain availability of resources. The Millennium Challenge Account (MCC) Compact has conducted a desk-based mapping of renewable energy resources in the country focusing on wind, solar and mini-hydro. There is now need for further 'on the ground' work to build on this mapping in order to assess the feasibility of exploiting these renewable energy resources, and this should include hot springs for possible geothermal electricity generation.

5.3 Hydropower

As mentioned above, Malawi has a high potential of hydropower i.e. 900 MW along various perennial rivers across the country. However, the resource has not been fully utilized. To this end, the Government intends to conduct feasibility studies on some of the sites and make data/information available to potential private investors. Independent power producers (IPPs) are encouraged to conduct feasibility studies on their own and construct the power plants (if found to be bankable), generate electricity and feed into the national grid at a tariff to be agreed upon between the IPP and ESCOM Ltd but approved by MERA).

Currently, Malawi does not have feed-in tariffs but a draft has been developed which was presented to stakeholders in March, 2011 at a National Seminar for comments.

5.4 Biogas Technology

This technology has not been exploited that much in the country although the resource potential is very high. There are very few biogas plants in the country, most of them communal type benefiting between 6 and 10 households.

Considering the potential of the technology, MNREE through DoE intends to construct, on pilot basis, 38 biogas plants in 38 villages across the country. The gas to be produced will be used for lighting and cooking.

5.5 Geothermal power technology

Currently, Malawi does not generate electricity from geothermal energy despite having the resource. Some of the potential sites for geothermal power generation are Chiweta in Rumphi District; Mawira and Chiphwidzi in Nkhotakota District; and Chipudze in Chikwawa District. According to Geological Surveys Department, the Chiweta hotspring is at 80^{o}C while Chipwidzi is at 78^{o}C. Considering that the temperatures are only surface temperatures, there is need for further exploration to establish parameters that would assist in estimating the potential capacity of these sites and their development.

MNREE/DoE wrote a concept paper on development of geothermal power which has since been submitted to Office of the President and Cabinet (OPC) for consideration.

5.6 Biofuels

Bioenergy developments are high on many countries' agendas today, including Malawi, in an effort to improve energy access, energy security and reduce greenhouse gas emissions. The advantages for promoting bioenergy in Malawi are numerous. For many non-oil-producing countries, including Malawi, access to local oil sources is very important. Development of bioenergy will provide a possibility for reducing Malawi's oil imports and save on foreign exchange. In agriculture, bioenergy offers the possibility for farmers to diversify sources of income away from tobacco, which is the major cash crop in the country but is under threat of the global anti-smoking lobby. Bioenergy offers a great opportunity for diversifying energy sources and livelihood systems of rural communities through employment creation and marketing of bioenergy products. Local or regional trade in bioenergy can grow rapidly because marketing chains already exist, especially for vegetable oils in particular, and Malawi stands to benefit from this.

However, against the background of world-wide strong desire for promoting bioenergy, concerns have arisen on food security impacts, social feasibility and sustainability of bioenergy, especially with first generation bioenergy. Thus countries have to frame clear policies and regulations on bioenergy development taking into account food security impacts, land issues, socio feasibility and sustainability, among others.

5.6.1 Current bioenergy policy in Malawi

The National Energy Policy (2003) provides a supportive legislative framework for the development of bioenergy in Malawi while safeguarding the livelihood systems of the rural communities. Guided and supported by the energy policy, the Government of Malawi is undertaking measures to reduce Malawi's dependence on importation of liquid fuels and gas by supporting import-substitution energy industries including the bioenergy industry. The Government is also working with the private sector to encourage expansion of fuel-ethanol production capacity to achieve a 20:80 petrol-ethanol blend and support other fuel-ethanol applications such as ethanol-diesel blends.

It should be mentioned that Malawi has a long history of bio-fuel production. The country produces ethanol from molasses, which is a by-product of sugar manufacturing, at two plants each having an installed capacity of about 20 million litres per annum. However, each plant is currently producing at about half that capacity due to insufficient feedstock material, among other reasons. To date, over a quarter billion litres of fuel ethanol also known as anhydrous alcohol (AA 99.8% v/v) and industrial alcohol (rectified spirit 96.5% v/v) has been produced since the commissioning of the first plant in 1982 (the second plant was commissioned in 2004). The country uses fuel ethanol for blending with petrol at a ratio of 10% ethanol to 90% petrol and this started in 1982 when the first plant was commissioned. The country is currently in the process of changing the blending ratio to 20% ethanol and 80% petrol in order to reduce the fuel import bill which is between 90 and 100 million litres of petrol per year. To achieve this, there is need to increase fuel ethanol production by addressing the issue of insufficient feedstock material. Sugar cane is widely grown in Malawi and its production can easily be expanded under rain-fed conditions or irrigation.

Malawi is considering using flex vehicles i.e. vehicles that can run on either pure petrol or ethanol or a blend of the two. In view of this, the country imported a flex vehicle from Brazil in October 2007 for experimental purposes. The Government, through its Department of Science and Technology and one of the technical colleges in the country, is also running trials on some vehicles whose engines have been modified to run on ethanol or a mixture of ethanol and petrol.

Malawi has about 30 years of experience in bio – ethanol produced from sugar cane molasses. Ethanol is well established with internationally accepted standards and legalised blending levels. There is an ethanol plant at Dwangwa in Nkhota kota District with a production capacity of 20 million litres of ethanol per year, and the plant was commissioned in 1982. In 2004 another plant was commissioned at

Ntchalo producing 15 million litres of ethanol per year. The country now needs to look at other emerging energy sources such as bio-diesel, bio-oil and others.

Malawi has already created an environment favourable to private sector initiatives in the bio-fuels sector and the role of governments in the National Energy Policy (2003) has been confined to designing adequate promotion policies for production, use and local trade of bio-fuels. Currently, there are about 5 companies that are producing biofuels and they have formed an association. One of the companies, Bio-energy Resources Limited (Berl) has entered into agreements with several farmers in the country, notably in Kasungu District, in form of contract farming whereby the farmers are planting jatropha in their gardens which is later bought by Berl for bio-fuel production. While land may limit areas where such cultivation can take place initially, it is believed that in the long run, farmers may have to make a choice just like they do with other cash crops.

Bio-fuel use has had environmental and social benefits and it is expected that development of biofuels will reduce fossil fuel importation bill and save foreign exchange. In order to promote bioenergy and to ensure its sustainable production and use, Malawi needs to frame a clear policy and regulatory framework.

5.6.2 Formulation of a clear bioenergy policy and regulatory framework

It is necessary for Malawi to formulate appropriate and clear policies and regulatory framework for bioenergy promotion and sustainability taking into consideration the following issues: food security; land rights and land-use rights; local and national energy security; biodiversity and natural resources; agro-ecological zoning; greenhouse gas emissions; climate change adaptation and mitigation; deforestation; poverty reduction and rural development issues; among other issues. The development pathways of bioenergy should be integrated into development agenda and strategies of the country, in this case, the country's overarching policy of Malawi Growth and Development Strategy II (2011-2016). In addition to this, the policy and regulatory framework should be aligned with policy, legal and regulatory framework regionally i.e. the SADC region and internationally if Malawi is to trade regionally and internationally on bioenergy. The SADC Secretariat formulated a framework for sustainable biofuel production and use in the region which gives broad recommendations describing how regional biofuel production should adhere to environmental, economic and social sustainable approaches. The framework was approved by SADC Energy Ministers on 29th April, 2010.

The National Energy Policy (2003) is due for review. The Government intends to formulate clear policies on bioenergy, taking into consideration issues raised above,

which should be incorporated in the revised energy policy document. However, the major challenge would be harmonisation of the various existing policies. Currently, the Agricultural Policy prohibits use of food crops such as maize, soy beans, cassava and sorghum for biofuel production. Jatropha is the only crop being used for biofuel production in the country. The crop is grown as a hedgerow/boundary crop and is being promoted as an additional crop to smallholder farmers. There is land pressure in the Central and Southern Regions of the country. However, there is still 26% of arable land unused. The current Land policy is to utilised marginal land for Jatropha production, while for sugar production, areas with irrigation potential are targeted. To facilitate development of an all-inclusive policy, legal and regulatory framework, a National Biofuel Advisory Council has been established comprising a number of players in the bioenergy industry.

To support sustainable biofuel production and use, a set of biofuels standards should be developed. Malawi developed ethanol and biodiesel standards and are now complete and in force while a bio-oil (vegetable oil) is under development. MERA has regulating authority on biofuels with a generic biofuels framework, and works with MBS to ensure adherence to set standards.

The need to have clear biofuel standards and legalised blending levels are driven by the fact that all petroleum products in Malawi are imported. This is exacerbated by the fact that Malawi is a landlocked country and has no oil reserves of its own - it relies solely on fuel imports. The development of Malawi's economy relies to a greater extent on secure fuel import which has an effect on retail fuel prices. Figure 1 below shows retail fuel price trends between 1991 and 2008. The demand for diesel in Malawi has increased from 155 million litres in 2006 to 200 million litres in 2010 with an average increase of 6.5% per annum. Blending diesel with biofuels will reduce the importation volumes of diesel. However, the blending requires clear standards and legalised blending level.

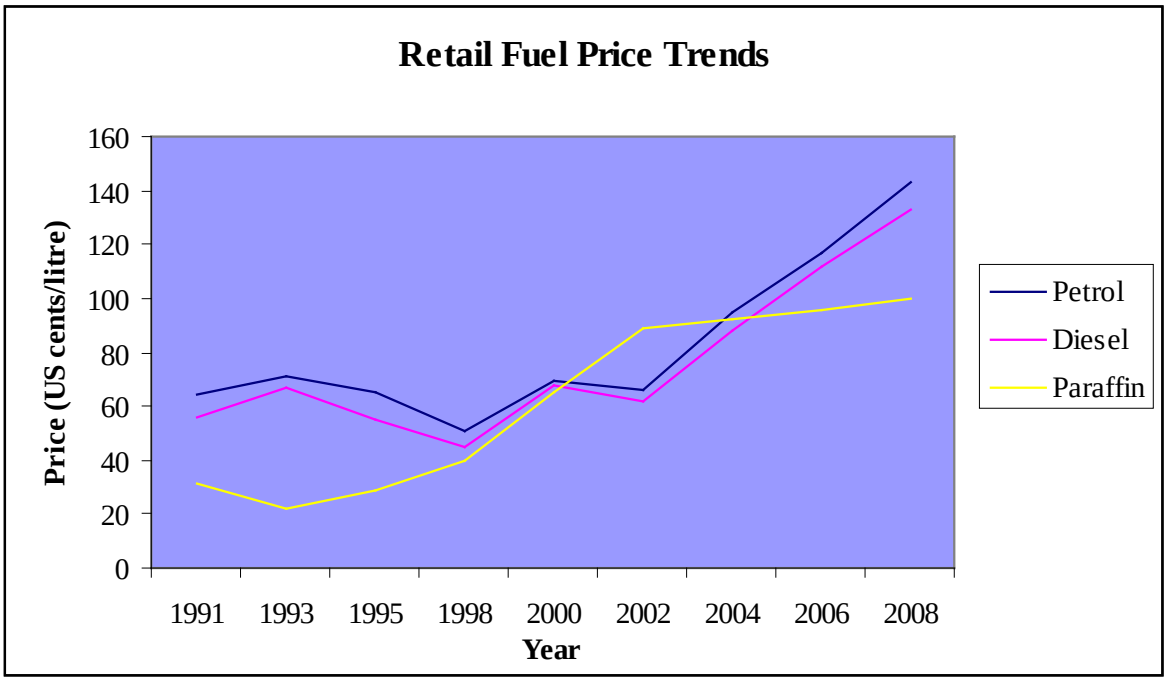


Figure A5.1: Retail fuel price trends

5.7 Biomass Fired Power Plants

Government is also encouraging the sugar and tea industry to invest in electricity production through use of biomass. This is expected to start with a minimum of 50 MW.

Currently, Illovo sugar companies are generating electricity for own use using bagasse. The generation capacity is about 18 MW (11 MW at Nchalo plant and 7 MW at Dwangwa plant). In addition to the sugar companies, there are other companies with boilers which are only used for thermal (heating) applications. In the Tea and Timber Industry, wood is the main source of boiler fuel used to generate steam for tea and timber processing. The remaining steam can therefore, be used to generate power for running the factory. These industries have a potential of generating addition 20MW which could be for own use and the surplus fed to the national grid.

6.0 ELECTRICITY INVESTMENT PLAN FOR MALAWI

Table 1 below shows the electricity investment plan for Malawi in the sort, medium and long term. The plans are basically for development of hydropower technology.

Table A5.1: Malawi Investment plan

PROJECT DESCRIPTION	POTENTIAL CAPACITY (MW)	INVESTMENT COST ESTIMATE (Million US$)
SHORT TERM INVESTMENT OPPORTUNITIES (0-5 Years)		

PROJECT DESCRIPTION		POTENTIAL CAPACITY (MW)	INVESTMENT COST ESTIMATE (Million US$)
Implementation of Demand Side Management	Across the Country	50	6.9
Development of Kapichira Phase II	Shire River	64	60.0
Installation of Diesel powered generators	Lilongwe, Blantyre and Mzuzu	46	40.0
Upgrading of Nkula A Hydro Power Plant	Shire River	26	25.0
Installation of Hydro Matrix Power Plants	Below most bridges	50	-
Ruo River Power plant	Zoa	41	57.0
Lunyina Mini Hydro power Plant	Nyika	7	10.5
Sub total		234	192.5
MEDIUM TERM INVESTMENT OPPORTUNITIES (5-10 Years)			
Coal Fired Power Plant	Northern Coal Field	300	400.0
Songwe River Basin Hydropower Project	Manolo	150	218.0
Bua River Power Plants	Chasombo	55	25.0
	Mbongozi	55	40.0
	Chizuma	50	15.0
	Malenga	65	70.0
Shire River	Mpatamanga	310	310.0
South Rukuru	Lower Fufu	170	140.0
North Rukuru	Kayelekera	10	20.0
Construction of Biomass Fired Power Plants	Sugar and Tea Factories	50	3.5
Installation of Wind Systems	Hills and Mountains	25	5.0
Sub total		1,240	1,246.5
LONG TERM INVESTMENT OPPORTUNITIES (More than 10 years)			
Shire River	Kholombidzo	365	410.0
Dwambazi River	Chimgonda	50	31.0
South Rukuru	Rumphi	15	-
	Henga Valley	40	-
	Fufu Falls High Dam	175	-
Modular Nuclear Reactor	-	125	312.5
Sub total		770	753.5
GRAND TOTAL		**2,244**	**2,192.5**

A2.12 Mauritius

1 Renewable Energy Regulatory Framework

The Long Term Energy Strategy 2009-2025 (updated in the Action Plan for the Energy Strategy 2011-2025) is the blue print for the development of renewable energy in the Republic Mauritius. It is a road map outlining the strategies that will enable the country to make a rapid shift to low carbon, energy efficient and environmentally friendly energy systems while balancing with the absolute requirement of maintaining security of supply at an affordable cost. With respect to renewable energy resources and technologies, the following targets and institutional strategies has been put forward:

Energy Balance, Energy Security, Financial sustainability:

- Achieve by 2025 about 35% self sufficiency in terms of electricity supply through use of renewable sources of energy.
- Ensure security of energy supply by diversifying the energy base and the creation of adequate stocks, to the extent it is financially viable.

Institutional and Regulatory Framework:

- Creation of a Board of Utility Regulatory under the Utility Regulatory Act of 2008.
- Proclaim the Electricity Act 2005 (see annexed).
- Enact the Sustainable Development Bill and set up the necessary institutional structure for the implementation of the long term Energy Strategy.
- Establish training and capacity building in collaboration with tertiary institutions and development partners in fields of renewable energy and energy efficiency.

Power Sector Reform:

- Create a financially sound and self-sustainable modern electricity sector, a transparent and fair regulatory environment that appropriately balances the interests of consumers, shareholders and suppliers, conditions that provide efficient supply of electricity to consumers and improvement in customer services.
- Encourage private sector participation in the generation side within the framework of a single buyer model
- Develop and implement a grid-code, feed-in tariffs and incentive schemes for small power producers.
- Introduce grants and fiscal incentives to promote choice of renewable and carbon-neutral options over fossil fuels.

Education and Training:

- Develop relevant educational materials on sustainable energy for use at all levels in schools, including primary and pre-primary children.
- Carry out appropriate training to build capacity and to develop a culture of sustainable development.

2 National Energy Policy with Reference to COMESA

In a nutshell, the LTES 2009-2025 is analogous to the COMESA model energy policy framework as it focuses on meeting the energy requirements in a sustainable and all inclusive manner. There is an obvious triple bottom line approach to the strategy as it encompasses Economical, Social and Environmental objectives.

Providing adequate and reliable supply of energy at an affordable cost is of utmost importance to support the social and core economic development of the republic (which is shifting gradually from agriculture to more energy-intensive service providers). Moreover, the key legislations and policy instruments that will be required on the way to achieve the set targets are outlined and interlinked so as to synergise the different components of the strategy.

There is also a heavy emphasis in the LTES on energy efficiency measures and demand side management at all levels of the economy as a means of reducing the carbon footprint of the action as well as reducing our imports of fossil fuels. Gender issue is also included in the LTES and the foundation is also set to establish the availability, potential of the different energy resources that can be harnessed. The Government is also fully aware that shifting to low carbon technologies may most certainly also carry a financial burden and to this regard, the LTES sets the ground for the formulation of financial incentives and tax regimes to promote these developments (see sections below). Finally by reviewing and updating the LTES in the Action Plan 2011-2025, the Government is showing its flexibility and willingness to actualise the strategy in line with the dynamics of the market.

3 Renewable Energy Strategy

The strategy adopted by the Government of Mauritius is aimed at achieving a market share of 35% in electricity generation from renewables as shown in below:

Fuel Source		Percentage of Total Electricity Generation			
		2010	2015	2020	2025
Renewable	Bagasse	16%	13%	14%	17%
	Hydro	4%	3%	3%	2%
	Waste to energy	0	5%	4%	4%
	Wind	0	2%	6%	8%
	Solar PV	0	1%	1%	2%
	Geothermal	0	0	0	2%
	Sub-total	20%	24%	28%	35%
Non-Renewable	Fuel Oil	37%	31%	28%	25%
	Coal	43%	45%	44%	40%
	Sub-total	80%	76%	72%	65%
	Total	100%	100%	100%	100%

Note: Forecasted energy mix 2010-2025

Table A6.1: Targets for Renewable Energy over period 2010-2025[20]

It should be noted however, that the targeted energy mix is based on the assumptions that the coal and waste energy projects approved by Government would be operational by 2013 and that the price of PV will be more affordable. Furthermore the targets will be subject to regular review and update, depending on changes and development in technology, including outcomes of local energy resource assessment and affordability.

The Government of Mauritius has been advocating a shift from conventional fossil fuels to renewable sources for a long time. The first ever power plant built in Mauritius was a small hydro power station at Réduit in 1906. Since then, despite the construction of 8 additional hydropower stations to date, ranging in installed capacities from 375 kW to 29 MW, the share of fossil fuels has been gradually increasing and has now become the major component in the energy mix for electricity generation. Production of electricity on a large scale from biomass (bagasse- a pulpy residue left after the extraction of juice from sugar cane) started in the late 1950's when sugar factories came to the conclusion that rather than using bagasse for just producing process steam (heat) required for sugar crystallisation, they could first use high pressure steam to generate electricity and the resulting low pressure steam as process heat. With the continued increase in the prices of fossil fuels over the years, the Government decided to turn its attention to renewable energy sources (bagasse, hydro, etc.) with the adoption of the Bagasse Energy Development Plan in the 1990s. The implementation of this plan allowed for a significant increase in the share of bagasse in the generation of electricity.

[20] Source: Mauritius Long Term Energy Strategy 2009-2025

The Government has also renewed its interest in furthering the development of renewable energy and even though around 20% (Central Elctriciy Board, 2009) of its electricity generation emanates from renewable sources (bagasse and hydro), the Government of Mauritius is keen to increase that share. However, most hydro resources have been tapped while the potential increase in the use of bagasse and efficiency improvement in its use for electricity generation are being pursued.

In line with the above, the Government adopted an "Outline of the Energy Policy 2007-2025" in April 2007 and followed it up in October 2009 with the adoption of a "Long Term Energy Strategy 2009-2025". The energy policy targets were further updated in the "Action Plan for the Energy Strategy 2011-2025" in mid 2011. The strategy framework covers all sectors, including electricity generation, transportation, petroleum products, renewable energy and energy efficiency. In the renewable energy sector, the thrust is on the promotion of technologies, with a focus on distributed and decentralised systems, not only to increase access to modern energy services, but also to enhance energy security. In this context, the challenge under the "Long Term Energy Strategy 2009-2025" is now to increase the renewable energy share to 35% over the next fifteen years, by 2025, with the application of technologies to harness the various renewable energy resources that the country is endowed with. Furthermore, in the context of a globalised economy, the Government is keen to encourage greater competition in the energy sector by avoiding a monopolistic situation, be it public or private.

4 Status of Renewable Energy Development and Future Plans

According to the Digest of Energy and Water Statistics- 2009[21], the total primary energy requirement of the country for 2009 was 1,347 ktoe (see trends from 2000 to 2009 in Figure 2). The imported fuels (petroleum products and coal) accounted for 82.5% while locally available resources (comprising of bagasse, hydro/wind and fuel wood) make up the rest of the energy requirements. Bagasse represented 92.2% of the renewable resources, with wind/hydro for electricity and fuel wood (mainly used in manufacturing and household) accounting for 4.5% and 3.3% respectively. Over the recent years, the share of energy from coal has risen significantly in order to cope with the increasing demand in electrical energy. Nearly 50% of all the energy consumed in Mauritius is in the transport sector (Figure 3) followed by the manufacturing sector (27.7% in 2009), household (14% in 2009), commercial and distributive trade and agriculture

[21] Source: Mauritius Central Statistics Office, 2010

Energy source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	Physical unit (Thousand tonne or GWh)									
Imported (Fossil fuels)										
Coal	253.0	299.2	312.8	316.2	289.3	363.8	484.5	572.6	651.4	595.7
Petroleum products										
Gasolene	92.0	87.7	87.5	89.2	90.4	92.7	89.1	98.9	101.4	111.7
Diesel Oil	189.4	188.7	196.8	208.8	213.8	212.1	228.3	205.3	203.4	204.6
Dual Purpose Kerosene	130.8	137.9	122.8	141.8	162.3	165.1	146.8	140.4	135.5	112.6
Aviation Fuel	*108.1*	*124.7*	*109.0*	*123.6*	*137.0*	*137.6*	*141.1*	*138.1*	*131.6*	*106.2*
Kerosene	*22.7*	*13.2*	*13.9*	*18.1*	*25.3*	*27.5*	*5.8*	*2.3*	*3.9*	*6.4*
Fuel Oil	224.5	246.0	241.1	260.1	269.9	263.8	284.6	262.4	222.2	237.4
LPG	46.3	47.1	48.6	51.7	54.9	60.9	63.9	63.8	62.9	63.8
Local (Renewables)										
Hydro/Wind GWh	96	71	86	118	123	115	77	84.3	108.4	123.9
Bagasse[1]	1,553.3	1,671.5	1,524.4	1,557.0	1,611.2	1,531.9	1,500.2	1,440.9	1,540.2	1,362.3
Fuelwood[1]	19.3	19.3	19.2	19.1	19.3	20.0	21.0	21.1	20.3	20.3

Table A6.2: Primary energy requirements, 2000- 2009[22]

%

Sector	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Manufacturing	33.4	33.5	32.6	32.2	30.9	29.4	30.9	30.8	29.4	27.7
2. Transport	47.5	47.5	47.6	47.9	48.8	49.5	48.6	47.9	48.3	48.4
3. Commercial and Distributive Trade	4.9	5.2	5.5	5.9	6.1	6.6	7.2	7.6	8.2	8.9
4. Household	13.3	13.0	13.4	13.1	13.2	13.6	12.4	12.7	13.1	14.0
5. Agriculture	0.6	0.6	0.6	0.6	0.5	0.6	0.5	0.6	0.5	0.5
6. Other (n.e.s) and losses	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure A6.3: Percentage share of final energy consumption by sector 2000- 2009[23]

The Central Electricity Board, a parastatal body wholly owned by the Government and established in 1952, has responsibility under the Central Electricity Board Act of 25 January 1964 to "*prepare and carry out development schemes with the general object of promoting, coordinating and improving the generation, transmission, distribution and sale of electricity*" in Mauritius. The utility has a monopolistic position in transmission, distribution and retailing as well as being a key player in decision making policies regarding the energy sector. It presently generates approximately 46% (Figure 4) of the country's total power requirements from its 4 thermal power stations and 9 hydroelectric plants; the remaining 54% is purchased from Independent Power Producers (IPP) using a combination of bagasse and imported coal for generation.

[22] Source: Mauritius Central Statistics Office
[23] Source: Mauritius Central Statistics Office

The main islands of Mauritius and Rodrigues are fully connected to the electricity grid of the CEB. Electricity generation in the Republic is highly dependent on fossil fuels. In 2009, 79% of the electricity generation in Mauritius was from fuel oil (diesel and heavy fuel oil), kerosene and coal, with the rest of the energy mix provided by hydro (5%) and bagasse. For the same year, Mauritius Island had an effective installed capacity (including plant capacity for electricity not exported to CEB) of 647 MW with a total energy production of 2,545 GWh.

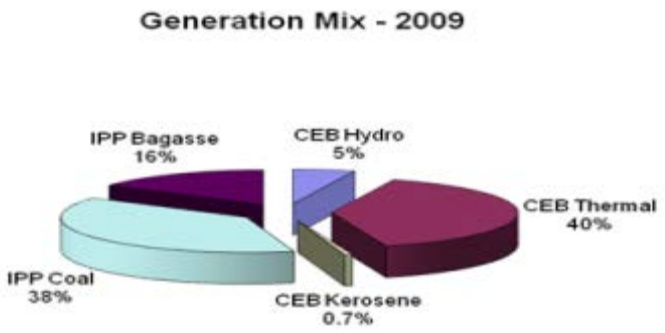


Figure A6.1: Energy mix for electricity generation in 2009[24]

Bagasse and hydro are the two main natural resources used for electricity generation. Mauritius has however nearly tapped in most of its hydro electric potential while the area of land under sugar cane cultivation is gradually reducing due to an increase in infrastructure requirements. Coupled with the fact that energy demand has been increasing at about 4-5% every year, the share of bagasse in the energy mix is therefore gradually decreasing.

[24] Source: Mauritius Central Statistics Office

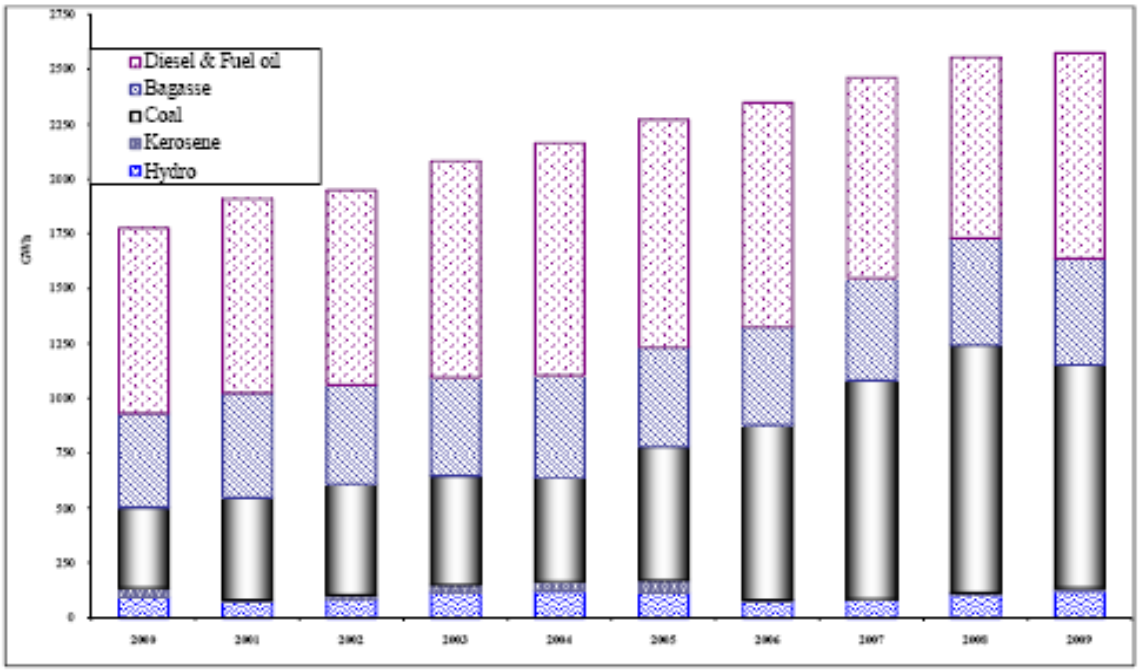


Figure A6.2 : Electricity production by source of energy, 2000 -2009[25]

Rodrigues, on the other hand, had a nominal installed capacity of 10.5 MW that generated 31.7 GWh during 2009, with 95.9% of the electricity generated derived from fuel oil and the balance of 4.1% was provided by small wind farms. There is no electric utility on the Island of Agalega where the 300 inhabitants are supplied with electrical power using small diesel generators operating in 3 isolated mini-grids under the responsibility of the Outer Islands Development Corporation.

The above statistics with regard to electricity reflect primarily on the grid connected market and hence privately owned off grid connections (primarily small photovoltaic systems) and the internal energy consumption of the sugar producers during crop season is not accounted for. Also, the St. Martin Wastewater Treatment Plant in the west of the Island operates a 630 kW off grid sewage gas operated generator that powers about 25% of its energy requirements.

4.1 Hydro Power

The Central Electricity Board operates 9 hydroelectric stations having a total installed capacity of 59MW. The full installed capacity can only be exploited in wet periods with heavy rainfall. The power stations at Champagne, Tamarind, Magenta, and Le Val are run with dam storage facilities. The remaining stations at Ferney, Réduit, Cascade Cécile, Nicoliere and La Ferme are of the run-of-river type. The amount of energy that can be generated from the hydro power stations varies significantly over

[25] Source: Mauritius Central Statistics Office

the year, from less than 5 GWh in the driest month to some 20 GWh/month in the wet season. For an average year, some 100 GWh is generated from the hydro power plants. The hydropower potential in the country has been almost fully tapped and there are very competitive uses of the existing water resources. Nevertheless, Government strategy is to encourage the setting up of mini and micro hydro plants, at potential sites wherever economically viable. In this context, the Nicoliere micro hydro plant (of a capacity of 375kW) was recently commissioned.

Future Plans

The long-term plan for Hydro Power projects, is as follows:

- To commission a 375 kW mini hydro plant at Midlands's dam in 2012.
- To commission 2 micro hydro plants (at Bagatelle dam and on the upstream of a water treatment plant) in 2015-2016.
- To undergo a study on increasing hydro storage at existing sites in 2012.

4.2 Biomass

Bagasse contributes the biggest share of the renewable energy in electricity generation (some 400 GWh/year presently). During crop season, the peak power output from the IPPs (when generating from bagasse only) sum up to about 155MW.

Future Plans

The long-term plan for biomass / bagasse related projects, is as follows:

- Increase bagasse-based energy from 350 to 520 GWh by 2015.
- Commissioning a study on the potential of cane residues for electricity generation in 2012.
- Using cane residues for electricity generation by existing IPPs by 2015-2020 subject to outcome of study.

4.3 Solar Energy

Despite enjoying more than 2900 hours of sunlight per year, there is negligible amount of grid connected PV systems on the network. The Government has launched an expression of interest lately for potential promoters wishing to install and operate a 10MW solar farm.

Future Plans

With respect to solar photovoltaic projects, the following projects are planned:

- Installation of 5 kW photovoltaic systems in 10 Government schools in 2012 and installation every two years of a capacity of 50 kW photovoltaic panels in Government buildings, as from 2013
- Setting up of a grid-connected photovoltaic plant of up to 10MW in 2013 and setting up of a grid-connected photovoltaic plant of 10MW, every 3 years after 2013.

For Solar water heater, the second phase of the SWH scheme is expected to be launched in 2011 and provision to the tune of US$ 5 million has been made. A range of complementary policies, incentives to promote solar water heating systems to achieve in a short-to-medium term the target of 50% households and businesses, and in the longer term near-eliminating the use of LPG and electricity for water heating purposes will also be introduced in 2012.

4.4 Wind Energy

The main islands of Mauritius and Rodrigues are for the major part of the year exposed to the South East Trade Winds and which are, therefore, conducive for wind energy exploitation. A Wind Energy Resource Assessment Study financed by the UNDP was carried out in the mid-1980s. The study confirmed that there are potential sites on the two islands for the setting up of wind farms, with some areas having an annual average speed of 8.0 m/s at 30 m above ground level. Recent power system impact studies have revealed that the total wind power that can be accommodated on the national grid must be limited to 30% of night load or some 60MW (by actual levels). An additional 2-3MW may be accommodated provided future growth in energy increases as per forecasted. Rodrigues is already equipped is with 7 units totalling 1280 kW with the last 2 units of 275 kW been recently connected to the grid. Based on predictions, it is expected that these units will power 10-12% of the energy requirements of the island.

Future Plans

The long-term plan for wind energy projects is as follows:

- a comprehensive wind assessment study will be undertaken by 2013 whereby potential offshore and onshore sites will be identified.
- Construction of a 4x275 kW wind farm at Bigara in 2012.
- Construction of a 20-30 MW wind farm at Curepipe Point in 2013.
- Construction of an 18 MW wind farm at Plaines des Roches by 2014.
- Construction of 20MW wind farms every three years, as from 2017.

4.5 Geothermal Energy

Mauritius does not have geothermal projects.

Future Plans

For Geothermal energy, the plan is to undertake preliminary studies on its potential in Mauritius by the end of 2011; if feasible the construction of a pilot geothermal energy plant is scheduled for 2015.

4.6 Other Possibilities

Waste to energy generation is part of the solid waste management strategy of Government to relieve the existing landfill site at Mare Chicose. The solid waste management policy has been designed on the basis of a feasibility study prepared in 2005.

The strategy of Government is to incinerate waste that allows for the generation of electricity as a useful output from the process. The electricity from such facilities will be supplied to the national grid at rates which are competitive and comparable to other sources. A 7 MW Waste-to-Energy plant at La Chaumiere, in the West of the island, is expected to be implemented as a BOO scheme pending the decision of the Environmental Tribunal

Moreover, a 3 MW Land fill Gas-to-Energy unit with an annual electricity generation of 20 GWh has recently been commissioned at the landfill site at Mare Chicose. At the time of writing, reliability testing was been carried out on the set up.

Other targets and action plan include:

- Studies to assess the technologies on Biomass, biogas, trigeneration and Ocean Energy for long-term options for energy generation and interaction with other sectors in 2013-2015
- Formulation of a clear framework for financing of renewable energy technologies in 2012.
- Develop regional cooperation in field of renewable energy and energy management in 2012
- Introduction of E10 in 2012 and carry out studies to determine whether and when E20 should become mandatory, taking into account the experience of the introduction of E10 by 2014. The produced ethanol may also be exported or used locally.

- Set cost-reflective electricity prices. Costs may also include support schemes for energy savings, for Demand Side Management and for renewable in 2012-2013.

5 Renewable Energy Incentives

5.1 Incentives

There are a multiple of existing incentives that encourage the use of renewables:

i. As mentioned above, private sugar producers stated electricity generation from bagasse to power their requirements and to export to the surplus to the utility. The export process protocol was set in a PPA. Since bagasse is a form of renewable resource, the PPA agreement for the purchase of power generated from bagasse can be viewed as a Feed n Tariff (FIT) system even though there is no general unified legislation regulating the purchase of power from the IPPs. These PPAs are generally signed over a period of 20 years.

ii. Solar water heating is the most common form of solar energy conversion, used in Mauritius. However, it is not sufficiently tapped, though the potential is very high. With the setting up of the MID Fund in July 2008, the Solar Water Heater (SWH) loan scheme operated by the Development Bank of Mauritius was revisited with an outright grant of Rs 10,000 from the MID Fund given for every solar water heater purchased so as to double the number of solar water for domestic use by end 2009. The outcome of the new scheme has been beyond expectations with some 49,000 applications received by the Bank. Given the budgetary ceiling of Rs 290 million from the MID Fund, only some 29,000 households would benefit from the grant scheme.

iii. A grid code for Small Scale Distributed Generation (SSDG) has been developed with the assistance of the UNDP to provide the technical framework for Small Independent Power Producers (SIPPs) with capacity below 50 kW to generate electricity for their own purpose and feed any surplus into the national grid (low voltage network only). Accordingly, the utility will purchase, at preferential rates (FITs), power from the SIPP's on the basis of net metering (i.e. remunerating the owner only for the energy been exported to the grid). The SIPP scheme was launched in December 2010 and was caped to 2MW or 200 first applications whichever came first. The scheme enjoyed a resounding success with more than 3.5MW worth of applications received, the overwhelming majority being for small photovoltaic systems. The scheme was closed in May 2011 and the first installations are currently been commissioned. There is however no grid code for connections greater than 50 kW or for connection on the medium voltage MV or high voltage HV grid.

iv. Most recently Sotravic Ltd was awarded a PPA to export the energy it will produce from its landfill gas to energy set up.

v. The Agence Francaise de Developement is providing a line of credit of €40 million through Mauritians banks for RE and EE projects. Green loans are hence available with preferential rates.

Future incentives currently in the pipeline include:

i. Phase 2 of the SWH scheme with a dedicated fund and improved standards for the equipment.
ii. The review of the SSDG scheme is planned in the short term and financially sustainable mechanism will be formulated to ensure PPAs will be fulfilled for the duration of the contract.
iii. Government will seek access to the Clean Development Mechanism market (CDM) through the designated authority.

5.2 Clean Development Mechanism and Carbon Tax

The Ministry of Finance and Economic Development is the designated national authority to formulate and enact any Tax policies. The contact detail of the Ministry is:

Ministry of Finance and Economic Development
Ground Floor
Government House
Port-Louis
Republic of Mauritius
Tel: (230) 201-1146
Fax: (230) 211-0096
Email: mof@mail.gov.mu

As Mauritius is a none-Annex I Country under the Kyoto Protocol, the Clean Development Mechanism (CDM) is the main vehicle to attract carbon financing to the energy sector. While the selling price for the CO_2 credits is unknown and volatile, Mauritius is keen to benefit from interesting annual cash flow if energy efficiency and renewable energy supply projects were implemented and carbon credits accordingly secured.

With regard to existing carbon tax applicable, there is a levy of 0.30 MUR (0.01 USD) per litre of gasoline that is credited to the Maurice Ile Durable Fund (State Trading Corporation, 2011). The government has also recently implemented a carbon tax to penalise the most polluting vehicle. Provision has been made for imposing excise taxes on every ounce of carbon emitted by vehicles per kilometre, based on a threshold (refer to attached Excise Act attached).

The law provides a minimum rate of 158 grams per kilometre, which will be exempt. From this threshold, an excise tax will be collected from the sales price of each vehicle. The fee will be equal to the emission level, less the allowed 158 grams, multiplied by a fixed amount per gram. This amount will vary depending on the level of pollution from vehicles. A car that will emit up to 190 grams of carbon per kilometre will be punished by an additional tax of MUR 2000 (USD 67) per gram beyond the limit of 158 grams. Which amount to a sum ranging between MUR 2000 and MUR 64,000 (USD 67 and USD 2130), the calculation is thus: 190-158 = 32, multiplied by 2000.

The amount of tax per gram increases in proportion to the emission level and may reach MUR 5000 (USD 167) for cars emitting more than 290 grams of carbon per kilometre. Thus, the most polluting cars will see their prices increase by more than MUR 660 000 (USD 22,000): 290-158 x 5000 = 660,000

On cars that pollute less than the limit, they will receive a rebate of excise duties exist. The amount of the rebate will be calculated using the same formula identified for the carbon tax. The result will, therefore, negative, for vehicles with emission levels below the threshold identified. This negative number equals the amount of the rebate to be applied.

6 Challenges, Constraints and Barriers to Renewable Energy Development

The road to achieve the targeted 35% share of RE in the energy mix is not without obstacles. Based on the literature review of the relevant documentation and through interaction with the different stakeholders involved in the energy market, the following list of challenges and possible recommendations (where applicable) have been identified (in no specific order of importance):

i. There seem to be some potential for overlapping responsibilities at institutional level (between government and parastal bodies) that may constrain their individual capacity in support of informed decision-making and implementation. Thus, they face the challenges to create a smooth and seamless policy, legal and regulatory framework to achieve the set targets. Consequently, this issue should be addressed through a review of their structures and measures implemented for capacity strengthening to ensure that these institutions would be able to implement their respective mandates in an effective and complementary manner.

ii. There is currently no Master Plan for Renewable energy. This document is critical to guide stakeholders on the exact way forward for the different RE

sources/ technologies. There also need to be a resource map to clearly define to what extent renewable sources like geothermal and solar PV can be tapped into.

iii. The implementation of RE measures will require heavy investment (e.g. PV) and the government might have to look into possible financial resources to have access to these technologies. Assistance from developed countries/ donor agencies is possible solutions as is access to CDM. However, project proponents in Mauritius face several constraints in developing CDM projects, namely, high transaction costs, complex and time-consuming procedures for obtaining CDM approvals and problem of economies of scale where individual projects cannot generate significant volumes of Certified Emissions Reductions to make the projects cost-effective.

iv. Besides bagasse and hydro, there is little capacity to understand the technicalities of other RE technologies. Much emphasis should therefore be placed on capacity building in all sectors of the economy to obtain a competent workforce to deal with all the modalities associated with these new technologies. Academic curriculums should also be updated to include more RE and research and development encouraged at University level and in the private sector.

v. There is an evident lack of capacity to define standards for the Mauritian context. This has been witnessed in the SWH scheme whereby poor quality SWHs were imported and distributed resulting in reduced lifetime and accrued maintenance costs. Providing capacity to accreditation bodies to define tailor made standards is hence crucial.

vi. Given that reliability of supply remains a priority it is crucial to determine how much intermittent sources of energy can be accommodated on the grid without impacting on power quality. In Rodrigues for instance, the introduction of two new 375kW has caused significant power quality disturbances particularly at night. As mentioned in Chapter 6, a study has already been carried out for wind potential in Mauritius but given the dynamic nature of the electricity grid, further studies and eventual grid codes (for MV and HV) must be elaborated.

vii. In recent years, there have been many disputes between the local authorities and the IPPs over the price/kWh paid to the private producers. These purchase agreements were made in the past for a guaranteed period of time but according to the local authorities, these agreements are out of phase with the current economic environment (NESC, 2009). Given that significant importance is allocated to the improvement of efficiency from bagasse, this issue might hinder the process.

7 Lessons Learned, Observations and Conclusion

It is undeniable that Mauritius has embarked on the quest to achieve sustainable livelihoods through the MID initiative. As a small Island developing state, Mauritius is at the forefront of climate change impacts and the high reliance of the country on imported fossil fuels imply that the economy is particularly vulnerable to any occurrences that might affect the supply of fuels from abroad. However, through the elaboration strategic action plans which are slowly being implemented, the nation is showing its willingness to embrace low carbon/ eco-friendly technologies.

The success of the SSDG scheme, the SWH scheme and campaign for replacement of incandescent lamps with energy efficient lamps has shown that the Mauritian society responds favourably to low carbon technologies provided appropriate incentives are put forward. Although there is a relatively good level of awareness, lack of capacity and access to funds seems to be the major barriers in attaining the development goals sets although much effort is being made to tackle these issues. As a final analogy to back up this statement, the progress made in neighbouring Reunion Island can be considered. This French territory has already a good mix of renewables on its power grid (solar PV, wind, biomass etc) and was able to achieve this status through the assistance of the French Government and Electricité De France.

A2.13 RWANDA

1. Renewable Energy Policy Framework

The "2004 Energy Policy Statement" of Rwanda was revised in 2007 and is entitled "National Energy Policy and National Energy Strategy 2008-2012".

The Policy main objectives are to support national development through:

- Ensuring the availability of reliable and affordable energy supplies for all Rwandans.
- Encouraging the rational and efficient use of energy and
- Establishing environmentally sound and sustainable systems of energy production, procurement, transportation, distribution and end-use.

One part of the policy document is the **"National Energy Policy"** which is an update of the 2004 Energy Policy statement which had a somehow short-term focus. The updated policy was required in order to:

- set the National Energy Policy within Rwanda's long-term development plans and strategies;
- give particular attention to requirements for the progressive development of the electricity sector;
- have greater focus on household energy requirements and gender dimensions;
- bring the statement up-to-date by reflecting the latest developments in methane and renewables and their environmental implications;
- state more clearly Rwanda's commitment to private sector participation and to regional cooperation in energy.

The updated policy is complemented by the **"National Energy Strategy"** (Part B of the policy document), covering the period 2008-2012.

The following energy sub-sectors are being specifically addressed in the policy: biomass, biofuels, petroleum, electricity and new & renewable energies. It sets clear statements for each of the sub-sectors.

As regards new and renewable energy resources, the Government is dedicated to the development of 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. In respect of these and other potential energy resources which are not being fully exploited, 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 programmes 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.

The energy policy document also addresses various energy demand categories and also covers crosscutting policy issues.

The National Energy Strategy mainly focuses towards the contribution to the accelerated sustainable socio-economic development so as to improve the well-being and the quality of life of the population by powering the social and economic sectors to meet the essential needs. This will be achieved by:

- Increasing access to electricity for enterprises and households;
- Reducing the cost of service in the supply of electricity, and introducing cost reflective electricity tariffs;
- Diversifying energy supply sources and ensuring security of supply and
- Strengthening the governance framework and institutional capacity of the energy sector.

The policy document equally recognizes the country's strong commitment towards working with its neighbours and regional organisations (particularly EAC, COMESA and EAPP) to deepen regional integration in the energy sector. Rwanda also seeks to share with other countries research and experience in the energy sub-sectors such as biomass and new and renewable forms of energy that is useful primarily at the national level.

2. Legal and Regulatory Framework

The Government has recently established the Law №21/2011 of 23/06/2011governing the electricity sector in Rwanda. The Law shall govern activities of electric power production, transmission, distribution and trading within or outside the national territory of the Republic of Rwanda.

The Law governing the electricity sector in Rwanda has the following objectives:

- Liberalization and regulation of electricity sector;
- Harmonious development of distribution of electric power for all categories of the population and for all economic and social development sectors;
- Setting up conditions enabling electric power investments;

- Respect for the conditions of fair and loyal competition and for rights of users and operators.

The Law clearly state activities in the electricity sector that are subject to licenses. The regulations for granting licenses are issued by the Regulatory Agency (RURA) who is also in charge of license issuance, fixing and approving tariffs.

The Law also establishes a "Universal Access Fund" with the main purpose of optimizing access to electricity in all areas of the country through cost effective means and minimized support.

The Universal Access Fund will operate upon contributions collected from dealers in electricity. Such contributions will be determined by a Presidential Order.
Dealers in electricity must, within time limits specified by the regulatory agency, indicate their expected income. The Regulatory Agency has the right to suspend or revoke the license issued to a dealer in electricity, when he/she refuses to pay contributions to the Universal Access Fund in accordance with specified modalities and time limits.

3. National Energy Policy with reference to COMESA Model Energy Policy

The analysis of the national energy policy versus the COMESA energy policy is aimed at determining the extent to which the former is in harmony with the latter.

Major elements of comparison	COMESA Model Energy Policy	National Energy Policy
Goal	To meet the energy needs, in an environmentally sustainable manner, through providing an adequate and reliable supply of energy at least cost; to support social and economic development and sustainable economic growth and also to improve the quality of life of the people.	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, thereby contributing to the goals of national socio-economic development, including the progressive elimination of poverty. *The national energy policy goal is in harmony with COMESA energy policy goal.*
Objectives	• Improve Effectiveness and Efficiency of the Commercial Energy Supply Industries; • Improve the Security and	• Ensure the availability of reliable and affordable energy supplies for all Rwandans; • Encourage the rational and

Major elements of comparison	COMESA Model Energy Policy	National Energy Policy
	Reliability of Energy Supply Systems; • Increase Access to Affordable and Modern Energy Services as a Contribution to Poverty Reduction; • Establish the Availability, Potential and Demand of the Various Energy Resources; • Stimulate Economic Development; • Improve Energy Sector Governance and Administration; • Manage Environmental, Safety, and Health Impacts of Energy Production and Utilization; and • Mitigate the Impact of High Energy Prices on Vulnerable Consumers	efficient use of energy; and • Establish environmentally sound and sustainable systems of energy production, procurement, transportation, distribution and end-use. *The objectives of the national energy policy have been customized from the COMESA Energy Policy Model but are discussed in detail in the national energy policy statements.*
Supply and demand side objectives	These are detailed in a separate section of the COMESA Energy Policy Model, with specific policy instruments for each of the renewable sources of energy.	Embedded in the national energy policy main objectives without specific policy instruments for some of the renewable energy resources (e.g. wind) Most of the policy instruments are being discussed in the National Energy Strategy (which is part of the national energy policy)
Cross-cutting issues	Regulatory frameworks, Integrated Energy Planning, Energy sector governance, Institutional framework, capacity building, energy efficiency and conservation, energy pricing, R&D, Regional and international co-operation, Environment and Gender are all cross-cutting elements being specifically addressed in COMESA energy policy model.	Similar elements are also being addressed in the national energy policy and the national energy strategy with specific policy mechanisms for each.
Policy framework	The COMESA Model Energy Policy Framework focuses on key issues in the energy sector; supply and demand side policy objectives and policy instruments; and cross cutting issues.	The national energy policy framework has been customized to the COMESA model but also includes the Energy sector strategic plan.

General Observation

The Model COMESA Energy Policy Framework, being a flexible policy guideline which is expected to provide a framework for COMESA member States to customize their policies based on the country's specific socio-economic considerations and circumstances, is compatible with the national energy policy in several aspects as shown in the table above. However, Rwanda Energy Policy is specific in that it also includes a national energy sector strategic plan with a long term vision of developing the energy sector in Rwanda, especially the renewable resources.

4. Status of Renewable Energy Development and Future Plans

4.1. Hydro power

Several studies for the hydropower potentials in Rwanda have been conducted over the years supported by various development partners. The most recent overview study was conducted by the Belgian firm SHER Ingénieurs-Conseils s.a., which prepared a Hydropower Atlas in 2008. The study broadly assessed the potential for micro and mini/small hydropower in the country as a precursor to the preparation of a hydropower master plan for the country. The hydropower Atlas examined the potential for hydropower in a total of three hundred thirty-three (333) sites.

The hydropower atlas examined sites with potentials ranging from the pico range (0-5 kW) to sites which could be classified as micro, mini or small hydro (greater than 5 MW). Of the hydropower sites which have not been exploited, 15 sites with a potential of 250kW and above, which represents about 5% of the total number of sites, represent about 60% of the total estimated available potential. Almost 50% of the unexploited hydropower sites have potential in the range of 5 to 100 kW.

The above does not include the hydropower potential in the regional projects, namely Ruzizi (I-IV) and Rusumo Falls, which account for some 165 MW. Also, not included in the list is the large and medium domestic hydropower project, Nyabarongo I 28MW (now under construction) and II (17MW), which together represent about 45 MW. The strategy for developing these relatively large projects is, obviously, different from the strategy to develop the micro/mini/small hydropower project sites.

Hydro electric power and thermal (Diesel and HFO) generation are still leading the power generation in Rwanda. The contribution of hydropower to the National Grid has increased significantly after new power plants of RUKARARA (9MW) and RUGEZI (2.2MW) have been added to the national grid.

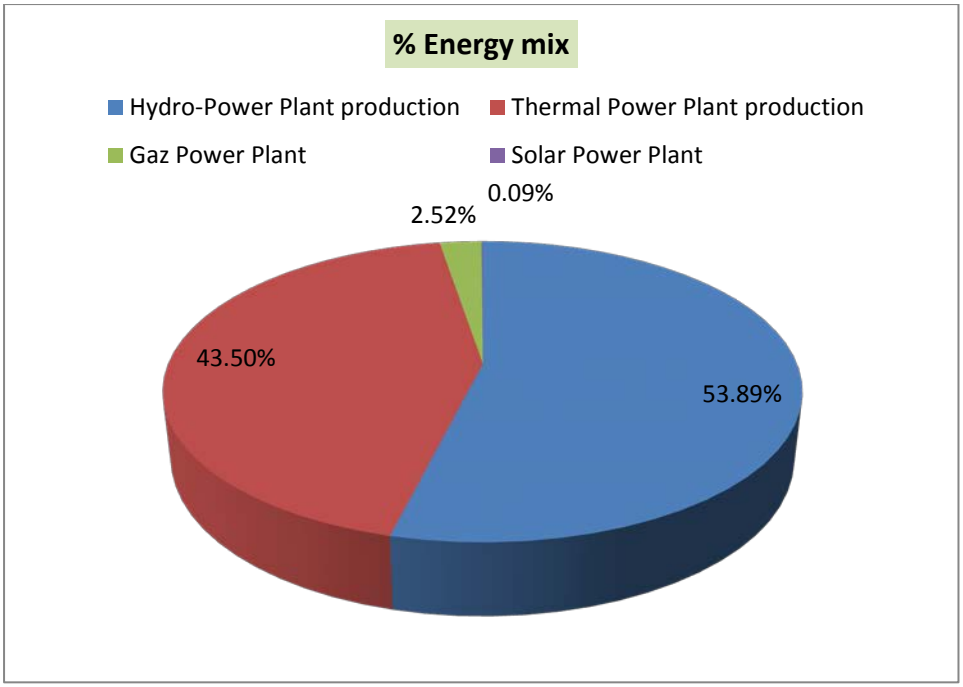
The table below shows the types of power plants and their contribution in the power production in the National grid.

Plant Name	Type	Year of Operation	Installed capacity in MW	Available capacity in MW	Comments
MUKUNGWA	Hydro	1982	12	12	
NTARUKA	Hydro	1959	11.25	9	
JABANA 1	Thermal	2004	7.8	7.8	
JABANA 2	Thermal	2009	20.5	20.5	
AGGREKO	Thermal	2005	10	10	
GIHIRA	Hydro	1957	1.8	0	Under rehabilitation
GISENYI	Hydro	1984	1.2	0	Under rehabilitation
METHANE GAS	Thermal	2008	4.2	1.2	
RUKARARA	Hydro	2010	9	6	
RUGEZI	Hydro	2011	2.2	2	
JALI SOLAR	PV	2007	0.25	0.25	

Imported Power from the Region

Plant Name	Type	Year of Operation	Installed capacity in MW	Available capacity in MW	Imported capacity MW
RUSIZI I (DRC)	Hydro	1957	-	-	3.5
RUSIZI II (SINELAC)	Hydro	1989	45	36	12
KABARE (UETCL)	-	-	-	-	1

The interconnected system installed capacity by mid-2011 is Hydro 53.95MW, Thermal 41.9MW, and solar PV 0.25MW to make the total domestic and imported installed capacity 96.1MW. However the total available capacity is currently 85.25 MW. The contribution of hydro, thermal (Diesel and HFO), Methane Gas and solar PV is respectively 53.89 %, 43.5%, 2.52% and 0.09% of the total energy delivered into the Electricity Grid as shown in the chart below:



The existing power plants will be complemented by an ongoing hydropower project of NYABARONGO (27.5 MW) expected to be commissioned in 2013. In addition, the government has embarked in putting efforts on projects to boost the energy production through methane gas, geothermal and peat resources. Furthermore, feasibility studies on regional projects of RUSUMO (80 MW), RUSIZI III (145 MW) and RUSIZI IV (267 MW) are on-going.

The Government in collaboration with the private sector and development partners is promoting small electricity projects as part of the general renewable Energy framework. To this end more than 16 micro hydropower sites with a combined potential exceeding 7 MW are being developed and are expected to be functional in a non distant future. Some of these projects listed in the table below are already operational off-grid supplying electricity to isolated areas.

Plant Name	Location (District)	Installed capacity MW	Comments
NYAMYOTSI I	NYABIHU	0.1	Operational (Off grid)
NYAMYOTSI II	NYABIHU	0.1	Completed but currently no operational due to defects on the penstock
MUKUNGWA II	MUSANZE	2.2	Under construction
JANJA	GAKENKE	0.22	Under construction
MUTOBO	MUSANZE	0.2	Operational (Off grid)

KEYA	RUBAVU	2.2	Under construction
GASHASHI	RUTSIRO	0.2	Under construction
CYIBILI	RUTSIRO	0.3	Under construction
REPRO	RUTSIRO	0.105	Operational
SOGMR		0.4	Under construction
NKORA	RUTSIRO	0.7	Under construction (Final stage)
ENNY	NYARUGURU	0.5	Under construction
NYABAHANGA	KARONGI	0.2	Under construction
AGATOBWE	NYAMAGABE	0.2	Operational (off grid)
NYIRABUHOMBOHOMBO	NYAMSHEKE	0.5	Under construction
TOTAL		**7.065**	

4.2. Solar energy

In Rwanda, solar energy has been exploited in recent decades by local and international organizations for the electrification of churches, schools and households in rural areas. The potential for solar energy in Rwanda is 4.5-5.5 kWh/ m^2/ day at an average of 8 hours of sunshine a day. However, the relatively high cost of solar systems has been a barrier to widespread dissemination until now.

Currently, solar energy is mainly used for two purposes in Rwanda:

- Electric power production through solar photovoltaic systems and
- Direct heating, for example solar water heaters or for sun-drying agricultural products

Under Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS), it is expected that all health centers, all administrative offices and 50% of schools further than 5

km from the grid will be electrified by off grid renewable energy sources, especially using solar PV systems.

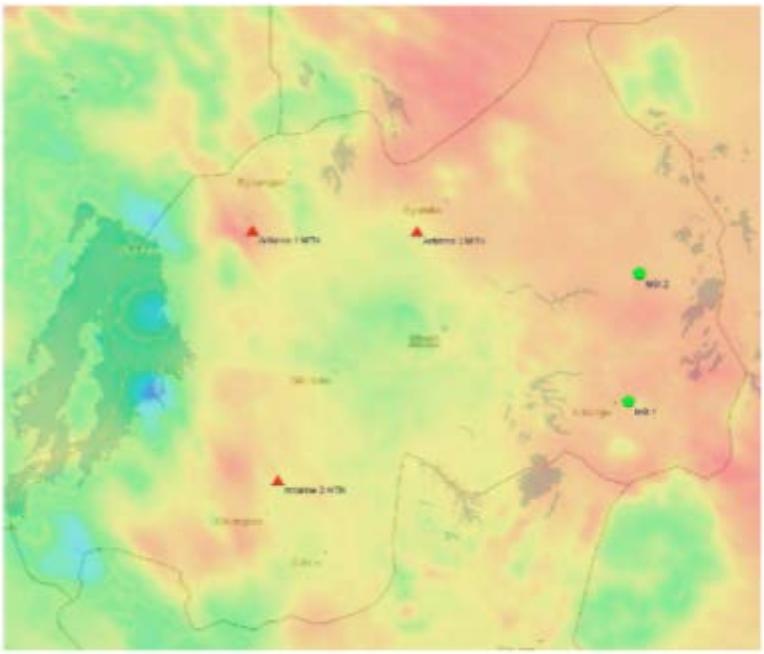
Rwanda has a 250 kW solar installation (Kigali Solaire) which is grid-connected. This project is owned by a German private operator called Stardwerke Mainz AG & the total project cost is estimated at 1,369,636 Euros (1,921,843 $). Electricity produced by Kigali Solaire is sold to EWSA at a fixed tariff of 0.07 US$/kWh.

Three hundred schools are planned to have electricity using solar PV systems through the European Commission funding but this project is at the contract negotiation phase.

Fifty three health centres will also have access to electricity by using solar PV technology. This project is financed by BTC and is still at the feasibility assessment phase.

4.3. Wind energy

A study on Wind Resource Assessment in Rwanda has been undertaken for almost three years now and has concluded that wind power resource in Rwanda is very limited except in some parts of the country, such as the Eastern Province, where further investigations are necessary.



Figure…: Location of the 5 measurement points (the red color indicates the zones identified in the preliminary study as being most windy)

The calculated capacity factors rarely exceed 10% at 100m height in the measurement locations. For selected sites, it was estimated that electricity production from wind resource cannot exceed 2MW especially due to seasonal and geographical variability of the wind speeds. However, according to certain sites' potential (e.g. Eastern province), wind

electricity production can be probable provided that further research and investigations are conducted.

4.4. Geothermal energy

Rwanda hosts two prospective areas for geothermal energy exploitation: the Volcanoes National Park and the faults associated with the East African Rift near Lake Kivu.

Exploration of geothermal resources in Rwanda began in 1982 with the French Bureau of Geology and Mines (BRGM) in the Western (Mashyuza, Gisenyi and Kibuye), Southern (Ntaresi) and Northern (Musanze) Provinces of the country. From these investigations, the identified prospective sites for geothermal energy development were Mashyuza, Gisenyi and Ntaresi with estimated reservoir temperatures of above 100°C.

In 2006, investigations were undertaken by an American company, Chevron, on the Mashyuza and Gisenyi prospects. A number of chemical geo-thermometers have been applied to the Gisenyi and Mashyuza (Bugarama) fluids in order to estimate the reservoir temperature. Based upon these geo-thermometer readings, the reservoir temperature was estimated to be in excess of 150°C.

Detailed exploration works were recommended in order to confirm the reservoir temperatures. Since January 2008, detailed geo-scientific investigations have been underway in collaboration with the Germany Institute for Geosciences and Natural Resources (BGR), the Kenya Electricity Generating Company (KENGEN), the Icelandic Geo Survey (ISOR) and the Spanish Institute for Technology and Renewable Energies (ITER).The results of the investigations have been presented and discussed among the involved parties, and the results indicate the possibility of the existence of a high temperature geothermal system on the southern slopes of Karisimbi volcano, and a medium temperature geothermal system along the North-east trending accommodation zone west of Mukamira to Lake Karago.

Further additional measurements were recommended in order to develop a higher resolution conceptual model, to assist in the definition of the drilling location and reduce drilling risks. The Government has allocated budget resources to undertake the additional detailed scientific studies and drill three exploratory wells. Early results starting March 2012 should confirm the commercial viability of tapping geothermal resources in Karisimbi. Detailed studies and test drilling is also planned for other prospective areas.

The potential for power generation from geothermal energy is estimated to be more than 700 MW and the Government is targeting 300 MW in the next seven years at the estimated cost of $935 millions. A 10MW wellhead plant will be installed to test the viability of the resources.

4.5. Biomass energy

A Co-generation plant is installed at one sugar factory (Kabuye Sugar Works) with a power production estimated at 2MW. Existing biogas projects are not focused on electricity generation but rather on producing gas for cooking purposes.

Bio-gas projects

Project name	Project size (MW)	Status	Location	Technology	Developer	Project costs (US$)	Projects impacts, benefits & issues
13 Institutional Biogas plants installed in Prisons	-	All operational	All prisons of Rwanda	Camatec model	KIST/CITT, MININFRA, MININTER	N.A	Reduction of fire wood consumption from 45% to 30% for institutions that have biogas plants.
549 plants from different users in baseline (2008-2009)	-	All operational	Countrywide (especially the rural area)	Masonry type	National Domestic Biogas Programme (NDBP)/MININFRA	770,526.32	Reduction of firewood consumption, better/improved cooking & health conditions
495 plants constructed since January 2010	-	All operational	Countrywide (especially the rural area)	Masonry type	National Domestic Biogas Programme (NDBP)/MININFRA	694,736.84	Reduction of firewood consumption, better/improved cooking & health conditions

The projects' size in terms of MW is not available since most of the gas produced is used for cooking purposes and for lighting one or two bulbs.

4.6. Biodiesel production

The "Institut de Recherche Scientifique et Technologie" (IRST) has contributed to both energy development and environmental conservation, by starting to produce Biodiesel fuel from palm oil, which is currently used by one transport bus car that runs on 100% bio-diesel, one of its kind in Africa. The Biodiesel plant production capacity is estimated at 2,000 liters per day.

The Government of Rwanda has recently prioritized the replacement of the palm oil by jatropha plants that are being planted at selected sites in the country.



A private Company, Rwanda Bio-fuel Ltd, has started the cultivation of jatropha plants in Kayonza district that will be used to produce bio-diesel fuel. More than 8,000 hectares have already been cultivated.

4.7. Methane-to-power production

The extraction of Lake Kivu methane gas for power production is currently the Government's priority.
The potential is estimated at 700 MW (shared between Rwanda and DRC).

The following are the on-going methane-to-electricity projects:

- Contour Global (CG) US-based Company, through its subsidiary Kivu Watt Ltd, is interested in converting Lake Kivu Methane gas energy potential into electrical power generation of 100 MW in two phases. Ideally, the first phase is targeting to deliver to the national grid 25 MW by end of 2012 and followed by 75 MW for the second phase in 2014.

- The Rwanda Energy Company (REC) is a subsidiary of Rwanda Investment Group (RIG). This company has been granted a gas concession agreement to develop a gas fired power plant in Rwanda. This pilot project has the objective of producing 3.6 MW in the first phase before moving to the production 50 MW in the second phase. The project has been encountering some technical difficulties relating to the gas extraction platform, and the firm is seeking new partners and investors to revive the project.

- In March 2005, the first Gas Concession Agreement (GCA) for the extraction of methane gas tapped in deep water of Lake Kivu for power generation was awarded by the

Government to the Kibuye Power 1 (KP1) project, with the overall mandate to exhibit the possibility of electricity production from the methane gas. The facility is currently generating almost 2 MW of electricity, about half of its designed capacity of 4.5 MW due to technology bottlenecks.

- The Government is also negotiating with an Israeli firm to lease its pilot methane plant on Lake Kivu in western Rwanda in an effort to increase the plant's electricity production capacity. When Israel Africa Energy Limited takes over operations of the plant, the facility's output will at least be increased to 50 MW.

5. Renewable energy incentives

5.1. Incentives

Appropriate regulations on renewable energy incentive mechanisms need to be put in place in order to match with the national energy policy strategies. The policy proposes to provide a secure framework for investors in new and renewable electricity generation technologies by introducing a system of ***feed-in tariffs*** or some other mechanisms. However, the following renewable energy projects are currently being incentivized by the Government:

- Solar panels and other equipment for solar PV & solar water heaters are tax-exempted but a detailed study of subsidy scheme for solar projects is still going on.

- Development agencies such as GIZ and BTC are providing 50% of the total project costs to private operators in order to encourage private sector participation in the development of the micro hydropower sub-sector.

- A study on REFIT is being reviewed by the Regulator before its adoption and implementation.

- The GoR's subsidy scheme for domestic biogas plants is RWF 300,000/unit (more than $ 500); for institutional biogas plants which is estimated at 40% of the total project costs.

5.2. Clean Development Mechanism

The United Nations Framework Convention on Climate Change (UNFCCC) accepted the ratification of the Government of Rwanda on 18th August 1998 as a non-Annex 1 country.

The Rwandan Parliament ratified the Kyoto Protocol on 22nd July 2004. In September 2005, the Designated National Authority (DNA) of Rwanda was established by the Right Honorable Prime Minister upon the request from the Honorable Minister of State in charge of Lands, Environment and Forestry. The request further proposed that the secretariat of the DNA would be hosted by Rwanda Environment Management Authority (REMA), now under the Ministry in charge of Environment and Lands (MINELA). In addition to coordinating Clean Development Mechanism (CDM) projects in Rwanda, the DNA also coordinates voluntary carbon market (VCM) projects in Rwanda.

Within the energy sector, Rwanda has a great potential for carbon credit projects. Potential projects include: hydropower, solar energy, methane gas from Lake Kivu, biogas recovery from wastes, energy efficiency cook-stoves and energy efficiency in buildings.

The national energy policy therefore supports the development of environmentally sound energy through accessing internationally marketable carbon credits through the Clean Development Mechanism (CDM) or through the voluntary carbon emissions market. The following policy measures are to be considered:

- Applications will be made to obtain Certified Emissions Reductions (CERs) which require that project promoters can demonstrate "additionality", that is showing that the planned reductions would not occur without the additional incentive provided by emission reductions credits.

- In other cases, Verified Emissions Reductions (VERs) will be pursued, using internationally recognised standards such as the Gold Standard on the Voluntary Carbon Standard to enhance their value in the voluntary carbon market. The proceeds from VERs will be invested by the Government in further renewable and sustainable energy projects.

- The Government is also committed to developing the capability to evaluate proposals for carbon credit projects and ensure that Rwanda maximizes the benefits that can be derived from the CDM programme and the voluntary carbon market.

"Compact Fluorescent Lamp" Project under CDM

There is currently one registered project with the following details:

- *Project location*: countrywide
- *Project participant*: EWSA
- *Project developer*: World Bank
- *Standard*: CDM
- *Project type*: Energy efficiency
- *Methodology*: AMS- II.J, AMS- II.C
- *Average estimated CER volume (tCO2e/yr)*: 18,579
- *Crediting period (years)*: 10
- *Operation start date*: 2007
- *Project status*: Registered on 30/05/10

The contact details of the DNA (which is hosted by the Rwanda Environment Management Authority) are:

Rwanda Environment Management Authority (REMA)
Kacyiru-Boulevard de l'Umuganda
I Nyota House
P.O Box 7436 Kigali, Rwanda

E-mail: rwandadna@gmail.com
Phone: (+250) 025 258 0101
Fax: (+250) 025 258 0017
Mobile: (+250) 78 848 1439
Web: http://www.rema.gov.rw/dna

6. Challenges, constraints and barriers to renewable energy development

Rwanda is endowed with a great potential of renewable resources. The development of these resources however is not without constraints, some of which are being addressed in the national energy policy with a set of mitigation measures proposed for the Government's action. Those challenges/constraints/barriers are:

- High tariff per kWh
- Capital-intensive projects.
- Lack of a defined incentive regime for renewable energy resources
- Lack of technical know-how especially in monitoring renewable energy projects (starting from the construction phase up to the implementation phase)
- Limited access for poor households to improved stoves and modern energy

7. Lessons learned/Observations and Conclusion

The National Energy policy was drafted in a concise manner regarding all available renewable energy resources in Rwanda.

Considering that the end of the period to be covered by the national energy policy and national energy strategy is drawing near, monitoring of the policy implementation is, therefore, paramount so as to assess whether policy instruments and measures addressing the development of renewable energy resources were effective or not.

It is to be noted that energy resources available in Rwanda are mostly renewable so a separate RE policy is not to be advised but rather a renewable energy sector strategic plan would be necessary for the development of these resources. In addition, a Policy and/or Regulations on appropriate incentive mechanisms for RE development in Rwanda are also to be recommended.

A2.14 SEYCHELLES

Seychelles has taken several steps in the past few years to consolidate its national energy laws, policies and programs, and to establish the development of renewable energy technologies in the country as a national priority. Among the recent steps in this direction have been: a) the establishment in 2009 of a Seychelles Energy Commission; b) the formulation of the Seychelles Energy Policy 2010-2030; c) the lifting of tariffs and tax on all renewable energy technology imports with endorsement from the Energy Commission; d) and various measures to promote energy conservation and renewable energy, including the removal of taxes on solar water heaters and other energy saving devices.

Seychelles Energy Commission (SEC)

The Seychelles Energy Commission (SEC) was set up in July 2009 under the Ministry of Environment, Natural Resources and Transport (Ministry of Home Affairs, Environment, Transport and Energy (MHAETE)) with responsibility for the oversight and planning of the Government's approach on energy issues. The Commission has the mandate to ensure the provision of adequate, reliable, cost effective and affordable energy while protecting and preserving the environment and reports directly to its Minister. At present, the SEC has not been officially designated as an energy regulator; however, it is the commission's vision to become a highly recognised and effective energy regulator as well as the authority on energy matters. The Seychelles Energy Commission Act, which authorizes the establishment of the SEC, provides the broad parameters of its mandate, which is directed towards the liberalization of the Seychelles energy markets. The SEC Act also introduces and promotes the use of renewable energy in Seychelles.

Energy Policy 2010 – 2030

The Energy Policy 2010 – 2030 which was approved by cabinet in 2010, is designed to ensure that Seychelles achieves: "*A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies.*"

The Energy Policy examined the energy situation we face and proposed a range of options and strategies which Seychelles should pursue over the short, medium and longer term. These options range from incorporating energy efficiency and conservation measures in our daily lives, through modernizing Seychelles' energy infrastructure to diversifying our energy base, as previously mentioned.

It places priority attention on three key areas:

1. Land transport
2. Consumption of electricity
3. Production of electricity

By focusing on these three priority areas listed above, the Energy Policy ensures that Seychelles minimizes the effect of volatile and rising crude oil prices, takes advantages of renewable resources and promotes conservation and efficiency in the use of energy resources amongst all sectors of society. The policy proposes key changes to the institutional and regulatory framework for energy in the country, including strengthening the Seychelles Energy Commission, creation of an independent Energy Regulator, and clearly defined IPP regulations to promote renewable energy development.
Furthermore, the policy proposed the need to undertake the following tasks and who should undertake them:

- regulation of prices and services, including private participation in electricity supply;
- development of coherent energy strategies and scenarios and ability to aid in revising energy-related legislation;
- information to stakeholders and to the public regarding efficient energy consumption and renewable energy options.

The Energy Policy sets a national target of 15% of energy demand met by renewable energy by 2030 and a target of 30% of electricity generation from renewable energy by 2030.

Other policy documents which have some relevance to the energy sector and promotion of renewable energy are 1) the National Climate Change Strategy (2009) which identifies five strategic objectives:

(i) advance understanding of climate change, its impacts and appropriate responses
(ii) put in place measures to adapt, build resilience and minimize vulnerability to the impacts of climate change
(iii) achieve sustainable energy security through reduction of greenhouse gas emissions
(iv) mainstream climate change considerations into national policies, strategies and plans
(v) build capacity and social empowerment at all levels to adequately respond to climate change.

And 2) the Seychelles Sustainable Development Strategy 2011-2020 - like the National Climate Change Strategy, identifies the “promotion of renewable and alternative energy at the national level” as one of 5 strategic objectives for the energy sector in the country.

Energy Act

The Seychelles Energy Commission is currently undertaking the preparation of the Energy Bill through funding from the European Union. The Energy Bill is expected to be completed by end of this year. It will contain rules and constitute the legal framework related to:

1. Identification and definition of primary and secondary energy sources;
2. Identification of energy sectors;

3. principles and general rules applicable to energy policy and instruments for its rules;
4. CDM provisions;
5. Energy efficiency requirements and environmental related protection in performing energy activities;
6. Rules related to promotion of renewable energy;
7. Electricity sector legislation;
8. Governance and powers of the Seychelles Energy Commission, with competences in energy efficiency, promotion of renewable energy sources and regulation of the electricity sector.
9. Define the roles of other stakeholders.

The Bill will bring cohesion in the energy sector by taking into account all the secondary (subsidiary) legislations including (just naming a few)

- The Energy Commission Act, 2010
- The Public Utilities Corporation Act and Regulations,
- The Seychelles Petroleum Act,

2 National Energy Policy with Reference to COMESA

In principle, the main objectives of the Seychelles Energy Policy 2010-2030 is more or less similar to those of the COMESA Model Energy Policy Framework and it has the main goal of meeting the energy needs of the country in an environmentally sustainable manner, through the provision of an adequate and reliable supply of energy at an affordable cost; to support social and economic development and sustainable economic growth and also improve the quality of life of the people. The Seychelles Energy Policy has a broad scope and considers aspects of energy supply and demand focussing on policy measures for the medium and long term. The energy Policy places emphasis on three main areas to be targeted and they are;

1. Production of electricity,
2. Consumption of electricity and
3. Transportation.

Numbers 1 and 3 account for more than 80% of oil consumption in Seychelles. For this reason, security of supply was an important consideration during the formulation of the Energy Policy. Like the COMESA Model, the Energy Policy focuses on the need 1) to increased energy efficiency and effectiveness in all areas, 2) for capacity building, 3) for institutional reform, 4) to improve public and private initiatives in the energy sector and 5) increase the contribution from renewable energy in the energy matrix of Seychelles. In conclusion, the goals and objectives of Seychelles Energy Policy are analogous to those of the COMESA Model Energy Policy Framework.

3 Renewable Energy Strategy

Seychelles' renewable energy strategies are found in its national policies such the Sustainable Development Strategy 2011-2020 and the Energy Policy 2010-2030. The latter sets targets of 30% renewable energy in the electrical energy mix and 15% renewable energy in our total energy mix by 2030.

Cost of electricity

As mentioned previously, electricity production in Seychelles is carried out by PUC which operates production facilities on two main islands, namely Mahe and Praslin. The table below shows the cost of electricity based on fuel prices for the year 2009 and 2011. Note that Seychelles is 100% dependent on imported oil for its electricity.

	2009 Fuel Prices				**2011 Fuel Prices**			
	PUC Mahe Electricity Produced	PUC Praslin Electricity Produced	PUC Mahe Electricity Sold	PUC Praslin Electricity Sold	PUC Mahe Electricity Produced	PUC Praslin Electricity Produced	PUC Mahe Electricity Sold	PUC Praslin Electricity Sold
Fuel costs SR/kWh	1.74	1.87	2.01	2.20	3.43	3.68	3.96	4.33
Capex cost SR/kWh	0.05	0.028	0.06	0.03	0.05	0.028	0.06	0.03
Opex SR/kWh	0.20	0.277	0.23	0.33	0.20	0.277	0.23	0.33
Total Cost SR/kWh	**1.99**	**2.18**	**2.30**	**2.56**	**3.68**	**3.98**	**4.25**	**4.69**
Total cost US$/kWh	**0.16**	**0.17**	**0.18**	**0.20**	**0.29**	**0.32**	**0.34**	**0.37**

NB: The exchange rate for the Seychelles Rupee (SR) is about SR 12.50 to USD 1

Electricity Tariff Structure

The electricity tariff structure of Seychelles comprises seven main customer categories and they are:

1. Domestic Sector, which includes three sub-categories depending on subscribed demand: (i) Up to 2.4 kVA, (ii) above 2.4 kVA but less than 9.6 kVA and (iii) 9.6 kVA and above. The tariff in each case comprises a demand charge based on the subscribed demand plus five monthly blocks of energy charges, with each block progressively increasing in price: (i) 0 to 200 kWh, (ii) 201 to 300 kWh, (iii) 301 to 400 kWh, (iv) 401-500 kWh and (v) all monthly consumption above 500 kWh. The demand charge for subscribed demands up to 2.4 kVA is equal to zero. This charge progressively increases to a maximum value of SCR 9.37 per kVA for the largest customers.

2. Commercial and Industrial, which is divided into single-phase supply and three phase supply. Each of these groups comprises two sub-categories: (i) those consuming 200 kWh or less per month and (ii) those consuming more than 200 kWh per month. The tariff in each case comprises a demand charge based on subscribed

demand (which may be measured in the case of three phase supply) plus three monthly blocks of energy, with each block progressively increasing in price: (i) 0 to 500 kWh, (ii) 501 to 1000 kWh and (iii) all monthly consumption above 1000 kWh. The demand charge progressively increases from SCR 9.16 per kVA for the "under 200 kWh" group to SCR 15.87 per kVA for the largest group. Energy charges for each block across groups and categories are equal.

3. Government Sector, which is divided into single-phase supply and three phase supply. The tariff for each is identical, except that the demand for three-phase supply may be measured. The charge per kVA is relatively high at SCR 27.49 per kVA. However, this is "compensated" by a relatively very low single energy charge for all consumption.

4. "Export Sector", which includes customers engaged in export-oriented industries and businesses. Demand may be subscribed or measured. The tariff is almost identical to that of the Government Sector, except the demand charge is equal to SCR 21.00 per kVA, making these customers the lowestpaying electricity consumers in the country on an average per kWh basis, after (most) Domestic customers.

5. "Bulk Consumers", which is applicable to any customer having power demand over 150 kVA. This tariff comprises a relatively high demand charge of SCR 81.21 per kVA, plus two blocks of relatively high-priced energy, making these customers the highest-paying electricity consumers in the country on an average per kWh basis.

6. Public Lighting. This tariff comprises a relatively high demand charge of SCR 134 per kVA, but a relatively very low energy charge, equivalent to that paid by the Government and Export sector, which more than compensates for the "high" demand charge.

7. BBC. For one unique customer, this tariff comprises only a single middle-of-the-range energy charge.

4 Status of Renewable Energy Development and Future Plan

4.1 Hydro Power

Current status
Seychelles does not have hydro projects.

Potential

A 2008 study estimated that the total potential for hydropower for Seychelles is 1.8 MW, distributed at 25 installations with sizes ranging from 30 kW to almost 200 kW.

Future plans

Suggestion to exploit one or two sites for electricity generation but due to persistent drought period, hydro energy is not an option.

4.2 Biomass

- *Current status*
- Most of the work carried out in the past focused on gasification of biomass. The equipment used was all prototypes. Although some promising results were reported by the Technological Support Service Division (TSSD), there were technological failures which prevented the marketing and uptake by the local consumers.
- The use of wood resources is mostly for charcoal production, and for heating in the food drying process, although the vast majority of cooking is done with liquid petroleum gas.
- *Potential*
- No data available. The potential is there however the viability of generating electricity from these residues remains to be evaluated.
- *Future plans*
- To carry out study to determine the full potential.

4.3 Solar Energy

Current status

Most of the work in the field of solar energy in the past looked at thermal technologies and few projects exploring the production of electricity were carried out. The solar thermal projects included wood drying technologies and solar water heating. Past trials with solar energy applications have shown that solar water heating is one of the most viable of renewable energy for the Seychelles and currently the most widespread use of solar energy in the country. Currently, there is a SWH loan scheme project being implemented in Seychelles and will be financed by the government.

With regards to PV, there were a few off-grid PV systems installed for remote communications and small installations on outlying islands. To date, there is no PV farm in Seychelles. The only grid-tied systems are; a 600Wp owned by the utility company, PUC for research purposes.

The Seychelles Energy Commission is currently undertaking a Grid-connected PV systems project in partnership with the GEF, UNDP and government of Seychelles. The aim of the project is to increase the use of grid-connected rooftop PV systems to generate electricity. It will also look at 1) the policy strategies and legal framework, 2) strengthening of the technology support, 3) delivery system and 4) barriers and constraints with regards to the dissemination of grid-connected rooftop PV systems.

Potential

Seychelles has a high level of solar radiation. Data from a the 600W PV system installed by the Electricity company, Public Utility Corporation, PUC, is indicating that solar radiation value for Seychelles are very good. Average daily insolation recorded over three years on the main island of Mahe is 5.762 kWh/m². However, the high mountains on Mahe create a microclimate with increased cloudiness and rainfall; locations farther from Mahe will have significantly higher insolation. Moreover, Seychelles is lacking land or large space limiting size of PV farm on the 3 main islands. But potential for larger capacity PV farm is possible on outlying islands however financially such venture might not be feasible. On the other hand, distributed potential is quite huge and needs to be investigated especially grid-connected rooftop PV systems.

Future plans

For PV:

- Installation of demonstration grid-connected rooftop PV systems for the purpose of promotion and public awareness and feasibility analysis.
- Setting up the necessary framework (legal, incentives etc...) for the development of PV systems.
- Capacity building

Launching of the SWH interest-free loan scheme in 2012.

4.4 Wind Energy

Current status

Wind energy is currently one of the most competitive renewable energy technologies that exist. The wind regime is limited to around five to six months a year during the South East Monsoon period spanning from June to October. Studies on wind energy and its potential began in the 1980s. Two wind generators of 11kVA each were installed on the island of Ste Anne and connected to the grid. This was however a complete failure as one of the turbines was seriously damaged beyond repairs and the other was eventually taken out of service. The reason of failure of

this project was mainly due to the technical characteristics of the equipment and lack of maintenance due to the fact that the manufacturer went bankrupt immediately following the commissioning of the project.

An onshore wind farm project is currently being implemented and is expected to be commissioned by 2012. The wind farm, which will be known as the Port Victoria Wind Farm, will be located in the inner harbor area of Port Victoria on two reclaimed islands, Ile du Port and Ile Romainville. With installed capacity of 6MW (8 turbines of 750kW capacity each), will generate approximately 6-7 GWh of electricity annually which represent about 3% total annual energy production of Seychelles. The project is being funded by the Abu Dhabi Funds for Development (28mil US$).

Potential

According to 25 years of wind measurements at the Seychelles International airport, the average speed at 10 meters height is 4 m/s. However, the resource assessment carried out for the onshore Port Victoria Wind Farm Project has shown a reasonable wind energy potential with wind speeds around 7 to 9 m/s during the South East Monsoon season. Potential for offshore is assumed to be higher and more favourable.

Future Plans

To undertake further study especially for offshore wind farm to determine full potential. There is also plan to erect wind turbines on the third largest island of Seychelles, La Digue, as part of the Vision 2020 to turn La Digue into a green island.

4.5 Geothermal Energy

Seychelles does not have geothermal energy.

4.6 Other Possibilities

Wave / tidal / Ocean Thermal Energy Conversion (OTEC)

Very little work was carried out in these fields. With the ocean area of over 1.3 million sq. km, one would think that this can be a promising opportunity for Seychelles and one which we can exploit in the future.

Waste-to-energy

A 2009 analysis of the landfill in Mahe investigated the possibility of methane recovery, which could provide electrical production: approx. 1MW capacity. In addition, we have an on-going Waste-to-Energy (WtE) project on the main island of

Seychelles. Operation of the WtE plant has been scheduled for commissioning in 2013.

5 Renewable Energy Incentives

5.1 Incentives

Recent amendments to existing tax legislation have had a direct and beneficial impact on renewable energy in the country. Currently, imports of technologies for non-renewable energy production, such as diesel generators, are subject to a 15% tax rate under the Goods and Services Tax Act. Amendment 3 to the 2010 regulations of the Goods and Services Tax Act of 2001 (Regulation 163F) state that "Goods imported to be used in the process of conservation, generation or production of renewable or environment friendly energy sources, as endorsed by the Seychelles Energy Commission are exempt from Goods and Services Tax". A similar exemption for renewable energy technologies is offered in the 2010 "Promotion of Environment Friendly Energy Regulations" under the Trades Tax Act.

The Energy Bill which is currently being prepared will make provision for the adoption of schemes for the promotion of renewable energy sources, including Feed-in-Tariffs, Power Purchase Agreements, Quota obligations and creation of Funds.

5.2 Clean Development Mechanism and Carbon Tax

There is no designated national authority for CDM in Seychelles however the Energy Bill will make provision and will recommend the establishment of a designated national authority within the Ministry responsible for environment.

6 Challenges, Constraints and Barriers to Renewable Energy Development

There are three major barriers and they are as follow:

Policy, Legal and Institutional barrier: Most of the early policy initiatives on renewables in the Seychelles were driven by past oil crises especially that of the 2007-2008. In response to the crises, the government has taken steps such as mentioned previously to develop and promote sound energy policies, including those that foster the development of RETs. The Seychelles Energy Policy 2010-2030 is not a traditional policy or planning document and does not a clear-cut policy on the development and promotion of RETs. PUC is the sole authorized supplier of energy to the national electrical grid, and there is no legal / regulatory framework or

administrative mechanism in place that allows for independent power producers to access and feed power into the grid. The existing PUC Act does not contain any directives regarding renewable energy, nor does it include any provisions to allow for third party energy generation, or entry and sale of this energy to the grid. Moreover, neither financial incentives nor a feed-in tariff system are in place to support independent power producers, and the current tax code and energy-related legislation do not provide authorization for such programs. On the institutional side, despite the recent creation of a Seychelles Energy Commission (SEC), institutional responsibilities remain incomplete, unclear, and in some cases, overlapping. The functions of the SEC, as defined in the Energy Commission Act, designate the SEC as an advisory board, and although it states that one of the functions of the SEC is "to implement and enforce the energy supply laws, to review other laws relating to energy and to make recommendations for the legislation to the Minister", the Commission has no regulatory and/or enforcement powers under the Legislative Framework proposed by the National Energy Policy. Last but not least, there is no independent regulator of the electricity sector in the country.

Technical barriers: There is very limited technical and institutional capacity and experience with RETs in the Seychelles. It is very important to have the technical know-how in the utilisation of RETs and the whole technology in general. Previous experience with solar water heaters in the country has revealed that without adequately trained technicians to service and repair equipment, the equipment will quickly fall into disuse. In context of the RETs, there are technical barriers like limited land/ space for PV or Wind farm hence no firm and reasonable power, drought period affecting hydro potential, cloudiness affecting PV.

Financial barriers: The Government of Seychelles is keen to develop the utilization of RETs, but it has not done so because of a continued lack of investment capital, a situation that has become steadily worse in the past decade with the increasing debt burden. And with the Government currently participating in an IMF-sponsored economic reform process, the likelihood of significant capital for new power generation capacity in RETs is low. The private sector on the other hand has also faced constraints to adopting PV technology. The small market size limits economies of scale, while the isolated location of the country greatly increases transport costs. The Government has expressed its willingness to implement financial incentives (e.g. purchase and tax rebates, concessionary loans, etc.) to support renewable energy, but has no experience in this area, as well as little technical expertise in assessing RETs or selecting from among various financial incentive models, and thus has yet to make progress in this area. Another barrier to the adoption of RETs is the lack of financing mechanisms to allow purchasers to pay the high up-front costs associated with such systems; to date there have been no bank loans for renewable energy technology programs / projects in the country.

7 Lessons Learned, Observation, and Conclusion

The issue of energy is one that is critical for Seychelles and its future. And RETs have an important role to play in Seychelles's energy sector. With the right approach, the renewable energy industry can become a major player in the energy sector, and meet a significant proportion of the country's energy needs. In addition, RETs, as well as being clean, can play a major role in our national development in terms of job creation and income generation.

Also, since the level of technical expertise is a key prerequisite for the successful implementation of RETs, capacity building and training programs are required. Some of the previously mentioned barriers to RETs development need to be addressed.

A2.15 SUDAN

1 Renewable Energy Regulatory Framework

The main resources used are non-commercial - i.e., fuel wood and agricultural residue. In Sudan, work on renewable energy started in the early eighties. It includes solar technologies, PV and thermal conversions. Biomass technologies were based on biogas and producing briquettes of agricultural residues. Sudan possesses a relatively high abundance of solar radiation, moderate wind speeds, and hydro and biomass energy resources.

The first national energy resources assessment included the sources of new and renewable energy (i.e. solar, wind, non-woody biomass and micro-hydropower). That assessment and for the first time revealed that Sudan is rich in abundant sources of new and renewable energy which if properly utilized could contribute to solving the bottle necks in energy supply in many sectors, particularly in alleviating energy supply problems in rural areas.

Programs / projects that use renewable energy have been given top priority in the government policy and the financing of such programs.

National Energy Policy

The Ministry responsible for Energy is composed of three (3)l regulatory institutions which are responsible for implementing energy policy and these are:

i. Electricity: Electricity Regulatory Authority.
ii. Petroleum: Sudanese Petroleum Corporation.
iii. Mining: Public Geological Research Authority.

The government formulates its renewable energy policies by using a participatory process between relevant ministries and relevant stakeholders for each policy field. It sets the direction for the development of the energy in order to meet the national development goals in a sustainable manner.

The renewable energy policy objectives are:

- To review the current status of renewable energy development in Sudan.
- To assess the prospects and propose a master plan for policy development and systematic implementation of programs for promoting and commercialization of renewable energy applications including appropriate institutional structure and linkages.

- To facilitate through a master plan, a progressively increasing contribution by renewable energy sources as part of the national energy balance and thereby helping to improve on conventional energy; thus, leading to environmentally sound and sustainable development.

5.2 National Energy Policy with Reference to COMESA

Sudan's energy policy objectives are designed around the COMESA Model Energy Policy Framework. New policy developments will ensure that the ultimately Sudan's energy policy is harmonized with COMESA's energy policy model. When considering the Sudan's energy policies, two different periods should be considered. The first is the period before oil production and export – that is prior to 1999. This period was characterized by energy shortages and power blackouts. The dominant feature in energy policies was the security of energy supply to consumers. During this period the high usage of firewood for energy led to big losses in Sudan's forest as well as to desertification.

The second period started in 1999 when Sudan became an oil producing and exporting country. In this period the policies focused on rehabilitation of the energy sector, implementation of huge hydropower projects and the encouragement of the use of gas instead of firewood and charcoal. The measure was intended to protect the local environment. In Sudan, forests depletion and desertification is one of the of the primary environmental issues.

3 Renewable Energy Strategy

Table below shows the outline national policy development on renewable energy.[26]

Year	Additions Description	Number Of Units	Unit Capacity (Mw)	System Installed Capacity (Mw)	Available (Mw)
2012	Sennar Hydro(retired)	2	-7.5	-15	-13.5
	Nyala Wind	24	0.85	20.4	0
	Khartoum solar	1	10	10	0
	Dongola Wind	60	1.67	100.2	0
	Sennar Hydro	2	13.5	27	24.3
2014	Port Sudan Wind	72	2.5	180	0
	Waste Energy Khartoum	1	50	50	42.5
	Khartoum Solar	1	40	40	0
2016	Port Sudan Wind	20	2.5	50	0
	Sennar Hydro (Matrix)	1	50	50	45

[26] Source: Ministry of Electricity and Dams Ministry of Electricity and Dams

Year	Additions Description	Number Of Units	Unit Capacity (Mw)	System Installed Capacity (Mw)	Available (Mw)
	Upper Atbara (Sitate) Hydro	4	80	320	288
	Khartoum Geothermal	2	50	100	85

Table A2.9.1 – Sudan Energy Targets

4 Status of Renewable Energy Development and Future Plans

Sudan is characterized by a variety of energy resources and most of them are still unexploited. Sudan's renewable energy development is still very low; though the potential is good as discussed below.

Conventional energy is available – mostly in the North – and increased supply only started with the discovery of oil. Electrification in the South is still very low at the moment. The application of new and renewable sources of energy available in Sudan is now a major issue in strategic planning for alternatives to fossil fuels to provide part of local energy demand. The country is has significant oil reserves and is progressively distributing the oil / energy to its people.

4.1 Hydro Power

Hydro power supplies are less than 10 % of Sudan's energy requirements.

4.2 Biomass

Biomass represents quite significant percentage of the Sudan Energy Balance. In 1995 biomass contributed 78% of the energy mix in the form of woody fuels i.e. Charcoal and firewood. The bulk of this is wood from the forest, which has led to massive deforestation. The discovery of oil has somewhat reduced the extent of deforestation, but large areas in the Sudan – particularly the South –do not have access to electricity and oil based alternatives are expensive for the majority of the population. This is expected to change with the division of the country and as the South Government has the obligation to make resources available to its population.

4.3 Solar Energy

Sudan is rich in solar energy with daily solar radiation and sun shining availability for more than 10 hours throughout the year. Research and development on solar energy began in Sudan forty years back at the level of the universities. This has not trickled down to project implementation. The research and field applications proved that the utilization of solar energy may contribute significantly to solving the energy problems in Sudan rural areas, particularly for community services (schools, health

centers, clubs, mosque, etc. The separation of Southern Sudan led to remarkable increase in the governmental concern & willingness to support renewable energy. The reason could be that Southern Sudan lags behind the North in energy supply to households.

4.4 Wind Energy

Sudan is considered to have a low to medium range of wind energy resource. The coastal site (Red Sea) is the most promising, with annual average wind speed of 6.5 m/s. Also the North States (Karema & Dongola areas) are also good sites. They have average annual wind speeds of 5 - 5.5 m/s. Khartoum and central states have annual average wind speeds of 4 - 4.5 m/s. West States have annual average wind speeds of 3 - 3.5 m/s.

Wind energy in Sudan is currently used for pumping water from both deep & shallow wells to provide water for drinking and irrigation through the use of wind pumps. This application is presently applied in the North, Khartoum, Central Butana and Nile States. The attractiveness of wind pumps is that they can be manufactured completely from local available materials. However, the electricity generation from wind is now under progress with a number of wind farms at the tender stage; none so far has been developed. Southern Sudan is not suitable for wind energy applications.

4.5 Geothermal Energy

No detailed studies of the potential of the geothermal as a source of energy is being carried out in Sudan, but the following sites are thought to have a significant potential: Jabel Mara Area, Volcanic territories, Suwakin, red sea.

4.6 Other Possibilities

Currently, municipal solid waste energy has not been harnessed to generate energy.

5 Renewable Energy Incentives

5.1 Incentives

A number of financial incentives are available for the installation of renewable energy and conversion technologies. These incentives are significant because they often make the difference between a non-viable and a viable project - thus influencing profitability and viability. Careful thought should be put into determining which incentives apply to each new project, and how to best take advantage of such incentives.

Although the state does not have a program at this time that provides funding of renewable energy equipment on an individual basis. Availability of financial conditions is the most important catalyst for the growth of renewable energy projects.

The details of the incentives are outlined in the national renewable energy policy/regulations.

5.2 Clean Development Mechanism and Carbon Tax

Sudan ratified the kyoto protocol in 2005. There are no plans up to date to introduce carbon tax. The DNA contact details are:

The Higher Council For Environment and Natural Resources
P.O. Box 10488, Tel: 0183784279. Fax: 0183787617
e-mail:hcenr2005@yahoo.com

6 Challenges, Constraints and Barriers to Renewable Energy Development

There are many challenges facing renewable energy projects in Sudan, including:

i. Lack of appropriate strategies and comprehensive level of government and the private sector to finance renewable energy projects.
ii. Absence of policies, legislation and laws for attracting investment in Sudan.
iii. Lack of regulation and institutional coordination at the level of Sudan for projects that aim to benefit from renewable energies.
iv. The absence of the role of government and private companies in the promotion of renewable energy activities.

Thoughts and recommendations on how the above challenges can be overcome:

i. Improve the planning capacity at the national and regional levels to the development of renewable energies.
ii. Preparation of qualified human frameworks and to employ renewable energies in electricity generation, and conduct training for them in cooperation with regional and international experiences.
iii. Encourage the use of solar energy as the most abundant in Sudan.
iv. Government must be support for banks to lend long-term benefits of a few of the investors in the field of renewable energy.

v. Create an environment for the recruitment of industrial uses of renewable energy and encourage scientific research and technology transfer between countries.
vi. Benefit from the experiences of countries that have experience in the use of renewable energies.
vii. Activating the role of legislatures to enact laws that encourage investment in renewable energies.
viii. Develop information that defines the citizen and the importance of renewable energies.

7 Lessons Learned, Observation, and Conclusion

Sudan from countries with weak experience in the field of renewable energies and but the most important lessons that must be taken into account in the projects of new and renewable energies is the coordination between different institutions for the advancement of renewable energy technology in Sudan. We do not have lessons learned in carbon tax because we do not have a Clean Development Mechanism project up to now.

There are factors that encourage the use of new and renewable energies at the national level and regional:

i. The abundant availability of renewable energy resources – that is solar energy, wind energy and biomass energy.
ii. They alleviate the growing burden on conventional energy sources.
iii. The development of new technology that can be manufactured locally, thus creating jobs.
iv. The new energy and renewable energy are easy to install, maintain, and operate.
v. The global trend is to invest in of renewable energy to meet the needs of the future of energy. Such investment lead to new jobs.

A2.16 SWAZILAND

1 Renewable Energy Regulatory Framework

The Ministry completed a comprehensive implementation strategy for the National Energy Policy, with the assistance of the European Union , under the European Union Energy Initiative (EUEI) on Poverty Alleviation and Economic Development, in partnership with European Union Partnership Dialogue Facility.

This National Energy Policy Implementation Strategy project commenced in July 2007 and was completed in October 2009. The Strategy outlines the concrete actions and clear programmes and methodologies required in the implementation mainly of the Poverty Reduction Strategy and Action Programme. The strategy will focuses on realistic fulfilment of the energy policy statements and elaboration of strategies as well as a time frame for implementing the policies during the short and medium/long term in line with the National Poverty Strategy.

The policy recommends programs for liberalising the energy markets and on how the reforms could improve the expansion of access to energy services for the poor. In essence, the policy acknowledges that addressing poverty alleviation for sustainable energy means finding technological and institutional innovations that can lower the costs of obtaining and using energy services, and tailoring these services to the requirements of low income households and communities.

2 National Energy Policy with Reference to COMESA

Swaziland's energy policy is a comprehensive document that embraces most the issues contained in the COMESA Model Energy Policy Framework. The policy was developed using local and international expertise and was benchmarked against progressive energy policies that embrace the use of renewable energy.

3 Renewable Energy Strategy

The concern on Climate Change and diminishing power capacity and be addressed through renewable energies. Renewable energy offers nearly unlimited supply of energy if one considers the energy needs of mankind compared to the energy we receive from the sun. Renewable energy resources include traditional biomass e.g. firewood, wood-waste from the forest industries, bagasse from the sugar industries; hydropower from water and new renewables such as solar and wind. There is a significant scope for increased renewable energy use in Swaziland. Renewable energy will play an important role in the world's energy supply in the near future mainly because of environmental concerns associated with conventional energy use.

The Ministry will therefore continue to initiate, implement and support renewable energy projects and initiatives.

The Ministry of Natural Resources and Energy formulated a strategic framework and Action Plan with regards to renewable energy development in the country to address access to energy.

The Government of Swaziland seeks to: -

i. Develop a renewable energy information programme and will establish and maintain an appropriate renewable energy information system.
ii. Establish a centre for demonstration and education on renewable energy and sustainable energy
iii. Encourage and enhance, where applicable, topics on renewable energy and energy in general in educational and training curricula.
iv. Maximise the use of renewable energy technologies wherever they are viable
v. Promote greater understanding and awareness of renewable energy resources and the associated technologies;
vi. Develop and maintain accurate renewable energy resource data and make it available to all, so as to make informed policy decisions regarding sustainable energy use and supply.
vii. Develop woodlots in areas where there is an acute fuel wood shortage.

4 Status of Renewable Energy Development and Future Plans

4.1 Hydro Power

Swaziland has three small hydro power stations, namely:

i. Edwaleni hydro power station;
ii. Ezulwini hydro power station; and,
iii. Maguga hydro power station.

This power station based on man-made dams. They do not have the capacity to supply the base load. They are essentially used on full capacity during the maximum demand period and usage outside this 5 hours per day period is dependent on the level of the dam. In rainy seasons, they provide a lot more power than during dry seasons.

Future Plans

The goal for the MNRE is that access to electricity is made available to all citizens of the country by 2022. The MNRE has established a database on the potential of

developing mini-micro hydropower electricity schemes. The target was to pin point specific sites around the country where the river basin that exist can be used to generate electricity and further quantify the cost related to establishing the respective electricity schemes. A report was produced from the study and 35 sites were identified. The capacity of the schemes identified ranged between 0.032MW to 1.525MW.

A desktop approach was used to identify these sites hence there was a need to further investigate the sites and quantify the capacities practically. The Ministry in 2006 engaged the consultants to investigate two sites that were seen to be having a high capacity at a reasonable cost. The sites were along the Ngwempisi River. The objective of the Ministry was to develop one these sites into a pilot project. Unfortunately, before the study was completed the consultants noted that the environmental conditions would not permit that either of these sites could be developed into the pilot project. The river was found to be one of the rivers that is protected as it still has its habitat intact and undisturbed.

The MNRE then changed the scope of the consultants to now determine from the remaining sites the feasibility of developing them into the electricity schemes. The study will cover the environmental investigations, and the actual cost that would be required to develop each of these sites. With that information, it would be then possible to identify the right project to be used as a pilot. The report will further rank the sites according to their capacity, cost and impact to the community should the site be approved as the pilot project.

The three sites identified were Mbuluzi, Lusushwana and Mnjoli Dam. In the feasibility study all these sites were investigated and ranked accordingly. Mnjoli was cheaper to develop compared to the other sites as a result Mnjoli has picked as the pilot project site. The developments are on-going to build a 0.5 MW mini hydro scheme at Mnjoli Dam.

4.2 Biomass

Swaziland has abundant sources of waste from agro-industries that could be used for power production. These industrial wastes include bagasse from processing sugar-cane and wood-waste from the timber processing industries. A pre-feasibility study for a 100 MW bagasse-fired power plant concluded that a 54 MW plant could be built at Simunye sugar factory, an 85 MW plant at Mhlume sugar factory and a 30 MW plant at Ubombo Sugar Plant. A study (2007) was conducted by AFREPREN/FWD, supported by the Global Environment Facility through the United Nations Environmental Programme and the African Development Bank under the Cogen for Africa project, indicated that the potential for cogeneration in Swaziland

can be as high as 185 MW. Indications show that the bagasse and wood-waste may have to be supplemented by other forms of fuel such as coal and Natural Gas.

Detailed feasibility studies are proposed that will investigate and define in sufficient detail a series of measures that might prove beneficial for the future utilisation of commercial firewood (or fuels derived from agro-forestry residues).

Following these investigations the proposed measures can be tested as a pilot project, limited to certain regions initially. The specific activities include:

i. Developing commercial cooking fuel distribution.
ii. Woodstove performance enhancement
iii. More efficient use of biomass.

The Programme for Basic Energy and Conservation concentrates on low-income biomass energy users. ProBEC's first component consists of the promotion of efficient energy devices, primarily associated with cooking, such as, wood-fired and charcoal stoves, solar cookers and heat retention devices. In order to do this, ProBEC adopts a commercial approach. In order to develop a market, ProBEC builds capacity by training producers to manufacture energy saving cooking devices and in parallel, ProBEC stimulates the demand for these devices through raising awareness to potential users.

Measures to counter the deforestation in the country through investigations in the wood fuel market chain in the country, the possibility of licensing wood fuel sellers, alternative cooking fuel options and wood lots pilot projects in areas of acute wood fuel shortages, are under development.

4.3 Solar Energy

Solar Energy has great potential for widespread use in Swaziland. Experience through Pilot Projects has demonstrated that careful planning and consultation when developing rural solar installations is very important. In particular, community participation and ownership are key ingredients to success and sustainability. Investigations are underway with a view to developing a large-scale grid-connected demonstration PV plant in Swaziland.

Preliminary investigations have shown that there is a large potential for the use of SWH in residential and commercial buildings. Presently, water heating in residential and commercial buildings is carried out through electric water heaters, which in turn creates a large electricity demand that could otherwise be reduced. A reduction in maximum demand is particularly important for Swaziland because it import approximately 77% of its energy. Government encourages a wider use of SWH in

residential and commercial buildings through promotional means for private sector initiatives. The SWH program has not really taken of as the market and use of SWH is relatively still very low in Swaziland.

The MNRE is currently undertaking a feasibility study and Action Plan for a solar energy programme for the country. The study will look at the sustainable use of solar technologies in the country. Funding is being sought for a solar schools programme to develop and implement a programme for electrification of ten schools in rural areas using solar technologies.

Pre-Electrification Using PV Systems

This programme involves the electrification of remote areas where it is still too costly to bring in grid electricity. It will involve the evaluation of private sector participation and identify possible areas for co-operation in the marketing and distribution of solar home power systems. This programme will also be undertaken with the local utility, (Swaziland Electricity Company) to test the technical, financial and operational feasibility of offering solar home systems in lieu of the main electrical connections as well as enlightening the public on how the two technologies complement each other. It is anticipated that the cost of solar photovoltaic systems will continue to fall; yet even at present prices it still makes economic sense to use solar electricity for small applications such as lighting. An important aspect of the project would be to investigate ways in which the private sector can assist in the project perhaps by operating as sub-contractors.

Government and the utility will work together on technical requirements for PV systems to ensure that electricity and solar systems are able to coexist and complement each other.

4.4 Wind Energy

For maximum, cost-effective use to be made of renewable energy resources, a comprehensive knowledge of the resources is required. In Swaziland, there is a considerable lack of such resource data. This makes it difficult to design cost effective renewable energy systems and to plan for the integration of renewable energy into the national energy balance. To assist in system sizing, economic viability assessment and evaluations, a solar and wind resource monitoring programme should be initiated. The Ministry is working in close collaboration with the National Meteorological Service, on this programme, to determine whether there is any realistic potential for effective utilisation of solar and wind energy in the country.

A wind and solar resource monitoring programme has been initiated to focus on the Lubombo Plateau plus one other moveable station for identifying areas that are particularly windy to make an accurate assessment of the wind power generation potential. Local funding will be required to monitor the project and to obtain external assistance when preliminary data is being analysed during the plan period.

There is an ongoing project that will install wind measuring equipment at strategic points along the Lubombo Plateau for data collection regarding wind power generation.

4.5 Geothermal Energy

No studies have been done on Swaziland's geothermal potential. The size of the market and the complexity of geothermal technology does not make this a viable option at this stage. There are known potential geothermal sites around Ezulwini.

4.6 Other Possibilities

The two major cities, Mbabane and Manzini have the largest waste dump sites – both of which are near capacity. However, by world standards these are relatively small and as such municipal solid waste based renewable energy has not been explored.

5 Renewable Energy Incentives

5.1 Incentives

Swaziland does not yet offer incentives for renewable energy. However, the research work done by the government on RE potential – particularly solar is a form of subsidised research. Government does offer financial assistance for rural electrification – be it based on the main grid at the moment. The same funds could be used to assist promoted RE, particularly solar. The relatively high electricity prices and declining costs of PV systems (worldwide) could make solar energy cost effective in the short-term.

5.2 Clean Development Mechanism and Carbon Tax

Swaziland's production is primarily hydro – thus, the opportunities for benefiting from CDM are limited. As previously indicated, some 77% of the energy is imported and the supplies are primarily thermal power stations.

Swaziland does not impose carbon tax and the potential to do so in the future appear to be remote as it would discourage foreign direct investment.

6 Challenges, Constraints and Barriers to Renewable Energy Development

No additional Information available other than what is discussed above.

7 Lessons Learned, Observation, and Conclusion

Swaziland has invested in policy development and the MNRE's investigations and studies on RE will act as a catalyst on the development of:

i. Additional hydro power stations.
ii. Biomass energy in all the sugar mills – following the successful commissioning of Illovo bagasse based power generation.
iii. Solar energy for the rural areas, where the grid is currently an expensive source.
iv. Use of SWH which will reduce peak hour maximum demand.

A2.17 UGANDA ELECTRICITY INDUSTRY

About 97 per cent of Uganda's population does not have access to electricity. Load shedding remains rampant countrywide and prospects for a lasting solutions are not in the horizons as Benon Herbert Oluka reports. Electricity consumers will continue to pay for expensive thermal power for the unforeseeable future, according to a study.

The finding is based on delays experienced in the development of more than half of 28 mini hydro power, biomass and solar power projects licensed by the Electricity Regulation Authority between 2007 and 2009. The projects are expected to produce a total of 700 megawatts of electricity, nearly two times the current peak demand countrywide.

However, mini projects with the potential to produce a combined total of 230 MW – nearly the same capacity expected to be generated at the Bujagali Hydropower Project after its anticipated completion next year – are running behind schedule, according to the ERA study that was released in January 2010.

The study, titled: Status of Electricity Projects under Development, reveals that three of the developers had not carried out feasibility studies or other initial activities by the time their one year permits expired. Another five are yet to fulfill all requirements for acquisition of permits and cannot, therefore, start any work. For others, the delays have been occasioned by a series of setbacks, including increasing development costs, delays in sourcing sufficient funding and difficulties in connecting to the national grid.

The ERA is of the view that the delays are likely to affect long term national planning and lead to the continued use of tax payers' money by the government to subsidise the production of the more expensive thermal electricity. In 2010, the government spent about US$ 51 million per annum to subsidise electricity prices. The delay will impact on Uganda because it shall continue to use expensive power. About 150 megawatts of the current power is thermal. The Electricity Regulator wants that to be removed. They want to replace expensive thermal starting with Aggreko and then eventually other thermal plants.

Over the years, Uganda has suffered from power shortages exacerbated in recent times by significant reductions of water levels on Lake Victoria. Attempts to alleviate the situation with thermal power have only led to increased tariffs for both domestic and commercial / industrial use.

Aggreko produces 50 MW of thermal electricity in Jinja District, which the government plans to phase out as soon as there is a cheaper and cleaner source of electricity. This will be followed by the 50 MW plant in Mutundwe, which will be shut down once the three-year period that the World Bank is financing it ends. However, the one plant at Namanve will be maintained for use during peak hours.

Four of the mini hydro power projects are expected to be ready within the next year. They include Buseruka project in Hoima District, which is being developed by Hydromax Ltd to produce 9 MW, the Mpanga project in Kamwenge District - that is being developed by Africa EMS Mpanga Ltd to produce 18 MW - and the Ishasha project in Rukungiri District that is being developed by Eco Power to produce 7 MW. The other is the thermal plant at Kaiso Tonya, in which Tullow Oil and Jacobsen Elektro have partnered to produce 52 MW.

The West Nile Rural Electrification Company, which is developing a 3.4 MW plant at Nyagak in Nebbi District, has resolved the problems that had derailed it and could be ready early this year. The Electricity Regulatory Authority report says the hydro power companies whose permits expired and did not apply for extension include: Ziba Ltd (8.3 MW at Kyambura hydro electricity project (HEP) and Bushenyi District.

The other is the Norwegian company Tronder Energie AS (5 MW at Waki HEP, Masindi District), who abandoned the project because of other commitments. Hydromax Ltd, who are about to complete the 9 MW Buseruka project in Hoima District, applied for a permit to develop Waki.

Tronder Energie bought the interest of the 10 MW Kikagati project at the Uganda-Tanzania border from China Shan Sheng International (U) Ltd. The Chinese firm reportedly failed to resolve cross-border issues with the Tanzanian government. According to the ERA, Tronder Energie wants to increase the capacity of the project and applied to review its designs. The biomass/waste project developer, whose permit expired, is Sesam Energetics 1 Ltd (33 MW in Kampala). They intended to generate electricity from garbage in the city but had to shelve the idea following runs in with officials of Kampala City Council. They wanted to work on garbage from the city but for some reason City Council does not want them to touch their garbage. They have been having a problem with people who want to use garbage.

Among the solar power developers, Energy Systems Africa applied to set up a generation plant at Namugoga on Entebbe Road to produce 50 MW but are facing a major stumbling in the form of the tariffs that they propose to charge. They can generate power at 15 cents, if they don't get a subsidy that will be a high tariff - Ugandans cannot afford that price. They are still negotiating with the government to give them some subsidy. The licenced hydro power plants' long term tariff are around 7 cents so that of Energy Systems is twice as much. Solar technology is expensive although it is still cheaper (in Uganda) and cleaner than thermal.

Three other solar developers that have expressed interest in investing in solar power. They are Stewards Net Uganda Inc. Ltd (50 MW solar-PV plant in Kampala), Micro Power Group (0.24MW solar-PV in Mbale, Arua and Lira), and East African Energy Technology Development Network (60kW and 150kW at River Dirigana in Sironko District).

A2.18 ZAMBIA

1 Renewable Energy Regulatory Framework

The 2008 National Energy Policy is the current energy policy for the country. It recognises solar, wind, micro-hydro (mini-hydro), biomass, and bio-fuels as renewable energy[27]. The policy sets as its objective the increase in the utilisation of renewable energies by raising awareness, developing regulatory frameworks, improving technology and provision of fiscal incentives[28].

A Bio-fuels Regulatory Framework is under consideration by the Government which was developed following a consultative process with relevant stakeholders. This regulatory framework comprises the following elements:

i. Licensing guidelines
ii. Pricing methodology
iii. Technical guidelines

This bio-fuels regulatory framework has however only been partially adopted by Government[29] by the announcement of blending ratios. The blending ratios of up to 10% bio-ethanol and up to 5% bio-diesel recommended in the framework have been adopted by Government but these have not been set as mandatory. Technical standards for both bio-ethanol and bio-diesel for automotive application were developed in 2010 by the ERB and Zambia Bureau of Standards (ZABS) in anticipation of blending rations being announced by Government.

National Energy Policy on RE

The 2008 National Energy Policy recognises renewable energies as a source of energy and sets out as one of Government's objectives the increase in the role of biofuels in the national energy mix. The country however does not have a stand alone National Renewable Energy policy.

The Government amended the Energy Regulation Act Cap 436 in 2010 to included biofuels as part of the definition of energy in the Act to allow for the Energy Regulation Board to regulate bio-fuels in addition to other forms of renewable energy such as solar.

[27] Republic Of Zambia, Ministry of Energy and Water Development, *National Energy Policy 2008*, page 2.
[28] *National Energy Policy 2008*, page 14-17.
[29] Energy Regulation Board, 2009 Energy Sector Report p. 42-43

Further the government in 2010 developed the National Renewable Energy Strategy, however this is yet to be published.

There are currently no consolidated reports of statistics on renewable energy sources in Zambia and this lack of information remains ones of the major challenges to the development of renewable energy in the country.

The Energy Regulation Board, through its newly established Renewable Energy Section is attempting to bridge the information gap and it held the first ever Renewable Energy Forum in August 2011, drawing policy makers, researchers and developers.

2 National Energy Policy with Reference to COMESA

Zambia is almost total dependent on renewable energy because over 99 % of its generation sources are from hydro power plants. The Nation Energy Policy encapsulates most of the requirements of the COMESA Model Energy Policy. Additional incentives are required to ensure other forms of RE contribute to closing the growing gap between installed capacity versus demand. This could include solar water heaters incentives and so on.

3 Renewable Energy Strategy

The Government is yet to publish its Renewable Energy Strategy which will spell out the national targets for renewable energy until 2030. A positive indicator for the future of the renewable energy sector in the country is the willingness of Government to provide incentives for the sector such as the waving of taxes.

The Energy Regulator) in the country uses a light handed form of regulation for the renewable energy sector and does not charge licence fees for the solar sector. This is to ensure that the cost of solar equipment is low and thus accessible to many. In additions, the Energy Regulator allows any independent power producer to charge an electricity tariff that will allow for a reasonable rate of return without bench-making such a tariff with the national utility which has not yet attained a cost reflective tariff. Such a model will be applied to the renewable energy sector if any new power generation project from renewable energy do come on line under the present regulatory regime.

4 Status of Renewable Energy Development and Future Plans

The national mix of energy, refers to all forms of energy, whereas the comment above is only for electricity form of energy.

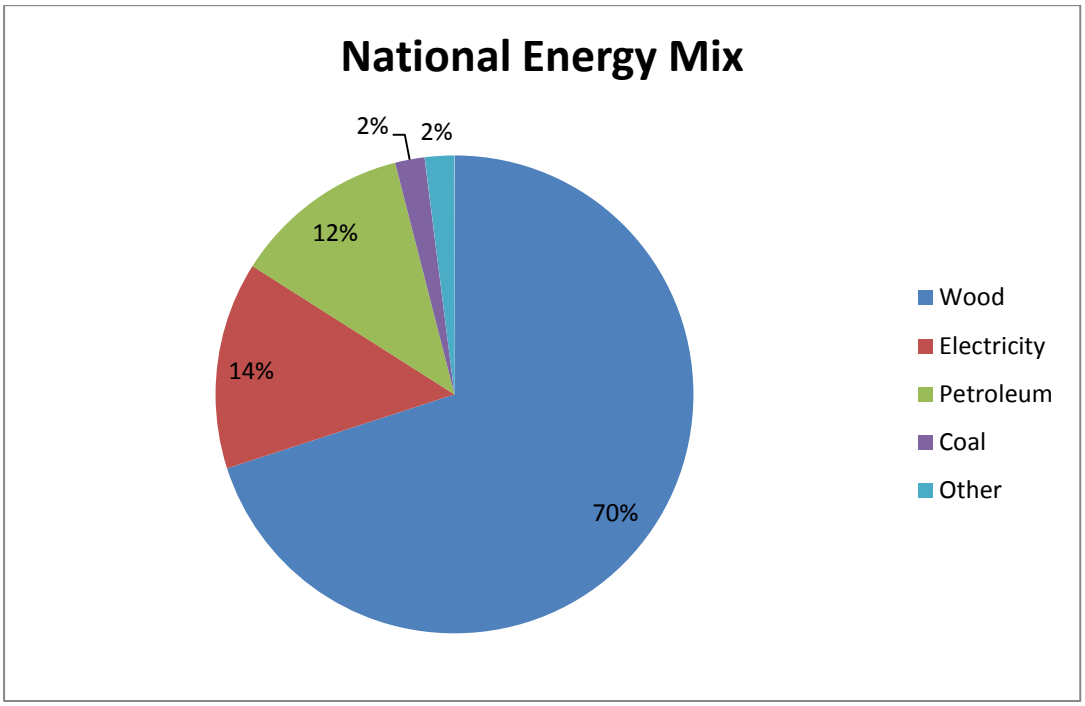


Figure 2.12.1 – Zambia's Energy Mix

4.1 Hydro Power

Hydro Power is the dominant source of electricity generation in Zambia – contributing over 99% of locally generated electricity. Other forms of RE are still in their infancy and do not make a significant contribution to the national energy mix. Government policy in renewable energies has only now started to be seriously considered partly due to the rising cost of crude oil, the power deficit being experienced and advocacy from the private sector.

Future Plans

The Country is estimated to have over 6 000 MW of hydro power potential and less than 2 000 MW has been exploited thus far. Additional investment needs to be attracted to invest in hydro power generation. Since ZESCO is the main off-taker of most electricity generated in the country, the low tariffs are believed to be the main contributing factor for the low investment in generation in the country. Potentially, Zambia should be a net exporter of electricity instead of the current situation where imports are required to meet demand, and power rationing has become to norm in the short-term.

POWER PLANT	CAPACITY (MW)	COMMENT
Kafue Gorge Power Plant	990	In operation

POWER PLANT	CAPACITY (MW)	COMMENT
Kariba North Bank Power Plant	720	In operation
Victoria Falls Power Plant	108	In operation
Small Hydros(4)	24	In operation
Itezhi Tezhi Hydro Power Project	120	Commission in 2014
Kariba North Bank Power Station Expansion (hydro)	360	2012 (extended due to fire at plant)
Kafue Gorge Lower Power Station	750	2014 (start delayed)
Maamba Coal Fired Plant	300	Commission in 2013
EMCO Coal Fired Plant	300	Commission in 2014
Kalungwishi Power	252	Commission in 215
Lunzua Power Plants (Hydro)	14.4	Commission in 2014
Shiwang'andu Mini Hydro Power	1	Commission in 2012

Table A2.12.1 : Existing and planned hydro power projects

4.2 Biomass

Bio-mass in the form of firewood is the predominant source of energy for the rural population. Charcoal is the preferred form of biomass in the peri-urban and urban areas. Even in areas that are serviced with electricity charcoal is still used because of load shedding and the perceived low cost of charcoal compared to electricity.

The Ministry of Energy and Water Development estimate that wood fuel accounts for 70% of the total national energy consumption. It further estimated that households accounted for about 88% of wood fuel consumed which is used for cooking and heating.

At the household level wood fuel consumption is estimated to be about 60.9% and 24.3% charcoal, while electricity accounts for 13.8%.

The only major single bio-mass project is the Zambia Sugar Plc bagasse (sugar cane waste) power plant in Mazabuka, in the southern part of the country that produces 45MW of power for its own use in the sugar plant and estate.

4.3 Solar Energy

Zambia has solar radiation of about 5kW h/m2/day which is suitable for generation of power with solar photo voltaic panels.

Solar systems were primarily used by the state owned telecommunications company and the national radio and television broadcaster for their repeater stations and remote telephone exchanges. Solar systems became widely used in the early 1990s when smaller PV systems for domestics use were introduced in the country.

In 1998, the Government through the Department of Energy, with funding from the Swedish International Development Agency embarked on a pilot project by establishing three (3) Energy Service Companies in the Eastern Province of the country. The three companies Nyimba Energy Services Company, Chipata Energy Services Company and Lundazi Energy Service Company were provided with 50 Wp solar photo voltaic systems and these were installed in domestic dwellings in the three respective areas. The clients paid a fee to the ESCOs for the service but the equipment remained the property of government. In total four hundred (400) by 50 Wp units were installed with NESCO having 100 and both Chipata Energy Services Company Chipata Energy Services Company Chipata Energy Services Company and Lundazi Energy Service Company having 150 units each[30].

The sustainability of the project ,however, proved to be a challenge and it was not expanded after the project ended in 2000. In a study of one of the ESCOs and Nyimba Energy Services Company, it was found that the energy costs of the ESCO clients were higher than the households that did not have the service but the clients nonetheless appreciated the service because of increased light hours which provided opportunities for reading by school children and entertainment through television and radio[31].

The recently launched ZESCO Ltd Solar Geysers Project is planned to free the national grid of 150MW of electrical power especially during peak power consumption times as shown in figure 3 below . This project is in the procurement stage of phase of the project which aims to role out 100,000 solar geysers for free to identified areas.

[30] http://www.erb.org.zm/viewpage.php?page=adtls&aid=13

[31] *Gustavsson M and Elbergard A, (2003) Impact of Solar Home System on Rural Livelihoods. Experiences from the Nyimba Energy Services Company in Zambia.* *http://www.mtonga.se/documents/2004%20RENEWABLE%20ENERGY%20The%20impact%20of%20solar%20home%20systems,%20experiences%20from%20Nyimba.pdf*

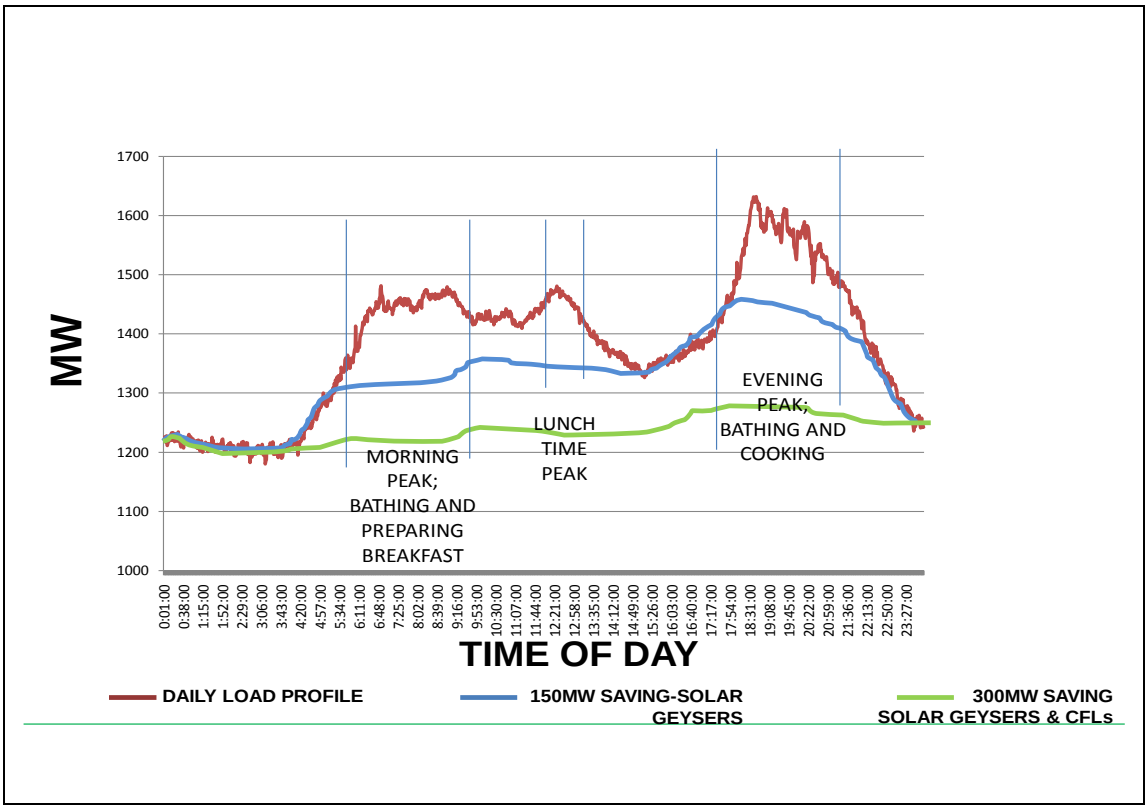


Figure A2.12.2: Electricity Consumption Profile showing impact of Solar Water Heaters

An independent power producer Luangwa Solar Power Corporation is preparing to establish a 5MW solar PV generation plant in Luangwa district for Zambia and if the project goes ahead it will be the first major solar generation plant in the country[32]. The off-taker will be ZESCO Ltd which generates power in Luangwa using diesel generators at close to 35US cents per kilo watt hour. This project is however, at the inception stage and the power purchase agreement, which will be the main determining factor if the project is to go ahead is yet to be signed.

4.4 Wind Energy

The are no plans to introduce wind energy is Zambia's energy mix.

4.5 Geothermal Energy

The country has the potential to exploit the geothermal plant that was installed in 1988 at Kapisya hot springs but was only partially commissioned. It had the installed capacity to generate 0.2MW of power. This site has the potential to generate 2MW

[32] http://wcpsolarservices.com/local_project_team.htm

using Rankine thermodynamic cycle technology. Other sites need to be mapped and accessed in the country for geothermal potential.

4.6 Other Possibilities

The country does not have waste based RE projects at the moment.

5 Renewable Energy Incentives

5.1 Incentives

The Government has provided financial incentives for the solar sector by waving import duty on solar equipment in order to reduce the price of solar equipment. Further, the ERB has waved the licence fees (0.7% of annual turn over) for solar distributors. These two incentives have resulted in an increase in the number of solar distributors from 18 in 2008 to 34 in 2011.

5.2 Clean Development Mechanism and Carbon Tax

The country a signatory of the Kyoto Protocol. Carbon tax (introduced in 2011) is only applied to motor vehicles and the funds raised do not go directly to dealing with reducing or studying carbon emissions in the country. The carbon tax is collected by the national Road and Transportation Safety Agency in the same way road taxes for vehicles are collected.

The greatest carbon emissions are released from the burning of wood fuel at domestic level and from coal used mostly in the mines. Heavy industry are also significant producers of CO_2. There are no indications that the Government is considering additional carbon taxes either than for motor vehicles as mentioned.

6 Challenges, Constraints and Barriers to Renewable Energy Development

There are a number of challenges that are barriers to the development of the renewable sector in the country. The following are some of the major challenges:

i. The lack of clear Government targets for the renewable energy sector in a policy document.

ii. Lack of verifiable information on the available sources of renewable energy in the country. It is clear that there is a lot of research and investment being undertaken in the renewable energy sector but this is not published. Further, as a result of this lack of information there is a lot of debate which is not supported by facts currently going on around issues of the threat to food security by bio-fuels, the environmental impacts of feed stock plants like

jatropha and the proliferation of cheap and sometimes substandard solar equipment from China.

iii. Lack of funding for research in the renewable energy sector. The research being conducted by the University of Zambia, Copperbelt University, the Institute for Scientific and Industrial Research and some other organisations is not adequately funded.

iv. The lack of mandatory blending ratios is sited as the major hindrance to the development of the bio-fuels sector in the country. The mandatory blending rations, it is believed will create a market for bio-fuels in the country.

v. There are currently no special incentives for the renewable energy sector in the form of feed in tariffs for renewable energy sources. This could be responsible for the apparent lack of projects to develop power generation projects from renewable energies.

Recommendations on how some of the above can be overcome.

i. The Government needs to expediently publish the National Renewable Energy Strategy Paper which will set out the national targets for renewable energies for the country.

ii. There must be more collaboration between researchers and producers of bio-fuels with the Department of Energy and Energy Regulator to consolidate information in the renewable energy sector so that there would be verifiable information available for policy formulation, regulation and more importantly investment in the sector.

iii. Funding for research both by Government and the private sector must be increased to ensure that the national debate on renewable energy is based on fact rather heresy and emotion.

iv. The government must declare mandatory blending rations for bio-fuels as soon as possible to create a market for bio-fuels.

v. In countries where renewable energies have made a significant contribution to the national energy mix there has been a deliberate Government policy to have favourable renewable energy feed in tariffs for power generated from renewable. Favourable REFITs must therefore be provided for the sector to develop.

7 Lessons Learned, Observation, and Conclusion

It is clear from this study that there is insufficient and verifiable data on renewable energy in Zambia. There are a number of projects being undertaken but there is no central repository of information on renewable energies.

The Government through the Department of Energy needs to take a more proactive role in the promotion of renewable energies in the country.

There still remains a number of barriers to the development of renewable energies in Zambia and the most significant is the lack of clear policy targets for the country.

It is clear from this study that there is insufficient and verifiable data on renewable energy in Zambia. There are a number of projects being undertaken but there is no central repository of information on renewable energies.

The Government through the Department of Energy needs to take a more proactive role in the promotion of renewable energies in the country.

There still remains a number of barriers to the development of renewable energies in Zambia and the most significant is the lack of clear policy targets for the country.

A2.19 ZIMBABWE

1 Renewable Energy Regulatory Framework

The National Energy Policy was approved by Cabinet in 2010 and is meant to be reviewed soon to incorporate some emerging issues. Renewable energy, though not a stand-alone item in the NEP, has been an issue of national importance since independence in 1980. Early energy sector studies have highlighted the potential of renewable energy to support development. In 1995 Zimbabwe hosted the International Solar Energy Society Conference and the President was elected Chairman of the World Solar Commission. Renewable energy was elevated in the national energy sector discussion with several projects being identified for priority implementation. These projects included a solar village which was established on the basis of a solar powered mini-grid.

The Ministry of Energy and Power Development has a history of promoting renewable energy and energy efficiency. The Ministry still runs a biogas promotion and support program. Efficient wood stoves have also been promoted with over 200 units having been constructed in rural households. Zimbabwe also implemented a GEF Solar PV Pilot project for household lighting. The project saw the installation of 9000 units each equivalent to 45W. Several new solar energy small businesses were established. One lesson from the project was the effect of market distortion from a large public sector project with a limited life and limited funding. The other lesson was the appropriateness of a subsidized delivery mode where the subsidies have short term availability.

Several studies were carried out by SADC, Southern Centre for Energy and Environment, GTZ, African Development Bank, World Bank and others. These studies sought to analyse the barriers to market penetration of renewable energy technologies including policy gaps, technology gaps, financial constraints and cultural norms and values. Pilot projects were carried out to demonstrate various technologies such as solar PV pumps, wind electric machines, solar cookers and solar driers.

The Zimbabwe electricity Supply Authority embarked on a rural electrification program in the mid 1980s. The program was based on priorities set by Government but was financed by the utility. The program stopped after electrification of about 48 rural centres due to shortage of funding.

Government established the Rural Electrification Agency. The main objective was to isolate normal utility electrification from rural electrification that was dependent on

subsidies. The program was financed entirely by an electrification levy, government grants and grants from development partners. Beneficiaries also contributed to the program by collecting contributions for group projects or paying connection fees for individual connections. Solar pv mini grids were installed in some locations and some households and institutions were electrified through solar pv systems. Apart from solar PV and grid electricity there was no other source of electricity used in the rural electrification program.

In 2005 Zimbabwe established the Zimbabwe Electricity Regulatory Commission. The role of the Commission was clearly spelt out as to manage pricing and enable entry into the sector by private investors. This was part of the sector deregulation process which saw explicit rules being spelt out for the participation of independent power producers in the sector. There was however no clear policy advantage spelt out for those using renewable energy. Experience gained with the independent regulatory body has prompted Government to start considering an energy sector regulator to include non-electricity issues.

In 2005 Ministry of Energy and Power Development initiated a process to finalise the drafting of an energy policy which had been on the cards since the early 1980s. The process included confirmation of the potential for energy efficiency improvement through energy audits and a consultative process that included urban and rural sector stakeholders. The energy policy formulation process also benefited from an energy resource assessment study that was carried out by the Ministry of Energy and Power Development. During the process to draft the energy policy it was recognised that there would be need for a policy to cover issues of energy efficiency as well as issues specific to renewable energy. The energy policy includes statements on renewable energy and energy efficiency but does not go into detail on these issues.

The Ministry has gone on to successfully lobby for removal of duties on some renewable energy technologies. Due to the current electricity shortages government lifted duties on diesel generators but had not lifted duty on renewable energy technologies till the representations by the Ministry of Energy and Power Development. There still remain some gaps in terms of levelling the playing field between renewable energy and conventional energy when it comes to duties and taxes. Power utility projects are almost always exempt from duties and taxes and renewable energy projects are not granted the same status. Government is aware of the environmental benefits of renewable energy as well as the potential developmental benefits of adopting renewable energy in remote areas. However there needs to be a more expressive representation to explain the benefits of duty and tax exemption for renewable energy projects and technologies. The main

challenge being validation and monitoring of such projects as similar equipment could be imported for other purposes.

The key objectives of the National Energy Policy are to:

1) Increase access to affordable energy services to all sectors of the economy; through optimal use of available energy resources and diversification of supply options;
2) Stimulate sustainable economic growth by promoting competition, efficiency and investment in the sector;
3) Improve institutional framework and governance in the energy sector to enhance efficiency and energy services delivery;
4) Promote research and development in the energy sector; and
5) Develop the use of other renewable sources of energy to complement conventional sources of energy.

2 National Energy Policy with Reference to COMESA

The National Energy policy for Zimbabwe was structured along the format of the COMESA Model Energy Policy. The outline matches closely that suggested by COMESA and issues of particular relevance to Zimbabwe are highlighted. During the drafting of the policy report the outline suggested by the COMESA model was used as a template.

Zimbabwe has had numerous studies carried out in the energy sector. These include energy sector planning studies sponsored by World Bank and UNDP in the early 1980s, energy efficiency studies carried out by World Bank, UNDP, UNEP, SADC Industrial Energy Management Program, Ministry of Energy and Power Development and GTZ. Such studies highlighted specific issues in the energy sector that remain valid till now. There is quantified evidence and detailed evidence based analysis. The energy policy does not use this information to justify policy statements and strategies. This leaves the report too generic in most sections. Examples are suggestions to improve use of infrastructure where minimum throughput for the oil pipeline, minimum performance of the power transmission network and standards on device efficiency could be stated as these are fundamental to the statements.

The COMESA Framework Policy emphasizes the need for integrated planning. The energy policy for Zimbabwe alludes to integrated planning but does not make explicit statements to this fact. Currently energy prices and energy cost of production point at room for adjustment to encourage conservation and investment. However energy users still complain of high energy cost. The policy could be more

explicit on the pricing policy as well as investment policy needs that would guide integration.

Zimbabwe is highly dependent on coal and petroleum fuels. The global move is to reduce greenhouse gas emissions. Despite the current argument for not sharing the cost of historical emissions, policies that are being adopted by developed countries on technology and emission reduction will inherently affect countries like Zimbabwe that rely on imported technologies and fossil fuels. The policy document does not make a strong statement on environment issues and does not indicate strong commitment to reduce the impact of coal combustion through technology interventions. Explicit statements could be made on the performance of power plant. Issues of sulphur content in diesel and coal could also be made explicit.

It is safe to conclude that the energy policy is a useful document that now needs additional input to either include more specific policy commitments or to draft a strategy document that presents evidence based targets to support the policy statements. The strategy document would evolve faster than the policy document.

3 Renewable Energy Strategy

The energy policy in Zimbabwe does not have explicit targets for integrating renewable energy. The potential is known but the policy statements are general. There are plans to reintroduce fuel blending especially ethanol and gasoline. There are also plans to introduce biodiesel for blending with petroleum diesel. Targets are to achieve 5 to 10% blending ratios in the long term. Biodiesel is meant to be mainly from Jatropher. A program is underway to increase production of jatropher seed. The National Oil Company of Zimbabwe is sponsoring the program. Production of biodiesel is seen as an opportunity for channelling some of the revenue from the energy sector to rural development. A pilot biodiesel plant was installed and initially operated from soya bean. However lack of feedstock has left the plant idle.

The Zimbabwe Power Company, ZPC, a subsidiary of the Zimbabwe Electricity Supply Authority, ZESA, plans to develop small hydro plants with a capacity beyond 10 MW. Those sites with a lower capacity have been left to the Rural Electrification Agency. Both organisations have carried out feasibility studies to develop the first four sites. There is no target for renewable energy in the grid but small power plant have been drawing attention as they do not require large upfront financing and are also closer to the energy users.

Reduction of duties and taxes is said to have been approved by cabinet. Diesel generators had their duty lifted as a way to help alleviate the current energy

shortages but importers of renewable energy equipment are not clear on how to access the approved duty exemption. Information is that the Ministry of energy and Power Development has to participate in clearing each consignment.

4 Status of Renewable Energy Development and Future Plans

Most of the energy used in the country is based on biomass fuels mostly used by rural households. The national energy balance was last produced in 2000 and looked as follows;

TYPE	TJ
Coal	44 478
Ethanol	0
Jet A1	2 672
Gasoline	13 593
Diesel	19 921
Avgas	26
LPG	54
Paraffin	2 469
Electricity	37 757
Charcoal	9
Wood	13 5931
TOTAL	**256 910**

Table 2.13.1: Energy Balance (2000)[33]

Since 2000 the depressed economic performance has led to a suppressed energy demand especially electricity and coal. Petroleum fuel consumption has continued to rise due to a growing vehicle fleet. Despite the suppressed demand for electricity there is a major shortage of grid electricity with load curtailment options being employed to manage grid integrity.

Zimbabwe is a member of the Southern Africa Power Pool but there is inadequate capacity in the member countries which are also employing load shedding to manage their supply situations. Rural electrification programmes continue to extend the grid into rural communities. The pace of electrification has however slowed down due to limited finance. Consideration of alternative sources of energy continue as part of the effort to improve energy supply to rural communities. The Rural Electrification Agency, a government agency for rural energy supply, has plans to upscale use of renewable energy for rural development.

[33] Source: Zimbabwe Ministry of Energy and Power Development

4.1 Hydro Power

Renewable energy is dominated by small scale hydro power plants that are installed to supply energy to remote sites and rural homes. There is limited but growing use of larger systems for productive energy. Most systems were installed with grant funding from donors. Technologies that are in use include small and micro hydro, solar PV, biogas for households, sugar bagasse cogeneration and sawmill waste cogeneration and sawmill waste steam production. Wind power is used in few sites where low speed machines are used for pumping water. In this discussion large scale hydro is not included.

SITE	CAPACITY (kW)
Rusitu	750
Nyafaru	18
Chipendeke	24
Claremont	250
Inyanga	1 000
Svinurai	10
Mutsikira	3
Aberfoyle	25
Sithole-Chikate	25
Kuenda	75

Table 2.13.2 : Existing Small and Micro Hydro Installations[34]

Most of the small and micro-hydro installations in the country are in the Eastern Highlands. The windward side of the mountains have a wet climate with perennial streams and rivers and precipitation throughout the year. This offers an opportunity for small hydro development. There is more hydro activity on the Mozambique side of the border as individuals and private enterprises rely on small hydro power for electricity. The technologies employed range from water wheels to commercially produced turbines. Practical Action Southern Africa has been working to improve dissemination and upgrade of the technologies. They have installed several micro hydro schemes mostly owned and operated by rural communities in the area. Government through ZESA is keen to support development of small hydro power plant to augment grid electricity. Legislation is now in place to enable increased private ownership of power generation plant.

Future Plans

[34] Source: Zimbabwe's Energy resource Assessment

The Zambezi river, South Bank, has a potential for five large hydro power station. Due to a shortage of Capital and low level private sector investment, these hydro power sites have not been studies in detail with a view to develop them. The potential hydro projects are listed below.

SITE	CAPACITY (MW)	CAPACITY (GWH)
Kariba South Bank	300	-
Katambora	390	2 000
Batoka	800	4 370
Devil's Gorge	600	3 000
Mupata Gorge	600	3 000

Table A2.13.3 : Hydro Potential on the Zambezi (South Bank)[35]

Hydro power potential for inland rivers and dams is highlighted in the tables below.

SITE	CAPACITY(MW)	CAPACITY (GWH)
Rusitu II	4.5	30.7
Rusitu	1.0	7.2
Duru	2.3	6.0
Tsanga	3.3	8.0
Gairezi	30.0	70.0

Table A2.13.4 : Zimbabwe Hydro Potential on Inland Rivers[36]

SITE	POTENTIAL (KW)	MWH
Mazowe	170	740
Sebakwe	820	3590
Mutirikwe	5 000	26 670
Bangala	5 510	24 130
Manjirenji	1 430	6 260
Ingwezi	110	480
Mwenji	250	1090
Lesapi	200	880
Upper Ncema	150	660
Manyuchi	1 400	5 000
Siya	650	2 850
Ruti	880	3 850
Ngezi	450	1 970
Mazvikadei	980	4 290
Biri	750	3 280

[35] Source: Zimbabwe Energy Resource Assessment
[36] Source: Zimbabwe Power Company

SITE	POTENTIAL (KW)	MWH
Masembura	100	440
Arcadia	120	530
Mteri	180	790
Mundi Mataga	100	440
Lilstock	100	440

Table A2.13.5 : Hydro Potential Sites on Inland Dams[37]

4.2 Biomass

The sugar industry has traditionally produced electricity for own consumption. Bagasse from sugar milling is stored and used to fire boilers. The steam is used for generating electricity before being sent to the mill for sugar processing and refining. Currently the two sugar mills in the South Eastern part of the country employ 40 bar boilers to supply steam to a total 45MW of power generation equipment. Each mill demands about 15MW during the milling season and can send about 5MW to the grid. The tariff agreement is for banking power therefore the mill gets to draw power from the grid at a lower tariff during the off season. Attempts to secure better tariffs to enable increased power export is meeting with various administrative and technical barriers in negotiating with the utility.

A new sugarcane production and milling facility has just been constructed. The objective of the plant is to produce only anhydrous ethanol from cane and to use bagasse to produce electricity. The plant will use 14MW of the electricity and export the balance, about 4.5MW, to the grid. In the long term the plant will produce more electricity for export to the grid. The boiler pressure is 44 bar which if increased to 80 or 100 bar would enable production of about double the electricity output. This would entail replacing the boiler plant and some of the steam lines. The project faces the same problems with negotiating a power purchase agreement as the other sugar mills. The challenges are motivated by a government controlled retail tariff and a legal framework that subsidizes the public utility and not the private power producers. Subsidies are also not paid and this has affected the power sector investments. The new sugar mill will produce about 350 000 litres of ethanol per day. That yields about 100 million litres per year which is in addition to the 45 million litres per from the other sugar mills.

Zimbabwe has about 100 000 hectares of commercial wood plantations in the Eastern Highlands. The plantations include wattle, eucalyptus and pine. There are 4 major timber companies and several smaller ones. Timber is harvested and processed at a mixture of large and small sawmills distributed in the region. All

[37] Source: Ministry of Energy and Power Development

sawmills have a problem with managing sawmill waste which apart from being used to heat timber driers is incinerated. This attracts a monthly fee from the environment protection agency. One company installed a 500 kW steam engine for generating electricity. The electricity is used in sawmilling but the power plant can also be synchronised to the grid. There is sufficient sawmill waste produced to yield up to 2MW of electricity. If improved boiler technology is used the site can produce over 3MW of electricity. There are other sawmills in the region that can produce similar amounts of electricity or more. Estimates are that the industry can produce over 10MW of electricity if plantation waste is collected as fuel.

4.3 Solar Energy

There is no record of the total number of solar PV systems operating in Zimbabwe. The GEF PV Pilot Project installed 9000 45W equivalent systems. Private companies have continued to sell solar PV systems since then but at a lower rate. One company reports installing systems for various donor funded development projects that include 30 malaria testing centres, tourist facilities in game parks, 22 vaccine refrigeration sites, schools and clinics for Plan International, 28 backup power sites for telecommunication equipment and clinics in Matabeleland for Lutheran development Service. There are also low cost and substandard systems being sold by numerous retailers in the country.

The challenge faced by the GEF PV project was that systems would fail and new users with limited experience of solar technology would fail to seek assistance and assume the systems were not an ideal solution for their needs. Most suppliers were based in urban areas and travel costs to visit rural customers and carry out maintenance became prohibitive. It is therefore difficult to know the number of systems that are still operational.

The Rural Electrification Agency uses solar for electrification of households and institutions. By end of 2010 they had installed 218 solar PV systems at rural sites. This included 23 chief's homesteads. The total number of electrified sites in the period was 5987 which meant solar PV was used at about 3.6% of the sites. 61 of the systems were mini-grids. This means the number of beneficiaries was higher in such cases. Electricity benefits in a rural setting flow beyond the connected site. Communities tend to share services such as water, battery charging, communication and radio and tv. A school would also be considered one site but there may be more than 500 children and 20 or 30 teacher's families at the school. Most of the mini grids were installed at schools and clinics.

SITE	SPEED (MJ/m^2)
Beit Bridge	19.9
Binga	21.4
Buffalo Range	20.1
Chisengu	19.6
Masvingo	20.2
Kadoma	20.6
Grand Reef	20.2
Gweru	20.4
Nyanga	19.7
Kariba	20.9
Karoi	20.5
Makoholi	20.2
Marondera	20.3
Mt Darwin	20.3
Nyanyadzi	20.3
Save Valley	20.2
Hrare Agric Show Grounds	20.2
Harare Belvedere	20.3
Tsholotsho	20.9
Vic Falls	21.5
West Nicholson	21.3
Bulawayo Goetz	20.6

Table2.13.6: Mean Daly Solar Radiation[38]

Solar water heaters have long been recognised as an option to displace electric water heaters in Zimbabwe. Currently there are over 200 000 households using electricity to heat water. If solar water heaters were used it is estimated that about 600 MW of peak power would be displaced from the grid. There are companies supplying a wide range of solar water heating technologies on the market. These range from high quality glass lined storage tanks with vacuum tube collectors to simple locally made asbestos lined storage tanks and non-selective copper tube collectors. In 2000 the estimate was that there were over 10 000 solar water heaters installed in the country. Private companies have continued to install solar water

[38] Source: Zimbabwe Ministry of Energy and Power Development

heaters but some may have gone out of service. There is no official record of solar water heating systems that are still operational.

4.4 Wind Energy

Wind Energy has not been successful in Zimbabwe despite various attempts. The prevailing wind speeds are too low for most wind technologies. Low speed multi-blade machines have been used for water pumping around the country. A study carried out by the World Bank in 1987 identified a total of 116 of this type of wind pump of various sizes. The trend has been that these machines fail and due to the need of heavy lifting equipment and lack of skills the machines are not repaired. In various locations, towers with damaged or missing wind machines are observed.

Some companies have continued to install new machines but the numbers are small and there is no record of how many are still operational. A pilot wind pump was installed about 200km East of Harare along the Nyanga road. The wind farm constituted of 5 wind electric machines each capable to produce 3.6kW. The machines were specially designed for local wind speeds and could start generating power at $2ms^{-1}$. The project was community owned and managed. Electricity was sold to a business centre where it provided lighting and refrigeration services. Unfortunately the community did not collect sufficient revenue to maintain the equipment and it is now out of service. The machine is however still manufactured locally for an export market.

SITE	SPEED (m/s)
Binga	2.45
Buffalo Range	2.4
Bulawayo Airport	4.34
Bulawayo Goetz	3.21
Chipinge	3.93
Chirundu	1.89
Masingo	2.91
Kadoma	3.52
Grand Reef	2.09
Gweru	3.93
Nyanga	3.01
Kariba Airport	2.04
Karoi	3.11
Lake W/Is	3.88

Table A2.13.7 : Mean Wind Speed at Highest Potential Sites

4.5 Geothermal Energy

Currently, Zimbabwe does not have an operational or project development for geothermal energy. The potential sites are shown in the table below.

SITE	TEMPERATURE (SURFACE POOL °C)
Kariba Gushers	>90
Tchipise Hot Springs	>60
Zongala Gushers	60-90
Lubimbi	>90
Mwengezi	>50
Msampakaruma	>100
Sibila	>50

Table A.3.13.8: Potential Geothermal Power Sites

4.6 Other Possibilities

Despite the good potential no investor has made any serious attempts to exploit the opportunities. The reasons may be energy prices and the regulatory framework for the waste and the energy sectors.

CITY	METHANE GENERATED M^3/YEAR	METHANE EMITTED INTO THE ATMOSPHERE M^3/YEAR
HARARE	2 065 846	1 442 546
BULAWAYO	999 072	999 072
MUTARE	375 257	375 257
MASVINGO	210 840	210 840
TOTAL	**3 651 014**	**3 027 715**

Table A2.13.9: Municipal Waste Productions in Major Cities in Zimbabwe

5 Renewable Energy Incentives

5.1 Incentives

Power generation is dominated by the State utility , Zimbabwe Electricity Supply Authority. While the importance of Renewable Sources of energy is recognized, the government has not offered any incentives for renewable energy. It should be noted that hydro power from Kariba is a significant source of electricity.

The current economic conditions in Zimbabwe presents a serious challenge to the government's ability to offer any State funded RE programs such as feed-in-tariffs.

5.2 Clean Development Mechanism and Carbon Tax

Zimbabwe ratified the Kyoto Protocol and thus has a Designated National Authority. The DNA is the Minister of Environment and natural Resources Management. A committee is to be mandated to handle the issues related to carbon emission trading. Currently the legal documents to guide the functions of the DNA are still being drafted. The committee will be inter-ministerial with representatives from other stakeholders such as research institutions and NGOs.

Zimbabwe has a carbon tax. However this tax is included in fuel price and is not visible to the end user. As a result there is no explicit effect in terms of reducing fuel consumption. Initially the tax was charged as an annual permit and was matched to the vehicle engine size. Larger engines attracted a higher tax. Collection of the payments became a challenge as long queues would form at the offices of the revenue authority. It is correct to say the carbon tax was not introduced in relation to climate change. The revenue collected is deposited together with other government revenue.

6 Challenges, Constraints and Barriers to Renewable Energy Development

Barriers to renewable energy in Zimbabwe have previously been identified as:

1. Economic
   - High initial investment.
   - High Operation and Maintenance cost.
   - Low / poor access to capital.
2. Technology
   - Poor access to technologies.
   - Poor skills to adopt and adapt technologies.
3. Social
   - Poor appreciation of linkage between individual and national development goals.
   - Persistence of traditional habits like open fires.
4. Institutional and Policy/Regulatory
   - Subsidised conventional energy.
   - Domination of state owned enterprises in the energy sector.
   - Absence of effective regulation.

- Poor protection of private capital in energy sector.
- Poor receipt and channelling of global policies on renewable energy and environment.
- Poor integration of energy planning in other sector planning.

The above barriers are linked and also subjective. The impact of barriers depends on the perspective of the affected party. Some analysts have attempted to identify those who benefit from these barriers hence impede barrier removal. In reality the apparent beneficiaries are most likely net losers. An example is electricity subsidies that encourage energy wastage thereby imposing poor load profiles for the utility. Even though the power utility would monopolise the market, supply of energy to inefficient customers eventually leads to unpaid subsidies and low net revenue.

Lack of clarity and explicit instruction in the relationship between the utility and independent power producers is appearing as a major impediment to investment in renewable energy. Most private sector project in electricity production are facing delays and frustrations in the negotiation of tariffs. The electricity regulator appears to emphasize on cost recovery tariffs and minimization of overheads. The investors appear to aim for very short paybacks which the utility is not willing to accept. At the same time the government tends to restrict tariff approvals for the utility to small incremental steps. This frustrates potential investor. Current projects are based on either wheeling through the grid to a sole customer who offsets the cost of diesel generators or banking on the grid where the producer has the option to access the banked power at a later time. Banking is suitable for co-generators. It is apparent that lack of experience with independent power producers and tariff negotiations and power purchase agreements are all factors that are limiting investment in grid connected renewable energy.

7 Lessons Learned, Observation, and Conclusion

There great potential for renewable energy in Zimbabwe. Small scale energy opportunities are distributed evenly around the country.

i. Small hydro power plants are mostly in agro-ecological region 1 where there are perennial streams and at irrigation dams in all regions where water is released for agriculture.

ii. Solar energy is abundant but levels of exploitation are low. There is insufficient monitoring to determine the rate at which solar power is being adopted by communities.

iii. Rural households lack energy for cooking. Biogas which could meet this need is not favourable especially in dry areas. There has been poor acceptance of biogas in most areas.

iv. Despite low wind speeds there is the possibility to use wind power for livestock watering and for small scale power generation. There is a need to carry out wind measurements to identify localised wind speeds which are important for small scale machines.

v. Biomass fuels are produced in industrial processes and opportunities exist for large scale power production. Technology upgrading for biomass power could increase capacity to almost double the current levels especially in the sugar mills. Rural households have challenges in accessing fuel wood. Efficient stoves have been promoted but it appears rate of adoption does not match with the high levels of fuel wood deficiency. Households tend to prefer open fires.

Annexures 2 – List of COMESA RE Projects

A BURUNDI

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Kabu 16	Hydropower	implementation	20 MW	-	Kabu
Mpanda	Hydropower	implementation	10.4 MW	-	Mpanda
Jiji/Mulembwe/Siguvyaye	Hydropower	Planned	100 MW	-	Burundi

B COMOROS

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Rehabilitation of small hydro	Hydropower	implementation	1.25 MW	-	Island of Anjoun
Hydroelectric power to Moheli	Hydropower	implementation	-	-	Island of Moheli
Hydroelectric plant in Anjouna	Hydropower	implementation	-	-	Island of Anjoun
Installation of photovoltaic solar farms	Solar	implementation	7 MW	-	Island of Anjoun and Moheli
Photovoltaic solar power and hot water	Solar	implementation	-	-	Island of Anjoun , Moheli ,Grande and Comore
Supply of solar power in Moroni and Diboini	Solar	implementation	-	-	Island of Ngazidja
Mastery of wood consumption	Biomass	Under study	-	-	Island of Anjoun , Moheli ,Grande and Comore
Installations of power plant heavy fuel oil	Liquid biofuels	Under study	30 MW	-	Island of Grande and Comore

B. EGYPT

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Aswan2	Hydropower	operational	4*67.5 MW	EEHC*	Aswan
El-Ezab	Hydropower	operational	2*340 MW	EEHC*	Fayoum
Isna Barrage	Hydropower	operational	6*14.5 MW	EEHC*	-
Mini hydro plant	Hydropower	operational	2*400 MW	EEHC	-
New Nag Hammadi	Hydropower	operational	4*16 MW	EEHC	-
Barrage hydro power plant	Hydropower	Expected commission date 2016	32 MW	EEHC	-
High Dam	Hydropower	Commissioned	2100 MW	EEHC	Aswan
Aswan Dam	Hydropower	Commissioned	7 x 46 mw + 4 x 67.5 mw	EEHC	Aswan
Hurghada wind	Wind	Connected to the grid since 1993	5.2 MW	NREA***	Hurghada –Red sea
Zafrana	Wind	operational	425 MW	NREA	Gulf of El-Zayt
project with denmark	Wind	Planned to operate in june 2010	120 MW	in cooperation with Denmark	Zafrana - Red sea
wind farm with German	Wind	Planned to operate 2012/2013	200 MW	NREA	Gulf of El-Zayt
wind farm with Japan	Wind	Financial assessment	220 MW	NREA	Gulf of El-Zayt
Italgen	Wind	Feasibility studies and	120 MW	Italgen –Italy	Gulf of El-Zayt

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
		environmental studies done			
Gulf of Suez	Wind	Under preparation	300 MW	NREA	Gulf of Suez
Wind farm with spain	Wind	under preparation	180 MW	NREA	Gulf of Suez
Korimat	Solar	-	140 MW	NREA	90 Km south Cairo
Wadi Houf	Natural gas	Commissioned	3 * 33.3 MW	EEHC	Wadi houf
Shebab	Natural gas	Commissioned	3 x 33.5 MW	EEHC	East Delta
Port Said	Natural gas	Commissioned	2 x 23. 96 + 1 x 24. 6 (MW)	EEHC	Port Said
Sharm Elsheikh	Natural gas	-	2 x 23.7 + 4 x 24. 27 + 4 x 5.8 + 2 x 5 3 x 23. 5 + 3 x 24.3 (MW)	EEHC	Sharm El-Sheikh
Hurghada	Natural gas	-	3 x 23. 5 + 3 x 24.3 (MW)	EEHC	Hrghada
Mahmoudia2	Natural gas	Commissioned	1 x 50+ 1 x 25 (MW)	EEHC	-
Elseiuf	Natural gas	Commissioned	6 x 33.3 (mw)	EEHC	-
Karmouz	Natural gas	Commissioned	1 x 11.37 + 1 x 11.68 (mw)	EEHC	-
Abu Kir	Natural gas	Commissioned	1 x 24.27 (MW)	EEHC	-

C. ETHIOPIA

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Gilgel Gibe 3	Hydropower	Construction	1870 MW	EEPCO	Southern Nations
Fincha Amer Neshile	Hydropower	Construction	97 MW	EEPCO	Oromiya
Chemoga Yeda	Hydropower	Construction	278 MW	EEPCO	Amhara
Geba	Hydropower	Construction	490 MW	EEPCO	Oromiya
Hallele Werabesa	Hydropower	Construction	422 MW	EEPCO	Oromiya
Genale Dawa 3	Hydropower	Construction	258 MW	EEPCO	Oromiya-Somalie
Genale Dawa 6	Hydropower	Construction	256 MW	EEPCO	Oromiya-Somalie
Renaissance dam	Hydropower	Construction	5250 MW	EEPCO	Amhara-Benishangul
Hagere Sodicha MHP	Hydropower	Just commissioned	60 KW	GIZ Ethiopia	Southern Nations
Ererte MHP	Hydropower	Just commissioned	34 KW	GIZ Ethiopia	Southern Nations
Gobecho 1 MHP	Hydropower	Just commissioned	10 KW	GIZ Ethiopia	Southern Nations
Gobecho 2	Hydropower	Just commissioned	30 KW	GIZ Ethiopia	Tigray region
Ashegoda Power plant	Wind	Construction	120 MW	French Company	Tigray region
Adam-1 Power plant	Wind	Study	51 MW	Chinese Company	Oromia region
Aisha Power plant	Wind	Study	300 MW	German Company	Somali
Mesobo	Wind	Study	42 MW	-	Tigray region
Debre Berhan	Wind	Study	100 MW	-	Amhara region
Adam 2	Wind	Study	153 MW	-	Oromia region
Asele	Wind	Study	100 MW	-	Oromia region
Langano	Geothermal	Ceased operation	7.2 MW	EEPCO	Oromiya
Aluto Langano	Geothermal	Feasibility study	75 MW	EEPCO	Oromiya
Abaya	Geothermal	Reconnaissance study	100 MW	-	Oromiya

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Corbetti	Geothermal	Reconnaissance study	100 MW	-	Oromiya
Dofan Fantale	Geothermal	Reconnaissance study	100 MW	-	Afar
Tendaho	Geothermal	Feasibility study	100 MW	-	Afar
Tulu moyo	Geothermal	Reconnaissance study	40 MW	-	Oromiya
Ethiopian Telecommunication	Solar	Installed	3,500 KWp	Ethiopian Telecommunication Corporation	Country wide
Rural Electrification Fund	Solar	Installed(1,111) SYSTEMS	-	REF	-
Institutional Solar PV 1	Solar	Installed(345) SYSTEMS	-	REF	
Institutional Solar PV-2	Solar	Installed(270) SYSTEMS	-	REF	-
Solar home systems	Solar	Tendering(24,000) SYSTEMS	-	-	-
GIZ Energy(ECO)-1	Solar	Installed(100) SYSTEMS	155.7 KWp	GIZ ECO	-
GIZ Energy Coordination	Solar	-	7.7 KWp	GIZ ECO	-
Solar Energy Foundation	Solar	Systems installed	48 KWp	Solar Energy Foundation	Country wide
European Union Grant(energy)	Solar	Systems installed	85 KWp	Plant International Ethiopia	Amhara , Oromia , Southern Regions
Ministry of Water and Energy	Biomass	3 million improved cook stoves distributed	-	Ministry of water and energy , Regional Energy Bureaus	Country wide

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
GIZ ECO	Biomass	400,000 improved cook stoves distributed	-	-	-
Bioethanol blending	Biomass	Gasoline blending	-	Ministry of water and energy	Addis Ababa
Bioethanol Production	Biomass	20million liters per year	20 million liters	Tendaho sugar factory and Fincha sugar factory	Oromia region
National Biogas	Biomass	Installed (1500) biogas digesters	14,000 biogas digesters	-	Tigray , Amhara , Oromia , Southern Regions
Addis Ababa LFG	Municipal waste	Reconnaissance study	186,515 waste/year	Addis Ababa City Government	ADDIS Ababa
Adama	Municipal waste	Reconnaissance study	9,703 waste/year	Local Municipality	Oromia
Hawassa	Municipal waste	Reconnaissance study	5,840 waste/year	Local Municipality	Southern Nations
Bahirdar	Municipal waste	Reconnaissance study	6,139 waste/year	Local Municipality	Amhara
Mekele	Municipal waste	Reconnaissance study	19,345 waste/year	Local Municipality	Tigray
Harar	Municipal waste	Reconnaissance study	8,200 waste/year	Local Municipality	Harari
Diredawa	Municipal waste	Reconnaissance study	22,365 waste/year	Local Municipality	Dire Dawa

D. KENYA

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Tana Power Station	Hydropower	Operational	14.4 MW	Kenya Electricity Generation Co.	River Tana
Kamburu Power Station	Hydropower	Operational	94.2 MW	Kenya Electricity Generation Co	River Tana
Gitaru Power Station	Hydropower	Operational	225 MW	Kenya Electricity Generation Co.	River Tana
Kindaruma Power Station	Hydropower	Operational	40 MW	Kenya Electricity Generation Co	River Tana
Wanjii Power Station	Hydropower	Operational	7.4 MW	Kenya Electricity Generation Co	Maragua River
Ndula Power Station	Hydropower	Operational	2 MW	Kenya Electricity Generation Co	Thika River
Sagana Power Station	Hydropower	Operational	1.5 MW	Kenya Electricity Generation Co	River Tana
Masinga Power Station	Hydropower	Operational	40 MW	Kenya Electricity Generation Co	River Tana
Kiambere Power Station	Hydropower	Operational	168 MW	Kenya Electricity Generation Co	River Tana
Turkwel Power Station	Hydropower	Operational	106 MW	Kenya Electricity Generation Co	River Turkwel
Sondu Miriu Power Station	Hydropower	Operational	60 MW	Kenya Electricity Generation Co	River Sondu Miriu
Gogo Power Station	Hydropower	Operational	2 MW	Kenya Electricity Generation Co	River Kuja
Kindaruma Upgrade	Hydropower	Construction	32 MW	Kenya Electricity Generation Co	Kindaruma
Sangoro	Hydropower	Construction	20.6 MW	Kenya Electricity	River Sondu Miriu

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
				Generation Co	
Gura SHP	Hydropower	Engineering stage	2.8 MW	KTDA	Gura River, Nyeri
Teremi falls SHP	Hydropower	Construction	3.4 MW	Genpro Power Systems LTD	MT Elgon
Ngong 1-Existing	Wind	Commissioned	5.1 MW	Kenya Electricity Generation Co	Nairobi
Ngong 1-extension	Wind	Delayed(FINANCING)	6.8 MW	Kenya Electricity Generation Co	Nairobi
Ngong 2	Wind	Construction	13.6 MW	Kenya Electricity Generation Co	Nairobi
Lake Turkana	Wind	Overhanging	300 MW	Lake Turkana Wnd Power LTD	Turkana
Aeolus Kinangop	Wind	PPA Singed	60 MW	Aeolus Kenya LTD	Kinangop
Olkaria 1	Geothermal	Completed	45 MW	Kenya Electricity Generation Co	Olkaria
Olkaria 2	Geothermal	Completed	105 MW	Kenya Electricity Generation Co	Olkaria
Olkaria 3-Unit 4 and 5	Geothermal	Construction	140 MW	Kenya Electricity Generation Co	Olkaria
Olkaria 4	Geothermal	Construction	140 MW	Kenya Electricity Generation Co	Olkaria
Eburu	Geothermal	Construction	2.5 MW	Kenya Electricity Generation Co	Olkaria
Olkaria 5	Geothermal	Operational	48 MW	Orpower4 Inc	Olkaria
Olkaria 5-extension	Geothermal	PPA Singed	36 MW	Orpower4 Inc	Olkaria
Automotive Gasoline E-10	Liquid biofuels	Complete	-	Ministry of Energy	Kisumu
Mumias	Biomass	Operational	26 MW	Mumias Sugar	Mumias

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Cogeneration				Company	

E. MADAGASCAR

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Andekaleka (1st & 2nd units)	Hydro	Operational	58	JIRAMA	Vohitra
Mandraka	Hydro	Operational	24	JIRAMA	Barrage Mantasoa
Antelomita	Hydro	Operational	8,2	JIRAMA	Ikopa
Volobe	Hydro	Operational	6,76	JIRAMA	Ivondro
Namorona	Hydro	Operational	5,6	JIRAMA	Namorona
Manandona	Hydro	Operational	1,6	JIRAMA	Manandona
Manandray	Hydro	Operational	0,45	JIRAMA	Fianarantsoa
Vatomandry	Hydro	Operational	0,17	JIRAMA	Ambodiriana
Ankazobe	Hydro	Operational	0,05	JIRAMA	Fitososona
Tsiazompaniry	Hydro	Operational	5,2	IPP = Henri Fraise & Fils	Varahina
Sahanivotry	Hydro	Operational	15	IPP =HYDELEC	Sahanivotry
Maroantsetra	Hydro	Operational	2,6	IPP = HYDELEC	Voloina
Andriantsiazo	Hydro	Operational	0,0075	IPP = AIDER	Andriantsiazo
Andriatsemboka	Hydro	Operational	0,01	IPP = AIDER	Andriatsemboka
Antetezambato	Hydro	Operational	0,053	IPP = Coopérative ADITSARA	Antetezambato

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Ranotsara nord	Hydro	Operational	0,02	IPP = VITASOA ENERGY	Ranotsara nord

Ranomafana est	Hydro	Operational	0,03	IPP = ELEC & EAU	Ranomafana est
Sahamadio - Milamaina - Fandriana	Hydro	Operational	0,128	IPP = JIRAFI	Sahamadio
Ankazomiriotra	Hydro	Operational	0,12	IPP = POWER & WATER	Iandratsay
Mangamila	Hydro	Operational	0,08	IPP = ELEC & EAU	Mangamila
Andekaleka G3 (3rd unit)	Hydro	Construction	34	JIRAMA	Vohitra
Lily	Hydro	Construction	3,5	IPP = SAEE	Lily
Mahitsy	Hydro	Construction	12	IPP = HYDELEC	Ikopa
Andekaleka G4 (4th unit)	Hydro	Detailed Preliminary Design	34	JIRAMA	Vohitra
Beandrarezona	Hydro	Basic Preliminary Design	0,43		Beandrarezona
Lokoho	Hydro	Feasibility Study	6		Lokoho
Ambodiroka	Hydro	Feasibility Study	40		Betsiboka
Sahofika	Hydro	Pre-Feasibility Study	300	IPP = HYDELEC	Onive
Volobe amont	Hydro	Pre-Feasibility Study	90		Ivondro
Mahavola	Hydro	Pre-Feasibility Study	300		Ikopa
Antetezambato	Hydro	Pre-Feasibility Study	210		Mania
Bevory	Hydro	Preliminary Study	6,5		Ramena

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Ampitabepoaky	Hydro	Preliminary Study	1,3		Manambolo
Talaviana	Hydro	Preliminary Study	15		Manandona

Tazonana	Hydro	Preliminary Study	8		Maintinandry
Rianambo	Hydro	Preliminary Study	0,42		Manatsimba
Isaka Ivondro	Hydro	Preliminary Study	1,2		Efaho
Andranomamofona	Hydro	Site recognition	15		Mahavavy Nord
Antsiafapiana	Hydro	Site recognition	1,2		Sahafihatra
Marobakoly	Hydro	Site recognition	0,8		Anjingo
Andohariana	Hydro	Site recognition	2,5		Bemarivo
Andriabe	Hydro	Site recognition	0,58		Demoka
Androkabe	Hydro	Site recognition	1,7		Lovoka
Namorona II	Hydro	Site recognition	12		Namorona
Befanaova	Hydro	Site recognition	0,6		Sahambano
Tsitongapiana	Hydro	Site recognition	0,2		Manambovona
Ampandriambazaha	Hydro	Site recognition	15		Mahavavy Nord
Nosy Ambositra	Hydro	Site recognition	20		Mangoky
Bejono	Hydro	Site recognition	0,40		Bejono
Ampanefena	Hydro	Site recognition	0,18		Ampanefena
Antohakabe	Hydro	Site recognition	0,45		Antohakabe
Bemanavy	Hydro	Site recognition	0,50		Bemanavy
Antsivaka	Hydro	Site recognition	0,34		Antsivaka
Andengibe	Hydro	Site recognition	0,21		Andengibe
Marobakoly	Hydro	Site recognition	0,42		Marobakoly
Tsaramandroso	Hydro	Site recognition	0,24		Tsaramandroso
Tolongoina	Hydro	Construction	0,12	NGO GRET	Mandiazano
Sahasinaka-Fenomby-Mahabako	Hydro	Construction	0,24	NGO GRET	Antsatoka

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Ampasimbe Onibe	Hydro	Construction	0,24	NGO GRET	Andrianambo

Ambatofotsy Ambohiborona	Hydro	Basic Preliminary Design	0,04	NGO GRET	Ambatofotsy Ambohiborona
Sahambano	Hydro	Detailed Preliminary Design	0,70	ERMA SARL	Ambia – Ankily
Ambohimasina	Hydro	Basic Preliminary Design	0,10	NGO GRET	Ambohimasina
Andriba	Hydro	Construction	0,14	SERMAD	Anjiajia
Ranomainty	Hydro	Construction	0,30	SERMAD	Ranomainty – Morarano Chrome
LEMENA	Hydro	Detailed Preliminary Design	1,20		Sahanivotry
Benenitra	Solar	Operational	0,008	JIRAMA	Benenitra
Ramena – Ivovona	Solar	Operational	0,002	IPP = MAD'EOLE	Ramena – Ivovona
Atsimo Atsinanana	Solar	Basic Preliminary Design	0,232	PEPSE Project	Atsimo Atsinanana
Amoron'I Mania	Solar	Basic Preliminary Design	0,251	PEPSE Project	Amoron'I Mania
Atsimo Andrefana	Solar	Basic Preliminary Design	0,206	PEPSE Project	Atsimo Andrefana
Haute Matsiatra	Solar	Basic Preliminary Design	0,135	PEPSE Project	Haute Matsiatra
Vatovavy Fitovinany	Solar	Basic Preliminary Design	0,342	PEPSE Project	Vatovavy Fitovinany
Ihorombe	Solar	Basic Preliminary Design	0,028	PEPSE Project	Irohombe

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Menabe	Solar	Basic Preliminary Design	0,195	PEPSE Project	Menabe
Analapatsy	Solar	Basic Preliminary Design	0,004	RESOUTH Project	Analapatsy
Anjiajia	Biomass	Operational	0,04	IPP = CASIELEC	Anjiajia
Mandrosoa	Biomass	Site recognition	0,16		Mandrosoa
Madirovalo	Biomass	Site recognition	0,20		Madirovalo
Ambolomoty	Biomass	Site recognition	0,20		Ambolomoty
Ambalambakisiny	Biomass	Site recognition	0,04		Ambalambakisiny
Ankijabe	Biomass	Site recognition	0,08		Ankijabe
Ambato	Biomass	Site recognition	0,16		Ambato
Boeny Doany	Biomass	Site recognition	0,13		Boeny Doany
Antanatsara	Biomass	Site recognition	0,15		Antanatsara
Antanankova	Biomass	Site recognition	0,09		Antanankova
Anjiamangirana	Biomass	Site recognition	0,03		Anjiamangirana
Ambatoriha est	Biomass	Site recognition	0,09		Ambatoriha est
Masiakomby	Biomass	Site recognition	0,10		Masiakomby
Ambodiamontana	Biomass	Site recognition	0,08		Ambodiamontana
Maroandriana	Biomass	Site recognition	0,05		Maroandriana
Ambodisely	Biomass	Site recognition	0,06		Ambodisely
Ambohitsara sud	Biomass	Site recognition	0,07		Ambohitsara sud
Antsirabe centre	Biomass	Site recognition	0,07		Antsirabe centre
Bejofo	Biomass	Commissioned	0,06	BE AU CARRE	Bejofo
Befeta	Biomass	Basic Preliminary Design	0,07	BIOENERGELEC	Befeta
Didy	Biomass	Basic Preliminary Design	0,07	BIOENERGELEC	Didy

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Ifarantsa	Biomass	Basic Preliminary Design	0,07	BIOENERGELEC	Ifarantsa
Mahaditra	Biomass	Basic Preliminary Design	0,07	BIOENERGELEC	Mahaditra
Ilakaka	Wind	Operationnal	0,08	IPP = SEEM	Ilakaka
Faux Cap	Wind	Operationnal	0,0075	IPP = IET	Faux Cap
Sahasifotra	Wind	Operationnal	0,015	IPP = MAD'EOLE	Sahasifotra
Andrafiabe - Ambolobozokely	Wind	Operationnal	0,022	IPP = MAD'EOLE	Andrafiabe - Ambolobozokely
Andrafiabe - Ambolobozobe	Wind	Operationnal	0,022	IPP = MAD'EOLE	Andrafiabe - Ambolobozobe
Ambondro	Wind	Operationnal	0,012	RESOUTH Project	Ambondro

F.MAURITIUS

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Champagne	Hydropower	running	29 MW	Central Electricity Board ,Royal Road Curepipe Mauritius	South East of Island
Ferney	Hydropower	running	10 MW	Central Electricity Board , Royal Road Curepipe Mauritius	South East of Island
Tamarind and Magenta	Hydropower	running	9 MW	Central Electricity Board , Royal Road Curepipe Mauritius	Central Plateau
LE VAL	Hydropower	running	4 MW	Central Electricity	South East of Island

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
				Board , Royal Road Curepipe Mauritius	
Reduit and others	Hydropower	running	5 MW	Central Electricity Board , Royal ROAD curepipe Mauritius	Centre , South and West
Nicoliere and Midlands Dam	Hydropower	Running/pipeline	1 MW	Central Electricity Board , Royal ROAD curepipe Mauritius	North and Centre
Plaines Des Roches Wind Farms	Wind	EIA approved and awaiting PPA	18 MW	Aerowatt Maritius Flic en Flac Mauritius	North East
Curepipe point	Wind	Being envaluated	20-30 MW	…….	Central Plateau
Rodrigues	Wind	running	1.28 MW	Central Electricity Board , Royal Road Curepipe Mauritius	Rodrigues
Bigara	Wind	Tendering process	1.1 MW	Central Electricity Board , Royal Road Curepipe Mauritius	Central Plateau
100 MW LNG	Natural gas	pipeline	100 MW	-	-
Centrale Thermique de Savannah	Biomass	Running	65.5 MW	Omnicane Limited Groups	South
Centrale Thermique de Belle VUE	Biomass	Running	46 MW	Harel Freres Limited	North
Fuel Power Station	Biomass	Running	20 MW	Flacq United Estates	East
Beau Champs power	Biomass	Running	11 MW	CIEL group	East
Agalega coconut oil-energy	Liquid biofuels	Feasibility study	0.06 MW	Mauritius Research council	Agalega
Mare Chicose Landfill	Municipal waste	Reliability testing	3 MW	Sotravic LTD	South

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
gas					
Waste to Energy	Municipal waste	Environmental Appeal Approval	3 MW	Gamma Civic Ltd	West

G. SEYCHELLES

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Port Victoria Wind Farms	Wind	Contract negotiation stage	6 MW	Masdar	Ile Du Port and Ile Romainville, Seychelles
Grid-connected Rooftop Photovoltaic systems	Solar	Development stage	500kW	SEC, UNDP-GEF, private partners	Seychelles
Energy-From-Waste project	Municipal Waste	Development stage	2-6 MW	Eau de Mascareines	Providence landfill, Mahe

H. SUDAN

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Ramp Roseires Dam	Hydro	In progress	280 MW	MED-SUDAN	Roseires
Upper Atbara	Hydro	In progress	320 MW	MED-SUDAN	Gadarif/Kasala
Kagbar	Hydro	Development	360 MW	MED-SUDAN	Dongla
Shereik	Hydro	Development	420 MW	MED-SUDAN	Atbara
Dal	Hydro	planning	648 MW	MEDSUDAN	Donglas
Mogrant	Hydro	planning	312 MW	MED-SUDAN	Merwe
Dagash	Hydro	planning	312 MW	MED-SUDAN	Merwe
Sabaloka	Hydro	planning	205 MW	MED-SUDAN	Khartoun
Sennar	Hydro	planning	50 MW	MED-SUDAN	Sennar Dam
Dongola	Wind	tendering	100 MW	MED-SUDAN	Dongola
Nyala	Wind	tendering	20 MW	MED-SUDAN	Nyala
Port Sudan	Wind	planning	180 MW	MED-SUDAN	Port Sudan
East Sudan	Wind	planning	10 MW	MED-SUDAN	East Sudan
Geothermal plant	Geothermal	planning	100 MW	MED-SUDAN	Western Sudan
Garri CSP	Solar	planning	40 MW	MED-SUDAN	Garri
Khartoum PV	Solar	planning	10 MW	MED-SUDAN	Khartoum
Nyala PV	Solar	planning	5 MW	MED-SUDAN	Nyala
AL-Fashir	Solar	planning	3 MW	MED-SUDAN	Al-Fashir
Jenyna	Solar	planning	2 MW	MED-SUDAN	Jenyna
White Nile	Biomass	planning	104 MW	Kenana Sugar Company	White Nilel
Redais	Biomass	planning	91 MW	Kenana Sugar Company	Redais
Ramash	Biomass	planning	23 MW	Kenana Sugar Company	Ramash
Blue Nile	Biomass	planning	39 MW	Kenana Sugar	Blue Nile

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
				Company	
Gafa	Biomass	planning	105 MW	Kenana Sugar Company	Gafa
Mashkour	Biomass	Planning	38 MW	Kenana Sugar Company	Mashkour
AL-Dueim Group	Biomass	planning	196 MW	Kenana Sugar Company	AL-Dueim
Bellah	Biomass	planning	19 MW	Kenana Sugar Company	Bellah
Sabina	Biomass	planning	130 MW	Kenana Sugar Company	Sabina
EL Gazira	Biomass	planning	700 MW	Kenana Sugar Company	EL Gazira
Abu Gota	Biomass	Planning	230 MW	Kenana Sugar Company	Abu Gota
Hafira	Biomass	Planning	60 MW	Kenana Sugar Company	Hafira
East Sudan	Biomass	Planning	387 MW	Kenana Sugar Company	East Sudan
Rahad	Biomass	Planning	39 MW	Keanana Sugar Company	Rahad
Khartoum state wast	Municipal waste	planning	50 MW	MED-SUDAN	Khartoum

I. SWAZILAND

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Ezulwini Power Station	Hydro	Operational	21 MW	SEC	Ezulwini

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Edwaleni Power Station	Hydro / Diesel	Operational	20 MW	SEC	Edwaleni
Maguga Power Station	Hydro	Operational	20 MW	SEC	Hhohho – Maguga Dam

J .ZAMBIA

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Itezhi Tezhi Hydo	Hydropower	Feasibility study	120 MW	Itezhi Tezhi Power Company	Itezhi Tezhi
Kariba North Bank Expansion	Hydropower	Construction	360 MW	ZESCO	Kariba
Kafue Gorge Lower Power Station	Hydropower	Tendering	750 MW	ZESCO	Kafue
Lunzua Power plant	Hydropower	-	201 MW	-	-
Geothermal pilot project	Geothermal	Piloted	0.2 MW	ZESCO Limited	Kapisya hot springs
Solar project	Solar	tendering	150 MW	ZESCO Limited	Nation Wind
Solar Project	Solar	planning		ZESCO Limited	Lusaka and Chipata
Solar Project	Solar	planning		Luangwa Solar Power	Luangwa
Solar Project	Solar	Piloted	0.02 MW	Nyimba and Petauke	Nyimba , Chipata , Lundazi
Zambia Sugar Bagas power	Biomass	Operational	45 MW	Zambia Sugar PLc	Mazabuka , Southern Province
Kansanshi Mine Bio-Fuels	Liquid biofuels	-	-	Kansanshi PLc	-
Copperbelt Energy Renewable	Liquid biofuels	-	1,000,000/year	Copperbelt Energy Corporations	-
Lumwana Mine	Liquid biofuels	-	-	Lumwana Mine	-

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
Jatropa					
D1 Oils PLc	Liquid biofuels	-	-	D1 Oils PLc	-

K. ZIMBABWE

PROJECT NAME	RE TYPE	STATUS	CAPACITY	DEVELOPER	LOCATION
	Hydro	Feasibility Study	40 MW	ZPC	Nyanga
	Hydro	Feasibility Study	20 MW	REA	Nyanga
	Solar	Planning	-	Practical Action South Africa	Several places
	Biomass	Fund Raising	2.5 MW	Wattle Company	Nyanga
	Biomass	Feasibility Study	2 MW	Allied Timbers	Chimanimani
	Biomass	Fund Raising	1.5 MW	Border Timbers	Chimanimani
	Liquid biofuels	Development	-	National Oil Company of Zimbabwe	Several sites
	Liquid biofuels	Construction	18 MW	Greenfuels	Chisumbanje
	Liquid biofuels	Planning and Technology	20 MW	Tongaart	Chiredzi
	Municipal Waste	Pre-feasibility	-	City of Harare	Harare
	Municipal Waste	Pre-feasibility	1 MW	City of Harare	Harare