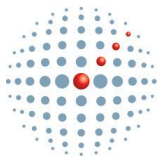


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# **MINI-GRID TOOLKIT FIELD STUDY REPORT FOR KENYA, MOZAMBIQUE AND ZAMBIA**



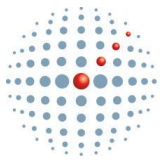
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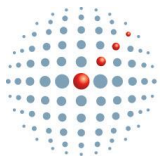


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## Acronyms

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ACP	Africa, Caribbean and Pacific
ACP-EC	African, Caribbean and Pacific - European Community
ERC	Energy Regulatory Commission
EU	European Union
FUNEA	Fundo de Energia
KPLC	Kenya Power and Lighting Company
MDGs	Millennium Development Goals
REA	Rural Electrification Authority
ZCCM	Zambia Consolidated Copper Mines
ZESCO	Zambia Electricity Supply Corporation



## 1 Introduction

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### 1.1 Background

Despite inadequate, weak or poor policy and legislative frameworks, mini-grids are being developed in a select number of African, Caribbean and Pacific (ACP) countries. Some of these mini-grids have been successful because of a number of factors including – government support, community support, proper financing arrangement, sound and/or appropriate technology, etc.

This is a report on field studies carried out in three African countries namely: Kenya, Mozambique and Zambia. The aim of the field studies was to determine supporting policy and legislative framework that has enabled these countries to successfully implement renewable energy based mini-grids, the financing mechanisms that have been employed to enable development of such mini-grids and the ownership, operation and management structures of mini-grids.

These countries were selected because: Mozambique has recorded tremendous success in the development of stand alone power plants and promotion of mini-grids in rural areas of Maputo, Sofala and Inhambane provinces through FUNEA (a publicly funded institution that provides finance to rural energy projects). Kenya has had success in implementing a mix of community owned and government owned mini-grids. Zambia has a great potential for renewable energy especially hydro, and for this reason, the country was chosen to examine how utility managed mini-grids compare to privately owned ones.

### 1.2 Methodology

The case study involved actual visits to selected mini-grid sites where guided interviews were administered to relevant contact people. This method was used to gather qualitative data relating to how mini-grids were initiated, and managed, who is included/excluded and why; users' perception on quality, reliability and adequacy of electricity services provided, etc.

Respondents included community leaders and users at the local level while at the regional/national level data was gathered from relevant government institutions (Rural Energy Authorities and national utilities)

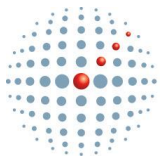
## 2 Field Study Findings

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### 2.1 Kenya Field Study

Kenya is a country in east Africa with a population of 38million people. It covers a geographical area of 580367 sq KM. The country is endowed with various renewable energy resources such as geothermal, hydro, solar and biomass. It is one of the countries in Africa where rural

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electrification is rapidly growing. Statistics from the Rural Electrification Authority (REA) indicate that, currently, there are 127 rural electrification projects in the pipeline, out of which funding for 22 projects has already been approved. The REA has adopted in many of these projects, decentralized generation and distribution systems (mini-grids). Besides rural electrification projects by REA, there are other projects being initiated and run by communities in various parts of the country.

It is under this backdrop that Camco set out a field study with the aim of establishing:

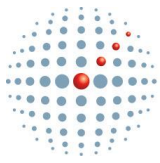
- a) The forms of ownership of the various mini-grid projects in the country
- b) Operation and management of the mini-grids
- c) Tariff regimes being applied
- d) Sources of funding of the mini-grids
- e) Sizes of the mini-grids in terms of the number of households/individuals served
- f) The enabling policy and legislation framework

The case study was carried out in five mini-grid/micro-grid projects namely: Kathamba, Thima, Tungu Kabiri, Mpeketoni and Kipini. These projects are based in two regions, Mt. Kenya Region and Coastal region. These mini-grids were chosen because they were the pioneering projects, and Camco has been involved with Kipini community from inception.

### **2.1.1 Field Study Findings**

#### ***Ownership***

The results from the studies indicate that there are two form of ownership of mini-grids. Community ownership as is the case in Kathamba, Tungu kabiri, Thima and Kipini mini-grid, and government owned mini-grids as is the case in Mpeketoni, Lamu and many other mini-grids under REA.



(Community owned mini-grid –Kipini)

### ***Operation and management***

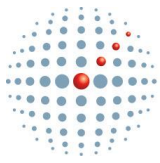
In all the community owned mini-grids studied (Thima, Kathamba, Tungu kabiri and Kipini); the community is responsible for the operation and maintenance of the whole system, from generation to transmission and collection of dues. The communities have management committees comprising of a chairman, vice chairman, a treasurer and an operations manager responsible for technical operation of the whole system. Members in the management committee are elected by the community members.

The government owned mini-grids on the other hand are operated and managed by the Kenya Power and Lightning Company (KPLC), the national transmission and distribution company. This is the case with the Mpeketoni mini-grid. The government owns the whole system but the operation and management is done through KPLC. KPLC manages the generation, transmission, distribution of power and the collection of levies.

### ***Tariffs***

Each of the projects in the study applied its own tariffs, which can be grouped into two main categories:

- a) Flat rate tariff regime – in this tariff, members pay a fixed fee for the energy used. In the case of Thima and Kathamba, the power is sold in packages. For Thima, packages are measured in watts (15w, 30w and 45w costing Ksh.100, Ksh.150 and Ksh.250 respectively); Kathamba on the other hand has two packages (one package that powers two lights costing Ksh.50 and two packages that can power three lights and Black and White TV costing Ksh.80). Kipini mini-grid also applies a flat rate tariff but the members are charged on a daily basis.



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- b) Invoicing/billing – under this regime the power consumer/household is invoiced for the energy used at the end of every month. The consumers/households are charged for every unit of energy used. One unit is equivalent to 1 kilowatt hour (kWh). This is the case with all mini-grids owned by the government. For example in the Mpeketoni mini-grid, consumers pay Ksh.2 per unit plus the standing charges.

### ***Sources of funding***

The study established that community owned mini-grids are generally initiated by local communities because of their desire to have electricity for lighting. The initial capital is usually raised through contributions from community members interested in the project.

In most of the mini-grid projects, the communities' efforts are augmented by donor support which comes in form of (i) technical support e.g. the Kathamba micro-hydro, or (ii) equipment as was the case in Kipini where the Norwegian Church Aid (NCA) provided transmission lines, poles and metering equipment. Other community mini-grids such as the Kipini project have tried to access CDF funds, although the funding provided was insufficient.

Funding for government owned mini-grids comes through the REA which is mandated to manage the Rural Electrification Programme Fund. The fund consists of:

- a) Levies from electricity sales
- b) Fees and other charges levied by the ERC according to the energy Act
- c) Fund appropriated by Parliament for the purpose of rural electrification;
- d) Donations, grants and loans; from multilateral organizations
- e) All other moneys lawfully received or made available for the programme as the Minister may approve.

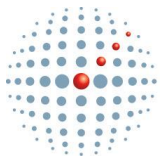
### ***Adequacy, quality of power and number of house hold served (Sizes of mini-grids)***

Kathamba and Thima micro-hydros currently serve 55 and 115 households respectively. However, power supply is limited and therefore limited application. The power generated is mainly used for lighting, although some households also use it to power their radios. Inadequate power supply is a common scenario for many other community-owned mini-grids, though Kipini mini-grid presented a different kind of power limitation. For Kipini, members are allowed to use power for all the major applications such as lighting, powering electronic items, ironing etc. However, the power supply is limited to 4.5 hours a day; the mini-grid serves 120 households. Due to inadequate funding, most community owned mini-grids have poor generation, transmission and distribution equipment yet they have a great potential to enhance rural electrification.

Government owned mini-grids on the other hand supply power the same way the central grid does and face the same challenges like the central grid. The Mpeketoni mini-grid supplies power to about 371 consumers including small industries, schools, a hospital and other institutions.

## **2.2 Mozambique Field Work Report**

Mozambique is located in south-east Africa and borders the United Republic of Tanzania,



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Malawi, Zambia, Zimbabwe, South Africa, Swaziland, and the Indian Ocean. It has a coastline of nearly 2,750km. The country is divided into eleven provinces (from south to north): Maputo, Maputo city, Gaza, Inhambane, Manica, Sofala, Zambézia, Tete, Nampula, Niassa, and Cabo Delgado. It has a total area of 801,590 sq km of which 784,090 sq km is land and 17,500 sq km is water. The July 2009 population estimate for Mozambique is 21,669,278, and the population density is estimated to be 28 people per sq km.

The country is endowed with huge energy resources. The Cahora Bassa dam is one of the largest hydropower installations in Africa generating 2,075 MW, though 90% of the power is exported to South Africa. Despite Mozambique's huge production of electricity, only about 5% of households have access to electricity and 85% of all energy needs are covered by traditional fuels, mainly wood and charcoal. Most Mozambique's poor people live without the comfort and services associated with modern energy. In its National Strategy to combat poverty, the Government of Mozambique has identified the energy sector as one of the main areas for investment.

The field study in Mozambique was carried out in order to document and firm up progress made, factors influencing success and other issues that impacts on sustainability of an energy fund *Fundo de Energia*, FUNAE, which is a public funded institution set up by the Electricity Law of 1997. FUNAE's aim is to provide finance to rural energy projects and had allegedly recorded tremendous success in the development of stand alone and promotion of mini-grids in rural areas of Maputo, Sofala and Inhambane provinces.

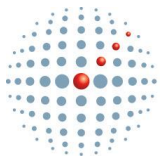
Field work took place during the month of October 2009, which coincided with election period. Structured interviews were held with an outgoing Member of Parliament who sits on the Parliamentary committee on Economic and Social; the Director General of FUNAE and a focused group meeting with the technical staff. A visit was also made to some of the beneficiaries of FUNAE.

## 2.2.1 Field Findings

### ***Fundo de Energia, FUNAE***

To develop energy resources, the Mozambique Government created an energy fund (FUNAE) under the Electricity Law of 1997 Law number 21/97. FUNAE is a publicly funded institution that provides finance to rural energy projects. FUNAE is managed by a Board of Directors drawn from the Ministries of Finance, Agriculture, Industry & Commerce and Energy. Private sector and civil society are not represented on this Board. This is of concern to critics of FUNAE including the interviewed Member of Parliament who felt that FUNAE could have operated more efficiently and effectively had it incorporated private sector and civil society on its board membership.

FUNAE has 61 employees, 80% have technical background whereas the rest have administrative, managerial skills as well as the support staff. Its Mission is to " *promote access to energy in a sustainable and rational way that contributes for the Economic and Social Development of the country.*" while the Vision is to " *Become the reference institution in the*



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*dissemination and promotion of alternatives forms of energy and in the rural electrification.”*

FUNAE receives funding from three main sources: E-Marked Revenues which is a levy collected from other utility companies, huge industrial consumers as well as consumers of electricity. The levy depends on consumption. Higher consumption therefore attracts a steeper levy. It is also allocated funds from the State Budget, while the rest of the funds is sourced from donors and development partners.

FUNAE funds the development of the following energy activities/projects: - generator sets and small grids; distribution of fuel; mini hydro; biomass energy development; solar PV electrification and productive uses of energy.

The criterion that FUNAE applies in funding a project in a particular region is this: that the national grid shall not reach the region in at least the next five years.

### ***Ownership and Implementation of FUNAE Funded Projects***

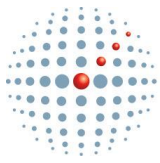
FUNAE, with the support of local authorities and local leaders, nominates a management commission to take care of the systems. The role of this commission is to do the maintenance of the systems and to collect monthly fees paid by households. The management commission deposits the funds collected in a specific account designated for the project.

### ***Challenges facing FUNAE***

The main challenge is the need for more funding. Funding does not match activities. As activities increase, the need to hire more personnel and train local people increases. As such there is need for more funding every year.

Spare parts and maintenance of systems in local areas, time lag between inception and implementation of projects are also some of the main challenges. FUNAE is working with dealers to ensure that they can source spares and train local technicians to maintain systems. With regards to time lag, the management is working to reduce it to reduce the period between inception and implementation to six months.

The few beneficiaries interviewed corroborated the above, citing lack of maintenance as one of the main problems facing FUNAE projects. It was however, not clear how beneficiaries, especially individuals, were selected. The two interviewed coincidentally happened to work with the Ministry of Energy.



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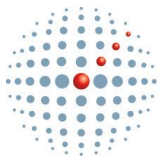
PV systems in Muxúngue Rural Clinic in Sofala, Mozambique

### 2.3 Zambia Field Work Report

Zambia is a landlocked country, located in Central and Southern Africa, with 8 neighbours. It has significant land (752,000 square Km), mineral and water resources and a population of about 10 Million people. It has substantial, albeit undeveloped renewable energy resources. Proven coal reserves are estimated at 30 million tones with several hundred million tones of probable reserves. However despite substantial water resources and a hydro potential of 6000 MW, the country has an installed capacity of about 1,700 MW. Hydroelectric plants represent 92% of the installed capacity and accounts for 99% of electricity production. The current rate of access to electricity is only 22% at national level and a meagre 3% in rural areas. The Government's goal is to increase the rural electrification rate to 51% by 2030. The electrical power sector in Zambia is dominated by ZESCO, a state owned utility company that owns most of the generation, transmission and distribution infrastructure including small hydro and most of the isolated diesel plants.

In 2008, Zambia signed a US\$75 million project financing agreement with the World Bank. The funds are aimed at increasing access to electricity services and improving efficiency and the quality of the country's electricity distribution system through the Increased Access to Electricity Services. Zambia is striving to achieve its national vision of becoming a middle income economy by 2030. Modern energy is crucial in achieving this vision and as such the government is providing rural electrification grants to the Rural Electrification Authority (REA) for grid extension, installation of mini power grid systems as well as installation and maintenance of solar photovoltaic systems for public facilities. Strengthening the capacity of private sector developers to undertake investments in rural areas in renewable energy is also prioritized.

The Government has also received funding from ACP-EC Energy Facility of the European Union (EU). The main goal of the project is to achieve increased access to electricity in rural areas in order to stimulate economic activities and improve social services.



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The energy facilities have three main components which include (i) Grid extension; (ii) Mini hydro development; and (iii) Solar Photovoltaic Systems and Biomass. It is envisaged that the project will contribute to the expansion of electricity infrastructure as part of the overall national rural development agenda. This will ultimately contribute to the achievement of sustainable development and fulfilment of the UN Millennium Development Goals (MDGs) within the framework of the EU Energy Initiative.

Field visit involved meeting with Parliamentary Committee on Energy and Natural Resources, officials of the Rural Electrification Authority (REA) and a field visit to Lunsemfwa Mini Hydro station. The main aim of the field work was to determine the success and mode of operation of REA.

### 2.3.1 Rural Electrification Authority (REA)

As a way of fast-tracking rural electrification, the Zambia Government established REA through an Act of Parliament in 2003 and mandated it to provide electricity infrastructure to all rural areas for increased access to electricity in order to contribute to improved productivity and quality of life for all Zambians. In order to ensure successful project implementation and sustainability, REA encourages community participation.

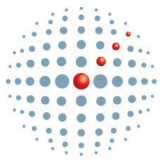
**REA's VISION** is Electricity for all Rural Areas by the year 2030 and the **MISSION** is to provide Electrical Infrastructure to all Rural Areas.

To achieve this, REA undertakes community sensitization programmes in areas targeted for electrification so that key stakeholders at community level are educated on issues such as operations of REA, productive uses of electricity, safety, internal wiring and HIV/AIDS.

A typical sensitization programme starts with courtesy visits on key stakeholders in the project area such as Government or traditional leaders, depending on the project area. Once the key stakeholders are engaged, community sensitisation meetings are organised where REA engages members of the community in an exchange of information and ideas. The sensitization meetings are often very interactive and offer learning opportunities for both the community and REA.

Community sensitization culminates into the formation of community committees composed of individuals from within the community who work closely with REA during project implementation.

The Board of Directors for the Rural Electrification Authority (REA) approved the 2009-2013 Strategic Plan whose theme is Enhancing Economic Growth and Diversification through Rural Electrification. In line with the theme, the implementation of the rural electrification programme will be focussed on among others:-



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- Procurement, delivery and installation of Solar Energy Systems for lighting and water pumping at identified Social Institutions in remote rural communities countrywide.
- Feasibility study on Chavuma Falls Mini-hydro project on the Zambezi River in Chavuma District of North-western Province.
- Designing and packaging of Chikata Falls Mini-hydro project in Kabompo District of North-western province.
- Designing of Mumbotuta Falls Mini-Hydro project in Milenge District of Luapula Province.

It is not very clear what the achievements of REA so far have been. The Members of Parliament whom we interviewed felt that there was need to give REA annual performance targets so that it could improve on its rural electrification rate because the renewable energy resource base was sufficient.

### ***Visit to Lunsemfwa Mini Hydro Electric Power Plant***

A visit was made to Kabale where Lunsemfwa HEP is located. Eskom Enterprises purchased a 51% shareholding in the Lunsemfwa Hydro Power Company, which owns two hydropower stations at Mulungushi and Lunsemfwa, Zambia, with a combined capacity of 36MW. Lunsemfwa hydro-power plants is situated about 160 km north-east of Lusaka and has provided power to Zambia Consolidated Copper Mines (ZCCM) since 1925. Originally built as run-of-river plants, these two plants were later upgraded through the construction of Mulungushi and Mita Hills Dams, respectively to regulate supply during the dry season.

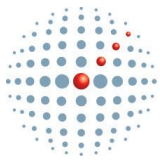
A group of ex-ZCCM managers formed the Lunsemfwa Hydro Power Company in order to bid for the two hydro stations in 1999 when the Zambian Government put them up for sale as part of its privatization programme. The acceptance of the ex-ZCCM bid by the Zambian Privatization Agency was on condition that sufficient finance was raised and that a credible technical partner with operational and maintenance experience was brought in.

Eskom Enterprises was approached in this regard. Eskom Enterprises duly struck a deal to with ex-ZCCM to acquire a 51% share in the company, with the ex-ZCCM holding the remaining 49%; a deal, which was accepted by all the parties involved including the Zambian Privatization Agency. Lunsemfwa is therefore managed by the ex- ZCCM managers, with technical support from Eskom.

The main challenge facing this mini hydro plant is how to directly sell power to rural communities because the existing Power Purchase Agreement (PPA) expressly states that power has to be uploaded to the grid, thus casting a doubt as to whether Lunsemfwa qualifies as a mini-grid.

## **3 Conclusion**

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### **3.1 Kenya enabling policy and legislation framework**

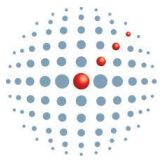
Kenya has had an energy policy since 2004. This policy paper led to the enactment of the Energy Act 2006 giving legal force to the policy. One of the key features of the policy is the establishment of the Energy Regulatory Commission (ERC) from its predecessor, the Electricity Regulatory Board (ERB). Rural electrification was given a new momentum through the formation of the Rural Electrification Authority (REA). Up until the establishment of REA, rural electrification programme had been managed by the Ministry of Energy. The current Energy Act (2006) explicitly encourages private electricity distribution by communities and other interested players. This is in contrast to the previous legislation (Electricity Act, 1997) which, although allowed private generation, did not permit distribution of electricity by private investors. Aside from simplifying and expediting the permitting process for investments below 3MW, the current Energy Act provides yet another key incentive: permission to charge tariffs that cover operating costs and yield a fair return on investment. An ability to charge tariffs that enable investors to recoup their investments has important implications for attracting private capital, thereby creating incentives and opportunities for scaling-up and replication of mini-grid systems. Through this legislation, two community micro hydro mini grids have been developed in addition to the two pilot projects initiated by Practical Action and the Ministry of Energy. Members of the Parliamentary Network on Renewable Energy and Climate Change (<http://www.panerecc.or.ke>) have been instrumental in ensuring that mini grids are developed in their constituencies and other remote districts.

### **3.2 Mozambique Public Energy Fund**

Although the creation of FUNAE is said to have recorded tremendous success in the development of stand alone energy systems and promotion of min grids in rural areas of Maputo, Sofala and Inhambane provinces, concerns about the institution's efficiency and effectiveness still arise given the fact that the private sector and civil society are not party to the leadership and decision making of this public organization. The criteria for selecting projects and the need to ensure that such projects are sustainable economically and socially are yet to be put in place. All in all, there is strong evidence that the Fund has made some difference in terms of facilitating rural electrification. However the role of Parliament and legislators concerned with energy in particular is yet to be determined.

### **3.3 Rural Electrification in Zambia**

The rural electrical power sector in Zambia is dominated by ZESCO; a state owned utility company that owns most of the generation, transmission and distribution infrastructure including small hydro and most of the isolated diesel plants. The creation of REA has focused on increasing energy access in rural areas. To meet growing energy demand in rural areas REA is focusing on mini-grids. It has received funding from the World Bank and Zambia's development partners to strengthen its rural electrification operations through promotion of renewable energy mini-grids in rural districts of Zambia. As a result, Solar and Micro-hydro mini-grids have been developed. However, although Members of Parliament supported its creation, it has so far operated without input from from the same people that created it, and it is therefore recommended that it could work with the Parliamentary Committee on Energy to fast track mini-grid development in the rural areas.



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Members of Parliament can also influence the management of the privately owned Lunsemfwa mini hydropower plants to directly distribute power to local communities.

The Members of Parliament interviewed expressed interest in joining a network such as PANERECC.