Supportive framework conditions for mini-grids employing renewable and hybrid generation in the SADC Region

Zimbabwe Case Study –

Gap analysis and National Action Plan

December 2013

This study has been elaborated on behalf of the Regional Electricity Regulators' Association of Southern Africa (RERA) to establish a framework for attracting increased investment in mini-grids employing renewable and hybrid generation in the countries of the Southern African Development Community (SADC). This project has been financed under the Africa-EU Renewable Energy Cooperation Programme (RECP, www.africa-eu-renewables.org), an integral part of the Africa-EU Energy Partnership (AEEP).

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Acronyms and abbreviations

CCDS	Centre for Community Development Solutions
EIA	Environmental Impact Assessment
EMA	Environmental Management agency
ESCO	Energy Service Company
EU	European Union
EUEI PDF	European Union Energy Initiative Partnership Dialogue Facility
EWURA	Energy & Water Utilities Regulatory Authority of Tanzania
IEA	International Energy Agency
IPP	Independent Power Producer
kW	kilowatt
kWh	kilowatthour
LP	Large project
MEPD	Ministry of Energy and Power Development
MTP	Medium Term Development Plan
MW	Megawatt
NAC	National Action Committee (water sector)
NamPower	Namibia Power Company
NEP	National Energy Policy
NEPIS	National Energy Policy Implementation Strategy
NGO	Non Governmental Organisation
NSSA	National Social Security Authority
NWEC	North West Energy Company, Zambia
PA	Practical Action
PPA	Power Purchase Agreement
PSC	Project Steering Committee
RE	Renewable Energy
REA	Rural Electrification Agency
REFIT	Renewable Energy Feed In Tariff
RERA	Regional Electricity Regulators Association of Southern Africa
RET	Renewable Energy Technology
SADC	Southern Africa Development Community
SAPP	Southern Africa Power Pool
SAZ	Standards Association of Zimbabwe
SE4ALL	Sustainable Energy for All
SEA	Sustainable Energy Authority (Sri Lanka)
SHP	small hydro power
SHS	Solar Home System
SPG	Small Power Generator

SPP	Small Power Project
SPPA	Standardised Power Purchase Agreement
SSP	Small-scale Project
STM	Standardised Tariff methodology
TWG	Technical Working Group
VSSP	Very small-scale Project
ZERA	Zimbabwe Energy Regulatory Authority
ZERO	Zimbabwe Energy and Environment Regional Organisation
ZESA	Zimbabwe Electricity Supply Authority
ZETDC	Zimbabwe Electricity Transmission and Distribution Company
ZINWA	Zimbabwe National Water Authority

Executive Summary

The regional project initiated by the Regional Electricity Regulators Association of Southern Africa (RERA) to create a framework for the development of mini-grids included provisions for two country case studies. Following a request by the Government, Zimbabwe was chosen by RERA as one of the two countries because of the strong expression of interest that was expressed, citing the country's commitment to introduce policies and regulations to promote investment in renewable energy generation. This interest is motivated by a national power crisis, the successful community and private sector investment in existing mini-grids and the absence of policy and legal barriers for mini-grid development. Mini-grids are therefore viewed as a potential quick win strategy for increasing supply in a sustainable, cost effective and environmentally sustainable manner.

The Government of Zimbabwe, working through the Renewable Energy and Conservation Department of the Ministry of Energy and Power Development (MEPD), the Zimbabwe Energy Regulatory Authority (ZERA), the national utility (ZESA) and the Rural Electrification Agency (REA) have participated in this study. It has been supported by non-governmental organisations, academic and research institutions and private sector developers. The study commenced on 26th August 2013 and was completed with a National Stakeholder Workshop on 25th October 2013. The workshop recommended a second national workshop to review and validate the national action plan prepared after the first workshop: this is planned for January 2014.

The policy and legal framework in Zimbabwe presents no barriers to mini-grid development under different ownership models, with donor-funded community schemes being the most prevalent to date. There is, however, a great need for establishing commercially viable pilot projects that can be models for scale-up because the current community schemes have had mixed operational and financial performance. There is scope for improving the policy and framework for mini-grids using the SADC framework.

Gaps in the policy and regulatory environment in Zimbabwe were identified and discussed at the National Stakeholder Workshop and the recommendations and key actions identified to strengthen the framework for mini-grids employing renewables energy and hybrid generation. These are summarized in the following sub-sections. The Action Plan is also presented in the form of a table in Section 6.

Market Needs and Demand

The country does not have a grid and off-grid masterplan for universal access to electricity and other modern energy services. National energy survey data is collected during the national census (the last being in 2012) but is not disseminated and used. It is recommended that:

- By December 2014, REA shall develop and implement a Rural Energy Master Plan that will define the selection and ranking criteria for mini-grid locations and provide indicative least-cost grid and off-grid solutions for universal energy access.

- By December 2014, MEPD shall have established a system for regular production of annual statistics on energy access and energy resources, starting with the 2012 census data.

Technology Choice and Technical regulation

With the exception of a wind and some solar mini-grids, existing mini-grids have generally been technically sound. The following recommendations will help to improve and strengthen this situation:

- REA shall, by April 2014, develop templates for technical proposals to guide mini-grid developers.
- MEPD shall carry out a National Renewable Energy Resource Assessment and will have assessed the necessary skills and budget requirements by June 2014.
- A technical audit to develop a rehabilitation and technical capacity building plan for solar mini-grids installed by REA, shall be completed by December 2013 for implementation from 2014.
- ZERA, in consultation with Standards Association of Zimbabwe (SAZ) and REA, shall develop and introduce minimum technical standards for RE technologies and mini-grids by June 2014.

Ownership, Funding and Economic Regulation

There are no legal barriers to the ownership and funding of mini-grids by communities, public utilities and private owners or any form of partnership or association among these categories of owner. Funding is however a challenge, as the country is currently experiencing a liquidity crisis and there are few options for the long term funding that mini-grid developers would require. The following recommendations would help to address some shortcomings observed:

- Ownership of community mini-grids is best vested in institutions such as schools, hospitals and rural district councils. These have established management structures for overseeing the operation and maintenance.
- ZERA shall, by June 2014, define guidelines for grid interface that shall specify responsibility for grid interconnection costs and compensation for cost differentials between parallel and island operations.
- The MEPD shall, by December 2014, incorporate in the Renewable Energy Policy appropriate principles of concessionary financing and other incentives for small scale renewable energy projects. Relatedly, the Zimbabwe National Water Authority (ZINWA) and Environmental Management Agency (EMA) shall respectively introduce lower non-consumptive water charges for hydropower projects and reduce EIA costs for small scale projects and this is to be recorded in the mini-grid guidelines to be produced by April 2014.

- REA shall, by December 2015, address the technical and financial sustainability of existing mini-grids and introduce new replicable and sustainable pilot projects for the different ownership models An energy working group shall be established to facilitate joint planning of anchor projects to increase mini-grid viability.

- By June 2014, and building upon the regional models and its own on-going work on REFIT and net metering, ZERA shall develop and introduce standardised mini-grid project agreements that can be used and understood without expensive legal assistance.

Planning and Development Process Guidelines & Role Clarity

There are no documented guidelines for the planning and development of mini-grids and current mini-grids have been developed in an *ad hoc* and uncoordinated manner. There is also no renewable energy (RE) policy and legislation to facilitate RE development. It is recommended that:

- The Rural Electrification Agency (REA) shall, through a stakeholder consultative process, document mini-grid planning and development process guidelines by April 2014.

- REA shall establish a coordinating unit that will approve all project proposals to avoid the current *ad hoc* development by donors and other stakeholders. This unit is to be established by April 2014.

- Ministry of Energy and Power Development (MEPD) shall work towards the enactment of a Renewable Energy Policy and Law by December 2014.

Some of the lessons from field visits and case studies of mini-grids in Zimbabwe are of benefit to the region. Examples include the following items:

- A practical example why clear strategies and a documented process is needed is the experience of Nyangani Renewable Energy Company (NRE), which has gone through a long journey of learning through discovery and trial and error. As a result, the development of projects was slow initially, with the first project Nyamingura (1.1 MW) taking 3 years to complete, the second Pungwe A (2.75 MW) 1.5 years, and the third Duru (2.2 MW) took 8 months. The fourth is a much bigger project (15 MW) and is expected to take 18 months.

- Climate change and river siltation risks are high for mini-hydro projects and these would impact negatively on power production and thus income. Oral evidence was presented during the stakeholder workshop from community run micro-hydro and mini-hydro schemes. This is so especially during the dry months of August to November. The use of many years of river flow data is important. This is possible where there is systematic energy resource data collection and recording. NRE used 40 years of information on the rivers in designing their projects.

- Most of the mini-grids installed in Zimbabwe are benefitting the communities in different ways. Among the benefits include extended study periods by school children, use of computers, printers and photocopying machines by the school administration, use of power by teachers and ancillary staff and surrounding community members. Electricity to clinics is providing quality and improved services through refrigeration for vaccines and perishable drugs, maternity lighting and use of power by nurses at home.

- Participatory methodologies enhance community ownership of rural infrastructure and sustainability. The lack of clear ownership on Temaruru wind mini-grid in Rusape was a factor in its collapse. Solar mini-grids installed by REA are failing because the communities have no idea of the next steps as they were not properly handed over. There is clear need for clarifying ownership and management of schemes for sustainability of on-going operations. The SADC and national mini-grid policy and regulatory frameworks should include guidelines for community participation.

1 Introduction

1.1 Background to the study

The Regional Electricity Regulators Association of Southern Africa (RERA), with support from the Africa-EU Renewable Energy Cooperation Program (RECP), managed by the EU Energy Initiative Partnership Dialog (EUEI-PDF) has developed draft guidelines to assist countries in the Southern African Development Community (SADC) to create a framework for attracting investment in mini-grids. Mini-grids employing renewable energy and hybrid generation will help to increase access to electricity for remote and low income communities and to increase investment in distributed renewable generation. Technological advances and cost reductions are making renewable energy technologies, which are environmentally friendly and sustainable, increasingly competitive compared to conventional fossil fuel generation.

Because projects are implemented at national level, the regional guidelines can only make an impact when countries use them to change their national policy and regulatory framework for mini-grids. Therefore two countries, Namibia and Zimbabwe, have been selected to pilot the application of the regional guidelines. Terms of reference for the country studies are outlined in Annex A2.

The two key deliverables of the country studies are a gap analysis and national action plan for creating the supportive framework for mini-grids. The gap analysis identifies areas where the existing policy and regulatory framework falls short of the proposed regional framework. The action plan is a series of recommendations for closing the gaps, with indicative timelines and sources of funding, for closing the gaps. This report presents the gap analysis and national action plan for Zimbabwe.

The report is the outcome of a two month study that formally started on 26th August 2013 and ended with a National Stakeholder Workshop on 25th October 2013. The study was facilitated by the Zimbabwe Energy Regulatory Authority (ZERA) and supported by a Project Steering Committee (PSC) and Technical Working Group (TWG) comprising technical experts from the following organisations that comprised the PSC membership: Ministry of Energy and Power Development (MEPD), ZERA, Zimbabwe Electricity Supply Authority (ZESA), Rural Electrification Agency (REA), Zimbabwe National Water Authority (ZINWA), the Ministry of Environment and Natural Resources, through the Environment Management Agency (EMA), and the Ministry of Local Government.

The key milestones for the study were as follows:

- 26th August 2013 - Inception meeting with ZERA CEO and appointment of the ZERA Director of Technical Services, Misheck Siyakatshana, as team leader and Renewable Energy Engineer, Tobias Mudzingwa, as his deputy. A list of organisations to comprise the PSC was drawn up.

- 5th September 2013 – meeting of representatives of the proposed PSC member organisations agreed the composition of the PSC and TWG. ZERA was requested to contact the organisations formally for PSC nominees and then call the first meeting.
- 24th September 2013 – first PSC meeting was held which agreed on the timetable of activities and date of the National Workshop, including the list of organisations from which workshop participants were to be drawn.
- 26th September 2013 – first TWG meeting to discuss study methodology and site visits. TWG members were allocated duties for desk studies on current policies and regulations relevant to mini-grids.
- 1st – 3rd October 2013 – site visits to selected mini-grids and small power projects in Manicaland Province. The generation technologies for the selected mini-grids included wind, mini-hydro, solar and biomass (forest residue).
- 14th October 2013 – second PSC meeting where TWG presented the preliminary gap analysis report based on information from the site visits and desk studies undertaken. Guidance on the draft final report to be presented to the National Workshop was provided by the PSC.
- 25th October 2013 – National Stakeholder Workshop discussed the Draft Final Gap Analysis report and provided valuable feedback and action plan recommendations. A second workshop was recommended to focus on the validation and implementation of the final action plan. The second workshop, to be funded by HIVOS, is scheduled for January 2014.

1.2 Outline of the Report and Study Limitations

This report provides a brief description of the current electrification situation in Zimbabwe, including the general policy, legal, regulatory and institutional framework. This is followed by a discussion on existing mini-grids and their contribution to electricity access and renewable energy development. The information is derived from the site visits and desk studies as well as discussions with developers and beneficiaries of representative operational and non-operational mini-grids.

A brief summary of the regional guidelines and how they were used for the gap analysis is then presented. The rest of the sections of the report discuss the gaps identified and the recommendations specific to Zimbabwe and lessons for the regional framework.

Study limitations

- Finance and time resources were not adequate to enable the working group to visit, assess and consult stakeholders in all the provinces of

country. Thus to maximise on the limited resources, the visit was restricted to Manicaland Province which provided a mix of various renewable energy technologies being used by that include biomass, wind, solar and hydro. Fossil fuel mini-grids were not studied as most of them are, or were, at institutions targeted for main-grid extension.

- ❑ To enhance stakeholder participation, the study would have desired representation of all stakeholder groups in the energy industry. Unfortunately due to time and budgetary constraints, the Project Steering Committee had to be limited to public enterprises and one NGO, Practical Action. The National Workshop provided some compensation by bringing in additional stakeholders.

- ❑ The country does not have many mini-grids that are bigger than 100kW capacity. Most of them are government or donor initiated schemes. However two IPP owned power plants were included as part of field tour since these can be useful as elements of public private partnerships for mini-grid development.

1.3 Current Electrification Situation in Zimbabwe

The Zimbabwe power sector is currently dominated by the state-owned national power utility, ZESA Holdings, the successor company to the parastatal, the Zimbabwe Electricity Supply Authority (ZESA). ZESA was created by the Electricity Act of 1985 which amalgamated six utilities inherited at independence – the Central African Power Corporation (CAPC), that was the generation and transmission company, the Electricity Supply Commission that was responsible for sub-transmission and distribution in the whole country except for the four main cities of Harare, Bulawayo, Gweru and Mutare which had their own electricity departments.

The Electricity Act of 2002, as amended in 2003 and 2007, and the Rural Electrification Fund (REF) Act of 2002 provided for the establishment of the Zimbabwe Electricity Regulatory Commission (ZERC) and the creation of a Rural Electrification Agency (REA), and restructured ZESA into a holding company with four subsidiary companies – the Zimbabwe Power Company (ZPC) responsible for Generation, Zimbabwe Electricity Transmission and Distribution Company (ZETDC), ZESA Enterprises for provision of products and services to support the power industry and Powertel, for commercialisation of the excess capacity of the utility's telecommunication network.

The Energy Regulatory Authority Act of 2011 established the Zimbabwe Regulatory Authority as the successor to the Zimbabwe Electricity Regulatory Commission. This act provides for more efficient use of scarce human and financial resources for the regulation of the whole energy sector. It also provides for greater autonomy of the regulator.

The Ministry of Energy and Power Development (MEPD) is responsible for formulation of energy policy and for overseeing the management and operations of

these organisations. The latest policy document is the National Energy Policy (NEP) of 2012. The NEP recognises the policy gap with respect to renewable energy and proposes to have a Renewable Energy Policy and law that will transform the Rural Electrification Agency into a Rural and Renewable Energy Agency.

Other laws and regulations that impact on the energy sector and renewable energy development include the Water Act, the Environmental Management Act, Zimbabwe National Water Authority (ZINWA) Act, electricity licensing regulations, energy pricing study and the grid code. A summary of the relevant policies and laws are summarised in the table below.

Table 1: Key energy policies, legislation and regulations

Policy/Law/Regulation	Year	Description
National Energy Policy (NEP)	2012	Provides a framework for the exploitation, distribution and utilisation of the country's energy resources and outlines the principal strategies for implementing policy. It strongly advocates for the promotion of renewable energy to address the supply gap. The policy also provides for the formation of the Rural Energy Agency, the establishment of REFIT, National Grid Code and IPPs.
Energy Regulatory Authority Act (Chapter 13:23, No. 3 of 2011)	2011	Establishes ZERA and defines the regulatory framework for the procurement, production, transportation, transmission, distribution, importation and exportation of energy derived from any energy source.
Electricity Act (Chapter 13:19, No.4 of 2002) amended in 2003 and 2007	2002	Provides the framework for the unbundling, commercialisation and privatisation of ZESA's different business areas. It specifies licensing requirements for energy generation system greater than 100kW.
Rural Electrification Fund Act (Chapter 13:20, No. 3 of 2002)	2002	Establishes the Rural Electrification Fund (REF) to facilitate the rapid and equitable electrification of rural areas using grid and off-grid technologies.
Zimbabwe Energy Pricing Study	2004	Provides a basis for establishment of cost reflective prices for the three segments of the electricity supply industry – generation, transmission and distribution.
Electricity (Licensing) Regulations (Chapter 13:19, No 103 of 2008)	2008	Provides for the issuance of generation, transmission and distribution licences by ZERA, including detailed application guidelines
Electricity Licensing Guidelines and Requirements	2013	Provide simple guidelines on the licence application process including the required documentation. It applies to systems above 100kW.
Zimbabwe Grid Code	2013	It establishes the basic rules, procedures, requirements and standards that govern the operation, maintenance, and development of the electricity distribution systems in Zimbabwe to ensure the safe, reliable, and efficient operation of the electricity distribution system.
Environmental Management Act (Chapter 20:27, No. 13 of 2002)	2002	It provides for the sustainable management of natural resources and protection of the environment in accordance with global commitments. Energy is a prescribed activity under schedule 1 of the act. Thus it is mandatory for Environment Impact Assessment of all

Policy/Law/Regulation	Year	Description
		energy projects to be undertaken.
Water Act of 1998 (Chapter 20:24, No. 31of 1998)	1998	It regulates the development and utilisation of water resources within Zimbabwe such as for inland dams with potential for hydropower generation in addition to their primary purpose of irrigation and urban water supply.
Zimbabwe National Water Authority (ZINWA) Act Chapter 20:25, No. 11 of 1998)	1998	ZINWA is required to undertake and publish the results of research and hydrological and geographical surveys and to develop and maintain a database on hydrological issues of interest for the development and exploitation of water resources in Zimbabwe. Hydrological data is required for planning hydro generation systems on inland dams and perennial rivers. Provides for tariffs for water users. All hydro systems pay consumptive use tariff for water.

Statistical highlights of Zimbabwe's electricity sector

Electricity access statistics in Zimbabwe are unreliable as these have never been properly compiled and what are available are estimates by the national utility, Zimbabwe Electricity Supply Authority (ZESA). According to the National Energy Policy Implementation Strategy document of January 2012, the utility estimates that 31% to 40% of households have access to electricity, 83% in urban areas and 13% in rural areas. The higher national electrification figure was based on estimates made around the year 2000. The lower figure is a more recent estimate that takes account of the fact that there has been a slowdown in electrification since then while the population has continued to grow.

Table 2: Zimbabwe Power Company's Power Station Capacity and Generation

Plant Name	Installed Capacity	Maximum Available Capacity	Generated energy
	MW	MW (average)	GWh (2012)
Kariba	750	650-750	5372
Hwange	920	500-700	
Harare	100	30	
Munyati	90	30	
Bulawayo	90	30	3575
Total Zesa	**1,950**	**1240-1540**	**8947**
Cogeneration*	?	?	167
Others**	?	?	3
Grand Total	**1950 +**		**9117**

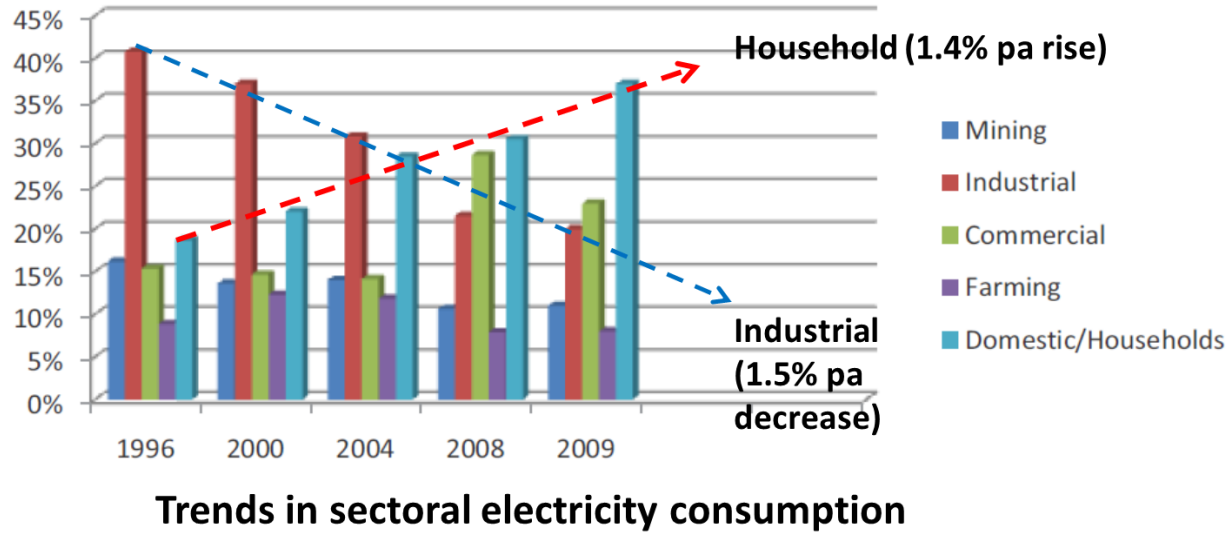
Source: *ZESA. *Sawmill and sugar estates. ** Only those selling to utility. Self-generation statistics not available but would be much more.*

The electrification rate has slowed down because of macroeconomic challenges that have faced the country over the past decade coupled with severe power supply shortages which are managed through daily load shedding. The table above highlights statistics from the Zimbabwe Power Company (ZPC) that show the gap

between installed and available capacity, especially for the thermal power plants which have much lower availability due to old age and overdue maintenance.

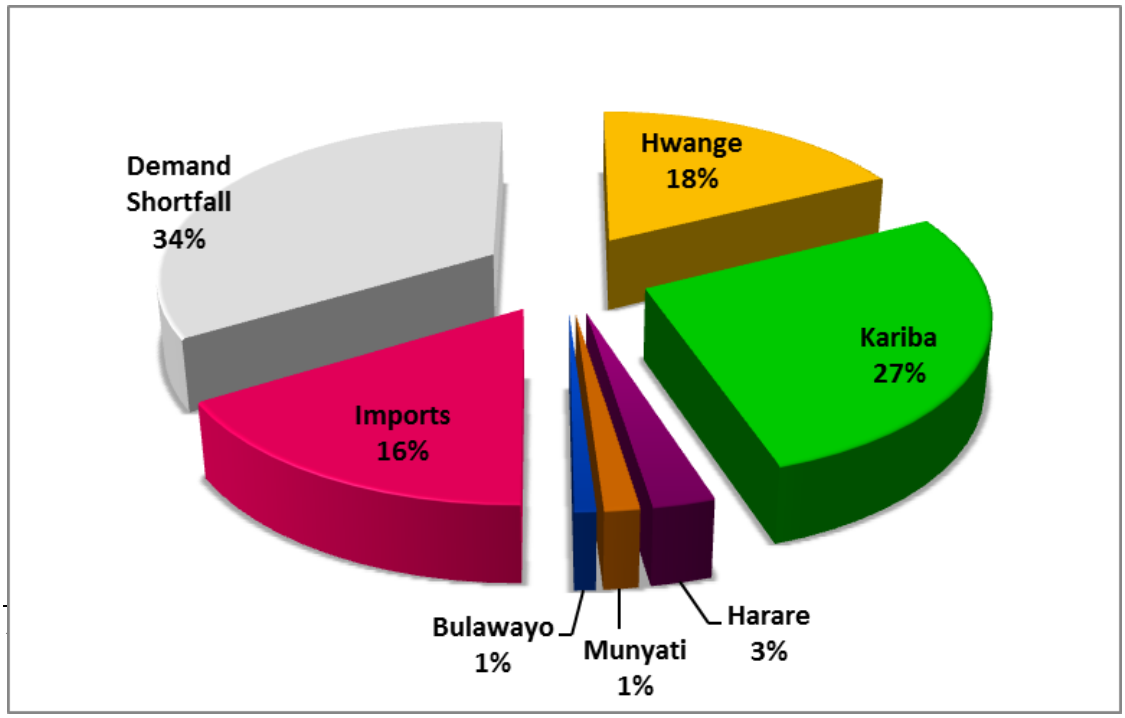
Annual peak power and energy demand figures in the 1999/2000 period, when the economy was performing at its post independence peak, were 2045 MW and 12500 GWh. Although industrial, mining and farming demand have been falling household demand has been rising and is now the largest consumption sector as shown in Figure 1.

Figure 1: ZESA customer consumption categories



Power imports average 100 to 150 MW per day but are absorbed by losses (over 20%) and committed exports to Namibia. Financial constraints and regional supply shortfall do not allow higher level of imports. Figure 2 illustrates the huge demand shortfall, assuming the economy recovers to past peak levels of demand.

Figure 2: Share of energy generated internally and imports



1.4 Role of Mini-grids

Although still insignificant, small generating units installed by independent power producers, government and NGO's have demonstrated that increased investment in these options can bring viable solutions to addressing the country's supply gap. Cogeneration units utilising bagasse have been installed in South Eastern Zimbabwe by Triangle and Hippo Valley Sugar Estates. They generate steam and power for sugar processing and export extra power to the national grid for six months. At Charter Saw Mill owned by Border Timbers Ltd, there is installed a 500kW steam engine fired by wood waste for internal power use.

In the Eastern Highlands of the country, independent power producers have installed nearly 7 MW of mini-hydro power generating units (Table 3).

Table 3: Mini hydro systems owned and operated by IPPs

Scheme Name	Owner	Installed Capacity (MW)
Duru	Nyangani Renewable Energy Company	2.2
Nyamingura		1.1
Pungwe A		2.75
Rusitu	Rusitu Power Company	0.75
Total		**6.8**

The Rusitu Mini hydro power plant is currently out of action due to flooding that destroyed the wooden penstock. Nyangani Renewable Energy Company is constructing a fourth plant, Pungwe B which is 15 MW and is anticipated to start generating in December 2014.

Table 4: Micro-hydro mini-grids in Zimbabwe

Name of Scheme	Date Installed	Capacity (kW)	Status
Chipendeke	June 2010	27	Operational
Claremont	-	30	Non functional
Dazi	2011	20	Operational
Himalaya	2013	80	Waiting commissioning
Hlabiso	2013	30	Operational
Ngarura	2013	30	Operational
Nyafaru	1990	20	Operational
Nyamwanga	2013	30	Waiting commissioning
Nyamarimbira	2003	30	Non functional
Svinurai	2005	30	Non functional
Chitofu, Rusape	-	20	Non functional
Total Capacity		**347**	

On micro-hydro power generation scale the Eastern Highlands has mini-grids with close to 350kW of generating capacity installed and these were mainly implemented

by the NGO Practical Action using funding from donors. The schemes are shown in the table above.

The non-functional systems provide a case for the need of supportive framework conditions for mini-grids. Claremont is a private owned power scheme which used to operate at Claremont farm but lack of technical expertise and cheap electricity resulted in the plant being neglected after its failure. Chitofu is an individual owned system and following the death of the owner, the sons who inherited the system were not interested in resuscitating it. Svinurai and Nyamarimbira are examples of mini-grids that were rendered dysfunctional when the mini-grid was extended to the areas. There is no framework in place that would facilitate their co-existence.

An estimated 32 kWp mini-grids providing pumping water for irrigation have also been installed countrywide through the efforts of a number of non-governmental organisations. The table summarises some known solar powered irrigation facilities in the country.

Table 5: Small-scale irrigation facility served by solar mini-grids

Name of Scheme	Developer	Capacity (kWp)
Ruti Dam Solar Irrigation facility	Practical Action/OXFAM	4.5
Ruwa Irrigation	Adventist Development and Relief Agency (ADRA)	1.02
Hatcliffe Irrigation		1.02
Epworth Irrigation		1.02
Tiritose Solar Irrigation (Zvishavane)	World Vision	2
Hope 24 (Mrewa)	Private	2
Solar Irrigation & Power	Tashinga Initiative (NGO)	20
Total		**31.56**

The Government has hitherto not been very active in using renewable energy for mini-grids, preferring instead to use the national utility ZESA and the Rural Electrification Agency (REA) to extend the main grid to rural administration centres, schools and hospitals that used to be supplied by diesel generating units. The Rural Electrification Agency (REA) has installed a total of 372 donor funded solar powered mini-grids of 0.9 kW each which were designed to provide power to limited essential services at schools and clinics. They represent an equivalent power generating capacity of 334.5kWp. The limited capacity has proved to be frustrating to users.

The Government has not yet established a Renewable Energy Policy but has a Department in the Ministry of Energy and Power Development which is dedicated to the promotion of renewable energy and energy conservation. The National Energy Policy proposes to strengthen the institutional capacity for implementing renewable energy projects by transforming the Rural Electrification Fund into a Rural and Renewable Energy Fund managed by a Rural and Renewable Energy Agency which will be the successor to the Rural Electrification Fund and Agency.

The current focus on main grid extension by the Rural Electrification Agency arises from the fact that it started as a Rural Electrification Unit of the national power utility, established when an electrification levy was introduced by ZESA in 1995. The

levy is paid by customers as a percentage of their bills. Between 1997 and 2002, the levy was 1% on electricity sales and was raised to 6% after the enactment of the rural electrification fund law. The Rural Electrification Agency (REA) created following the enactment of the Rural Electrification Fund (REF) Act of 2002 has a mandate that goes beyond main-grid extension. The Rural Electrification Fund Act definition of rural electrification project includes *"construction or extension of works for the distribution of electricity and the financing of its end-use infrastructure, including the construction of isolated mini-hydroelectricity, solar and wind generators for centres away from the national electricity grid"* (***REF Act, section 2***). This is a clear intention of using the fund to promote renewable energy development for rural electrification.

The institutional framework and funding for mini-grids using renewable energy resources for the generation of electricity is clearly provided for in the objects of the Rural Electrification Fund which are outlined in section 4 of the REF Act as follows:

> *Subject to this Act, the object of the Fund is to facilitate rapid and equitable electrification of the rural areas of Zimbabwe, in pursuance of which it may –*
>
> *(a) Play a promotional role in rural development, identifying rural electrification projects and finding or advertising for projects sponsors to take these up;*
>
> *(b) Assist and train projects promoters to ensure that rural electrification projects are implemented cost effectively and efficiently;*
>
> *(c) Be a centre of information and excellence on rural electrification in Zimbabwe, through collecting information about rural electrification practice, carrying out research and keeping abreast of technological developments in rural electrification world-wide;*
>
> *(d) Give particular attention to off-grid, stand-alone technologies for the supply of electricity to rural communities.*

The Energy Regulatory Authority Act of 2011 also mandates the regulatory authority *"to promote, identify and encourage the employment and development of sources of renewable energy ... to ensure the maximisation of access to energy by all consumers that is affordable and environmentally sustainable ... (and) to assess, promote studies of and advise the Minister and licensees on the environmental impact of energy projects before licensing."*

The country's Electricity Act of 2002 removed the legal barriers for private sector investment in the power sector but so far the private sector investment in power besides cogeneration has been very minimal. The Zimbabwe Energy Regulatory Authority (ZERA) has since licensed projects with combined capacity of more than 5000 MW but only 7 MW of mini-hydro generation have been successfully implemented for supplying the main grid, of which 6 MW is operational. This has demonstrated that there is an opportunity for the country to increase private sector generation capacity by scaling up small renewable power projects. ZERA is finalising a study on Renewable Feed in Tariffs which will include standardised power purchase agreements.

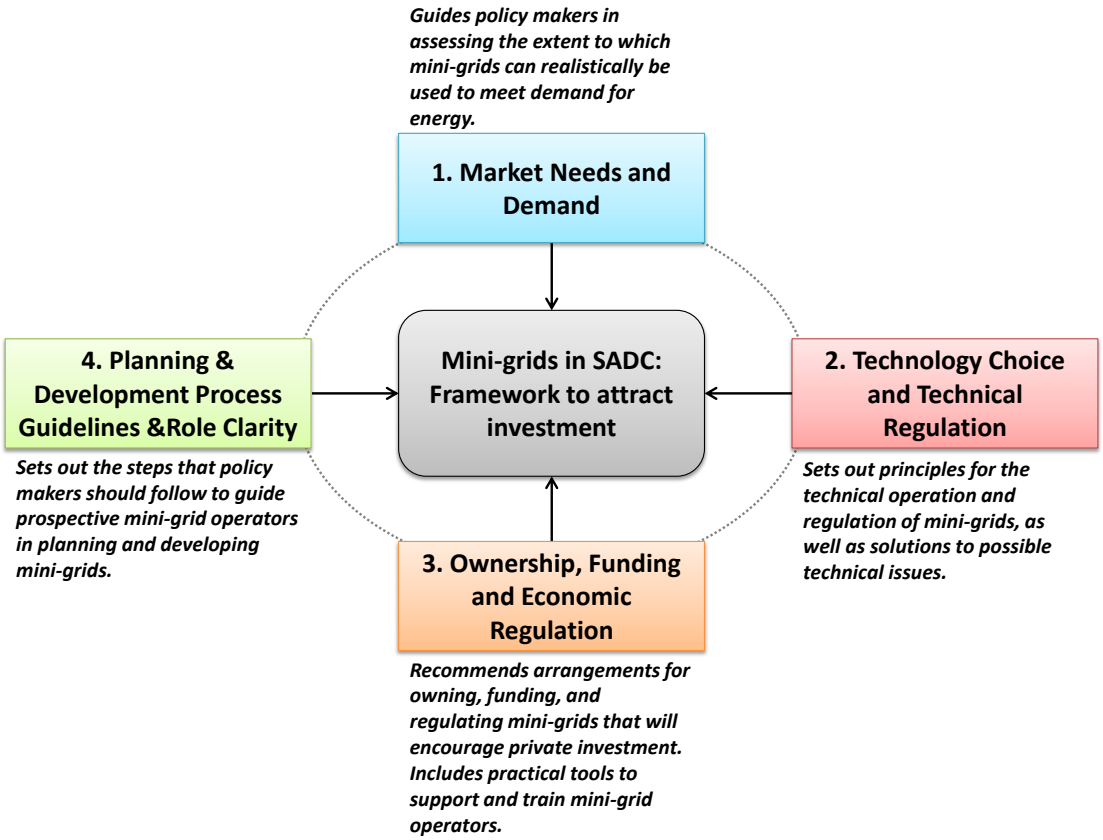
It is against this background of the current national power crisis, and the absence of policy and legal barriers for mini-grid development, that the Government,

Zimbabwe Energy Regulatory Authority, the national utility ZESA and the Rural Electrification Agency have expressed strong support for the regional mini-grids project. This strong expression of interest fulfilled the selection criteria established for the RERA mini-grids study and hence Zimbabwe was selected as one of the countries to pilot the application of the regional guidelines.

1.5 Application of SADC Regional Framework for Mini-grids in Country Case Study

The SADC RERA mini-grids project has established a framework with four focus areas illustrated in the following figure. The guidelines help policy makers to define the mission and vision for increased access and renewable energy development. The guidelines help regulators to facilitate policy implementation.

Figure 3: Support framework for mini-grids



To attract increased investment in mini-grids using renewable energy and hybrid generation it is recommended that countries use the guidelines to review their policy and regulatory framework as follows:

a) **Undertake research to establish a thorough understanding of market needs and demand.** The ability and willingness to pay by the end users is the foundation for sustainable mini-grid businesses. The development of a

universal access strategy and masterplan helps to create stakeholder consensus on

- Definition of energy access and access targets; that is the time horizon for achieving universal access for different end uses.
- The role of the 3 basic energy supply options in fulfilling market needs and demand: standalone devices, main-grids and mini-grids. A comprehensive assessment of options ensures that only those mini-grids that are the optimum solution for market needs are implemented.
- The selection and ranking of locations for use of the different options.

b) **Influence technology choice towards renewable energy.** This is an exercise in removal of barriers to renewable energy development through such measures as

- Renewable energy policy, targets and incentives
- Renewable energy resource assessments
- Development of safety and appropriate product and service quality standards to ensure value for money for mini-grid customers

c) **Provide for diverse ownership, funding and economic regulatory approaches.** Mini-grids can be developed by public sector, private sector and community organisation and by partnerships among these. A one-size fit all approach can be a barrier and therefore a classification system has been recommended.

- Mini-grid classification is by size, location relative to grid (off-grid or grid-connected) and ownership of mini-grid elements (vertically-integrated or non-vertically integrated).
- Some of the recommendations are that there should be no license or tariff regulation for very small projects; there should be non-negotiable standardised project documents and tariffs or methodology for small projects; standardised but negotiable for large projects can help to reduce transaction costs and time.

d) **Have dedicated institutional responsibility for promotion of mini-grids.** This institution's main function is to reduce transaction costs and time by ensuring stakeholder role clarity and transparency of the planning and development process. Some of the key actions required are ;

- Documentation of planning and development process through stakeholder consultation process

- Documentation of technical planning guidelines and undertake audits and training for operators
- Facilitating the process by providing a one-stop service for developers

This framework helped to assess and identify gaps in current policy and regulations related to mini-grids which are reported in the rest of this report.

2 Assessment of Market needs and demand

2.1 Existing studies of market needs and demand

Yearly statistical energy bulletins with data about the electricity market, including number of domestic customers were last published in 2008 by the Ministry of Energy and Power Development. The national population census undertaken once in 10 years has a section that collects energy related data for each household in the country and the last census was in 2012. However there is no further analysis of these data sets to help in understanding the energy needs and demand at household level in urban, peri urban and rural areas.

The proportion of the population with access to electricity is measured by number of utility connected households multiplied by the average household size according to the latest census statistics. Currently the quoted figures are 37% of the households nationally which is split into 83.2% being urban households and 13.3% being rural households. This approach does not include non-utility connected customers and also does not address the end uses.

2.2 Universal Access Targets and Plans

The Government is among the first 10 African countries to respond to the request for commitment to the UNDP SE4ALL agenda. Thus it has adopted the objectives of SE4ALL of having 100% access by 2030. However this commitment needs to be translated into action starting with the development of National System Development and a Rural Energy Master Plan (REMP).

The rural electrification programme has so far progressed on a general practice that prioritises connection by proximity to the main grid and the equal distribution of resources among the administrative provinces. The selection of centres for electrification is guided by an outdated Rural Electrification Master Plan developed in 1995 funded by Africa Development Bank and approved by cabinet in 1997 (Mapako, 2005). The master plan was produced to electrify 415 selected rural service centres in phases over 5 years. A national master study on rural electrification funded by the Japanese International Aid Agency (JICA) was undertaken from 1997 to 2002 but was limited in geographical coverage. The current grid proximity based "fast track" rural electrification programme was adopted in 2002. Those centres less than 5km from the existing grid have the highest priority.

The Rural Electrification Agency is planning to engage consultants to help develop a Rural Energy Master Plan (REMP) to provide a strategic roadmap for universal access. The objective is to guide the selection and ranking of grid and off grid solutions for different geographical locations. This study will include the definition, selection and ranking of different types of energy solutions, the development of least cost grid extension plan and complimentary off grid plan. ZERA will take account of the integrated resource master plans in licensing new capacity. The REMP will be

financed by REA and will be finalised by Dec 2014. The development is in line with the NEP where, "*Ministry will, in accordance with procedures to be outlined in the proposed Energy Management Act, develop and review integrated electricity energy resource master plans so as to increase the proportion of electricity generated from renewable energy resources for environmental sustainability*".

2.3 Gap Analysis – market needs and demand

Zimbabwe has no tools for assessing market needs and demand. The 2012 census collected data on household energy access but it remains to be analysed. The Ministry of Energy and Power Development (MEPD) can start with 2012 census data to generate a baseline energy access data and to use the demographic surveys held every two years to update the household energy statistics. It is recommended that MEPD (the Policy and Planning Department) generate annual energy balance reports and prepare a National Energy Outlook Report.

Multi-sector coordination is essential in assessing needs and demand. Just as there is need for the energy sector to be more focussed on understanding the end uses of customers, there is need for non-energy sector people to be more aware of energy requirements which should be incorporated in their sector plans. The MEPD's Policy and Planning Department should establish a multi-sector forum to facilitate awareness and better integrated resource planning.

The development of the rural energy master plan (REMP) is an opportunity for developing national consensus on a universal access strategy and action plan. The SADC guidelines will provide a checklist of issues to be taken into account. Capacity building should also be an important part of the REMP terms of reference to allow REA and the Ministry to replicate the studies on a regular basis to provide guidance to developers on site and technology selection. There are examples of mini-grids that were rendered dysfunctional after they were overtaken by the main grid when it was installed a few months later. The masterplan study should therefore recognise the need for mini-grids to operate in both grid-connected and island mode.

The Rural Energy Master Plan also needs to be coordinated with the National System Development Plan which is prepared with advice from ZESA.

3 Technology choice and technical regulation

3.1 Technology choice and resource assessments

One of the five broad policy objectives of the NEP is to '*Develop the use of other renewable sources of energy to complement conventional sources of energy*'. Zimbabwe does not have a renewable energy resource map. National assessments to map solar, wind, large and small scale hydro, bio-energy and other non-conventional renewable resources are needed. It is a crucial public investment that encourages the sustainable expansion of renewable power generation.

Knowing the scale and location of renewable energy resources such as biomass, small hydropower, solar and wind allows government to strategically plan for their development and create favourable policies, and provides commercial investors with greater resource certainty, thus reducing project risk and speeding up deployment. More detailed site-specific assessments will then be undertaken by project developers during project feasibility studies.

Once renewable energy resources are established it is necessary to define targets for the deployment of the renewable resources in the energy supply mix and to put in place a framework for implementation. ZERA is therefore finalising a renewable feed in tariff policy which is expected to be approved for implementation in 2014. The Government has set a target of 300 MW of renewable energy generation capacity by 2018.

Other specific incentives such as renewable feed in tariffs are required to facilitate achievement of the set renewable energy targets. The Renewable Energy Feed Tariff being developed by ZERA for different renewable energy generation technologies is a step in the right direction.

3.2 Technical planning guidelines

There are no technical planning guidelines for mini-grids in the country. According to Nyangani Renewable Energy Company, the developers of three operational mini-hydros feeding into the grid, it took them 3 years to establish their first 1.1 MW mini-hydro power plant (Nyamingura) partly due to the need to acquire the technical expertise for planning and designing such plants. After going through the learning curve the second scheme of 2.75 MW (Pungwe A) took 18 months while the latest one of 2.2 MW (Duru) took just 8 months to complete.

The site visit to Duru mini-hydro confirmed that the company now possesses the necessary technical design, project management and operational competency for mini-hydro power plants.

Site visits and presentations at the national workshop demonstrated that the solar mini-grids have technical design and operational problems arising from a mismatch

between market needs and demand and the systems installed. The absence of adequate end user training was also very evident.

The National Stakeholder workshop recommended that the Rural Electrification Agency, as the mini-grid coordinating agency, should develop and publicise technical planning guidelines for different technologies for use by project developers.

3.3 Gap Analysis – technology choice and technical regulation

MEPD (Renewable Energy and Energy Conservation Department) will need support to assess resource requirements and to undertake the RE resource assessments (hydrology, wind, solar maps, biomass).

There are no locally defined technical standards for renewable energy technologies and mini-grids. Standardising the sizes of mini-grid generators, solar modules, conductors, transformers and other components will help in creating the economies of scale that will make local manufacture viable. Common network safety and reliability performance standards also help in skills training and development. For the protection of consumers, it is necessary to define customer service standards and performance reporting requirements for mini-grids. ZERA in consultation with REA, SAZ and ZESA, need to develop the minimum technical standards that include but not limited to grid interface and safety.

The solar mini-grids installed by REA were failing to deliver the desired services due to mismatch between technical design and the demand and lack of adequate operation and maintenance. The value of electrification is lost if the supply is unreliable and prone to prolonged outages due to the absence of skills and spares within easy reach of the mini-grid. The most important technical consideration for mini-grids is the transfer of technology to allow sustainable operation, maintenance and management of the electricity supply system for the duration of its design life. It is recommended that REA undertake a technical audit of the solar mini-grids and to rehabilitate them. This should then be followed by putting in place sustainability measures that include operation and maintenance and defining the ownership of the mini-grids.

4 Ownership, funding and economic regulation

4.1 Ownership and Funding

Ownership and funding of most existing mini-grids is not well defined. Most were funded by donors and left to be run by communities without clear responsibility for on-going operation and maintenance.

A case in point is the ownership of the donor funded solar mini-grids installed by REA. During installation the beneficiaries were asked to contribute in kind but no tariff or other cost recovery mechanism was put in place for operation and maintenance. REA has been assisting with technical problems on an ad hoc basis, many of which relate to the batteries which were installed when they were already past their design life (the systems had been in storage for a long time before the decision to get REA to install them).

The Nyafaru mini-hydro which has been operating since the early 1990's. Sustainability has been achieved by the decision of the school administration to take the scheme under its management. There is a formal tariff system and school levy that supports the operation and maintenance and special contributions are made for major breakdowns requiring more money than that collected through the tariff and school levies.

The Chipendeke scheme is a community owned and managed scheme but which was donor funded. It has a prepaid meter revenue collection system that is based on a tariff structure which is higher than the national uniform tariffs but affordable to the beneficiaries. Although this is not yet breaking even the scheme's management structure has succeeded in maintaining the technical soundness of the scheme's.

4.2 Economic Regulation

Most of the mini-grids have generating units that are below the 100 kW licensing threshold defined in the law. ZERA does not regulate the tariffs that are charged but undertakes technical inspections to ensure safe operation. This approach is consistent with the recommendation of the SADC guidelines and should be maintained. What may need to be considered is the raising of the threshold above 100 kW to encourage the development of larger schemes.

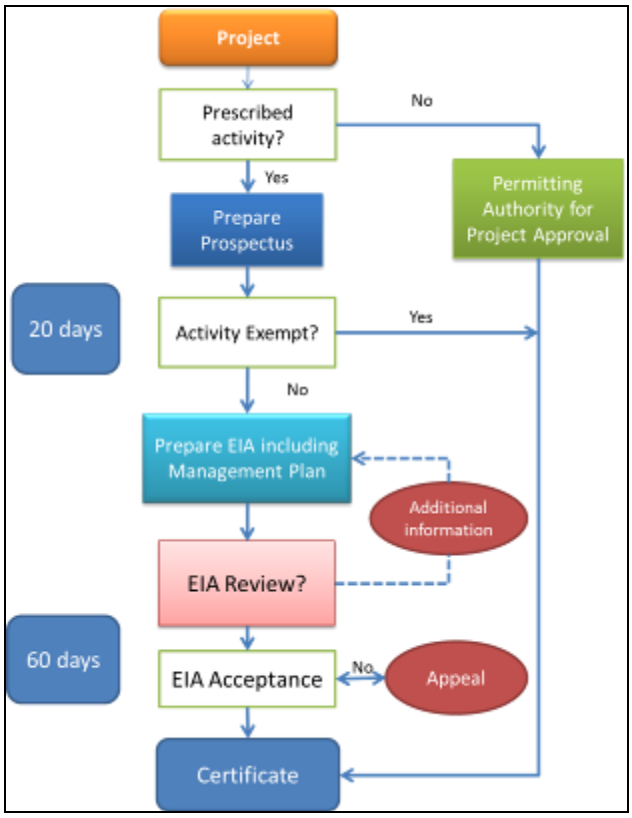
While ZERA does not have any charges for the very small projects, other agencies such as the Environmental Management Agency (EMA) and Zimbabwe National Water Authority (ZINWA) do have charges that are too high for the size of projects. The charges for ZINWA are only applicable to hydro projects.

Environment legislation is applied without due consideration of project size or capacity. It disregards scale and potential impacts on environment and this places a disproportionate burden on small scale renewable energy projects. Renewable

energy projects mitigate against GHG emissions and also bring socio-economic development to rural areas. Thus the total environmental and social benefit might far outweigh the negative impacts during construction. Further the EIA costs are highly prohibitive. EMA charges 1.5% of the total project value to assess the EIA Report and issue a certificate. Besides these charges there are independent consultant fees that vary depending on experience but at most are pegged at 10% of the project value. An example at Chipendeke micro-hydro power project where the total project cost was US$395,000 and the consultant quoted US$20,000 for the EIA[1]. The total cost for compliance to environment act is equivalent to 6.5% of the project budget which is an additional cost to the project.

The costs of EIA and water consumption are passed on to the rural consumers through high tariffs. Since RE mini-grids have positive environmental benefits for the country, the law should target the carbon tax on fuels and earmark it for subsiding RE developments. Zimbabwe National Water Authority (ZINWA) and Environmental Management Agency (EMA) shall respectively introduce lower non-consumptive water charges and reduce EIA costs for small scale projects and this is to be recorded in the mini-grid guidelines to be produced by April 2014.

Figure 4: Environment Impact Assessment Process in Zimbabwe



Mini-hydro schemes are run-of-river which are not net consumers of water but are nevertheless charged for water at the consumptive charges. This is because there are

[1] From interview with Energy Project Coordinator of Practical Action.

no gazetted tariffs for non-consumptive use of water. Water charges are US$2.16 per Mega-litre. The Chipendeke Micro-hydro example given above is designed to abstract 100 l/sec. This translates to 1576 Mega-litres per year assuming 50% capacity factor and costs the community US$3,400. Competing water uses among permit and non-permit holders is prevalent compromising system performance. At Duru Minihydro, there are 16 recognised water permit holders, but more than 40 farmers are abstracting water from the same point.

4.3 Gap analysis – ownership, funding and regulation

Although the REF Act requires the Rural Electrification Agency to support project developers with funding, the Agency has not yet developed guidelines for provision for such support. The absence of a Renewable Energy Policy explains why there is no clear RE incentive policy for mini-grid developers. Rural electrification funds have been utilised by REA mainly for grid extension for many projects where alternative RE solutions would have been more appropriate.

Rural electrification projects that have so far been developed have been on best efforts arrangements by the developers and the national utility. Mini-grids using renewable energy justify subsidy for the environmental and social benefits. This will ensure an equitable sharing of costs with customers who are then able to afford the cost of mini-grid electricity. The absence of a grid interface policy especially for off-grid projects has burdened developers who end up passing the cost of grid interconnection to the end users through tariffs. Other incentives include duty reductions for project equipment.

There is need for ZERA to define guidelines that address the responsibility for grid interconnection costs and the cost for parallel and islanding operations. The policy should encourage generation maximisation to mini-grid operators and, in the case of ZESA disconnection, the loss of generated power due to grid separation outside mini-grid operator control will require a clear definition of compensation mechanisms. These mechanisms need to strike a balance between risk sharing and the compensation being large enough to justify the administration involved in processing claims. The cost of grid interface beyond a defined distance should be a legitimate expense for the Rural Electrification Fund in supporting the REFIT policy.

5 Planning and Development Process

5.1 National development planning framework

At national level, energy policy and plans should be developed as an enabler of Zimbabwe's macroeconomic and social development. Unfortunately there is generally a mismatch between the time horizon that energy plans need and the short term macroeconomic policies that keep changing midway during implementation. For example a new national economic development plan, the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim-Asset), a five year (2013 – 2018) policy has just been launched to replace the Medium Term Economic Development Plan (MTEP) (2010 – 2015). It seeks to accelerate economic growth and wealth creation, and is anchored on indigenisation, empowerment and employment creation. It has four pillars namely; Food Security and Nutrition; Social Services and Poverty Reduction; Infrastructure and Utilities; and Value Addition and Beneficiation. Energy falls under Infrastructure and Utilities and the government has put emphasis on private public partnerships (PPPs) in energy supply.

Mini-grids need to be planned for a time horizon of 15 or more years. This is matched to the long payback period for mini-grid investment. For example, according to Nyangani Renewable Energy Company, Duru minihdyro project has an expected payback period of 8 years on condition the prevailing socio-economic and political conditions are maintained. Policy certainty over that period is required for Nyangani Renewable Energy Company to have confidence in future investment. This means that the mini-grids need to be protected against political risk of changes in policy and laws where such changes have an adverse impact on project viability.

Among the key policy measures to achieve these objectives include the adoption of long term, government driven, renewable energy technologies programme, which encourages IPPs and private partnerships.

5.2 Role Clarity

For coordination of the rural and renewable energy sector, the role of REA is clearly defined by law. However REA has not been executing this mandate leading to ad hoc project implementation. The Rural Electrification Fund Act 2002 gives the Rural Electrification Agency (REA) the mandate to coordinate and promote projects in the rural energy sector. The Zimbabwe Energy Regulatory Act of 2011 sets the office of the independent regulator, the Zimbabwe Energy Regulatory Authority (ZERA). The Ministry of Energy and Power Development need to reaffirm the coordinating role of REA.

Apart from the energy sector institutions highlighted in the introduction the following are some of the key stakeholders affecting mini-grids:

Scientific and Industrial Research and Technology Development Centre (SIRDC), formed under a statute, has the mandate of providing research and technology development to support Zimbabwe Industry, Government departments and the public. One of the institutes, the Energy Technology Institute (ETI) is dedicated to providing research and technology related to energy.

Non-Governmental Organisations (NGO's), Among the prominent international NGO's participating in the energy sector include Hivos, Practical Action, Oxfam, WWF (World Wide Fund for Nature) and SNV Netherlands. Except for WWF, the international NGO's are part of the civil society coalition on SE4ALL for Zimbabwe. They have been enhancing access to rural and peri –urban communities, financing and building capacity of communities, entrepreneurs, finance institutions and policy makers. Among the local NGOs active in the energy sector include Environment Africa, ZERO (Zimbabwe Energy and Environment Regional Environment Organisation, Zimbabwe Women's Bureau (ZWB) and Development Reality Institute (DRI).

Private Sector; The private sector group led by the Business Council for Sustainable Development and the Solar Energy Industries Association of Zimbabwe have been at the forefront for advocating the use of RE. Econet the leading mobile network has a solar distribution company Econet Solar that is involved in retailing solar lanterns and has been providing excess power from its remote base stations powered by solar to refrigerate vaccines and essential medicines for remote health centres.

5.3 Gap Analysis – Role Clarity, planning and development

Rural electrification sector has not been well coordinated despite the mandate given to REA. The National Energy Policy and the Rural Electrification Act mandates REA to coordinate the delivery of mini-grids in the country. According the NEP, "*The Rural Energy Agency that will be established as the successor to the electrification agency will become the coordinating agency for non-governmental organisations (NGOs), community-based organisations (CBOs), and other stakeholders currently involved in implementing energy projects on an ad hoc and uncoordinated basis.*" This fits the proposed one stop shop concept for mini-grid development. Because of this provision, the country is a step ahead in fulfilling one of the requirements of sector coordination under the SADC framework. MEPD should ensure that REA discharges its coordinating mandate by setting up an appropriate unit or other institutional arrangements.

Process guidelines have been developed by ZERA for IPPs wishing to get licenses for systems above 100kW. However there are other regulatory requirements that all the energy supply systems should comply with that include wiring and safety, environment and in some cases water use. Most mini-grids that have been developed and are below the capacity of 100kW have not fully complied with the ZERA's regulatory requirements that include informing ZERA of the presence of the project, reporting requirements and its technical specifications energy sector regulatory requirements. The planning process guidelines for mini-grids of capacity less than

100kW are not available. It is recommended that REA develop process guidelines and these can be a simplified version of the ZERA licensing guidelines.

Lessons from the field studies show that mini-grid projects in Zimbabwe have been developed in an ad hoc manner and have been uncoordinated. This is also confirmed by the NEP of 2012, that notes that there many "*stakeholders currently involved in implementing energy projects on an ad hoc and uncoordinated basis'*. The assumption by REA of its coordinating agency mandate is of primary importance to approve projects and ensure that they meet development objectives and the expectation of the target beneficiaries. REA can create a similar coordination body on energy that is similar to the one in the Water and Sanitation Sector that is coordinated by the National Action Committee on Water Supply and Sanitation (NAC).

6 National Action Plan for Zimbabwe

From the gap analysis results presented above and the workshop inputs, the following summarised plan of action was developed. The action plan will be discussed further in the proposed national workshop to be held in January 2014.

Table 6: Summary of the Zimbabwe Gap Analysis and National Plan of Action

Identified Gap	Objective / Deliverable	Description of Activities	Responsibility	Resources	Due date
Planning and Development Process Guidelines & Role Clarity					
1. Rural Electrification Fund (REF) Act requires REA to be rural and renewable energy project promoter (hence is the mini-grid coordinating agency). However there are no documented process guidelines for mini-grid development.	**Documented Process Guidelines**	Adapt Regional guidelines and ZERA licensing guidelines to develop and document Guidelines for planning and developing mini-grids, identifying all stakeholders involved, addressing those not requiring licences (threshold to be re-assessed) and those requiring resource permits	REA	REA funds	April 2014
2. Zimbabwe is yet to develop a Renewable Energy (RE) Policy and as such there are no RE targets or clear incentive and institutional framework for renewable energy investments.	**Renewable Energy Policy and Law enacted**	To develop the RE policy and define targets and enact Rural and Renewable Energy Agency (RREA) which will transform Rural Electrification Agency (REA) to RREA	MEPD (RE & Energy Conservation (REEC) Dept)	Ministry budget and Donor support	December 2014
		RE Policy to address use of carbon tax and subsidy policy to support RE development.			
3. Mini-grid projects have been developed by different stakeholders in an ad hoc manner and lack coordination.	**REA to establish a coordinating unit**	REA as coordinating agency to incorporate in process guidelines requirements for approval of all project proposals and ensure they meet development objectives and expectation of target beneficiaries	REA	REA funds	April 2014
Market Needs and Demand					
4.No rural energy master plan to guide developers in site and technology selection	**Rural Energy Master Plan developed and implemented**	Accelerate the delivery of National Study on development of Master Plan incorporating selection and ranking criteria for grid and off grid solution for different geographical locations; least-cost grid extension plan and complimentary off-grid plan	REA	REA funds	December 2014

Identified Gap	Objective/ Deliverable	Description of Activities	Responsibility	Resources	Due date
5. No published and up to date household (HH) and non-HH energy access data	**Annual statistics on energy access and energy resources produced**	MEPD to use census data of 2012 to develop updated energy access data for households and non-HH. Use the 2 year demographic surveys to generate a review of the data	MEPD (Planning Dept)	MEPD/ZERA funds	December 2014
Technology Choice and Technical regulation					
6. There are no technical planning guidelines for mini-grid developers	**Templates for technical proposals**	Develop a project proposal template for use by mini-grid developers as annexure to process guidelines	REA	REA funds	April 2014
7. There is lack of awareness of renewable energy resource availability and competitiveness.	**Energy Resource Assessment**	Support is required for MEPD to assess skills and budget requirement for resource assessments and then to undertake the RE resource assessments (to include hydrology, wind and solar maps, biomass)	MEPD (REEC Department)	Donor	June 2014
9. There are no standards for RE technologies and mini-grids	**Minimum technical standards**	ZERA in consultation with REA and SAZ to develop the Standards for RE components and mini-grids	ZERA	ZERA funds	June 2014
		ZERA, in consultation with Zesa, to finalise the draft national grid code to incorporate safety and grid interface requirements for mini-grids	ZERA	ZERA funds	December 2014
		ZERA to develop framework for monitoring and reporting on all mini-grids	ZERA	ZERA funds	June 2014
Ownership, Funding and Economic Regulation					
10. No clear guidelines for the roles and responsibilities for grid impact study when the mini-grid interfaces with main grid.	**Main Grid interface guidelines for mini-grids**	ZERA to define guidelines addressing responsibility for grid interconnection costs; compensation for parallel/island cost differentials	ZERA	ZERA funds	June 2014
11. EIA and water charges applied without due consideration of system size or consumptive/non-consumptive water use.	**Lower water and EIA costs**	MEPD to incorporate concessionary treatment for min-grids in RE Policy REA to ensure ZINWA and EMA are involved in development of process guidelines in order to incorporate the appropriate non-consumptive water charges and nominal EIA charges.	MEPD REA	MEPD funds REA funds	December 2014 April 2014

Identified Gap	Objective / Deliverable	Description of Activities	Responsibility	Resources	Due date
12. No clear economic incentives for RE development	**RE incentives**	MEPD to incorporate economic incentives for RE development, to include duty reduction or removal and subsidies	MEPD	MEPD funds	December 2014
13. Poor financial sustainability of existing pilot mini-grids	**Sustainable pilot projects**	REA to use existing mini-grids to establish a financially sustainable ownership and maintenance model	REA	REA and Donor funds	December 2015
		REA to develop and implement pilot projects under different ownership models in order to use these for roll out. An energy working group to be created to facilitate development of anchor projects to promote productive use	REA	REA and Donor funds	December 2015
14. No standardised tariff methodology and project agreements for small power projects and mini-grids	**Standardised agreements**	ZERA to adapt Regional model agreements for use in Zimbabwe, taking account of its on-going work on REFIT and net metering. Documents to be simplified for use without expensive legal assistance	ZERA	ZERA funds	June 2014

7 Conclusions and Lessons for Regional Guidelines

The following specific objectives were fulfilled in the country case study:

- **The development of a Gap Analysis Report**: The process entailed the review of the energy and related policies and legislation such as regulatory law, electricity law, investment law, licensing procedures, licenses, concession agreements and other relevant permits issued to existing mini-grids. From the assessment, a range of suitable policy options responsive to Zimbabwean situation was identified. In addition, field visits were carried out to learn from practical examples how policies were translated into practice.

- **The development of a national action plan that responded to the identified gaps**: The action plan, complete with responsibilities, time lines and the potential budget sources resources required to complete the tasks, was developed. The costing of the plan will be a separate activity that will need to be carried out The recommendations were limited to an outline of the specific policy and legal actions required and mini-grid planning and development process guidelines. Standardised templates for mini-grid registration or licensing, templates for power purchase and concession agreements, and templates demonstrating application of tariff tools.

- **The convening of a stakeholder consultation through a national workshop**: The workshop was well attended by more than 44 delegates drawn from organisations involved with or affected by mini-grid development such as electricity utilities, rural electrification agencies, regulatory agencies, energy and economic development ministries, local authorities, private sector, financing agencies, community and NGOs involved in energy and rural development.

The study also generated lessons that contribute to the development of SADC policy and regulatory framework.

- **Participatory methodologies** enhance community ownership and sustainability of mini-grids. The lack of clear ownership on Temaruru wind mini-grid in Rusape was a factor in its collapse. REA mini-grids are failing because the communities have no idea of the next steps as the projects are not properly handed over. *The SADC and national mini-grid policy and regulatory frameworks should include guidelines for community participatory methodologies.*

- The **need for clear strategies and a documented process** of contact institutions is demonstrated by the case of Nyangani Renewable Energy Company. It went through a difficult learning curve and trial and error. As a result the development of projects was slow initially with the first project (1.1 MW) taking 3 years to complete, but improved on subsequent projects as the second (2.75 MW) took 1.5 years and the third (2.2 MW)

took 8 months. The 4th is to be a larger project (16 MW) is expected to take 18 months. The regulatory environment should provide guidelines for project development procedures and processes. Institutions involved in the project development chain and the steps must be clear to avoid developers being led from one office to the other.

- **Climate change** risks are high for hydro projects, with potential impacts on power production. As shown by the recently commissioned mini-hydros, risks are high during the dry months of August to November. Thus climate proofing of RE designs such as use of many years of river flow data is important. This is possible where there is systematic energy resource data collection and recording. NRE used 40 years of hydrological information in the design of their projects. The data was useful for giving a clearer and more objective investment analysis.

- Most of the mini-grids installed in Zimbabwe are **benefitting the communities** in different ways. Among the benefits include extended study periods by school children, use of computers, printers and photocopying machines by the school administration, use of power by teachers and ancillary staff and surrounding community members. Electricity to clinics is providing quality and improved services such as refrigeration for vaccines and perishable drugs, maternity lighting and use of power by nurses at home. These benefits can be maximised if a regulatory framework that helps to attract private sector investment is put in place and complimented by capacity building to prepare bankable project proposals and technical and administrative skills to run various business models for mini-grids.

- The **Rural Electrification Fund** is financed by the 6% electricity levy charged to consumers. It is intended to finance both grid and off grid solutions and grid extension. The experience with the fund is that is has been heavily biased towards grid extension.

A1 References

Government of Zimbabwe, (2012) National Energy Policy (NEP) and NEP Implementation Strategy (NEPIS)

Government of Zimbabwe, Acts of Parliament for Electricity, Electricity Regulation, Rural Electrification, Water, Environment, Local Government

Mapako, M (2005), *Grid and Off Grid Rural Electrification and Poverty Alleviation: Lessons from Zimbabwe,* Paper Presented at EUEI facilitation workshop and policy dialogue, 12 – 15 April 2005, Maputo, Mozambique.

ZESA, Published and unpublished Annual and Operational reports

Terms of Reference for Country Case Studies

Terms of Reference

1. Country

Namibia & Zimbabwe

2. Background

Regional guidelines for mini-grids have been developed for RERA taking account of regional and international best practice. The objective of these guidelines and instruments is to assist RERA member countries in the development of supportive framework conditions for mini-grids using renewable energy and hybrid generation as a strategy for increasing access to economically, environmentally and socially sustainable energy services. The instruments provide guidance, but do need adaptation to the specific circumstances and needs of the member countries.

Following the regional and RERA subcommittee workshops that approved the draft regional regulations two SADC member states were selected where further investigations were carried out regarding mini-grid opportunities and constraints. The criteria for selection of the two countries included: 1) demonstrated interest from the relevant institutions (regulatory agencies, ministries and utilities); 2) the need for policy and regulatory support; 3) the potential for renewable energy development. The two country studies included a review of policy and regulatory issues around mini-grids and resulted in a set of recommendations and action plan whose implementation is outside the scope of the present project.

3. Purpose and Objective

3.1 Objective

The main objective is to review the policy and regulatory framework around mini-grids within two selected SADC countries in order to develop country specific action plans to improve this framework.

A secondary objective of this trial of the Regional Guidelines is to generate feedback and further improve those guidelines.

3.2 Activities

The main objective shall be achieved by the following activities:

- **Gap Analysis**: Study of the country's existing policy and regulatory framework to assess readiness against recommended framework. This will entail the review of the energy and related policies and legislation such as Regulatory law, Electricity law, Investment law, Licensing Procedures, licenses, concession agreements and other relevant permits issued to existing mini-grids.

- **Development of a national action plan**: Based on the gaps or constraints identified a report will be produced with a set of recommendations for application of the regional recommendations for the country. The recommendations will include, but not be limited to an outline of the specific policy and legal actions required, mini-grid planning and development process guidelines, standardised templates for mini-grid registration or licensing, templates for power purchase and concession agreements, and templates demonstrating application of tariff tools. The actual development of a tariff structure is not part of this assignment.

- **Stakeholder consultation through a national workshop**: in each country, the outcomes shall be presented during a workshop that is expected to have about 30 delegates drawn from organisations involved with or affected by mini-grid development such as electricity utilities, rural electrification agencies, regulatory agencies, energy and economic development ministries, local authorities, private sector, financing agencies, community and NGOs involved in energy and rural development including productive use of electricity. The list of participants shall be drawn up and agreed with the country counterpart at a kick off meeting for the study.

- **Production of Workshop and final Country Reports**: workshop proceedings shall be summarised in a report and the final country national action plan report shall incorporate stakeholder consensus and input from the national workshop.

3.2 Expected Outcomes

The outcomes of the national focused case studies will be country specific range of suitable policy options responsive to their situations and action plans that will assist

in developing or improving mini-grids frameworks that are consistent with the recommended Regional Policy and Regulatory Framework on Mini-grids for Southern Africa.

A secondary outcome is the adaptation of the regional guidelines, if the outcomes of the country studies have shown a need for adaptation.

4. Scope of Work

The work will involve a combination of a desk study and field trips for data gathering. Working with the counterpart team the consultant will undertake the following:

1. **Information and Data collection**: the Consultant will specify the information and data required and the country contact person will expedite the provision of the information by the counterpart team, preferably before or at the start of the country visit. Any additional information will be provided during the first week of the country visit. It will be desirable for the counterpart team to work on a day-to-day basis with the consultants so that capacity development can take place.

2. **Market mapping for Policy and Regulatory Gap Analysis**: The approach is to apply a market mapping methodology that looks at mini-grid development as a market system to analyse procedures and obstacles for investors. Investors are expected to be from the private and public sectors. The process will carry out a mapping of market actors in the sector and their interrelationships. Additionally, an audit trail will be taken; a journey through the system of an existing investor who has made investments in mini-grids within the country. We will follow through the investment process and identify constraints and bottlenecks. This historical perspective from existing mini-grid will provide valuable and localised lessons to input into the policy and regulatory framework. In addition we will look at potential obstacles that future investors may face.

3. **Analysis**: the analytic work will focus on defining the interrelationships between various actors doing business involving mini-grids, evaluation of the financial and economic performance of the existing service delivery system, identification of capacity gaps to support policy and technical capability for local manufacture and back service, evaluation of the technical and financial performance of existing mini-grids, assessment of funding sources and opportunities for alternative funding sources. It will include an assessment of the renewable

energy framework in the countries as well as the extent of mainstreaming of gender.

4. **Workshop organisation**: the consultant will organise the workshops and prepare power point presentations to stimulate active and focused discussion and feedback on the national action plan report. The workshop will also in addition seek to identify other important issues that the country will have to follow up on after the study. Because of the limited time available for the country studies the workshops will be restricted to a single day and the focus will be on achieving consensus on an action plan to increase mini-grid investments. Thirty participants are expected to attend the workshop with costs for the workshop, excluding participants' travel, being met by the consultant.

5. Deliverables

The key deliverables from the assignment will be

- Gap analysis report
- National action plan

In addition, the consultant will be responsible for providing the meeting/workshop reports to EUEI-PDF, RERA and the country counterpart.

Furthermore, adaptations made to the Regional Guidelines should be indicated.

Note: *This assignment is a part of an existing project and ends with the development of the National Action Plan. Please note that the implementation of the National Action Plan is not envisaged as part of this assignment. However, separate specific needs for further EUEI PDF assistance in the implementation of the National Action Plan may be requested and obtained by the country under certain circumstances and beyond the scope of this project*[2].

6. Coordination and Reporting

The country studies will be undertaken within the respective countries under the direction of a Project Steering Committee (PSC) supported by counterpart team of 1 to 2 people to be established by the country and advised to the Consultant and RERA Secretariat before the start of the project. The membership of the PSC could comprise a representative each from ministry responsible for energy, regulator, power utility and rural electrification agency, as the case maybe. The PSC Chairperson is expected

[2] See www.euei-pdf.org for more information

to have sufficient authority to make or obtain the necessary approvals required to facilitate the conduct of the country study.

The Consultant will meet with the full PSC at the beginning of the cooperation and liaise with the PSC Chairperson to establish the actual dates and logistics for the project activities which are expected to be completed within three calendar weeks from the start date for each country. The Country Workshops are expected to be scheduled during the last five days of the country visit.

Background Note on National Consultation and Finalisation

(*Task 4: National Focused Consultation - Extract from the RERA Project Terms of Reference*)

Following the regional workshop and the analytic work done during earlier phases, the consultant (in consultation with RERA) will select two motivated SADC member states where there will be further investigations regarding mini-grid opportunities and constraints. The criteria to select the countries should at least include: 1) demonstrated interest from the relevant institutions (REAs, ministries); 2) the need for policy and regulatory support; 3) the potential for renewable energies.

The consultant will develop, before the start of the two national activities, brief terms of reference to address regulatory and policy issues in these countries. These ToRs must be approved by EUEI-PDF and RERA, as well as be requested by the appropriate ministries of the countries targeted.

The two national consultancies will include a review of policy and regulatory issues around mini-grids in the subject countries, and will result in a set of recommendations for implementation of mini-grids, including specific legal actions required, templates for contracts, and a proposed structure for a tariff regime. The national consultancies will each result in a country study and a proposed country action plan including potential funding sources. The study and action plan will be presented to relevant stakeholders in the country (at least including relevant ministries, agencies and REA) during a national workshop. All costs related to the workshops should be included in the offer.

This work of the national consultancies will be sufficiently detailed to enable generation of specific recommendations for authorities in the subject countries, assisting them in developing their own policy and regulatory approach to mini-grids, whilst ensuring that the resulting work is closely aligned to, and contributes to, the policy options for the region. The expected length of the consultancy will be ca. 3 weeks per country, excluding write-up time. As this activity will require strong cooperation with national bodies, the consultant is expected to carry out the activity in the respective countries.

A2 Mini-grid Case Studies

A2.1 Temaruru wind mini-grid

Date: 1996 - 1999

Developer: Zimbabwe Energy and Environment Regional Organisation (ZERO)

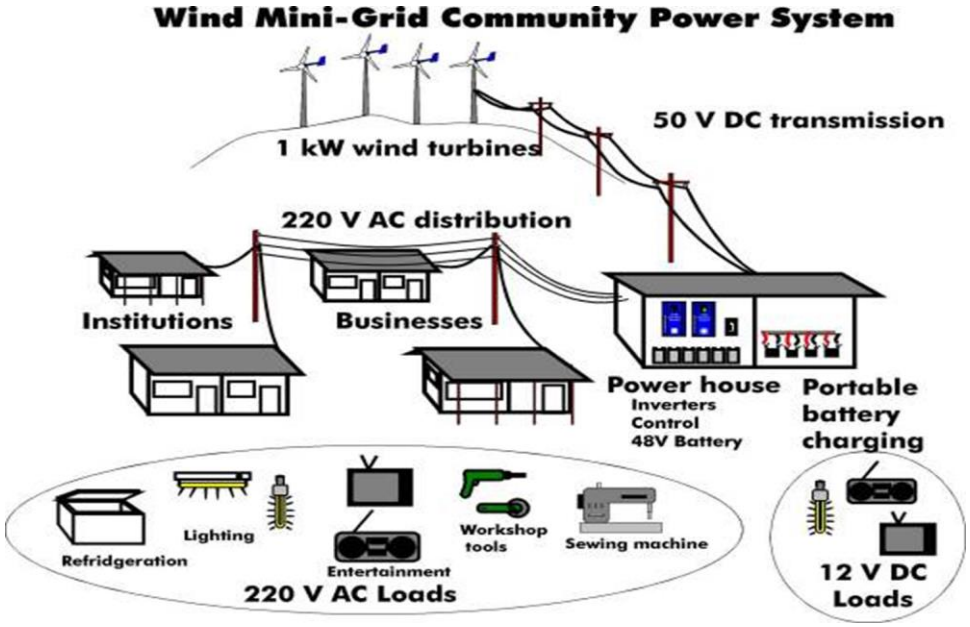
Technical Partners: Powertronics (Harare) through a joint venture with Innovision (of Denmark)

Generating Capacity: 4 kW, 48 volts DC in a 400 amphour battery capacity.

Status: Temaruru was part of a wider project that sought to demonstrate electricity generation from wind at selected sites in Zimbabwe. Wind measurements were carried that resulted in the selection of the following sites; Temaruru Business Centre and Clinic (Rusape), Msampa Fishing Camp (Kariba), Chikukwa Permaculture Training Centre (Chimanimani), Wiltshire Headquarters Clinic (Chivhu) and Vungu Secondary School (Lower Gweru).

Temaruru was installed in 1999 following wind assessments and a market survey to gauge market response. Socio-economic study to assess economic viability of wind-powered water pumping system was carried out. The technical layout of the system is shown below.

Figure 5: Temaruru Wind Powered Mini-grid



The system had wind turbines producing a combined power of 4kW. It had a 48V DC transmission line and a 220V AC distribution line. Local personnel were trained on basic repair work and maintenance.

The scheme stopped functioning more than 5 years ago. This has been attributed to the inverter that had failed and the community could not afford to repair it. After the inverters, the batteries also failed. The community was unable to replace all the failed components as there was no dedicated fund for operation and maintenance. The shop owners who were the main beneficiaries are currently relying on solar and small petrol powered generators. Subsequently as years passed the powerhouse and the power lines were vandalised. It is alleged that this was due to political differences among the community and the operators.

Skeletons of the wind masts with some having fallen on the ground are what remain of the first wind powered mini-grid in the country. The wind turbines are all gone and the former powerhouse has its roof broken and all the installation pulled out of the walls.

Figure 6: The skeleton to the towers and remains of the battery house.

Figure 7: The remains of the mini-grid network.

Project Development

The project was the first of its kind in Zimbabwe, demonstrating electricity generation from wind using micro turbines. The project was developed in 3 phases with the 1st phase dedicated to studying the wind speeds and patterns. After confirmation of reasonable winds, Temaruru was selected among 6 other sites in the country. The project was developed by ZERO, a local NGO in partnership with Powertronics, an private company and Ministry of Energy and Power Development. It is known that there were wind measurements carried out on site but data has since gone missing. The area has relatively higher wind speeds compared to the rest of the country pointing to potential wind resources within the area that can be harnessed for power generation.

Ownership and Funding

The scheme was funded by the Dutch government. The project was implemented through a PPP involving the Ministry of Energy and Power Development, ZERO a local NGO and Powertronics Private Ltd company. The ownership of the scheme was given to Temaruru Community Power Trust (established as an independent energy service company). The company never got to be registered, but had put in place structures that include a board with a diverse range of stakeholders and it employed two people for the day to day operations.

Technical

Despite having the turbines locally fabricated the batteries were all imported. Although there are locally available equivalent batteries, lack of technical understanding of the system and capacity to operate and maintain the system by the community further exacerbated the problem.

The system capacity could not match the demand of the users. The users were mainly shops with loads such as refrigerators, lights, radios and speakers, the clinic and the school with the teacher houses. There are 10 shops, a clinic, school and teacher houses being fed by a 4kW system with 400Ahr battery capacity. Thus the capacity could not match the demand and they had to resort to power rationing. This situation worsened when the batteries were aging and past their expected life.

Capacity for operation and maintenance of the scheme was available and at a distance in Harare. Because there were no user fees being paid the community could not afford to pay for the technical assistance. The failure by the system to meet demand of the communities has given the technology a bad name and the users now prefer mains supply than to resuscitate the scheme.

Economic and Financial

The users did not pay for the electricity consumed. They enjoyed a 100% end user subsidy.

Recommendations

- ❑ Wind measurements of the district particularly in areas around Temaruru should continue to be made.
- ❑ The scheme can be revised as a sustainable pilot using improved small wind generators now available.
- ❑ Although the people are no longer keen on the wind system, this can be connected to the main grid that is just 7 km away and act as a grid connected scheme with net metering.

Conclusion

The failure of the Temaruru mini-grid is attributed to a number of factors the major one being the lack of financial and economic mechanisms put in place for operation and maintenance. The consumers enjoyed 100% electricity subsidy that could not be sustained. Failure of the system components such as the inverter and the batteries that are at the core of the system is attributed to lack of technical capacity among the community members to facilitate the repair and maintenance of the system components.

Thus the targeted beneficiaries have lost trust in the technology and they prefer to have the main grid connected to the shopping centre.

A2.2 Community Mini-hydro Mini-grids

Lessons from Micro-Hydro Mini-grids

Practical Action with funding from EU Energy Facility established a number of mini-grids powered by hydro. In the range of micro (less than 100kW), these schemes were led by the local communities. The target beneficiaries were schools, clinics, business facilities and those households within reach of the distribution grid. The main objective was to test the socio-economic viability of establishing mini-grids for increasing access to energy among the isolated rural communities.

The lessons here summarised are derived from 2 schemes situated in Nyanga at Nyafaru and in Mutare at Chipendeke. Nyafaru mini-grid is twenty years old whilst Chipendeke mini-grid is 3 years old. It is estimated that the country has over 10 micro-hydro power schemes installed mainly in Manicaland Province.

Ownership

All the schemes are community owned. Community engagement and training has helped in building the high level of community ownership at both schemes. At Nyafaru the school development committee is in charge of the system whilst at Chipendeke the community is in the process of registering a company Chipendeke Microhydro Power Company. The Chipendeke scheme has members who participated in its construction as the shareholders through their sweat contribution. It has a board of management that includes the community leadership.

Community Based ownership model

In both schemes there is good and dedicated ownership of the systems. There is a strong community ownership at Chipendeke and the school at Nyafaru has been committed to seeing that the power is always available at the school.

Economic and Financial

At Nyafaru, the users pay their tariffs through the number of installed light bulbs (the Edison Model). One light bulb, regardless of size, is charged at US$10 per month and additional bulb is charged US$3 extra. There is no metering either at the supply side or at the household side. The students from the boarding school pay an electricity levy which is US$20 per term (3 months). The school has 150 students in its boarding facility. This translates to US$9000 per year in terms of school electricity levies. It employs a machine operator and a guard who work full time.

It has experienced both minor and major repairs to the machine. These costs are a burden to the school and they have been queried by the school's auditors. The spares that are replaced include bearings and seals.

At Chipendeke, the users have prepaid meters. There are 3 customer categories consisting of business, households and social institutions (clinics and schools). They pay 32 US cents/kWh, 16 US cents/kWh and 10 US cents/kWh respectively. Household consumption is very low. A total of 5400kWh have been consumed since 2010 by 27 households that are connected. This gives an average of only 5.5 kWh per month per household. Chipendeke employs a machine operator and a vendor for the energy units.

In terms of financial viability, Nyafaru is better than Chipendeke due to the better revenue streams. This is one of the factors that have contributed to the long life of the Nyafaru scheme (20 years). Managing operation and maintenance costs has been cited as a burden by the school. They are preferring connection to the main national grid.

Technical

The level of technical input on both schemes is very high. Communities have been involved in the construction, operation and maintenance of the system. This has been due to capacity building that the communities were taken through from the construction up to management and operation and maintenance of the schemes.

There are power generation capacity challenges as the demand greatly exceeds the supply. In addition there are seasonal variations with the period August to November generating low power. The main challenge is competing water needs between water for irrigation, drinking and power generation. Chipendeke has an estimated 60ha of land under irrigation. At Nyafaru, an exotic plantation of trees (eucalyptus) and upstream cultivation have been alleged to be disturbing the watershed area. Thus there is frequent water rationing especially during the dry part of the summer season leading to power shedding during the day when water will be diverted to irrigation fields. The safety record has been good with only one accident

having been reported at Nyafaru where a drunken machine operator fell and tripped on the v-belts and got two of his fingers cut off. There have been no major accidents reported at Chipendeke.

Conclusion

Among the over 10 small scale mini-grids in the country, Chipendeke and Nyafaru have demonstrated high levels of sustainability. Nyafaru has been in operation for the past 20 years whilst Chipendeke is 3 years old. This can be attributed to a number of factors that include community participation and engagement to ensure buy in by the community. They were consulted and they accepted the project as theirs. They contributed to the success of the project through providing labour and local materials. District authorities, traditional and political leadership were involved in all the stages of the project and helped to facilitate mobilisation of the community. The users at Nyafaru and Chipendeke are paying tariffs despite the lack of financial viability. With the level of appreciation of the need to pay for energy used, the system can easily be turned into a sustainable project. The application of SADC RERA guidelines on tariff determination will be useful for such schemes. The level of technical quality has been high and thus the system reliability and functionality has been high. This has also been enhanced by the capacity building given to the communities to manage the operation and maintenance of the systems.

These two schemes are in direct contrast to other small scale mini-grids in Zimbabwe. Lessons from other schemes show that community ownership is not deeply embedded as only a few members of the community claim ownership. The users connected to the systems do not pay fees for energy use and they expect the donors to take over responsibility for operation and maintenance.

A2.3 Solar Micro-grids

This was a donor funded national programme under the Ministry of Energy and Power Development which was implemented by Rural Electrification Agency. These came courtesy of the Italian aid in 1995. A total of 372 x 0.9kWp mini-grids have been installed since 2008. These were targeted at institutions as clinics and schools which were greater than 10km from the main grid.

Figure 8: Solar Powered Mini-grid at Chitora Secondary School, Mutare.

Priority was given to secondary schools and clinics. However the materials, particularly batteries, were kept in storage for a long period of time and this affected their performance when they were installed 13 years later.

The main lessons and issues emerging from solar powered mini-grid have been the same in the schemes that were visited. The lessons are based on mini-grids at Magadzire Primary School in Nyanga, Chitora Secondary School and Chitora Clinic.

Technical Issues

- Failure of batteries storage (24 Vdc, 20 Ahr each). They were past their useful life when they were installed and most of them lasted no more

than 1 year. So in most instances all the systems are being used during the day only.

- ❑ Technical capacity for operation and maintenance was lacking. REA mandated to take over operation and maintenance of the systems but they lacked financial capacity.
- ❑ Installation sizing issues at one school - 10 teacher houses connected against 0.9kW. The school has devised a power rationing scheme. It was one size fit all scheme regardless of the number of houses or the demands of the schools and clinics.
- ❑ Small conductors were used on the mini-grid. Thus compromising performance due to excessive voltage drop.

Financial and Economic Issues

No tariff is paid by the system users. Thus there were no funds for minor repairs of the systems.

Social

- ❑ The technology has been given a bad name due to its failure to meet expectations of the communities.
- ❑ There is a desire for grid extension among the beneficiaries who do not want the solar systems any longer.
- ❑ Ownership is not clear. There is an understanding from the community that these are owned by REA and they have no authority to perform any repairs, hence the poor technical operation of the systems. On the other hand REA is still to officially hand over the system.
- ❑ Management left to the clinic or school authorities who could be transferred at any time. Thus there is no sustainable plan for O&M.

Recommendations

- ❑ REA should create a special fund for the replacement of batteries and other electronic control systems on all the 372 systems countrywide
- ❑ A training programme in electrical repairs and solar systems targeting the communities on O&M of the mini-grids is needed.
- ❑ Ownership and management structures need to be created.
- ❑ Financing mechanism need to be put in place for O&M to ensure future sustainability of the systems and potential upgrade of the systems.
- ❑ The communities need help them with tariff setting.

Conclusion

Clearly there was no community engagement plan. Most of the sustainability elements are missing from the programme.

A2.4 Private Small Power Projects

Nyangani Renewable Energy (NRE), was formed in 2007 as a private Zimbabwean registered company dedicated to the provision of renewable energy through the development of mini-hydro electric power schemes.

The company is based in Harare and operates within the Honde Valley, situated in the eastern highlands of Zimbabwe.

Since inception, NRE has developed expertise in design, construction and commercial operation of small hydro electric power plants. The intellectual property residing within NRE is all Zimbabwean and NRE intends to grow this further so that Zimbabwe will in future be seen as the centre of excellence within this sector in Africa.

NRE is the only Independent Power Producer (IPP) in Zimbabwe operating in the small hydro sector, generating electricity from run of river mini-hydroelectric power stations and selling the power to the National Grid. NRE does not own a mini-grid. NRE looks forward to other IPP's coming on stream within the country.

NRE has to date completed three run-of-river hydroelectric schemes and is currently constructing a fourth. The three completed schemes are:

- 1,100 kW scheme on Nyamingura River (commissioned in 2010)
- 2,725 kW scheme on the Pungwe River (commissioned in 2012)
- 2,200 kW scheme on the Duru River (commissioned in 2013)

The scheme currently being constructed (anticipated start of generation in December 2014) is a 15 MW scheme on the Pungwe River (construction of which commenced in July 2013). This scheme is the second phase of the Pungwe project, combining with the existing 1st phase of 2,725 kW resulting in an 18 MW development on the Pungwe River.

All these schemes are located in the Honde Valley, Zimbabwe and have been designed to generate electricity for sale into the National Grid. These plants are the only mini-hydro electric generators delivering into the grid across eastern Zimbabwe. Their location on the opposite side of the country from Kariba and Hwange power stations results in a significant reduction of grid losses in respect of the energy which they inject into the grid.

All these plants are run-of-river which means that there is no water storage and the output is seasonal depending on river flow levels which dictate energy generation.

As such these are classed as renewable energy sources, whereas the larger Kariba type projects with large water storage do not necessarily attract this classification. The NRE plants are not suitable for base load due to their seasonal nature.

The number of customers served by the mini-hydroelectric power stations is difficult to determine as ZETDC has not released this figure to NRE. Under full output, the ZETDC grid is back fed to Nyanga and with Pungwe B in operation this may extend to Mutare.

NRE schemes are not conventional mini-grids – they are a grid connected IPP feeding into the main grid. The customer for NRE is ZETDC with whom they have a Power Purchase Agreement. The tariff is based on capital investment, operation and maintenance costs and a marginal return on investment and has been approved by ZERA. This is a fundamental difference for three reasons.

- The plant output is seasonal and they must therefore capture and export all available energy to maximise the capacity factor.
- Operation in an Isolated or Island mode destroys viability due to
  - the mismatch between demand and supply
  - the need to have reserve capacity available to ensure the load always is less than the supply to avoid plant tripping on overload
  - poor power factors.
- The schemes are run-of-river and therefore there is no ability to store energy – available output must be used immediately – use it, or lose it!

Zimbabwe hydrology warrants comment. The seasonality of the flow in Zimbabwe's rivers is typical of sub tropical regions. The flow regime varies from very low in the winter to floods in the summer. The challenge for the developer of mini hydro schemes is to appraise the hydrograph and optimise the turbine / generator size and the resultant cost of energy delivered into the grid. Zimbabwe needs as much annual energy as possible and because there are only a finite number of run-of-river sites within the country each of these sites must, in the National interest, be developed to capture the maximum amount of annual energy potential.

This means that the capacity factors for Zimbabwean run-of-river plants will be lower than those in more temperate regions where run-off is more evenly spread over the year. A small plant on a big river will have a high capacity factor, low cost of energy and **low annual energy output**. Conversely a bigger plant on the same river will have a lower capacity factor, higher cost of energy and a **higher annual energy output**.

Crucially, a small plant on a large river, due to the physical or geographical constraints, obstructs any further development at that site which is not in the best interests of the Nation as a whole. In the National interests the limited sites available should be developed to their maximum in terms of annual energy output within the

constraints of reasonable long term tariffs. This has a bearing on REFIT tariffs which if pitched too low, will result in the under capitalisation of the finite National resource.

Typically mini hydro projects cost in the region of US$2.5M per MW to build. Project funding has been a combination of equity and loan finance secured against a PPA with ZETDC. The economics of these projects are long term and therefore require long term finance. Long term finance is not available within the country at acceptable rates and therefore loans are obtained offshore.

It is anticipated that by the completion of the Pungwe B Project, NRE will have invested in the region of US$45 million. The ability of these projects to repay the providers of finance will be a litmus test of the attractiveness of Zimbabwe as a destination for energy finance.

NRE took the policy decision in 2007 to empower themselves in terms of investigation, design, construction and operational experience, rather than rely on non-Zimbabwean expertise. The downside of this decision is that mistakes are made in the course of the learning curve, the costs of which are borne by NRE, however the upside is that NRE has valuable knowledge and experience that remains here and is specifically local.

NRE has developed excellent working relationships with the Ministries of Energy and Power Development and Finance, ZERA, ZETDC, ZIA, ZINWA, Mutasa Rural District Council and local Traditional Leaders and their communities. All NRE's hydro plants have been constructed through agreements with the local communities, using workforces entirely made up of generally un-trained residents.

The project implementations have uplifted the communities in the vicinity of the projects both directly, through employment, training, development (roads, schools, electrification) and indirectly through infrastructure improvement and economic activity flowing from the injection of payrolls into local villages and the targeted local procurement of services and materials.

NRE's experiences, past and ongoing, are closely observed by potential investors into the IPP sector, as a real time test model.

A3 Main contributors to the study

The TWG team that was set up consisted of the following: Mrs Gwyneth Ngoma, Mr. Tobias Mudzingwa, Mr Man'arai Ndovorwi (all from ZERA), Mr. Isaac Chiridza (MEPD), Ms. Sharon Marerwa, Mr. M. S. Ncube (both from Zimbabwe Electricity Transmission and Distribution Company (ZETDC)), Mr. Lewis Makurumure (REA), Mr.R. Mavondo (Ministry of Local Government), Mr. Marshall Jeyacheya (EMA), Mr.Simbarashe Chari and Mr.Marcos Jinya (both ZINWA).

The key people interviewed included the following: the community of Temaruru in Rusape District; Messrs G. Muomba Bernard Maoko, the headmasters of Nyafaru Primary and High School respectively and Mr. Elvis Muomba, the headmaster of Magadzire Primary School, all of Nyanga district; staff of Nyangani Renewable Energy Company (NRE) working at Duru Hydro Power Plant in Honde Valley, Mutasa District; management of Border Timbers Limited at Charter Saw Mill in Chimanimani District; the CEO and the District Engineer, Engineer Ryan Musungo, of Mutare Rural District Council and the community of Chipendeke mini-hydro scheme and mini-grid in that district, in particular Mr. Noah Sengasenga and Mr.Dovi.

The organising team for the workshop composed of staff members from Practical Action Consulting (PAC) and ZERA. The speakers and presenters included the Guest of honour, the Permanent Secretary in the Ministry of Energy and Power Development whose speech was read on his behalf by the Director of Renewable Energy and Energy Conservation, Mr. Raphael Tirivanhu. Other presenters, besides the consulting team, were Mr. Ian McKersie of Nyangani Renewable Energy Company which has three operating small power projects, Mr. Rodrick Saungweme the Headmaster of Chitora Secondary School which has a solar mini-grid, Mr. Bernard Maoko, the Headmaster of Nyafaru High School,which has a mini-hydro mini-grid and Mr. Noah Sengasenga of Chipendeke mini-hydro scheme.

The workshop participants included representatives from MEPD, ZERA, Local Government, ZINWA, Small Enterprises, Civil Society, Non-governmental Organisations (NGOs), Hivos, SNV, ZERO and OXFAM, IPPs, Media, Research Institutes: Scientific and Industrial Research and Technology Development Centre (SIRDC) and Chinhoyi University of Technology (CUT) and the National Utility, ZESA. The workshop was successfully facilitated by Mr. Absolom Masendeke of Centre for Community Development Solutions (CCDS).

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