Regional Electricity Regulators Association of Southern Africa

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

Overview of Framework to Attract Investment into Mini-Grids in the SADC Region

December 2013

RECP
Africa-EU Renewable Energy Cooperation Programme

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

BOT	Build Operate and Transfer
CA	Concession Agreement
CFL	compact florescent lamp
CNELEC	National Electricity Advisory Council of Mozambique
COA	Comprehensive Options Assessment
CSP	Concentrating Solar Power
DOE	Department of Energy, South Africa
DSCR	Debt Service Coverage Ratio
ECA	Economic Consulting Associates
EDM	Electricidade de Mozambique
ENE	Empresa Nacional de Electricidade, Angola
ERB	Energy Regulation Board of Zambia
ESCOM	Electricity Supply Commission of Malawi
ESKOM	National Utility of South Africa
EU	European Union
EUEI PDF	European Union Energy Initiative Partnership Dialogue Facility
EUR	Euro (currency)
EWURA	Energy & Water Utilities Regulatory Authority of Tanzania
FiT	Feed-in-Tariff
GHG	Green House Gas
GVEP	Global Village Energy Partnership
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
IRSE	Institute for Electricity Sector Regulation of Angola
kVA	kilo volt-amperes
kW	kilowatt
kWh	kilo watt-hour
LCOE	Levelised cost of energy
LEWA	Lesotho Electricity and Water Authority
LP	Large project
LPG	liquefied petroleum gas
MAED	Model for Analysis of Energy Demand
MERA	Malawi Energy Regulatory Authority
MPCA	Mini-grid Project Coordinating Agency
MW	Megawatt
NamPower	National Utility of Namibia
NERSA	National Energy Regulator of South Africa
NGO	Non-governmental organisation

NRECA	National Rural Electric Cooperative Association, USA
NWEC	North West Energy Company, Zambia
O&M	operations and maintenance
OBA	Output-Based Aid
PA	Practical Action
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PRODUSE	Productive Use of Energy
PV	photovoltaic
PVPS	Photovoltaic Power Systems
REA	Rural Energy Agency, Tanzania
REASAP	Regional Energy Access Strategy and Action Plan
RECP	Africa-EU Renewable Energy Cooperation Programme
REF	Rural Electrification or Energy Funds
RERA	Regional Electricity Regulators Association of Southern Africa
RESAP	Renewable Energy Strategy and Action Plan
RRA	Renewable Readiness Assessment
SADC	Southern Africa Development Community
SAPP	Southern African Power Pool
SAPP	Southern African Power Pool
SCADA	Supervisory Control and Data Acquisition
SE4ALL	Sustainable Energy for All
SEA	Sustainable Energy Authority (Sri Lanka)
SEC	Swaziland Electricity Company
SERA	Swaziland Energy Regulatory Authority
SHP	small hydro power
SNEL	Societe Nationale d'Electricite, DRC
SOMA	Standardised operations and maintenance agreement
SPP	small power project
SPPA	Standardised power purchase agreement
SSP	Small-scale Project
STM	Standardised Tariff Methodology
SWH	Solar Water Heater
TANESCO	Tanzania Electricity Supply Corporation
TEDAP	Tanzania Energy Development Access Project
UAF	Universal Access Fund
UNEP	United Nations Environment Programme
US$, USD	United States dollar
USc	United States cents
VSSP	Very small-scale Project

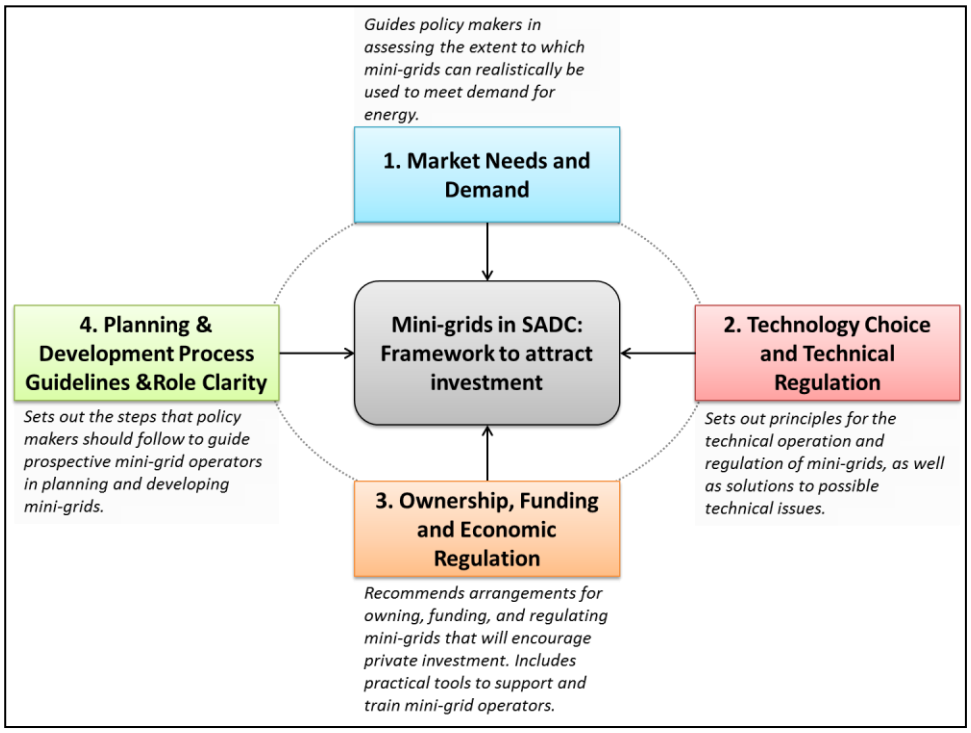
ZERA	Zimbabwe Energy Regulatory Authority
ZESA	National Utility of Zimbabwe
ZESCO	National Utility of Zambia

Executive Summary

An assessment of the current status of electricity and renewable energy policy and regulatory frameworks in the Southern African Development Community (SADC) shows that most countries in the region do not have explicit policies and regulations for promoting the development of mini-grids. There is a general bias by the public sector towards main-grid extension with the few fossil-fuel based mini-grids that exist being owned, funded, operated and maintained on a subsidised basis by government departments or state owned utilities. Uncoordinated donor and private sector initiatives have developed a number of off-grid mini-grids using a combination of mostly small hydro, solar PV and diesel hybrid generation.

Tanzania is the country in the region that has the most advanced policy and regulatory framework for small power projects supplying both the main grid and off-grid mini-grids. The Energy and Water Utilities Regulatory Authority (EWURA) has developed a standardised tariff methodology and standardised power purchase agreements and process guidelines that have assisted a number of developers to conclude agreements with the national power utility, Tanzania Electricity Supply Company, TANESCO to supply power using biomass, mini-hydro and solar power plants. However the rate at which investment is taking place is too low to make a significant impact on electricity access and renewable energy development.

The framework for attracting increased investment in mini-grids employing renewable and hybrid generation is summarised in the diagram below:



The four focus areas in the diagram reflect the key issues that need to be addressed as follows to ensure sustainability of mini-grid investments:

1) **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 three basic energy supply options in fulfilling market needs and demand, namely 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. For remote and low income communities mini-grids are best used where there are existing or potential prospects for productive use of electricity.

2) **Influence technology choice towards renewable energy and safe, reliable, secure and efficient supply and utilisation of power and energy.** At national level 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
   - Localisation of technology (expertise, experts and equipment) – at regional, country and project levels as appropriate

   At project level technical regulations must focus on development of safety and appropriate product and service quality standards to ensure value for money for mini-grid customers; they should also provide for operational flexibility to allow parallel and island operation between the mini-grid and main-grid

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

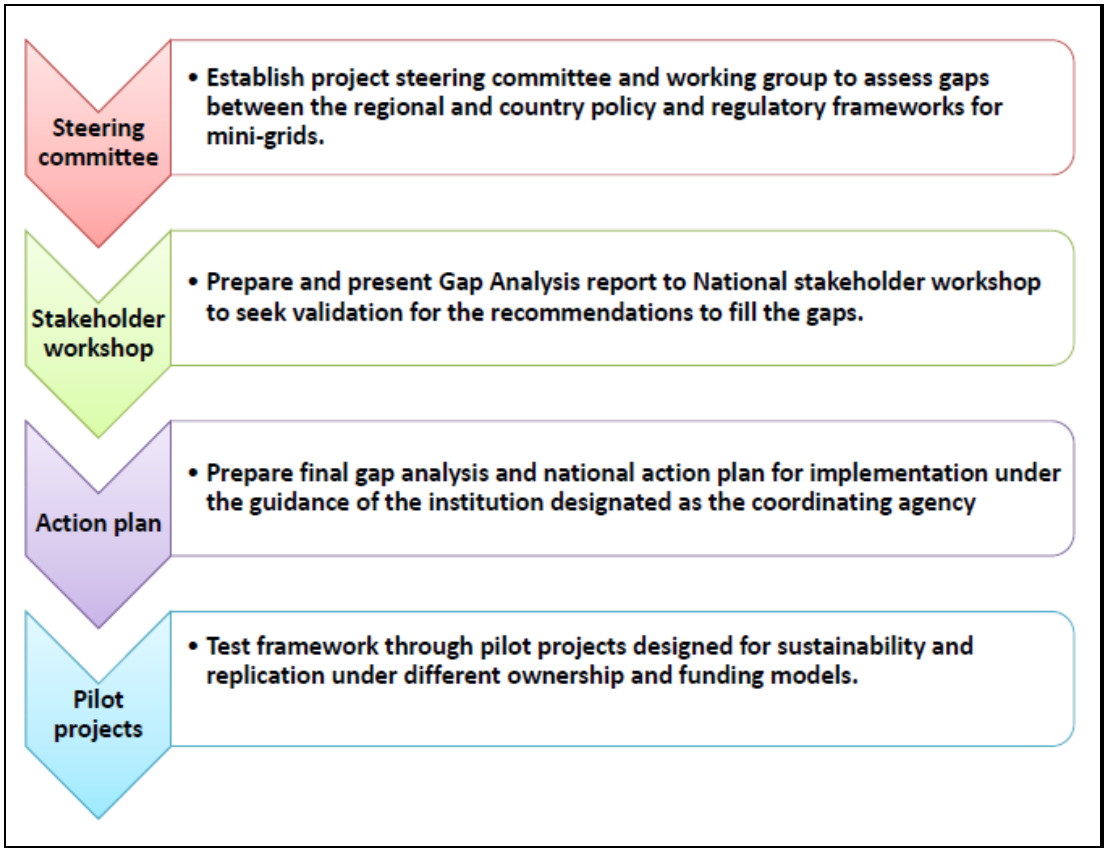
   - Mini-grid classification is by size, location relative to grid (off-grid or grid-connected) and ownership of mini-grid elements (vertically-integrated or non-vertically integrated)
   - Funding for mini-grids must have the objective of empowering customers to re-direct purchases from traditional towards modern energy services

At project level, some of the economic regulation recommendations are that there should be no license or tariff regulation for very small projects and there should be non-negotiable standardised project documents and tariffs or methodology for small projects. For large projects above 10 MW standardised but negotiable agreements can help to reduce transaction costs and time.

4) **Have dedicated institutional responsibility for promotion of mini-grids.** It is necessary 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

The following steps outline the process by which these guidelines are used to assist countries to improve their mini-grids policy and regulatory framework.



This approach was successfully used to develop national action plans for Namibia and Zimbabwe. Other countries should easily replicate the approach. To maximise

the benefit of this mini-grids project it is recommended that countries should immediately embark on the implementation of the national action plans, starting with the pilot project phase. Funding can be provided from government, regulatory and electrification agencies and utilities, backed up where needed by coordinated donor support programs.

The maximum benefits will come from a roll out of the pilot phase but that requires much more than an enabling environment. The Africa-EU Renewable Energy Cooperation Program (RECP) 2020 strategy identifies three other pillars:

- Promotion of private sector involvement to unlock financial resources and facilitate effective technology transfer
- Preparation of bankable project proposals in order to access funding
- Capacity building through education, research and innovation and retention of the skills by using them in local manufacture, project design, construction, operation and maintenance.

1 Project description and background

1.1 Introduction

The SADC region faces the challenges of increasing access to modern energy services and contributing to the global effort to mitigate the adverse impacts on climate change. The majority of the population is currently dependent on inefficient traditional energy services and there is a high dependency on local and imported fossil fuels for power generation. The SADC Energy Ministers took steps to address these challenges when they endorsed the ***SADC Regional Energy Access Strategy and Action Plan (REASAP)*** in 2010 and approved a project to develop the ***SADC Renewable Energy Strategy and Action Plan (RESAP).***

Responding to these policy directions, the Regional Electricity Regulators Association of Southern Africa (RERA) identified mini-grids employing renewable energy and hybrid generation as a strategy for addressing these twin challenges. With support from the SADC Secretariat, RERA applied and obtained technical assistance from the Africa-EU Renewable Energy Cooperation Programme (RECP), managed by the European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) to develop tools to assist countries to create the enabling policy and regulatory framework to attract increased investment in mini-grids.

At present, RERA member regulators and countries are from ten SADC member states:

- Institute for Electricity Sector Regulation of Angola (IRSE)
- Lesotho Electricity and Water Authority (LEWA)
- Malawi Energy Regulatory Authority (MERA)
- National Electricity Advisory Council of Mozambique (CNELEC)
- Electricity Control Board of Namibia (ECB)
- National Energy Regulator of South Africa (NERSA)
- Energy and Water Utilities Regulatory Authority of Tanzania (EWURA)
- Energy Regulation Board of Zambia (ERB)
- Swaziland Energy Regulatory Authority (SERA)
- Zimbabwe Energy Regulatory Authority (ZERA)

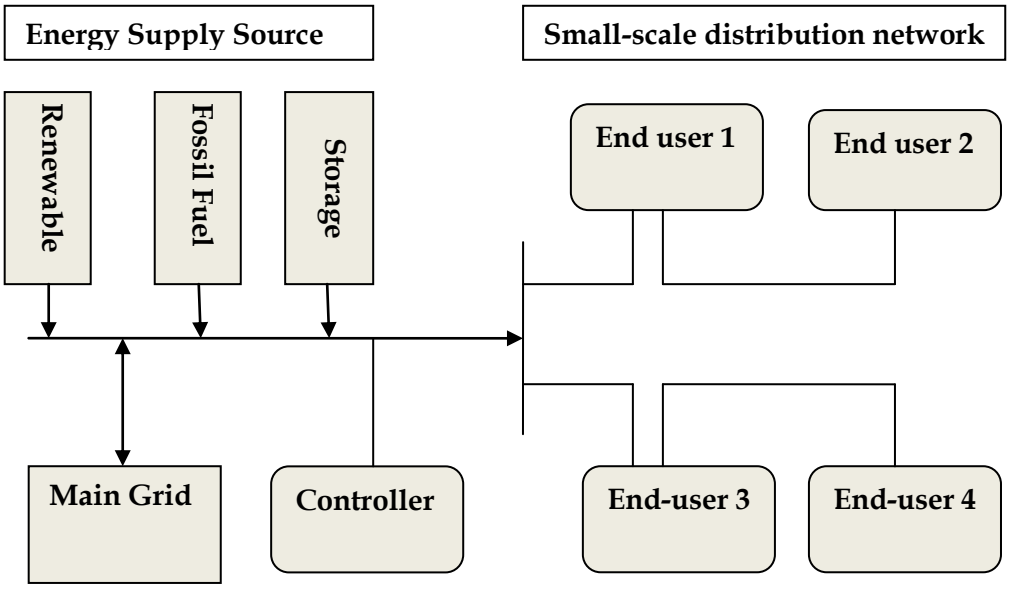
The non-member countries (Botswana, Democratic Republic of the Congo, Mauritius, Madagascar and Seychelles) are expected to join as soon as they establish operational regulatory agencies or when their country circumstances allow them to. This study is

therefore based on an assessment of the situation in both member and non-member countries. Appendix A1 provides a summary of the terms of reference for the study.

1.2 Mini-grid definition and classification

In this project, a mini-grid is a small-scale distribution network supplied by one or more energy sources including the main-grid and that can operate as an isolated system or with clearly defined physical and electrical boundaries when connected to the main grid.

Hybrid generation involves a combination of complementary supply sources for enhanced security and reliability. The following diagram provides a representation of a mini-grid using hybrid generation as well as the main grid.



Storage is required to cope with the variable and uncertain output that is characteristic of renewable energy sources. Storage is critical even for main-grid connected mini-grids if they are expected to support essential services when there is a breakdown of the main-grid. In developed countries which have achieved universal access there is increased interest in mini-grids because of this ability to provide supply to essential services such as hospitals during emergencies.

A control system is necessary to regulate the supply and demand of individual supply sources (for example to prevent batteries over charging or over discharging) and to coordinate the operation of the various supply sources (for example using solar during the day and diesel or batteries in the evening).

It is necessary to classify mini-grids in order to adapt policies and regulations to suit different circumstances likely to be encountered. The following table summarises the classification system that has been adopted which takes account of the size, location

and ownership of the energy source. A vertically integrated mini-gird is one where the energy source and network have the same owner.

Table 1 Mini-grid classification and applicable tariff tools

		Energy Source for the mini-grid			
		Vertically integrated		Non-vertically integrated	
		Main-grid	Off-grid	Main-grid	Off-grid
Size of energy source	**Very small-scale project (up to 1 MW)**	(Part of main grid)	1Retail tariff tool to ensure cost-reflectivity	4 Simple wholesale price = an agreed percentage of main grid retail price	7. Retail tariff tool; Simple wholesale price = an agreed percentage of retail price
	Small-scale project (> 1 - 10 MW)	(Part of main grid)	2. Retail tariff tool required to ensure cost-reflectivity	5. Wholesale price based on STM (FiT or PPA tool, etc) and non-negotiable SPPA	8. STM and non-negotiable SPPA; retail tariff tool
	Large project (> 10 MW)	(Part of main grid)	3. Retail tariff tool to ensure cost-reflectivity	6. Negotiable SPPA with tariff from STM (FiT or PPA tool, etc)	9. Negotiable SPPA with tariff from STM

Notes: STM = standardised tariff methodology; SPPA = standardised power purchase agreement; FiT = Feed in Tariff

As explained in the following paragraphs the very small projects (the threshold being differently specified in different countries) are not subject to any of the instruments discussed in this report, except for issues of safety and quality of supply as well as guidance on tariffs from the retail tariff tool.

The different tariff approaches that are indicated show why a one-size-fit-all approach would not be appropriate:

- **Vertically-integrated off-grid mini-grids:** these represent the traditional definition of a mini-grid. Policy and regulatory options depend on size as follows:
  - Type 1: Very small scale mini-grids supplied by the owner need to be registered but do not need a generation license or tariff regulation. Regulators should only be concerned with issues of safety and providing support to enable the owners to establish cost reflective tariffs. The retail tariff tool has been developed for this purpose.
  - Type 2: Small-scale mini-grids supplied by the owner require a generation and mini-grid license as well as support for developing cost-reflective tariffs. Light handed regulation that minimises

transaction costs and time should be used by both energy and non-energy sector regulators.

- Type 3: Large mini-grids supplied by the owner require a generation and mini-grid licence and retail tariff tool for cost reflectivity. An arms-length power purchase agreement between the generation and mini-grid business may be needed as an investment and operational efficiency monitoring tool.

- **Mini-grids supplied by the main-grid:** these are also called small power distributors (SPD) and ***are likely to be the easiest and most viable mini-grids to develop in SADC***. Such mini-grids could have started as off-grid projects that are then interconnected to the main-grid but then continue as independent business operations. Policy and regulatory options depend on size as follows:

  - Type 4: Very small scale mini-grids supplied by the main-grid do not need to be licensed but need to be registered and provided with regulatory support in determining the wholesale price as a percentage of the retail tariff and dealing with any disputes that cannot be amicably settled between the mini-grid and main-grid operator. Technical regulatory issues can be delegated to the main grid operator.

  - Type 5: Small-scale mini-grids supplied by the main-grid require a mini-grid license with minimal compliance costs. Standardised tariff methodology and a non-negotiable power purchase agreement should be part of the light handed regulations that minimise transaction costs and time. Both energy and non-energy sector regulators need to apply light handed procedures, that is minimal compliance requirements and costs.

  - Type 6: Large mini-grids supplied by the main-grid require a mini-grid licence and an arms-length power purchase agreement negotiated based on a standardised tariff methodology. A model power purchase agreement can help to minimise the time and cost of negotiation.

- **Off-grid mini-grids supplied by a separate small power producer:** these represent the traditional hybrid ownership mini-grids where risks are shared between different developers. Policy and regulatory options depend on size as follows:

  - Type 7: Very small scale mini-grids supplied by another operator need to be registered but there is no need for a generation license or tariff regulation. Regulators should only be concerned with issues of safety and providing support to enable the owners to establish cost reflective tariffs. The SPP price can simply be defined as a percentage of the retail tariff. Since more than half of the revenue is

likely to be due to the SPP owner, the regulator should ensure that the revenue collected is shared in the relevant proportion.

- Type 8: Small-scale mini-grids supplied by another operator require a mini-grid license as well as support for developing cost-reflective tariffs. Light handed regulation that minimises transaction costs and time should be used by both energy and non-energy sector regulators. A non-negotiable standardised tariff methodology and power purchase agreement is recommended.

- Type 9: Large mini-grids supplied by another operator need a mini-grid licence and an arms-length power purchase agreement negotiated between the generation and mini-grid business based on a standardised tariff methodology. A model power purchase agreement can help to reduce time and cost of negotiating.

1.3 Framework for attracting investment in mini-grids

A review of both successful and failed mini-grids projects within the region and internationally highlighted four critical issues:

- **Market needs and demand** – this is the first focus area which addresses the purpose of the mini-grids in fulfilling the energy services needed by the target beneficiaries. The important issue for investing in mini-grids is to quantify the demand, which is the ability and willing to pay for the energy services provided. For remote and low income communities it is generally necessary to have explicit subsidies and support for productive end uses in order to create sufficient demand to justify mini-grid investment.

- **Technology choice and technical regulation** – this is the second focus area that seeks to match the choice of technology to the market demand. In this project the objective is to promote renewable energy technologies which are not only locally available in abundance but also increasingly cost competitive when compared to non-renewable fossil fuels. Technical regulation needs to ensure the safety of life and equipment and protect the customer's right to quality products and services.

- **Ownership, funding and economic regulation** – this is the third focus area that addresses the investment and operational requirements for different ownership and financial arrangements. The principal objective of economic regulation is to promote investment by having tariffs that are high enough to cover costs but structured to reflect the spending patterns on the traditional energy services. Appropriate subsidies and financing terms are needed to achieve this objective.

- **Planning & development process and role clarity** – this is the fourth focus area that addresses the need for transparency of the project approval process and the role of the different stakeholders within and

outside the energy sectors. This reduces transaction time and costs. A project champion in the form of an institution, usually an existing one, is necessary to provide a coordinating and facilitating role for project developers.

This overview document provides a summary of the contents of the guidelines for each of the focus areas. The detailed guidelines are elaborated in different documents that are inter-related but that can be read as standalone documents for convenience.

2 Guidelines on Market Needs and Demand

The instruments in the first volume address the first focus area – Market Needs and Demand – this being the foundation for planning and developing mini-grids. Energy needs are universal but the ability and willingness to pay (demand) is limited, especially in remote and low income communities which constitute the bulk of the population without access to modern energy services. In order to achieve universal access policy makers have to intervene to influence demand.

Research to establish a thorough understanding of market needs and demand is done at national and project level.

The key actions at national level are:

- National energy surveys to create databases of energy services for different end uses, customer categories, income and geographical locations – households, social & administrative institutions and business institutions. The guidelines provide a checklist of the different energy services.

- Definition of criteria for determining affordability and locations that are zoned for grid and off-grid solutions. Criteria include income (existing or potential)[1], grid proximity, population density and geographical equity.

- Prioritisation of rural locations for phased development towards universal access. This prioritisation helps to target subsidies and income generating projects which can create the anchor loads for energy service providers. The Off-Grid Energisation Masterplan (OGEMP) of Namibia provides an example of the application of a prioritisation system

- Development of grid and off-grid electrification masterplans

The development of a universal access strategy and masterplans 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 three basic energy supply options in fulfilling market needs and demand, namely 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.

[1] EUEI PDF (2011), *Productive Use of Energy – PRODUSE, A Manual for Electrification Practitioners*. www.euei-pdf.org is a useful step by step guide for promotion of productive use of energy

- The selection and ranking of locations for use of the different options. For remote and low income communities mini-grids are best used where prospects for productive use of electricity exist.

These national level actions help project developers to identify the best locations where detailed needs and demand assessments can be made for specific mini-grid projects.

The project level assessments are focussed on guiding the sizing and design of the energy source and distribution network.

3 Guidelines on Technology Choice and Technical Regulation

The instruments in this volume address the second focus area – Technology Choice and Technical Regulation. This sets out the principles for the technical design, operation and regulation which mini-grids must comply with. The guidelines outline national and project level actions that need to be undertaken.

The overriding principle for technology choice and technical regulation for sustainable mini-grids is fulfilment of market needs and demand. That is why the establishment of market needs and demand takes precedence. It is also the reason why it is necessary to undertake a comprehensive assessment of technology options including demand side and energy efficiency. A case study on comprehensive assessment of technologies is presented for guidance.

The objective of national level actions is to influence technology choice towards renewable energy and safe, reliable, secure and efficient supply and utilisation of 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
- Localisation of technology - local manufacture of equipment, local development and adaptation of expertise and retention of experts – at regional, country and project levels as appropriate

At project level technical regulations must focus on development of safety and appropriate product and service quality standards to ensure value for money for mini-grid customers. They should also provide for operational flexibility to allow parallel and island operation between the mini-grid and main-grid.

Key technical issues and possible solutions that can be adopted are:

- **Variability and uncertainty of output of renewable energy technologies**: solutions include energy storage (which is relatively expensive), back up from fossil fuel generators, connection to the main-grid or demand response using smart grid technologies. Comprehensive assessment of technologies is required to arrive at the least cost option.
- **Distribution network limitations against low customer density and incomes**: voltage constraints limit the distance of the distribution network from the energy source which requires the mini-grid to focus on densely populated part of the community, or for changes to the settlement pattern by having a designated growth centre with planned residential and business stands. Costs can also be reduced through phased development (for example starting with a single phase network

that is upgraded to a three phase as load grows), use of simplified wiring techniques, and using standard equipment.

- **Balancing supply and demand reflected by stable voltages and frequency and low harmonics:** mini-grid should be designed for flexible operation in island or parallel mode; control can be automated through smart grid technologies; main-grid operator can assist with grid interface issues and the training and certification of skilled operation and maintenance personnel.

- **Efficiency of customer management system:** metering, billing and revenue collection are critical but can now be facilitated through smart and prepayment meters, mobile banking, and smart-grid technologies for automated compilation and analysis of customer service statistics.

- **Proactive preparation for main-grid interconnection:** designing the mini-grid for easy integration with the main-grid to allow for either sale of the whole or part of the business to the main grid operator or adding the grid as another supplier or customer for the mini-grid.

The guidelines include a list of the key technical features and related policy and regulatory issues for the most common renewable energy options for SADC countries.

4 Guidelines on Ownership, Funding and Economic Regulation

The instruments which are provided in this document and in supporting additional legal templates are addressing the third focus area – Ownership, Funding and Economic Regulation. The templates are:

- Standardised licencing procedures and licence templates
- Guidelines for use of energy funds for mini-grid investment support ('Subsidy guidelines')
- Procurement guidelines for competitive bidding of large mini-grid generation and/or distribution and supply (whether or not the mini-grid is connected to the main grid), small projects can be considered on a first come first served basis, subject to enforcement of time for specific deliverables
- Standardised concession agreement (SCA)
- Standardised operation and maintenance agreement (SOMA)
- Standardised tariff methodology (STM) comprising Retail Tariff Tool, Feed in Tariff (FiT) Tool and Power Purchase Tool
- Standardised power purchase agreement (SPPA) templates

The instruments are oriented to facilitating efficient mini-grids being established on a viable, sustainable basis. ***The main regulatory objective for mini-grids should be to facilitate community and private investment in mini-grids***. The approach needed to maximise investment in mini-grids is to make regulation as ***light-handed*** as possible. This should not be taken to imply cutting corners in critical areas such as safety and other technical concerns. What is implied by light-handed economic regulation is:

- Procedures that are as streamlined as possible in order to reduce transactions costs when mini-grids are established
  - Minimisation of number of regulatory processes and decisions
  - Standardised documents
- Only essential reporting requirements so as to minimise administrative costs during project operation
  - Careful specification of information required by the regulator
- Reliance on related decisions made by other government or community bodies

There are dangers in being too light-handed: it could lead to a flood of applications that would be difficult to process (as occurred in Nepal and Sri Lanka)[2]. However, this would be a desirable outcome compared with the current situation where the number of minigrids in many if not most SADC countries can be counted on the fingers of one hand.

The purpose of economic regulation is to protect consumers while providing confidence for investors, the main focus therefore being on tariffs. At first gloss, it may seem that the regulatory approaches traditionally used for regulating a large national utility can simply be transferred across to a mini-grid. However, this would be a counterproductive approach for a number of key reasons:

- ***Mini-grid consumers need electricity much more than they need low tariffs.***
  - People in communities without electricity have to resort to extremely expensive forms of electricity, such as dry cell batteries at US$1-2 per kWh, which limits their consumption of electricity to very small quantities. To have access to electricity which can be used for a wide range of end uses is a huge improvement in people's lives, opening up all sorts of income earning and social enhancement possibilities.
  - One of the biggest single threat to mini-grid viability and hence to people having access to electricity in communities remote from the grid, is the idea that mini-grid tariffs should be no higher than the tariffs enjoyed by grid-connected households in the urban areas. Mini-grid costs per kWh are often higher than the costs of grid supply (despite mini-grid capital subsidies) and in urban areas domestic consumption is cross-subsidised by other consumer categories. Opportunities for such cross-subsidisation are very rare in mini-grids.
  - Policy makers and the communities themselves need to be made aware of this important 'fact of life' that mini-grid tariffs may often have to be higher for households than urban tariffs. There is need for the benefits of electricity to be carefully explained, together with the principles of the equity-oriented subsidy policy (as laid out above).
- ***Mini-grid tariffs are unlikely to exceed the ability and willingness to pay*** of the beneficiary community
  - In community-owned schemes, it is clearly up to the beneficiaries themselves to decide on the tariffs which they are going to charge themselves, and the levels will not exceed ability and willingness to pay of the different kinds of consumer. The danger is that the tariffs will be set too low to ensure sustainability, and some guidance

[2]See Tenenbaum et al pg 80.

would be useful in this regard from the retail tariff tool. If the tariffs are set too high, a surplus would be generated, but this can always be paid back to consumers or devoted to some other community project.

- In privately owned schemes, the electricity supplier will be in a monopoly position and this is precisely the situation for which the instruments of economic regulation have been designed. However, in a typical mini-grid setting, it would be impossible for the private supplier to charge more than the community is able and willing to pay. The guiding framework is that the costs of electricity (a superior form of energy) should be less than the costs of the energy sources which are displaced by electricity (such as kerosene for lighting and batteries for phone charging, radios, TVs and other low power applications).

In light of the above, ***it is recommended that regulatory authorities should not directly regulate mini-grid tariffs***. The time and attention needed to do this on a thorough basis would not be warranted when the aim is to encourage electricity provision in a remote location. There can instead be a ***provision for mini-grid communities to appeal to the regulator*** if they feel that they are being over-charged and an investigation can then be carried out. The framework, however, should be that mini-grid tariffs need to be high enough for the system to be sustainable, and this will invariably mean that tariffs need to be higher than those enjoyed by urban grid-connected electricity consumers.

It may be seen as unfair for low income mini-grid customers to pay more per kWh for power than higher income main-grid customers, but the real unfairness is for people in remote centres not to have electricity at all. Costs are high in mini-grids, and to ensure viability tariffs may need to be allowed to be above uniform national tariff levels. This should be acceptable to mini-grid consumers if the monthly cost of mini-grid electricity is less than the cost of their previous forms of energy (that they paid for before the mini-grid was constructed) or if they can increase income because of the energy access.

These views are supported by the detailed, multi-country analysis in the about-to-be published seminal volume by Bernard Tenenbaum, Chris Greacen and Tilak Siyambalapitiya *From the Bottom Up: How Small Power Producers Can Deliver Electrification and Renewable Energy in Africa.* The key elements of the arguments made in Chapter 9 of this book are:

- In order for SPPs that operate isolated mini-grids to exist as commercially viable entities, they must be allowed to charge tariffs that are higher than the uniform national tariff (pg 275)

- Rural household customers can afford cost reflective tariffs if they are allowed to pay for the initial connection cost in small monthly payments over time. Once they get over the connection cost hurdle, they can afford to pay electricity tariffs that will produce monthly expenditures equal to or less than their prior expenditures on non-electricity energy sources

> (kerosene, candles, batteries). Electricity has the added benefit of producing better energy services: higher quality lighting, better access to information, and health benefits (pg 278).

Public resources to subsidise mini-grids are woefully inadequate in relation to need, and the most needs to be made of any opportunity to secure non-public financing. Subsidies should be limited to once-off capital subsidies, as this will enable many more mini-grid users to benefit than the provision of recurrent subsidies to those few mini-grid beneficiaries lucky enough to already have access to electricity.

5 Guidelines on Planning & Development Process and Role Clarity

The instruments which are provided in this document are addressing the fourth focus area – Planning & Development Process and Role Clarity. Good policies and regulations can fail to achieve their objective if the key stakeholders are unaware of these and of the process for getting the necessary approvals.

Recognising the critical importance of regulatory processes, Bernard Tenenbaum, Chris Greacen and Tilak Siyambalapitiya in the May 2013 working draft of their book "*From the Bottom Up: How Small Power Producers Can Deliver Electrification and Renewable Energy in Africa*" devote a chapter to the subject of how to create an efficient and effective approval process.

There are many stakeholders involved who comprise both energy sector and non-energy sector players who have the following key roles in mini-grid development:

- **Policy makers:** define the energy access and environmental protection mission and vision of mini-grids; define the polices and plans that facilitate demand and productive use required to realise the mission and vision; establish the legal and institutional framework for implementation of the policies and plans; decide the allocation of public financial and other resources and incentives required to support mini-grid development

- **Regulators:** energy regulators facilitate the implementation of policies and plans for mini-grids through (a) light handed regulations comprising standardised tariff methodologies and project agreements to minimise transaction costs and time for investors; (b) product and service quality standards for consumer protection. Non-energy sector regulators provide resource utilisation permits, ensure minimum adverse environmental and social impacts, and ensure compliance with tax, standards and other business compliance requirements.

- **Administrators and civil society:** concerned with the protection of the interests of the host community and of the public in general. Mini-grid developers therefore need skills in community based planning approaches.

- **Target beneficiaries:** these are the households, social and administrative and business institutions that are the principal source of funding for mini-grids. Project developers must include considerations of gender and youth in assessment of mini-grid benefits.

- **Investors:** the communities, public and private utilities involved on their own or in partnership to finance, develop, operate and maintain mini-grids.

- **Service providers:** support investors by providing producer and consumer finance, technical assistance for feasibility studies and project design and implementation, research and development, skills training, manufacture, construction, operation and maintenance services.

It is necessary to have a project champion in the form of an institution that can coordinate all the stakeholders by documenting process guidelines, managing the project approval process, provide capacity building for project developers and facilitate the administration of financial and other incentive schemes. Such a mini-grid project coordinating agency (MPCA) can be an existing institution such as a government department, regulator or electrification agency.

The Guidelines outline the steps which the policy makers and the MPCA should follow in documenting the planning and development process:

- **Definition and classification of mini-grids:** a recommended classification system is given (see section 1.2 of this document).

- **Extracts of electricity access and renewable energy policies, laws and regulations**: the guidelines must explain the latest government policies and targets for access and renewable energy development and the role of the main grid and mini-grid operators in achieving the targets; with reference to renewable energy resources, the relevant resource entitlement requirements such as water rights for hydropower must be explained.

- **Extracts of non-electricity sector policies, laws and regulations that also need to be complied with:** this includes but is not limited to environmental and social impact assessments, company and tax registration, land title or lease requirements and local authority by laws.

- **Description of fiscal and other incentives for mini-grid development**: potential developers need to understand if there are any incentives such as capital subsidies, loan guarantees, grants, tax concessions for mini-grids and, if so, how they can be accessed.

- **Description of the project development and approval process**: a generic process is described.

- **Definition of the licensing procedures and requirements for the different mini-grid classes**: should also be consistent with the Guidelines on "Ownership, Funding and Economic regulation"

- **Description of the tariff and technical regulations applicable to the different mini-grid classes:** should also be consistent with the Guidelines on "Ownership, Funding and Economic regulation" and Guidelines on "Technology Choice and Technical regulation".

The Guidelines also provide an extensive checklist of stakeholders and their role in mini-grid development, elaborate on the mini-grid classification system that helps to

direct policy and regulatory approaches that are appropriate to the size, location and ownership of mini-grids. A generic project approval process is outlined that involves planning, energy and general business permits and monitoring and review of project implementation.

6 Application of Regional Guidelines at Country level

Mini-grid development takes place at national level and therefore the regional guidelines are only effective if countries use them to improve their national policies and regulations. The project therefore included the application of the guidelines in two member countries that were selected on the basis of proven interest and readiness to develop a supportive framework for mini-grids. Namibia and Zimbabwe were selected.

The following steps outline the process by which these guidelines are used to assist countries to improve their mini-grids policy and regulatory framework:

- **A project steering committee (PSC) and working group (WG) are established to assess the gaps between the regional and country policy and regulatory frameworks.** The assessment includes site visits to existing minigrids. In Zimbabwe the PSC and WG comprised representatives of the energy regulator, Ministry of Energy and Power Development, Ministry of Local Government, the national power utility, the rural electrification agency, the environmental management agency, the national water authority and a non-governmental organisation involved in mini-grid development. In Namibia the PSC and WG (which is called the Project Management Unit, PMU) had representatives from the Ministry of Mines and Energy, Ministry of Transport and Works, Renewable Energy and Energy Efficiency Institute (REEEI), electricity regulator, national power utility, regional electricity distributors (REDs), research foundation and solar industry association.

- **Preparation and presentation of a gap analysis report and recommended action plan to a National Stakeholder Workshop to seek validation.** In Zimbabwe the National Workshop was attended by representatives of the organisations comprising the Project Steering Committee, research institutions, universities, private sector and community mini-grid developers and operators, and non-governmental organisations with interest in the sustainable energy for all initiative. In Namibia the National Workshop was attended by representatives of the PSC and PMU member organisations except the REDs which were unfortunately unable to send any representatives.

- **Preparation of the final gap analysis and action plan for implementation under the guidance of the designated mini-grid project coordinating agency.** In the Zimbabwe case study the National Workshop recommended the holding of a second workshop to review the final action plan before implementation. The second workshop would also provide an opportunity to involve other key stakeholders such as financing institutions who were unable to attend the first workshop.

- **Test framework through pilot projects designed for sustainability and replication under different ownership and funding models.** This phase

is important because it will help to fine tune the policy and regulatory framework based on practical experience.

This approach successfully demonstrated that the framework can be used to facilitate the development of a national action plan to improve the policy and regulatory framework for mini-grids in Namibia and Zimbabwe. Other countries should be able to easily replicate the approach. Funding can be provided from government, regulatory and electrification agencies and utilities, backed up where needed by coordinated donor support programs.

A1 Summary of Terms of Reference for the SADC Mini-grids Study

Project Title: Supportive framework conditions for mini-grids employing renewable and hybrid generation in the Regional Electricity Regulators' Association (SADC)

Duration: 12 Months; January - December 2013

1. Country/ Region

Southern African Development Community (Members of the Regional Electricity Regulators' Association of Southern Africa - RERA) (current members listed in Annex 1 of this appendix).

2. Background

The SADC region of Africa faces major challenges in improving access to modern energy services. Recent studies have suggested that overall household access to electricity in SADC remains persistently low outside of South Africa —as low as 14% in some member states. More critically, the ratio for rural households is as low as 3-4% in several countries, and only three countries have rural connection rates higher than 50%.

Responding to this concern, the SADC Energy Ministers endorsed the SADC Energy Access Strategy at their 2010 meeting, calling specifically for efforts "to ensure that the proportion of people without such access is halved within 10 years for each end use and halved again in successive five year periods until there is universal access for all end uses".

Since that time, several SADC member states have progressed significantly in addressing energy access issues by, for example introducing legislation to encourage independent power production; developing rural energy agencies to focus efforts on extending access for remote communities, and developing regulations governing the creation of local or mini-grids.

Despite these important steps, overall progress on energy access in the region has been slowed by a variety of factors, including:

- Financial difficulties due to persistence of tariff structures that are below cost-recovery levels, resulting in inability to finance new infrastructure.
- Lack of experience with independent, and particularly private sector, power producers, leading to a lack of appropriate regulations and of feed-in tariffs or other incentives for investment.

- Unfamiliarity with the operation and maintenance of mini-grids.
- Unfamiliarity with the real costs and technical requirements of renewable energy technologies.
- Low level of demand in remote areas due to low incomes, causing low return on investment.

It is generally agreed that grid extension alone will not suffice to reach the goal of universal access to energy. It is therefore clear that further development of mini-grids is likely to become an essential component of the SADC region's energy access efforts, enabling countries to provide a high standard of electricity service to consumers in small communities in advance of their eventual connection to the grid, and encouraging the use of renewable energy technologies as a key part of this effort, which is in many cases the least cost option.

In some cases, mini-grids may also be able to provide a longer-term alternative to grid connection, provided that 1) they are properly maintained and managed; 2) allow secure generation; 3) allow expansion of the infrastructure to accommodate growth of population and services; 4) are financially viable.

3. Request

The Africa-EU Renewable Energy Cooperation Programme (RECP), managed by EUEI PDF, has received a request from the SADC Regional Electricity Regulators Association (RERA) to provide technical assistance on the subject of mini-grids and their potential application in the SADC region.

The proposed assistance is fully supported by RERA's Executive Secretary and its Executive Committee, which includes representatives of all of the energy and electricity regulators in the region. The SADC Secretariat recognises the contribution the project can make to achieve the goals of the SADC Energy Access Strategy and the SADC Renewable Energy Strategy and Action Plan.

The, Africa-EU Renewable Energy Cooperation Programme (RECP), supports African countries and regions with the creation of enabling environments required to develop renewable energy markets and attract investments. Tailored regional policies and enabling frameworks are developed under the RECP that are adapted and piloted in selected national African contexts with a view to later replication in additional countries and regions. The main objective of the RECP is the acceleration of the use of the vast potential for renewable energy in Africa, to help meet future energy needs, and thereby contribute to increasing access to sustainable energy services.

3.1 Specific Focus

The proposed technical assistance will focus on developing a range of policy and regulatory options for the planning and development of mini-grids, including identification of a range of solutions appropriate to different energy resource mixes

and different economic circumstances. The term "mini-grids" is understood to include both off-grid and semi-connected applications (e.g. separate village or company networks). This assignment will only include mini-grids with renewable and hybrid (mix of fossil fuel and renewable) generation capacity. During the assignment, the current best practice in the region will be taken into account.

The assistance will be targeted to national electricity/energy regulators who are primarily responsible for development of appropriate regulations governing mini-grid development and operation, but will also include national ministries of energy in their role as developers of key enabling policies as well as public and private utilities and rural electrification or rural energy agencies (REAs). Especially REAs should be strongly involved in the project, as these organisations are increasingly vested with responsibility for development of off-grid solutions in general and renewable energy in particular in the member states of SADC.

4. Purpose and Objectives

4.1 Objectives

The objective of the proposed technical assistance is to create supportive framework conditions to foster the development of mini-grids in the SADC region to stimulate 1) access to energy and 2) distributed renewable generation capacity.

4.2 Activities

The objectives would be achieved by the following activities:

- Assessment of the current status of policy and regulation regarding mini-grids (including both off-grid and rural grid-connected systems and both renewable energy-based and hybrid grids) in the SADC region.
- Identification of the gaps in policy and regulation which can be addressed through implementation based on a regional set of guidelines for mini-grid implementation.
- Assisting at least two SADC member states that are currently in the process of considering the development of policies and regulations on mini-grids, including introduction of feed-in tariffs, in developing policies and regulations for mini-grids as part of the RERA work.
- Preparation of a draft set of policy options on mini-grid implementation through a consultative process including inter alia issues of financing, tariff structure, technical requirements, service agreements and service quality, licensing requirements and ownership.
- Review of the draft policy options in a (series of) workshop(s) and thereafter prepare a final set of guidelines for submission to the RERA Executive Committee and the SADC Energy Ministers.

4.2 Expected Outcomes

The outcomes of the project will be an increased understanding of the processes required to implement successful mini-grid programmes at the national level and increased awareness among SADC/RERA members of the required framework conditions for mini-grid development. Two countries will be provided with a specific range of suitable policy options for their situation and an action plan.

5. Scope of Work

5.1 Phase 1: Analytical/Inception Phase

Task 1: Mobilisation and analysis of existing situation

5.2 Phase 2: Formulation Phase

Task 2: Formulation of policy and regulatory options

Based on the analysis of the existing situation, the consultant will develop a first draft of the policy and regulatory options for mini-grid development. The options will include:

- Criteria for prioritization of off-grid options in SADC member states
- Regional principles for access to mini-grids
- Standardised templates for PPAs and other important documents, where appropriate
- Design technical operational principles (grid code) / regulation principles
- Proposed licensing procedures and standardised licensing templates for IPPs operating mini-grids
- A procedure for developing Renewable Energy Feed-in Tariffs and other tariff schedules appropriate for mini-grid applications.
- A compendium of key technical issues which mini-grid developers may face, including a range of solutions which will guide local adoption.
- An overall set of policy options to be used by regulators and national utilities in addressing the challenges of mini-grid development. These guidelines will present a range of options appropriate to the different circumstances prevailing in the different SADC member states.

The policy and regulatory options will take into account the following:

- Fiscal, legal, and institutional issues in each of the SADC member states (e.g. current status of grid connection, mandate of regulators, current existence of

mini-grids within the countries, current private sector involvement, funding of grid extension and of power sector development generally, regulations governing sale of electricity and general financial issues including foreign investment, subsidies, fiscal management and use of imported power).

- Environmental concerns and sustainability,
- Financial sustainability of the mini-grid installations.
- The needs for capacity development in the public and private sectors relating to mini-grids.
- Opportunities to make better use of local resources (i.e. renewables)
- Regional and national targets for energy access and for renewable energy in the power sector, if available and implemented.
- The need for energy security and resilience/diversity.
- Large differences among SADC members in level of regulation, energy markets, natural resources and national income.
- Latest international publications on the subject, including in particular guidelines for small power producers (B. Tenenbaum and others – World Bank (forthcoming early 2013)).

The draft will present options appropriate to the various conditions found within the region with explanation of the advantages and disadvantages of each.

Task 3: Review and Consultation to establish consensus on regional guidelines

5.3 Phase 3: National consultation and finalisation

Task 4: National Focused Consultation

Task 5: Finalisation of policy and regulatory options and submission to RERA

Further actions including submission of the range of policy options to the SADC Energy Ministers, will be the joint responsibility of RERA and the SADC Secretariat/Infrastructure and Services Directorate.

ANNEX 1: Regional Electricity Regulators Association

The Regional Electricity Regulators Association of Southern Africa (RERA) was established by the Southern African Development Community (SADC) as a formal association of electricity regulators in July 2002 in terms of the SADC Protocol on Energy (1996), the SADC Energy Cooperation Policy and Strategy (1996), the SADC Energy Sector Action Plan (1997), the SADC Energy Activity Plan (2000) and in pursuit of the broader initiative of the New Partnership for Africa's Development (NEPAD) and the African Energy Commission (AFREC).

The Association was officially launched on 26 September 2002 in Windhoek, Namibia which is also now the seat of the RERA Secretariat. RERA was incorporated as an Association (Not for Gain) under the Companies Act, 1973 of the Laws of Namibia (Act 61 of 1973) on 03 October 2003. RERA has its own Constitution stipulating the objectives, functions and other operational requirements of the Association.

RERA's mission is to facilitate harmonisation of regulatory policies, legislation, standards and practices and to be a platform for effective cooperation among energy regulators within the SADC region. The objectives of RERA fall into three broad categories, namely:

- Capacity Building & Information Sharing - Facilitate electricity regulatory capacity building among Members at both a national and regional level through information sharing and skills training.
- Facilitation of Electricity Supply Industry (ESI) Policy, Legislation and Regulations - Enhance the increasing integration of electricity systems and electricity trade in the southern African region and beyond through the facilitation of harmonized ESI policy, legislation and regulations for cross-border trading, focusing on terms and conditions for access to transmission capacity and cross-border tariffs.
- Regional Regulatory Cooperation - Deliberate and make recommendations on issues affecting the economic efficiency of electricity interconnections and electricity trade among members on issues that fall outside national jurisdiction, and to exercise such powers as may be conferred on RERA through the SADC Energy Protocol.

Membership in RERA is open to electricity supply industry regulatory agencies in each country within SADC region that pay annual subscriptions toward the costs of the Association. Each country is limited to a single membership. The current members are:

- Institute for Electricity Sector Regulation of Angola (IRSE)
- Lesotho Electricity and Water Authority (LEWA)
- Malawi Energy Regulatory Authority (MERA)
- National Electricity Advisory Council of Mozambique (CNELEC)
- Electricity Control Board of Namibia (ECB)
- National Energy Regulator of South Africa (NERSA)
- Energy and Water Utilities Regulatory Authority of Tanzania (EWURA)
- Energy Regulation Board of Zambia (ERB)
- Zimbabwe Energy Regulatory Authority (ZERA)

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