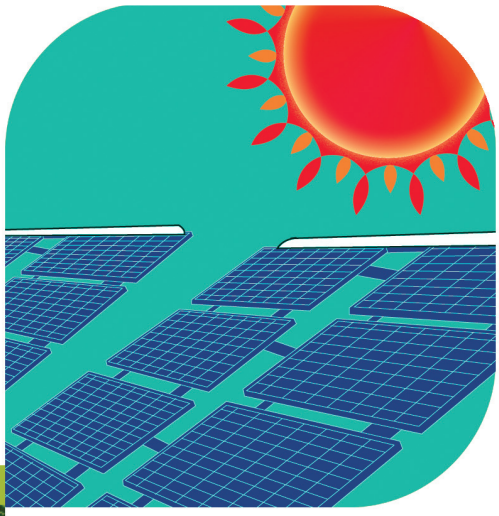
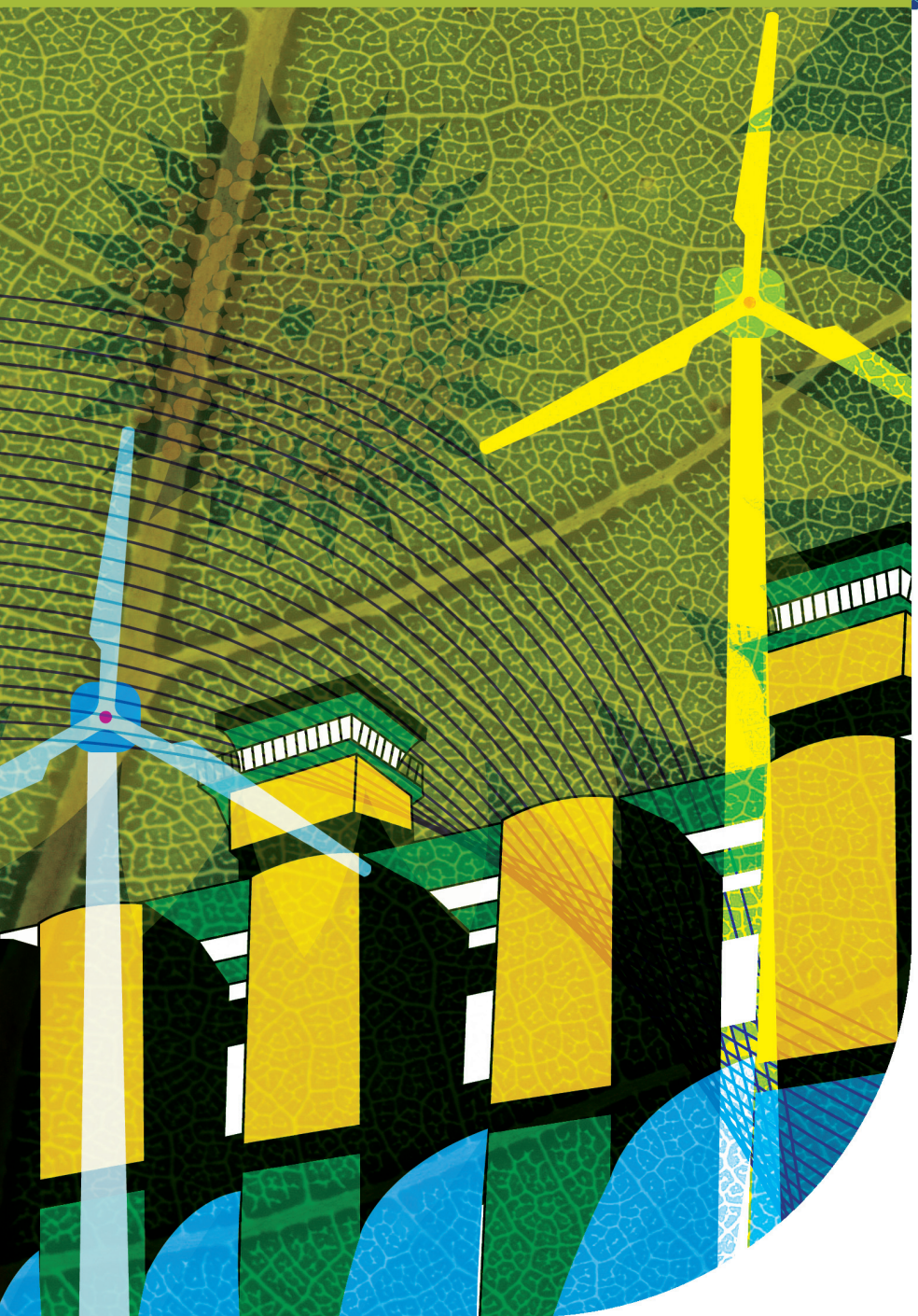
IRENA
International Renewable Energy Agency



MOZAMBIQUE

RENEWABLES READINESS ASSESSMENT 2012



About IRENA

The International Renewable Energy Agency (IRENA) promotes the accelerated adoption and sustainable use of all forms of renewable energy. IRENA's founding members were inspired by the opportunities offered by renewable energy to enable sustainable development while addressing issues of energy access, security and volatility. Established in 2009, the inter-governmental organisation provides a global networking hub, advisory resource and unified voice for renewable energy.

www.irena.org

MOZAMBIQUE
RENEWABLES READINESS ASSESSMENT 2012

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List of Acronyms

AMOMIF	Associação Moçambicana dos Operadores de Microfinanças
BTC	Belgian Technical Cooperation
CIA	Central Intelligence Agency
CIB	Inter-ministerial Committee on Biofuels
CNELEC	Conselho Nacional de Electricidade
CPI	Centro de Promoçaode Investimentos
CPS	Country PartnershipStrategy
CTA	Confederação das AssociaçõesEconómicas
EDENR	Strategy for New and Renewable Energy Development
EDM	Electricidade de Moçambique
ESCO	Energy Service Company
EUEI-PDF	European Union Energy Initiative Partnership Dialogue Facility
FNI	National Research Fund
FUNAE	Fundo de Energia
GDP	Gross Domestic Product
GIZ	Deutsche GesellschaftfürInternationale Zusammenarbeit
HCB	CahoraBassa HydroelectricCompany
IEA	International Energy Agency
INE	Instituto Nacional de Estatistica (National Statistics Agency)
INNOQ	Instituto Nacional de Normalização e Qualidade
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
KMTC	Knowledge Management and Technology Cooperation
MCT	Ministry of Science and Technology
MFI	Micro Finance Institutions
MIC	Ministry of Industry & Commerce
MICOA	Ministry of Coordination of Environmental Affairs
MINAG	Ministry of Agriculture
MoE	Ministry of Energy
MOTRACO	Mozambique Transmission Company

NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
PARPA	Plan for the Reduction of Absolute Poverty
PCES	Community Sustainable Energy Plans
PETROMOC	Petróleos de Moçambique
PNDB	National Programme for the Development of Biofuels
PV	Photovoltaic
RE	Renewable Energy
REA	Rural Electrification Agency
RRA	Renewables Readiness Assessment
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SNV	Netherlands Development Organization
STIFIMO	Programme of Cooperation in Science, Technology and Innovation between Finland and Mozambique
TPES	Total Primary Energy Supply
UEM	University Eduardo Mondlane
UNIDO	United Nations Industrial and Development Organization
USD	United States Dollars

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Acknowledgements

This Renewables Readiness Assessment report was prepared by the International Renewable Energy Agency (IRENA) working in close collaboration with the Government of Mozambique. The International Institute for Sustainable Development (IISD) provided valuable support to the process and the report.

We wish to thank the following experts, in alphabetical order, for their insights and constructive guidance during the peer review process: Boaventura Cuamba (Eduardo Mondlane University, Mozambique), Francis Yamba (CEEEZ), Haruna Gujba (ACPC), Peter Zhou (EECG Consultants Pty, Ltd), Veli-Pekka Heiskanen (SADC Secretariat),

Karmic Design provided the design and layout.

Comments or questions about this Renewable Readiness Assessment report can be sent to SAlzouma@irena.org, MSokona@irena.org, or to info@irena.org.

Foreword

Realising the full potential of my country's huge renewable energy resources is key to the development we require to expand our economy and lift our people out of poverty. Mozambique has worked tirelessly over the past decade to set up the framework in which these resources can be scaled up to the quantity we need. Our Ministry of Energy has been a separate entity since 2005 and incorporates a Directorate for New and Renewable Energy. We now have strategies and legal frameworks in place, and agencies – including the Energy Fund (Fundo de Energia, or FUNAE), and our national electricity utility (Electricidade de Moçambique, or EDM) – are making strong progress in increasing electrification. In addition, our petroleum company (PETROMOC) is engaged in biofuels production and future distribution.

Mozambique has been fortunate to receive very strong support for our renewables upscaling over many years, from within the country and from a number of strong donors and partners. Realising our plans will depend on the continuation of this support and the identification of increased resources for investment. We are actively looking at ways of maximising this investment, and have opportunities in the renewable energy sector at all sizes – from very large hydro to pico solar photovoltaic (PV) – and for all major resources: hydro, wind, solar and biomass.

Mozambique is a strong supporter of the International Renewable Energy Agency (IRENA) and its mission. We were proud to volunteer to host the second pilot study of the Renewables Readiness Assessment programme. The process and conversations with a range of

government and other stakeholders, and with the external team led by IRENA, were very stimulating and have helped us to identify the key opportunities and barriers we can focus on over the short term. We are pleased that two of our examples of good practice are included in this report and are very keen to discuss and help to roll out these opportunities and the good practice examples from other countries, in the months and years ahead.

I commend this report to you and look forward to working with you in upscaling Mozambique's renewable energy.

Salvador Namburete

Minister of Energy
Republic of Mozambique

Preface

IRENA has a mandate to act as the focal point for international cooperation to promote the adoption of renewable energy. The IRENA-Africa High-level Consultative Forum, held in July 2011, recognised "Renewable Energy Readiness" as a crucial first step for better understanding the opportunities and constraints in African countries and regions, and for a collaborative process that will provide a rapid, objective assessment of the status of renewable energy opportunities, and identify pathways to address gaps.

Renewables Readiness Assessments (RRAs) will allow IRENA to identify and provide country-specific support and advice to participating countries. More broadly, RRAs will also generate the knowledge of good practice and the cooperation between countries that are essential to increasing deployment. The readiness assessment will help IRENA to provide assistance to countries in a targeted manner. Receiving one of the first RRAs – presented here by Mozambique – is an important milestone for IRENA.

In keeping with its strong and consistent support of IRENA and its mission, Mozambique kindly volunteered to host one of the first country pilot studies and test the RRA methodology. The process and details of RRAs will necessarily evolve with experience. We thank Minister Namburete and his team for their patience and generosity in hosting this first study. Their engagement and input have gone beyond what we could have expected and we are grateful for their important contribution.

IRENA hopes that this RRA will enable Mozambique to increase its deployment of renewables. We offer our continuing support, across all our functions and work programmes, to Mozambique in implementing the actions identified.

Adnan Z. Amin

Director General, IRENA

Image 1: Mozambique Mipandi Solar Wind System
Source: renewable-world.org

Executive Summary

BACKGROUND

Mozambique, despite 16 years of civil war, is one of the fastest-growing economies in sub-Saharan Africa, with annual growth of 7% for the past decade and a 2011 GDP of USD 9.893 billion. This was partly achieved through the implemention of a comprehensive Structural Adjustment Programme initiated by the government which was aimed at liberalising the economy, improving resource distribution, promoting agricultural production, expanding the private sector, and adjusting the country's internal and external trade imbalances. As a result, Mozambique's economy is no longer solely dependent on the primary sector – all three sectors now play an important economic role with 31.5% of GDP from the primary, 23.8% from the secondary, and 44.7% from the tertiary sector.

RRA IN MOZAMBIQUE

Mozambique has one of the highest hydroelectric potentials in Africa and is home to one of the largest hydro dams in the continent, the Cahora Bassa Dam, which has an installed capacity of 2 075 MW and produces electricity for Mozambique, South Africa, Zimbabwe, Botswana and the Southern African Power Pool. The dam plays an important role in Mozambique's economy as a source of foreign revenue, especially after the country gained majority ownership of the dam (85% of the shares). Despite being endowed with significant renewable energy sources (hydro, biomass, solar and wind) as well as fossil fuels (natural gas and coal), Mozambique's national grid only serves about 18% of the population and is subject to transmission and high distribution losses (25%). The country constantly ranks among those with the lowest electricity access rates.

FUNAE is responsible for promoting distributed generation through both direct projects and the promotion of private sector projects. Although FUNAE has a successful record of implementing off-grid projects, the delivery of sustainable rural electrification on a wider scale will necessitate the participation of the private sector due to FUNAE's limited human and financial resources.

However, the number of privately led projects is currently low, suggesting that there is still room for further progress.

Mozambique has actively pursued energy sector reform for over two decades. Reform has included the privatisation of the national utility (EDM) and the introduction of the Electricity Law, which provided elements of competition and opened the electricity sector to new entrants. This required the setting up of a regulator (CNELEC) and the creation of a fund for rural electrification (FUNAE). Policies and strategies on the development of new and renewable energy and for biofuels, including multiple blending targets, were later adopted to reflect the country's changing priorities.

The country has a number of medium- and large-scale hydro power projects in the pipeline and plans to expand its distribution and transmission system. The setting up of small hydro power projects along the expanded grid network close to load centres will promote the connection of renewables-based electricity and increase electricity access rate.

Wind power in Mozambique is in an early stage of development.The government is conducting a mapping project, which includes the installation of a number of wind speed measurement stations throughout the country to produce a wind energy resource atlas. This resource mapping exercise should be used to further refine the estimates of generation costs and to inform the policies for the promotion of wind power.

FUNAE is responsible for promoting distributed generation through both direct projects and the promotion of private sector projects. Although FUNAE has a successful record of implementing off-grid projects, the delivery of sustainable rural electrification on a wider scale will necessitate the participation of the private sector due to FUNAE's limited human and financial resources. However, the number of privately led projects is currently low, suggesting that there is still room for further progress. FUNAE should therefore engage with the private sector by establishing a forum to discuss possible policies and regulations that will further stimulate private sector participation in off-grid renewable energy projects; expand the

tender process to include management, design and maintenance activities previously undertaken by FUNAE; pro-actively allow a business-led approach to emerge by encouraging private equipment suppliers and distributors to enter the market in partnership with micro-finance institutions; and consider the use of a concession-based system.

Mozambique is endowed with the potential for an expansion of biofuel production, which could reduce domestic demand for imported oil products. Cultivation of biofuels feedstock could provide local economic opportunities including the creation of direct employment and possibly through the production of additional feedstock from smaller farms. A number of concessions have already been granted for biofuels facilities and a number of additional expressions of interest have been received for further developments. However, concerns continue to be raised regarding the environmental and economic sustainability of biofuel production. Therefore, in addition to balancing sustainability criteria with land availability to identify available land for biofuels, Mozambique should investigate clear indications of local market size and process for allocating obligations for projects to supply to local markets.

KEY RECOMMENDATIONS

The Government of Mozambique should:

- Include potential sites for hydro-electricity projects in grid extension planning and support the development of small-scale hydro projects along the grid.
- Pursue wind ground resource assessment to set the priority for developing further policy in support of wind energy.
- Encourage private sector involvement in rural electrification and decentralised energy in order to scale up the deployment of renewables in these energy sectors.
- Promote the development of sustainable biofuel projects and clarify the requirements for biofuels producers to the local market.
- Build entrepreneurs and financiers capacity in developing and appraising bankable RE projects by creating synergies with programmes such as STIFIMO - Programme of Cooperation in Science, Technology and Innovation between Finland and Mozambique - aiming at mainstreaming innovation in the country.

MOZAMBIQUE

786 380

km^2

GEOGRAPHICAL AREA

Maputo

CAPITAL CITY

23.1

million

POPULATION

7%

ECONOMIC GROWTH RATE

(INE, 2012)

ONE OF THE FASTEST GROWING ECONOMIES IN AFRICA

1. Introduction

BACKGROUND

Mozambique, a member of the Southern African Development Community (SADC), borders Tanzania, Malawi, Zambia, Zimbabwe, South Africa and Swaziland. The country's land area is 786 380 km^2 and its population was estimated at 23.1 million in 2011 (INE, 2012). Mozambique is one of the fastest-growing economies in sub-Saharan Africa, with an average annual growth rate of 7% for the past decade, a 2011 GDP of USD 9.893 billion and a per capita GDP of USD 1 117. The economy is dependent on the primary, secondary and tertiary sectors (respectively representing 31.5%, 23.8% and 44.7% of GDP) (Ibid).

Despite the strong growth, about 54% of Mozambique's population still lives below the poverty line. The illiteracy rate is 52.2% and the unemployment rate 27%(Ibid). As a response, the government reorganised its development agenda around the Action Plan for the Reduction of Absolute Poverty (PARPA 2011-2014). This plan focuses on increasing agricultural production, promoting employment through the development of small- and medium-scale enterprises and investing in human and social development by aligning technical and vocational training systems to the needs of the market. Furthermore, through the PARPA and the Country Partnership Strategy (CPS), the government of Mozambique has made access to energy a national priority, by defining access to adequate and affordable energy services to households, rural schools, administrative offices, hospitals and rural enterprises as a key driver to economic growth and poverty alleviation.

RRAs are now an integral component of IRENA's work programme and are included under "Promotion of regional consensus to adopt renewable energy through strategic intervention". The RRA process is meant to provide input to national and regional renewable energy action plans and bring together partners who could support the implementation of those plans, including providing solutions to energy access.

Given the strong leadership of Mozambique in the energy sector[1] and the high share of renewables (mainly hydro) in electricity generation, SADC proposed Mozambique to pilot the first RRA in the region. This document, the final report from the Mozambique pilot study, also includes the insights gained from the RRA process.

IRENA became a fully-fledged international organisation in April 2011, with a mandate to promote increased adoption and sustainable use of all forms of renewable energy. With 104 Members of the Agency and 55 signatories, IRENA has the global reach to act as the focal point for international cooperation and to underpin the effort to increase the deployment of renewables in the energy mix of countries around the world. Through its work programme, IRENA is positioning itself as an inclusive global platform to stimulate policy dialogue and develop strategies to assist countries in their necessary transition to a renewables-based energy future.

In July 2011, more than 25 Ministers of Energy and Heads of Delegation attended the High-level IRENA-Africa Consultative Forum on Partnership on Accelerating Renewable Energy Uptake for Africa's Sustainable Development, where they set out a vision and direction for IRENA's work in Africa. The communiqué adopted at the end of this forum urged IRENA to *inter alia* "better understand the opportunities and constraints in our countries and regions by mapping 'Renewable Energy Readiness', a collaborative process that will provide a rapid, objective assessment of the status of renewable energy opportunities, and identify pathways to address gaps".

RRAs are now an integral component of IRENA's work programme and are included under "Promotion of regional consensus to adopt renewable energy through strategic intervention". The RRA process is meant to provide input to national and regional renewable energy action plans and bring together partners who could support the implementation of those plans, including providing solutions to energy access.

THE RENEWABLES READINESS ASSESSMENT

RRAs are designed to define a detailed list of criteria considered necessary for the installation and ongoing operation of renewable energy facilities. Application of the RRA framework to individual countries will provide a comprehensive analysis of the presence, or otherwise, of enabling conditions for the development of renewables. Crucially, this should take into account how the country's renewables policy contributes

1 Mozambique was the head of the Conference of Energy Ministers of Africa at the time of preparation of this RRA

IRENA
INTERNATIONAL RENEWABLE ENERGY AGENCY

AS OF NOVEMBER 2012

104
Members of the Agency

55
Signatories/applicants for membership

159
Total participation
(158 states plus the European Union)

48
Participating states in Africa

RRA
RENEWABLES READINESS ASSESSMENT

- Rapid assessment of the conditions necessary for the installation and ongoing operation of renewable energy facilities in a country.
- Covers all RE sources and services of preference to the country's national product.
- The RRA report is a product of the country, and the actions and insights in it come from a country-owned process.

to other policy objectives. The exercise also facilitates comparisons with case studies, and enables the useful matching of renewable energy attributes to opportunities.

An RRA comprises a process and a methodology that includes completing a set of templates and a final report. The RRA methodology covers all services (transport, heat, electricity and motive power), and all sources of renewable energy, with countries selecting those of relevance. The RRA process enlists strong country stakeholding as it is designed to be conducted by national governments, allowing countries to obtain a comprehensive overview of the conditions for renewable energy from their own particular national perspective. All the processes and the documentation are led by the country and derive inputs from discussions with stakeholders, facilitated by the country focal point with the assistance of IRENA. The resultant report is therefore a national one, developed and owned by the country. This sets the RRA process and methodology apart from other assessment processes led by international organisations. Although IRENA offers support during the RRA, it is the actions and insights that are developed through a country-owned process that provide the key to rapid deployment.

RRAs facilitate a coordinated approach and the setting of priorities, which can inform discussion with bilateral and multilateral cooperation agencies, financial institutions and the private sector regarding implementation of actions and initiatives emerging out of the RRA. With IRENA's backing, the RRA process offers countries access to a global network with the capacity to follow up on actions and exchange experiences. IRENA can facilitate the implementation of the follow-up actions where necessary after specific request from the country or regional entity.

MOZAMBICAN RRA MISSION

- Introductory meeting with MoE and affiliated institutions.
- Site visit to Pessene for decentralised PV electricity generation for the village school and dwellings.
- Fact-finding interviews with key stakeholders.
- Working sessions to fill RRA templates with employees of MoE and other stakeholders.
- Final workshop with stakeholders to present findings, obtain feedback and to develop a set of actions.

OBJECTIVES

- Assess and review the status and issues of energy & RE in Mozambique
- Approaches for developing institutional structures for RE
- Framework for providing access to RE technology & infrastructure for delivering energy & RE
- Opportunities & barriers for viable business models for RE development

THE RRA METHODOLOGY

The methodology adopted for the country-level RRA has a number of distinct stages, as shown in the RRA methodology chart.

PILOTING THE METHODOLOGY IN MOZAMBIQUE

The pilot study in Mozambique was undertaken to field-test the draft RRA methodology, obtain feedback from key stakeholders on the criteria being used to assess readiness, and further improve the methodology. An extensive literature review was also undertaken of recent relevant studies.

Stakeholder mapping helped identify the key stakeholders in government departments and public sector bodies, financial institutions, research bodies, the private sector and NGOs. These key stakeholders are highlighted in Section II. This research set the stage for a mission to Mozambique to complete the on-ground assessment process.

The mission comprised of the following elements:

- An introductory meeting with the Minister of Energy launched the project and provided knowledge-sharing opportunities with key stakeholders including representatives of the Ministry of Energy (MoE), Power Utility “Electricidade de Moçambique” (EDM), Energy Fund (FUNAE) and key institutions in the energy sector.

- A site visit to Pessene, a village located 40 kilometres from Maputo where very small-scale (“pico”) photovoltaic (PV) systems have been used to electrify a school building and teachers’ accommodation, as well as village dwellings.

- A series of fact-finding interviews with stakeholders from the renewable energy sector.

- Working sessions with senior MoE officials and other stakeholders to fill in RRA templates for different renewable energy resources and services.

- A validating workshop with stakeholderswas held on the final day of the mission, to present findings from the week, elicit further feedback and develop the set of actions needed to be taken to stimulate renewable energy dissemination.

Renewable Readiness Assessment Methodology

1 Scoping

STEP 1A PREPARATORY WORK

- Setting up of an RRA team initiated and led by national government.
- Contextualisation of RRA.
- Identification of key stakeholders, RE projects and programmes.
- Roadmap and timeline for assessment.

STEP 1B PLANNING THE PROCESS

- Identification of appropriate service–resource pairs.
- Preparation of list of interviewees, appointments and tentative questionnaire for bilateral meetings.

2 Assessing

STEP 2A INITIAL PLENARY SESSION

- Introductory session led by a high-level government official (e.g., Minister of RE).
- Discussion on status, potential and barriers to scale up RE.
- Description of how to conduct RRA.
- Refining and selection of key renewables applications.

STEP 2B ASSESSMENT

- Filling out of RRA templates with regards to:
  Policy and strategy;
  Business models;
  Institutional, regulatory and market structure;
  Resources, technologies and infrastructure; and
  Finance, build, operate & maintain.

STEP 2C VALIDATION WORKSHOP

- National workshop to present and validate preliminary findings.

3 Finalising

STEP 3A FINAL REPORT

- Final report writing drawn on preparatory materials, completed RRA templates and list of actions.
- RRA Director comments on and approves work on behalf of the country.

STEP 3B FOLLOW UP ACTIONS

- Working with IRENA.
- RRA Director and government focal point identify areas for subsequent collaboration and action.

OBJECTIVES

This report aims to foster understanding and debate around the renewable energy sector in Mozambique and provide an introduction to the issues facing the country together with a broad summary of the experiences of the energy market and the deployment of renewables. The key objectives for this report are:

- To assess the energy issues facing Mozambique and review the current status of energy policy and regulatory frameworks, and specifically renewable energy policy, at a regional and national level;
- To critically review existing and planned approaches to developing institutional structures for renewables;
- To review the framework for providing access to modern energy services using renewable energy and the status of technology and infrastructure in delivering it;
- To critically assess the opportunities and barriers for developing viable business models for renewable energy projects; and
- To suggest a set of actions to address any identified barriers.

The analysis presented here is intended to put the issues and proposed actions in the context of regional and international experience.

II. Energy Context

REGIONAL ENERGY SECTOR

The SADC region is characterised by fast-growing economies with most averaging GDP growth rate of 5% or more resulting in increasing power demand and consumption. While progress is being made to scale up access to modern energy, the region's average electricity access is about 30% despite abundant energy resources. In 2008, SADC primary energy supply was estimated at around 9 552 PJ (227 978 ktoe) (IEA, 2011). Coal dominated the primary energy mix with a large share of 44%, followed by renewable energy (39%), oil (14%), gas (2%), and nuclear (1%). The 39% share for renewable energy is distributed among traditional biomass (36.66%), primarily used for cooking and heating, hydro (1.95%), and modern biomass (0.39%). Other renewable energy sources such as solar, geothermal, wind and biofuels were negligible (Ibid).

Electricity generation, transmission and distribution are mainly provided by publicly owned, vertically integrated national utilities. Efforts have been made with varying degrees of success in a number of SADC countries to mobilise private sector finance through Independent Power Producers (IPPs). Policies in most countries reflect an aspiration for greater private sector involvement in power generation but efforts are hampered by risk perceptions from investors due to unfavourable legal and regulatory framework for private sector participation (concerns over competition between public and private generation assets) and difficulties in developing well-structured bank-able projects (DBSA, 2010).

Southern African Development Community

SOUTHERN AFRICAN POWER POOL (SAPP)

Set up in 1995 by 12 SADC countries to optimise the use of energy sources available in the region

56.558 GW
Regional installed capacity

49 877 MW
Secured capacity

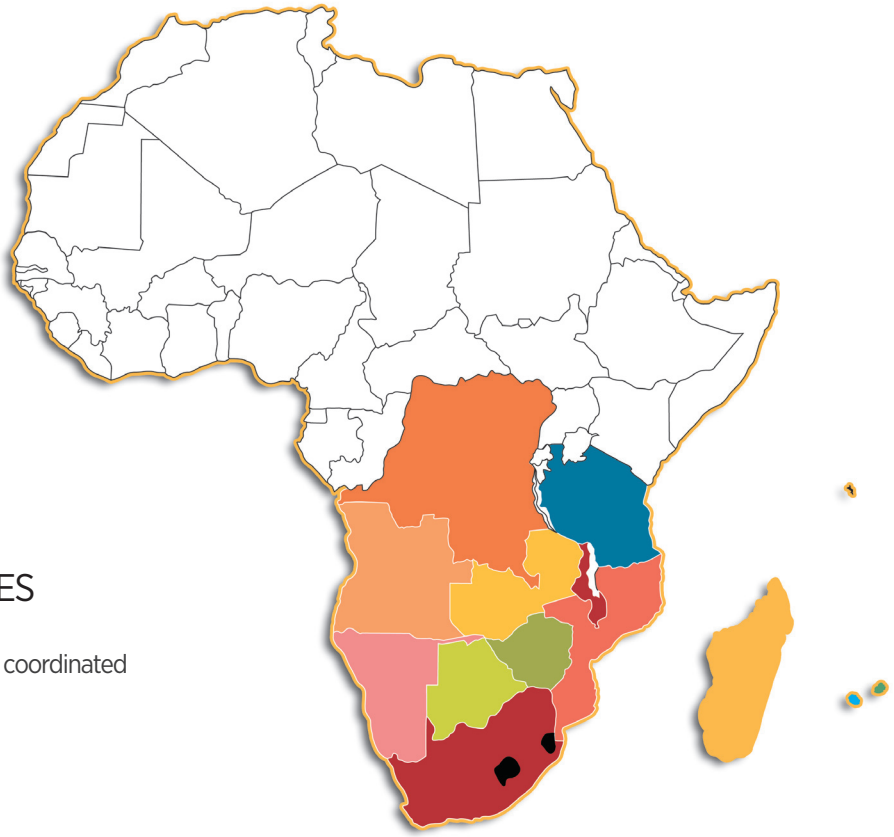
45 436 MW
Demand

1 214 kWh
Per capita electriciy generated

50%
Target set for electricity access

and

34%
RE penetratration by 2020



REGIONAL ENERGY POLICIES ENERGY PROTOCOL

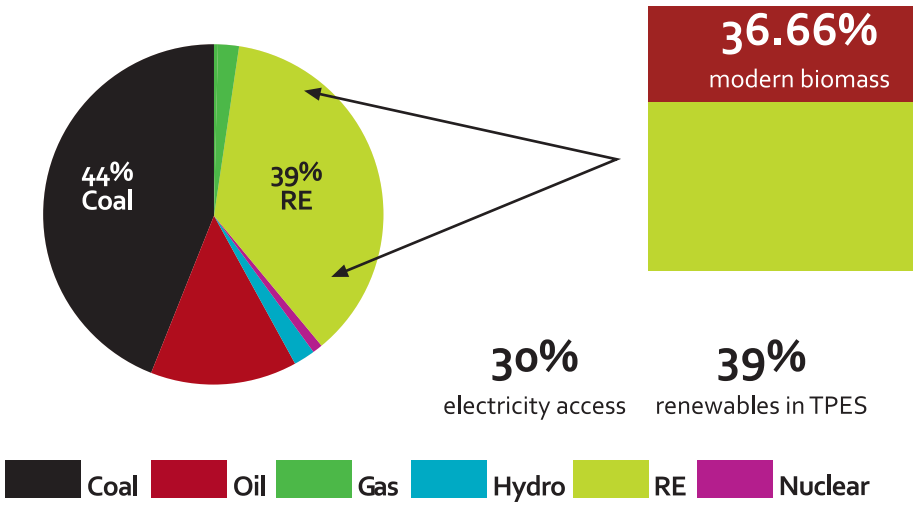
Signed in 1996; recognised the need for a coordinated approach to energy planning in SADC.

Regional Energy Strategy and ActionPlan drafted in 2010 with EUEI support.

RENEWABLE ENERGY STRATEGY AND ACTION PLAN (RESAP)

Under consideration for adoption, it focuses on enhancing integration of renewable energy and EE into present and future energy systems in the region.

Figure 1: Southern African Development Community



In 1995, 12 SADC countries (excluding island states) signed an Inter-Governmental Memorandum of Understanding that led to the creation of the Southern African Power Pool (SAPP) with the aim of creating a common market for electricity that would provide reliable and economical electricity to the consumers in each SAPP member country, optimise the use of available energy resources in the region, and support inter-country cooperation during emergencies. This initiative has been furthered by the 1996 signing of the Regional Energy Protocol, which recognises the need for a coordinated approach to energy strategy formulation and planning for the SADC. As of 2011, SAPP's total installed capacity was 56 558 MW with a secured capacity of 49 877 MW, against a peak demand of 45 436 MW (SAPP, 2012). This installed capacity generates on average 1 214 kWh/capita/year, providing access to about 35% of the region's urban population, although electricity access rates are much lower in rural and peri-urban areas. With a rising power demand estimated at 4% per year, it is estimated that a total additional generating capacity of 52 GW is required by 2025 (SADC, 2010). The SADC region generates about 74% of its electricity from thermal plants (mainly coal), while hydro accounts for only about 20%. The region intends to reduce its energy dependence on coal to about 59% by 2015. Gas and diesel is expected to contribute more than 18% and wind and solar are expected to account for about 2% (SADC, 2011).

SADC has drawn up multiple energy access goals. The strategic goal of energy access to adequate and reliable energy services for the entire SADC region was identified as playing a pivotal role in achieving a regional growth rate of 7% and reducing poverty on a sustainable basis. As a step towards this objective, SADC established an operational goal to reduce the number of SADC inhabitants without access to energy services by 50% by 2020, and halve the number of those remaining without access every five years until the strategic goal of full access is achieved. The 10-year goal to halve the number of people without energy access is indicative of the political will in the region to address energy access. Efforts are on to increase access to energy

Figure 2: Total Primary Energy Supply in Mozambique (IEA 2011a)

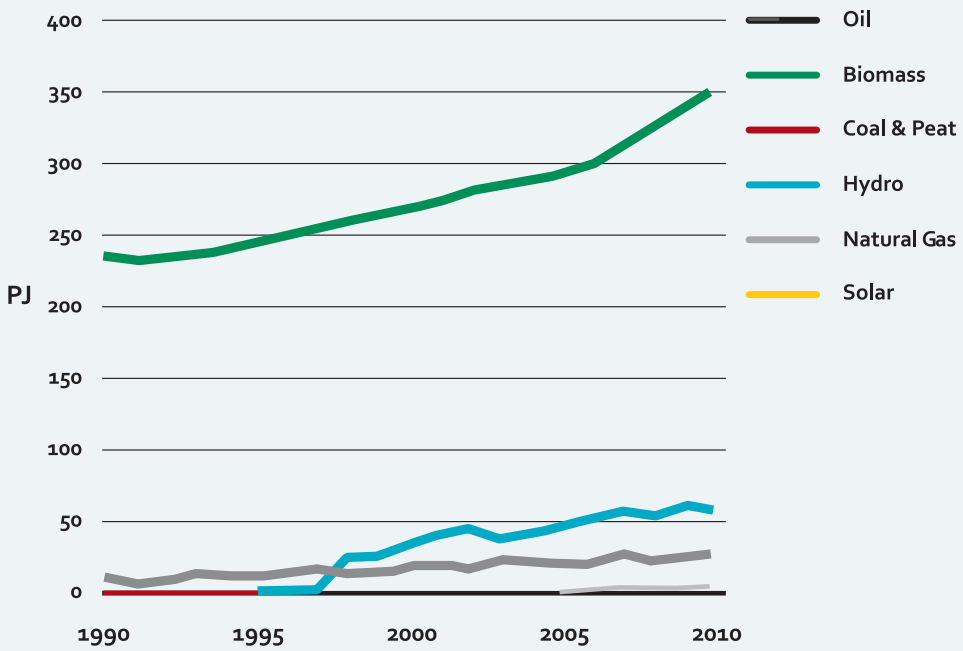
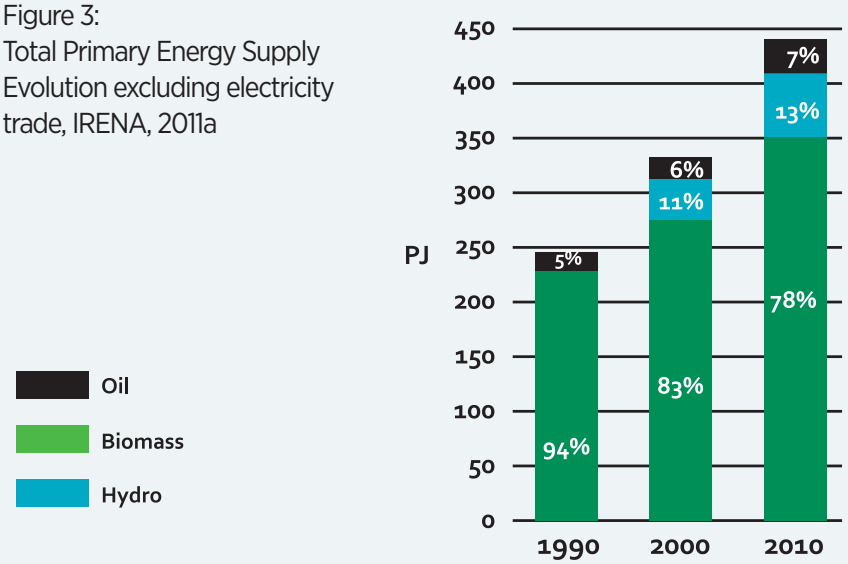


Figure 3:
Total Primary Energy Supply Evolution excluding electricity trade, IRENA, 2011a



focus on the expansion of distribution networks, often implemented by the national utilities, and the use of small-scale distributed generation, often implemented through Rural Electrification Agencies[2] (REAs) or funds.

A Regional Energy Access Strategy and Action Plan was drafted in 2010 with the support of the European Union Energy Initiative (EUEI) and a Renewable Energy Strategy and Actions Plan (RESAP) was being drafted at the time of the RRA.

2 Rural Electrification Agencies or Rural Electrification Funds will be henceforth referred to as REAs.

Table 1: **Types, location and potentials of energy resources**

Resources	Sites	Potential
Coal	Zambezi basin	20 billion tons
Natural Gas	Offshore & On Shore	127 billion m3
Biomass	Countrywide	8.9 million ha
Hydro	Zambezi Valley & other sites	12 000 MW (small Hydro >1 000 MW)
Solar	Countrywide	1.49 million GWh (5.2 kWh/m2/day)
Wind	Coast & Niassa Provinces	Speed 5 m/s(> 6 m/s in some areas)
Geothermal	Tete, Manica & Niassa Provinces	Conservative estimate of 25 MW

RESAP also covers energy efficiency and contributes to the overall goal of SADC member states to utilise and benefit from the significant renewable energy resources that exist in the region.

ENERGY SUPPLY AND DEMAND

The Total Primary Energy Supply (TPES) of Mozambique in 2009 was 408.9 Peta joules (PJ). Biomass meets 78% of the country's energy needs, followed by hydro (13%), oil products (7%) and other resources (2%) (See Figures 2 & 3). The current use of coal and gas is marginal and accounts for about 1% of the TPES and, although Mozambique is a producer of natural gas, most of the production is exported to South Africa. All oil products used are imported and their cost accounts for 15% of the country's imports, making Mozambique vulnerable to increases in the price of oil products.

Mozambique has no significant proven reserves of oil and no domestic upstream or downstream production capacity. Imports are used to meet the domestic demand for refined oil products. Meanwhile, coal reserves are significant with reserves in the Zambezi coal basin estimated at 20 billion

Image 2: Cahora Bassa Dam and Reservoir located on the Zambezi River in Mozambique

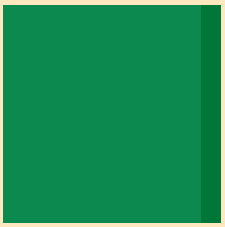
tons (Mozambique Coal Ltd, 2012). Gas reserves and production in Mozambique are substantial and are likely to remain important in the future. As of 2011, proven reserves of gas were estimated at 127 billion m^3, the 51st largest proven reserves in the world and the third-largest reserves in the SADC region. Recent discoveries off the coast of Mozambique by Anadarko Petroleum and EniSpA may increase proven reserves by many times in coming years. This large potential resource has pro-

Figure 4

Mozambique Energy Profile

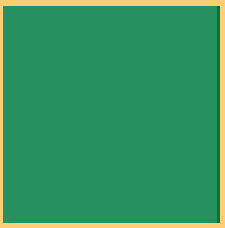
444 PJ
Total Primary Energy Supply

408 PJ
Share of renewables in TPES
(91% of TPES)



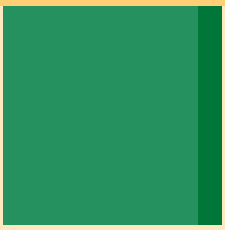
17 TWh
Electricity generation

17 TWh
Share of renewables
(99.9% of total)

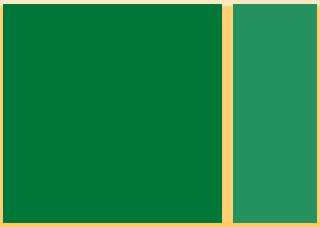


2 428 MW
Installed capacity (2008)

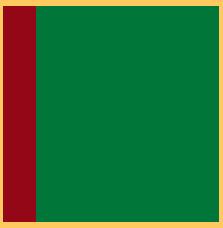
2 179 MW
Share of renewables
(89.7% of total)



122%
Mozambique's energy
Self-sufficiency



USD 581 Million
Mozambique's fuel imports
(15.4% of total imports)



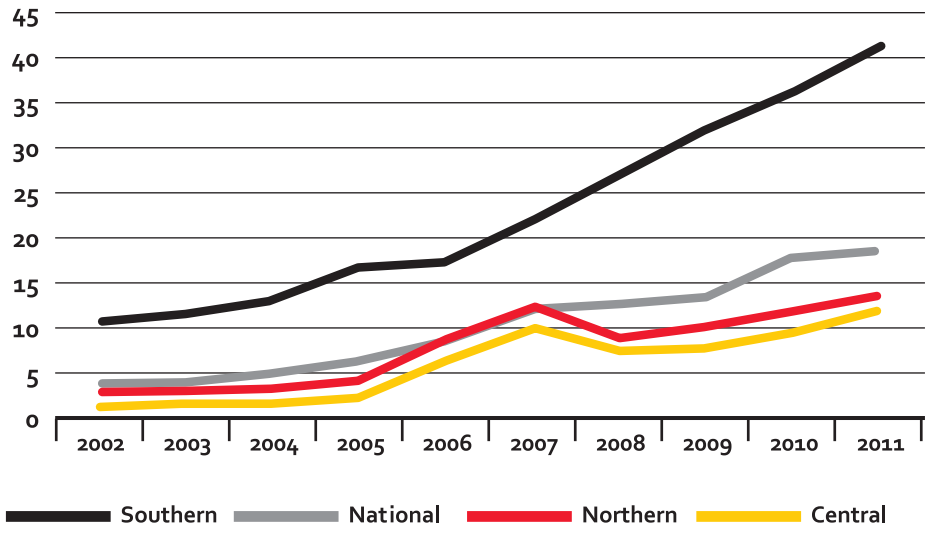
143 kWh
Per capita electricity consumption in Mozambique

579 kWh
Average - Africa

2 825 kWh
Average - world

USD 0.075/KWH
Average electricity tarriffs in Mozambique

Figure 5: Evolution of National Electricity Access through EDM, (EDM, 2011, Figures in percent)



mpted plans for an LNG terminal and considerable investment in infrastructure that may have a dramatic impact on Mozambique's economic future and could lead to the country overtaking Angola as the largest regional natural gas producer. In addition to these fossil fuels reserves, the country has significant potential of all types of renewable energy sources (Table 1).

Levels of access to electricity in Mozambique have increased significantly both on- and off-grid in recent years for the country and the three regions of Mozambique (Figure 3). National access to electricity is estimated for on-grid to be around 18% and off-grid around 11% (EDM, 2011; FUNAE, 2011). However, increasing electrification faces challenges, including the highly dispersed population.

Electricity consumption per capita in Mozambique was 143 kWh in 2011. Per capita electricity consumption is below the average of African countries (579 kWh) high-income countries (9 062 kWh), middle-income countries (1 693 kWh), and the world (2 825 kWh)

Overall electricity tariffs are estimated to be below cost recovery. Average tariffs in Mozambique are reported to be among the lowest in Africa, approximately USD 0.075/kWh. Historic power costs, including both operations and maintenance and capital, are estimated to be around USD 0.08/kWh. Long-run marginal costs[3] are approximately USD 0.06/kWh. In addition, EDM applies a large-scale, well-tracked cross-subsidisation scheme through the implementation of appropriate business units and separated accounts, leading to the application of a uniform tariff structure throughout the country.

Consumers in the remote regions (charac-

3 Long-run marginal cost (LRMC) refers to the cost of providing an additional unit of service or commodity under the assumption that this requires investment in capacity expansion. In this context, the LRMC are the operating and maintenance costs as well as the cost toincrease capacity of an already established hydropower plant.

terised by low customers density and low electricity consumption per capita) are the main beneficiaries from the cross-subsidy scheme, since supply and distribution of electricity is relatively more expensive.

RENEWABLE ENERGY RESOURCES AND POTENTIALS

The total hydro potential in Mozambique is estimated to be approximately 12 000 MW, of which around 1 000 MW is for small-scale hydro projects. In addition to Cahora Bassa operated by HCB, there are currently approximately 109 MW of hydro power plants owned and operated by EDM. Mozambique has been developing a pipeline of more than 4,000 MW - worth of hydro projects, mainly large- and medium-scale to expand generation capacity (see Table 2 below).

Mozambique has a significant and largely untapped solar potential. The potential for solar power is approximately 1.49 million GWh – many times more than the country's current energy consumption. Annual average solar radiation is estimated to be 5.2 kWh/m2/day and varies between 4 and 7 kWh/m^2/day across the country. Solar energy is therefore a potential key resource for off-grid areas. To date, it is estimated that approximately 1.0 MW of PV has been installed, much of it by FUNAE.

Mozambique's wind resource is believed to be considerable with average wind speeds of 6-7 m/s in some areas. A mapping project, under the remit of FUNAE, to better understand wind resources is under way, including the installation of a number of wind speed measurement stations in Ponta de Ouro, Salamanga, Tofinho and Chicumbane.

RENEWABLE RESOURCES IN MOZAMBIQUE

12 GW
Estimated hydropower potential

1.49 MILLION GWH
Solar power potential

6 to 7 m/s
Average wind speeds

78%
Of TPES is from biomass

Table 2: **Hydropower projects in Mozambique**

Project name	Location	Size	Status (as of 2010)
MphandaNikuwa	Tete	1 500 MW	Commercial agreements
CB North Bank	Tete	1 245 MW	Pre-Feasibility
Lupata	Sofala	600 MW	Feasibility
Boroma	Tete	200 MW	Feasibility
Lürio	Cabo Delgado	120 MW	Feasibility
Ruo	Zambezia	100 MW	-
Mavuzi 2&3	Manica	60 MW	Conceptual
Malema	Nampula	60 MW	Pre-Feasibility
Massingir	Gaza	25 MW	Pre-Feasibility

Source: EDM

Image 3 and 4: Mozambique: Solar water pumping; Community solar battery charger

The prospects of geo-thermal energy in Mozambique are high since it shares similar geological formation alongside the East African Rift Valley

Biomass, mainly in the form of wood, charcoal and agricultural wastes, provides over 78% of primary energy in Mozambique although "modern" biomass uses for electricity production or transport fuels are at an early stage. One study claimed that only 6.6% of Mozambique's 63.5 million ha of potential arable land was currently "used" for biofuels (Hankins 2009). Increased allocation of land for the cultivation of biomass and biofuels feedstock is a controversial issue, due to the social and environmental impacts of land use change. The expansion of biofuels production, while technically feasible, will require sensitive handling to avoid adverse outcomes.

KEY ENERGY STAKEHOLDERS

A wide range of stakeholders was identified to participate in the workshops and discussions in order to support the RRA process. The stakeholders were primarily technical staff drawn from government departments and public sector agencies, stakeholders from the private sector, from civil society, development and cooperation agencies as well as financial institutions who participated in the workshops, since they all play an important role in building a renewable energy sector. In addition, bilateral meetings and interviews were conducted with key senior officials of these different institutions. A considerable number of participants were able to give their inputs to the Renewables Readiness Assessment thus building national consensus on renewable energy in the country. A list and description of these institutions follows in Section 2.3.

Key Energy Stakeholders

Council of Ministers

Takes the major decisions related to energy, especially on-grid electricity.

Ministry of Energy (MoE)

- Sets policy objectives approved by the Council of Ministers.
- Is also mandated to regulate the sector and is therefore formed by three technical directorates to help accomplish this task:
- The National Directorate of Electrical Energy is the central technical body within the MoE responsible for the analysis, preparation and elaboration of energy policies, plans and programmes. It also determines environmental issues and promotes the rational use of national energy sources with relevance to the installed capacity by encouraging investment.
- The National Directorate of New and Renewable Energy is in charge of framing policies that will stimulate the use of new and renewable energy sources in the country energy mix.
- The National Directorate of Fuels is in charge of planning oil products needs and regulating the market. It also plays a role, in coordination with other entities, in the preparation, development and management of proposals with regards to forest resources and waste in order to produce energy, while also promoting the development and use of technologies for sustainable charcoal and biofuels production.

Ministry of Agriculture (MINAG)

Responsible for the country's all-important forestry resources.

Ministry for the Coordination of Environmental Affairs (MICOA)

Plays an important role in documenting and monitoring the effects of both the extraction and end use of energy resources.

The Inter-ministerial Committee on Biofuels (CIB)

Created to coordinate policy development issues and research needs as well as overall development potential in the biofuels sector by developing sustainability criteria, development models, legal and fiscal frameworks and project evaluation.

National Fund for Rural Electrification (FUNAE)

Is an autonomous government agency responsible for providing access to modern energy services and implementing off-grid electrification in rural and isolated communities.

Electricidade de Moçambique (EDM)

The state-owned utility responsible for the majority of electricity transmission, generation and distribution.

National Electricity Council (CNELEC)

Has an advisory and arbitration role as it leads consultation on regulatory issues and the performance of EDM.

Mozambican Transmission Company (MOTRACO)

Formed by Eskom, South Africa's power utility, Mozambique's EDM and the Swaziland Electricity Board to supply electricity from South Africa to Swaziland and Maputo.

Cahora Bassa Hydroelectric Company (HCB)

Is the privately owned (85 % Mozambique and 15% Portugal) company responsible for operating the Cahora Bassa dam.

Petróleos de Moçambique (PETROMOC)

The state-owned liquid fuels company responsible for the purchasing, transport and distribution of petroleum products, thereby holding half of the country's market.

University of Eduard Mondlane (UEM)

Has a renewable energy programme under the Faculty of Science, the focal point being several academics. UEM has also played an impressive role in studying renewable energy resources and training a small cadre of professionals and technicians.

National Research Fund (FNI)

Is an institution set up to finance innovative research in the field of science and technology (i.e. alternative energy sources to firewood) from government levies, with credit from the World Bank for strategic areas and donors (Finland and Sweden) for innovative research.

Centro de Promoção de Investimentos or Investment Promotion Centre (CPI)

Offers a package of services to assist national and foreign investors in facilitating access to the incentives offered by the government for establishment of their businesses.

Associação Moçambicana dos Operadores de Microfinanças (AMOMIF)

Is an umbrella organisation of insititutions operating in the microfinance sector that are licensed by the Bank of Mozambique in credit operations and other financial services.

Instituto Nacional de Normalização e Qualidade (INNOQ)

Is responsible for standards, quality control and certification systems, including some soon-to-be introduced biofuel standards.

Confederation of Business Associations (CTA)

Aims to contribute to a business environment conducive to private sector development and a strong associative movement that is participatory, socially responsible and able to influence economic policies promoting economic competitiveness and quality business.

Donors, NGOs, international cooperation and development organisations

- These include the World Bank, UNIDO, the Belgian Technical Cooperation (BTC), German International Cooperation (GIZ), Netherlands Development Organization (SNV), the Finnish, Swedish, Danish and Norwegian embassies.
- All play an important role in either providing credit and loans, grants and technical cooperation to improve clean energy access.

POLICY & REGULATORY FRAMEWORK

Mozambique's first major act of reform was to begin the corporatisation of EDM. In 1995, Decree 28/95 of 17 July defined the role of EDM and established its bylaws. As a commercial entity regulated by the law for state-owned companies (Law 17/91) with autonomy over its assets, administration and finances, EDM was given a degree of independence from the MoE (Ministry of Energy/ERAP Mozambique, 2011). In 1997, Mozambique further reformed the electricity market by adopting the Electricity Law (Law 21/97, 1 October), which was introduced with the aim of regulating the production, transmission, distribution and commercialisation of electricity. This law also established the principle that each activity should be carried out through concessions and created the advisory body CNELEC, acting as the regulator, as well as Energy Fund (FUNAE), for the promotion of rural electrification through renewables.

In theory, the Electricity Law opened up all areas of electricity production, distribution and sale to private operators through concession contracts, issued under the responsibility of the MoE. However, similar to the experience of many African countries, so far there has been little involvement of private sector operators. Following the Electricity Law, a number of supporting decrees have subsequently defined the roles of CNELEC (Decree 25/2000, of 3 October); awarded the concession for the operation of the transmission network to EDM (Decree 43/2005, of 29 November); and established the methodology by which tariffs are set (Decree 42/2005, of 29 November).

The National Energy Policy adopted in 1998 (Decree 5/98, of 3 March, 1998) sets the intended direction for the development of energy in Mozambique. To implement this policy, the National Energy Sector Strategy was established by Decree 24/2000 (3 October, 2000) and was revised in 2009 to reflect changing priorities and actions.

In 2009, the Policy on the Development of New and Renewable Energy (Resolution 62/2009, 14 October) was launched to promote greater access to clean energy services through the use of equitable, efficient, sustainable and culturally sensitive sources of new and renewable energies. In 2011, the Strategy for New and Renewable Energy Development (EDENR) 2011-2025 was adopted with the aim of

ENERGY PLANNING IN MOZAMBIQUE

- 1995: Corporitisation of EDM (Decree 28/95, 17July).
- 1997: Electricity Law (Law 21/97, 1 October) adopted; CNELEC and FUNAE created.
- 1998: National Energy Policy (decree 5/98, of 3 March 1998) adopted.
- 2000: National Energy Sector Strategy(decree 24/2000, 3 October 2000) established to implement National Energy Policy; revised in 2009 to reflect the changing priorities and actions.
- 2009: Policy on the Development of New and Renewable Energy (resolution 62/2009, 14 October) launched.
- 2009: National Policy and Strategy for Biofuels approved and formed the basis for the National Programme for Development of Biofuels (PNDB), the implementing programme of the Inter-ministerial Committee on Biofuels (CIB).
- 2011: Strategy for New and Renewable Energy Development 2011-2025 (EDENR) adopted.

THE ELECTRICITY LAW

Law 21/97, 1 October 1997

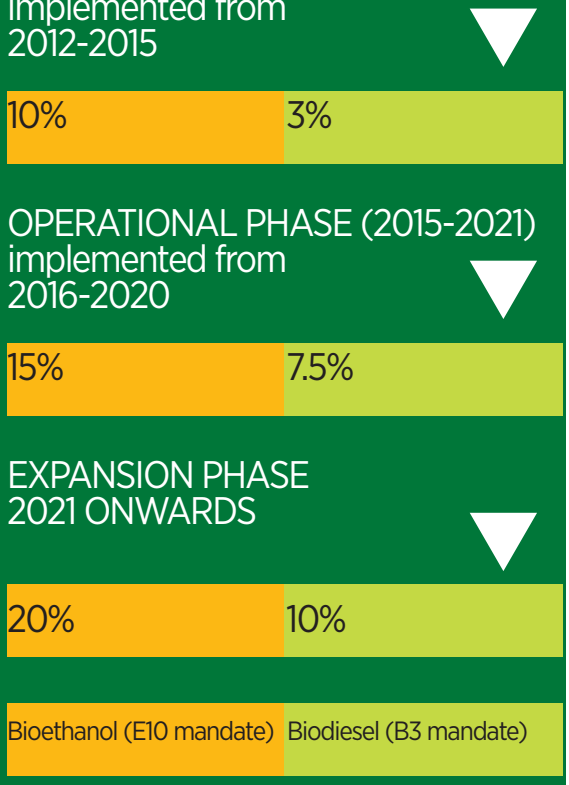
regulates the production, transmission, distribution and commercialisation of electricity in Mozambique.

SUPPORTING DECREES:

Decree 25/2000, 3 October – defined the role of CNELEC.

Decree 43/2005, 29 November – concession for the operation of the transmission network to EDM.

NATIONAL POLICY AND STRATEGY FOR BIOFUELS
fuel blending mandate



developing national renewable resources for generating electric power, ensuring that demand can be met, diversifying the energy mix, and preserving the environment. This is to be accomplished using both off-grid and on-grid applications. The off-grid component is linked to the PARPA II/III, which considers access to electricity as a catalyst for poverty alleviation and economic development in rural Mozambique.

In 2009, the National Policy and Strategy for Biofuels, which sets out the high priority of the biofuel resource in Mozambique's economic and energy policy and its contribution to energy security and economic development, was approved. This strategy is the basis of the National Programme for the Development of Biofuels (PNDB), which is the implementing programme of the Inter-ministerial Committee on Biofuels (CIB). The objectives of the policy are firstly, to promote and use agro-energy resources for energy and food security; secondly, to encourage socio-economic development (multiplier effect, synergies and byproducts); and thirdly, to address the instability, unpredictability and volatility of fossil fuel prices in the international market as well as to reduce the country's dependence on fuel imports and the burden of their import on the national economy. The National Policy and Strategy for Biofuels will be implemented in three phases. The pilot phase (2012-2015) is currently being implemented with a fuel blending mandate of 10% for bioethanol and 3% for biodiesel. An operational phase (2016 to 2020) will follow, with 15% bioethanol and 7.5% biodiesel blending and conclude with an expansion phase (2021-onwards) of 20% bioethanol and 10% biodiesel blending. This will progressively increase the proportion of biofuel in Mozambique's domestic liquid fuel mix.

FINANCING AND INVESTMENT

In Mozambique, the Investment Law (Law 3/93) seeks to promote investment by establishing a uniform framework for investments and providing tax incentives for investors. More precisely the Code of Fiscal Benefits (Law 4/2009) provides fiscal benefits such as exemptions and reductions on value added taxes (VAT), investment tax credits, corporate income, and tax deduction to attract investors. The Investment Promotion Centre (CPI) is responsible for implementing the Investment Law, although government approval is needed before any investment project is taken up.

At the national level, banks are not generally acquainted with the specifics related to renewable energy projects, resulting in high risks perception and extreme caution in granting credit. However, the capacity of project developers in presenting fully commercial and bankable renewable energy projects needs to be enhanced as well. Also, the general financing tenors of 5 to 7 years generally do not match the requirements for renewable energy projects of 10 to 15 years or more. Therefore, concessional and development aid funding still plays a dominant role in financing renewables in Mozambique. There is a need to build capacity on project development side but also on the financial institution side.

With regard to off-grid rural electrification, the combination of internal financial resources from taxes and levies on electrical energy concessions; taxes related to exploration, commercial licences, distribution and transmission of petroleum products; taxes on large electricity consumers; donor funding (World Bank-GEF, NORAD, and others); and budgetary allocations from government; constitute the source of revenue used by FUNAE to implement its rural electrification mandate.

FINANCING AND INVESTMENT

Investment Law (Law 3/93) –
To promote investment and provide tax incentives.

Code of Fiscal Benefits (Law 4/2009)
For provision of fiscal benefits.

Investment Promotion Centre (CPI).

FUNAE gets its funding from various internal and external sources.

Community Sustainable Energy Plans (PCESs).

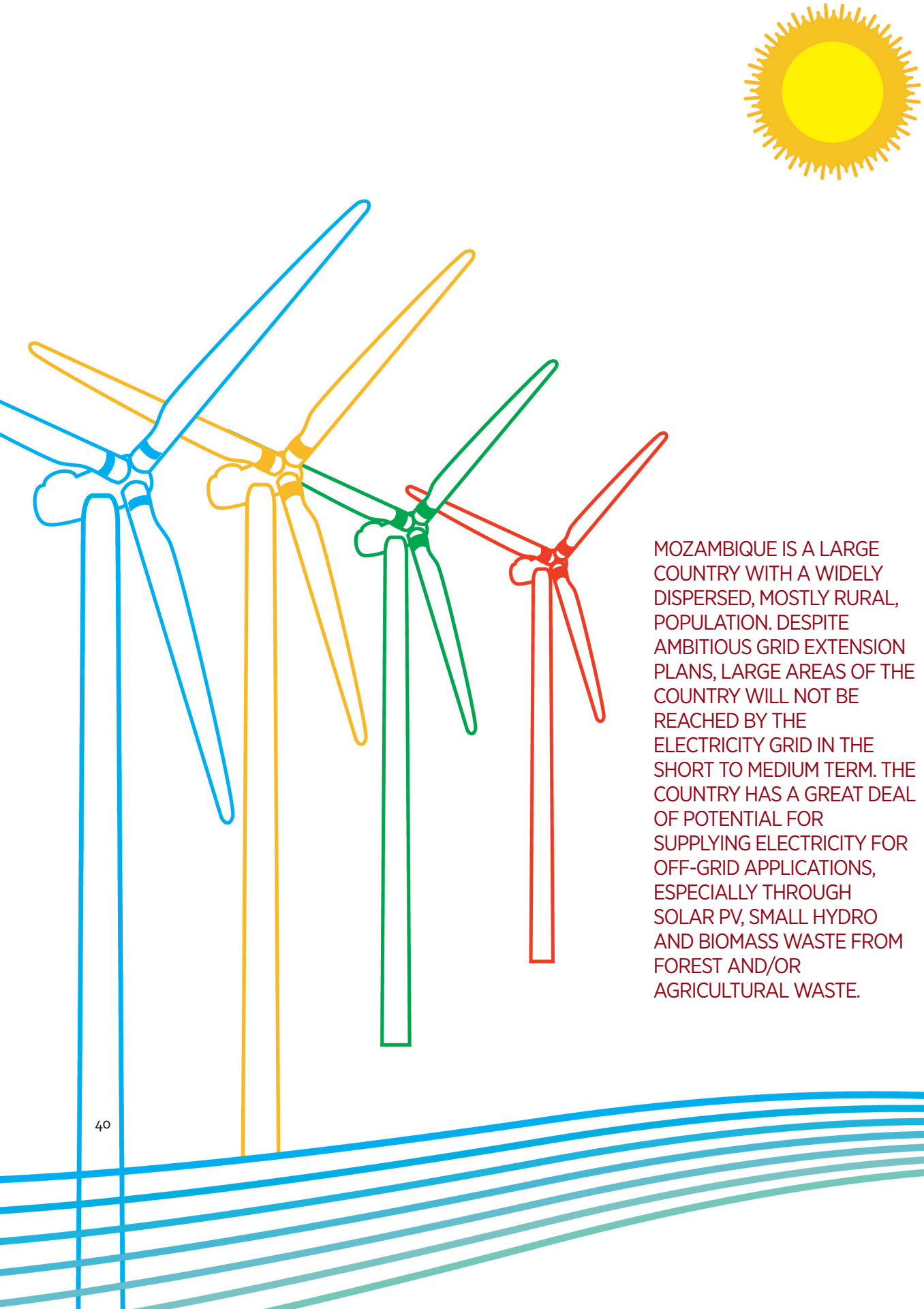
At the local level, Community Sustainable Energy Plans (PCES) are part of the effort to improve interaction between the state and civil society and to lay the groundwork for district-based development planning, including the allocation of financial resources directly to the district level to support local plans for the implementation of specific renewable energy projects. The PCES planning process is intended to identify particular projects, the actors needed to take them forward, and sources of implementation funding.

Micro-finance institutions (MFIs) have become very active in Mozambique ever since the government took steps to remove barriers to their establishment. Currently, only about 20% of the population have access to formal and informal finances. MFIs in Mozambique are under the umbrella of AMOMIF (Associacao Mocam-

Image 5: Wind Blade Manufacturing, Pemba
Source: www.renewable-world.org

bicana Dos Operadores de Microfinancias), established in 2007 to act as the main interface between MFIs and the Central Bank of Mozambique (regulator). AMOMIF is also involved in the Financing Mozambique portal, a public service project developed by Swiss Capital Partners and Financial (two consulting companies with extensive financial experience in Mozambique). The portal aims to bridge the gap between projects and available funding by facilitating local entrepreneurs' access to information regarding alternative sources of funding and by providing advice regarding drafting documents and business plans.

Finally, certain areas of the country have been designated as special economic zones under the regulation of the Investment Law (decree 43/2009) due to their favourable economic conditions. This, along with the presence of MFIs, could provide a useful testing bed for renewables-based electricity projects to be developed on a commercial basis.



MOZAMBIQUE IS A LARGE COUNTRY WITH A WIDELY DISPERSED, MOSTLY RURAL, POPULATION. DESPITE AMBITIOUS GRID EXTENSION PLANS, LARGE AREAS OF THE COUNTRY WILL NOT BE REACHED BY THE ELECTRICITY GRID IN THE SHORT TO MEDIUM TERM. THE COUNTRY HAS A GREAT DEAL OF POTENTIAL FOR SUPPLYING ELECTRICITY FOR OFF-GRID APPLICATIONS, ESPECIALLY THROUGH SOLAR PV, SMALL HYDRO AND BIOMASS WASTE FROM FOREST AND/OR AGRICULTURAL WASTE.

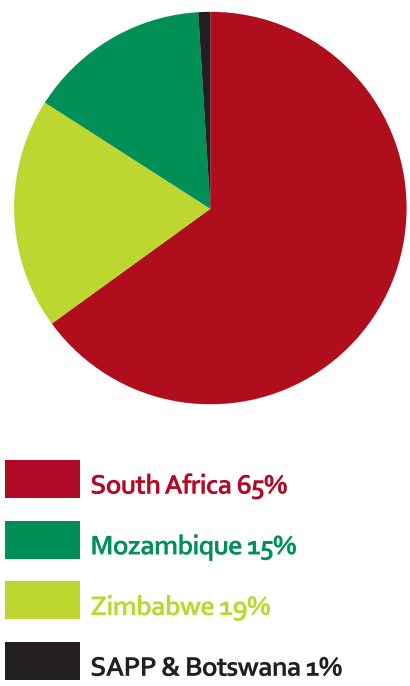
IV. Market Development by Sector

A. ON-GRID ELECTRICITY

The largest generator in Mozambique is the hydroelectric plant run by Hidroelectrica de Cahora Bassa (HCB), which is an IPP. HCB has two shareholders, the governments of Mozambique (85%) and Portugal (15%). However, Mozambique's EDM receives only a small share (15%) of HCB's total 2 075 MW output, and this provides 90% of the electricity supplied to the country's grid. Power from HCB is not connected directly to the south of the country but instead is exported to South Africa. The electricity used in Maputo and Matola actually comes from the combined generation of South Africa (primarily coal) and Mozambique (hydro and thermal).

Power generated from HCB is therefore distributed as follows: South Africa (ESKOM), 65%; Zimbabwe (ZESA), 19%; Southern African Power Pool (SAPP) and Botswana (BPC), less than 1% (HCB, 2012). EDM's existing installed capacity is approximately 240 MW of which 109 MW comes from hydro (81 MW of which is currently available and supplied to the grid). Grid losses are estimated at 5% for transmission and 20% for distribution (EDM, 2011). On the generation side, many of the country's power plants and related infrastructure are beyond their economic life-time. Planned expansion of the internal transmission infrastructure could reduce imports and exports. As an electricity exporter, Mozambique consumes less electricity than it produces. Overall, total production is equal to approximately 140% of domestic consumption.

Figure 6: Electricity generated from HCB



The EDM transmission system comprises three regions (see image 1):

- The northern region with a 220 kV transmission system covering about 1 000 km from the Songo substation to Nampula and continuing at 110 kV to the town of Nacala. A separate 220 kV (operated at 110 kV) system extends from Tete to link with the central region at Chibata.
- The central region has a 110 kV system linking the hydroelectric power stations of Chicamba and Mavuzi with the load centres within the Beira–Manica corridor.
- The southern region comprises a 110 kV network extending from Maputo to Xai-Xai, Chokwe and Inhambane, together with a 275 km single circuit line from Maputo to the ESKOM system at Komatipoort in South Africa.

In an effort to facilitate private sector involvement in electricity generation, transmission and distribution, the proposed revision of the Electricity Law will require project developers to apply for concessions through public tender. Before a tender is issued, full specifications are drawn up against which projects compete. This process limits speculative project development, effectively giving the responsibility for the development of project specifications to EDM (Ministry of Energy/ ERAP Mozam-bique, 2011). As a result of this process, a number of projects have been identified for possible private sector involvement.

KEY FINDINGS AND RECOMMENDATIONS

The issue of ensuring that targets are specified in policy and strategy documents was raised during the RRA. Targets would need to be specified, not just in terms of capacity, but also in terms of the contribution of different forms of renewable energy to the electricity mix. Strategy documents currently lack the estimated cost of implementation and, in some cases, clear assignment of responsibility for delivery. The current proposal for the reform of the Electricity Law is seen as an opportunity to clarify the roles of institutional stakeholders and expand the scope of Independent Power Producers beyond Cahora Bassa Electric Company.

The role of the regulator is still under discussion in Mozambique. Technically, CNELEC is an advisory body and regul-

atory authority rests with the MoE. However, CNELEC is still referred to as "the regulator", perhaps highlighting the ambiguity around the organisation's mandate, or an indication of differing opinions on its preferred future role. Electricity reform should therefore clearly redefine the role of CNELEC as an independent institution with secure financial funding in order to allow it to undertake some of the responsibilities currently resting with the MoE.

ON-GRID HYDRO

EDM has a long-term strategy for exploiting large hydro opportunities and has identified transmission infrastructure gaps that need to be addressed. It has also identified bilateral and multi-lateral funding for its hydro projects. The planned CESUL centre-south interconnection will enable the development of further large hydro projects. Furthermore, since Mozambique has a good track record of operating a network with a large hydro project (HCB), this experience would be useful in attracting further investment from the private sector.

The grid extension being carried out by EDM up to the district level provides an opportunity to link in and promote distributed on-grid generation through the development of small hydro projects. There are a number of sites for small hydro projects which would require only 5-10 km of grid extension to allow them to feed power into the grid. These sites could be prioritised for development in EDM's master plan for grid extension. The development of this plan for new generation and grid extension should therefore take the hydro potential into account and plan for grid connections for these sources.

An additional motivation for developing distributed small hydro projects is the fact that there is good technical experience in the hydro power sector in Mozambique and entry of private sector could be facilitated by formulating an attractive tariff as compared to the average tariff for large hydro. However, small hydro projects (5-25 MW) near load centres should be prioritised to take advantage of the grid extension and efforts should be made to mobilise funds to support the development. There is international experience for formulating feed-in tariffs that Mozambique could benefit from. This situation lends itself to the formulation of an attractive feed-in tariff to promote small hydro, which could reflect the positive impact of reduced transmission losses, and so allow for more attractive returns on investment for IPPs. A higher and more attractive tariff for small hydro, compared to the average tariff for large hydro, would be offset by the reduction in grid losses if the development of small hydro projects near load centres were prioritised. There is international experience for formulating feed-in tariffs that Mozambique could benefit from.

Mozambique does not currently have a Grid Code, although the MoE is looking into

ELECTRICIDADE DE MOÇAMBIQUE

240 MW
Total installed capacity

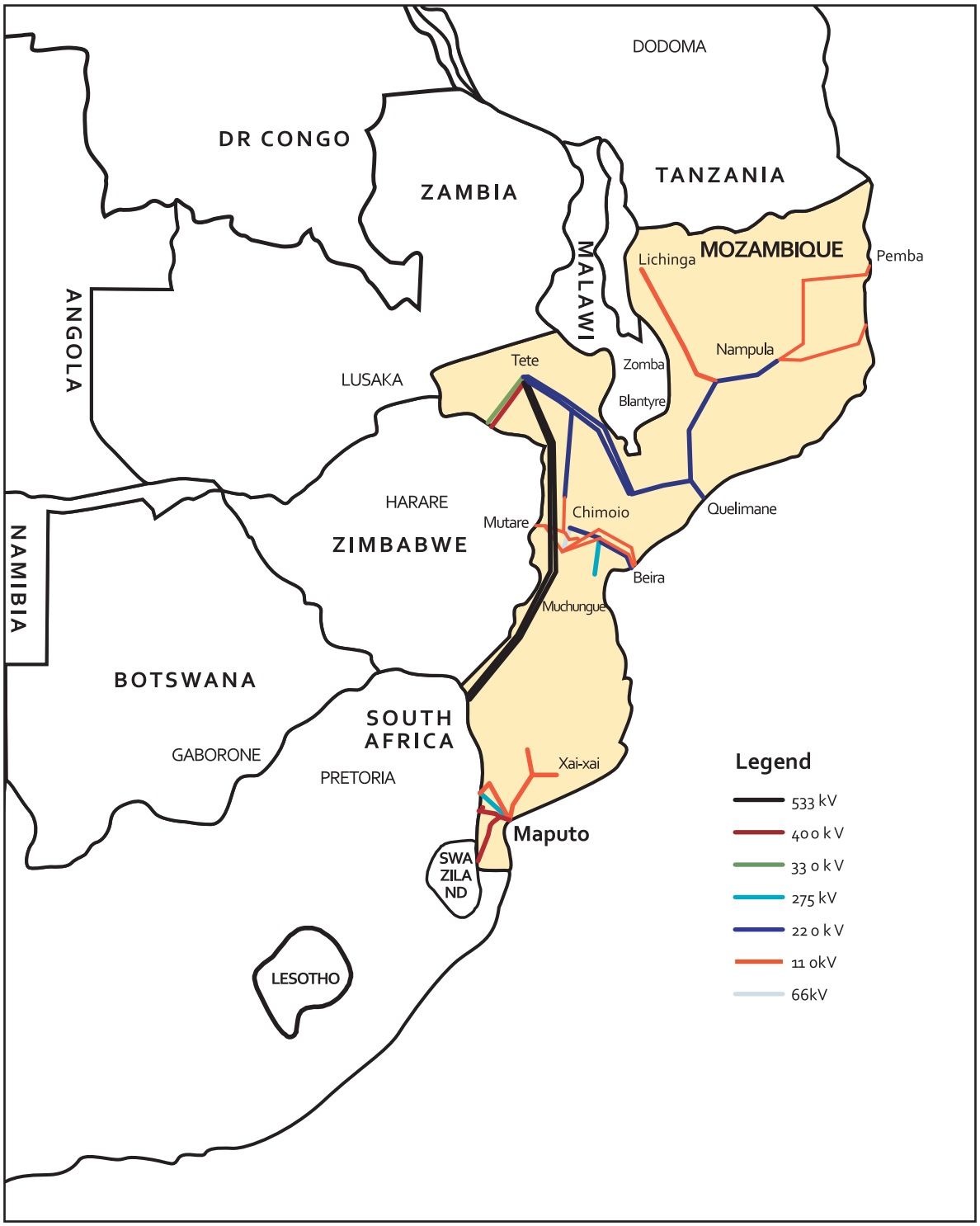
109 MW
From hydropower

5%
Grid loss (transmission)

20%
Grid loss (distibution)

Figure 8

Mozambique Electricity Grid.



Source: EDM

There is a need to share knowledge and experience from other countries regarding best practices, knowledge and know-how. This will build capacity and links with other international institutions/centres of excellence in the field of small hydro.

the possibility of introducing one and tenets of the Electricity Law should give impetus to its formulation and implementation. The Grid Code needs to be designed to permit the development, maintenance and operation of an efficient and coordinated system for the transmission of electricity, and to facilitate competition in the generation and supply of electricity. However, the Code also needs to allow real-time injection of variable power from wind and other renewable energy sources, while ensuring the stability of the power system as a whole.

The increase in distributed generation from small hydro IPPs also needs to be considered. The Grid Code must deal with the management of power quality and stability issues arising from injections of power across the network. An obligation should also be placed on the grid to allow access to generation from IPPs.

As a precursor to fully private sector projects, EDM could take a small equity stake in small hydro projects in order to make them more bankable by reinforcing the credibility of its long-term power purchase agreements (PPA). Incentives could be used to encourage the transfer of the technical expertise available within EDM into separate commercial ventures to develop small hydro projects. New graduates from universities could also be attracted to these ventures. This could help to form the next generation of IPPs.

The Ministry could also work with the donor group to develop a partial risk guarantee fund with financial institutions in Mozambique in order to promote lending to small hydro projects.

Finally, there is a need to share knowledge and experience from other countries regarding best practices, knowledge and know-how. This will build capacity and links with other international institutions/centres of excellence in the field of small hydro.

ON-GRID WIND

Wind power in Mozambique is in an early stage of development. A 300 kW single turbine had been installed at Praia, Inhambane, and was expected to generate experience and data on the operation of wind turbines as well as grid integration.

Mozambique is considered to have a good wind resource with average wind speeds of 6-7 m/s in some areas. To better evaluate these resources, FUNAE is conducting a mapping project, which includes the installation of a number of wind speed measurement stations in Ponta de Ouro, Salamanga, Tofinho and Chicumbaneto produce a wind atlas. This resource mapping exercise should be used to further refine the estimates of generation costs and to inform the policies for the promotion of wind power.

The cost of generation from wind turbines is likely to be higher than alternatives including hydro. However, geographical and infrastructural factors may increase the value of locally generated electricity. The

proposed feed-in tariffs will help provide clarity to developers and incentivise projects. They should take into account the costs of generation from wind, return on investment and the impact on electricity prices.

Presently, EDM is only partially involved with the pilot wind project. If future projects have to be implemented through IPPs, the PPAs would need to be designed to reflect the non-dispatchable nature of wind power. Steps should therefore be taken to involve EDM more extensively so that learning from the pilot projects can be embedded in future strategies.

The possibility of funding through carbon finance mechanisms[4] should also be evaluated to understand other sources of project revenue and to improve the bankability of projects.

B. OFF-GRID APPLICATION DECENTRALISED ELECTRIFICATION

Mozambique is a large country with a widely dispersed, mostly rural, population. Despite ambitious grid extension plans, large areas of the country will not be reached by the electricity grid in the short- to medium-term. The country has a great deal of potential for supplying electricity for off-grid applications, especially through solar PV, small hydro and biomass waste from forest and/or agricultural waste. The scale of these off-grid systems range from pico-scale lighting systems for individual buildings to more substantial systems for clinics, schools, or community-level mini-grids incorporating productive facilities.

FUNAE has the main responsibility for delivering the rural electrification strategy. Although FUNAE was originally set up to finance projects, it has moved increasingly into project management. FUNAE is now involved in identifying and tendering for projects, and in some cases providing operation and maintenance in order to get projects in rural areas off the ground. While FUNAE is currently the main player, there is a strong political ambition to create opportunities for the private sector to provide these rural energy services, so that they are based on a more sustainable business model.

Rural energy applications are part of the country's poverty reduction action plan (PARP) and the national development agenda known as Agenda 2025 and they therefore require strong coordination and commitment across several government agencies.

The policy framework under which FUNAE operates allows it to implement a social programme alongside its market-based projects. The social programme focuses on the provision of renewable energy to targeted communities. It is a well-funded programme implemented with funds from different sources, with international donors including the World Bank and a selected number of European countries providing about 60% of the funding and Mozambique's government about 40%. FUNAE has some mini-hydro and wind energy projects, but rural electrification in Mozambique is being accomplished mainly through solar PV systems.

Since Mozambique's rural population is highly dispersed, the majority of the PV systems installed by FUNAE are dec-

4 Carbon financing is now possible for countries like Mozambique, with high hydro potential but low emission factor.This is due to the fact that the SAPP regional Emission factor has been approved by the CDM Executive Board.

SOLAR PV

>1 MW
estimated off-grid PV installations through FUNAE

5 MWP
Estimated production capacity of planned PV module manufacturing facility in Maputo

Image 6: Mozambique rural village shop solar panel inside Limpopo National Transfrontier Park
Source: www.fredhoogervorst.com

entralised mini-grids. When selecting locations for PV systems, priority is given to health centres and schools, as well as water pumping systems to provide potable water for community and agricultural purposes. Public buildings, police stations and households are also included in these rural electrification projects.

Mozambique's success in these projects is partly due to the involvement of the local communities from a very early stage. The creation of "Management Committees" has played a special role in this process. These committees, made up of representatives from the communities and the local authorities, guarantee the maintenance and good performance of the systems, collect the monthly fees for the energy services, and protect the panels against theft and damage.

FUNAE is also looking into the possibilities of micro-financing for poor rural communities. This market-based programme involves the promotion of off-grid energy technologies through training, marketing and other promotional activities. The programme is intended to create favourable conditions for the deployment of off-grid renewable energy technologies and uses business loans to finance actual projects, although the loan may be provided by central government and cooperation partners, as well as by commercial sources. To date, however, there have not been significant numbers of commercial rural electrification projects. The implementation of the well-funded programme-based social approach, which has provided very low-cost electricity or equipment, may have created an expectation that the nominal fees charged were "fair" and that higher costs through alternative (market-based) schemes were therefore "unfair". This may lead to some communities refusing to engage with market-based initiatives, preferring to wait for the availability of programme-based services. It remains to be seen whether both approaches can coexist effectively.

It is estimated that more than 1.0 MW of PV capacity has been installed in the solar PV sector, mainly through FUNAE, in remote sites around the country. PV prices remain very high in Mozambique due to the fact that there is no tax exemption or reduced

duty for solar equipment. Consequently, active commercial markets have not yet developed and there is relatively little private sector activity. FUNAE is planning to build a PV module manufacturing plant in Maputo province with a production capacity of 5 MWp per year and modules ranging from 1.0 to 150 Wp.

Despite ample resources and a large number of potential sites, Mozambique has completed only a handful of small and micro hydro projects. Focusing on the sector and laying down clear guidelines for allocating capacities can lead to increasing the deployment of small and micro hydro projects. The government is now establishing a simplified process by which investors can obtain exclusive rights to develop concessions less than 15 MW in which FUNAE plays a role.

It is also worth noting that international companies have featured in the deployment of solar energy projects in Mozambique. UK-based company Fortune CP is reported to have won a contract for supervision of the supply and installation of solar PV systems in Namula, Cabo Delgado and Niassa. The German company Phaesun is also reported to be leading a consortium for the supply and installation of solar PV for households, small business enterprises and public institutions.

The use of biomass for decentralised electricity generation is far less widespread than other technologies. Although bagasse is used for electricity production by five sugar companies, with an installed capacity of 60 MW, this electricity is generated for captive use and could potentially feed into the grid. A grid in-feed mechanism will incentivise producers to invest in more efficient technology.

650
Solar refrigerators currently installed in health centres

100 000
Solar water heaters (2025 target as per EDENR)

5 000
Solar refrigerators (2025 target as per EDENR)

THERMAL AND MOTIVE APPLICATIONS

The EDENR strategy includes a number of specific targets for thermal technologies, such as the installation of 100 000 solar water heaters and 5 000 solar refrigerators over the lifetime of the strategy, which runs to 2025. To date, approximately 650 solar fridges have been installed in health centres across Mozambique. The use of renewable energy for thermal applications is still at an early stage. To support the development of thermal technologies FUNAE has commissioned a resource mapping exercise and is working with the MoE to develop plans for a number of solar thermal demonstration projects.

FUNAE has not yet implemented a large-scale programme using renewable energy to provide direct motive power. However, some experience has been developed and windmills for water pumping have been installed in Gaza and Inhambane provinces (FUNAE, 2011). The low speed, operation, simple construction and designs for motive power have changed little over the last hundred years, meaning that local manufacture is a plausible option for many technologies. Capacity-building to provide access to standard equipment designs is an area that could be explored.

KEY FINDINGS AND RECOMMENDATIONS FOR OFF-GRID APPLICATIONS

During the RRA process, the lack of detailed regulation for the rural electrification sector was cited as a gap that required addressing. The institutional structures and responsibilities for operation are broadly understood in practice, but are not clearly defined in policies and strategies. In some cases there may be some conflict. In particular, the coordination between FUNAE and EDM over rural electrification may benefit from clarification. Mozambique currently employs a system in which FUNAE is the sole body identifying projects, although in practice spontaneous project proposals are accepted.

Potential conflict also exists between FUNAE's "market-based" and "programme-based" approaches. Where well-funded programme-based approaches have provided very low-cost electricity or equipment, the expectation has been created that the nominal fees charged were "fair" and that higher costs through alternative (market-based) schemes were therefore "unfair". This may lead to some communities refusing to engage with market-based initiatives, preferring to wait for the availability of programme-based services. This conflict may also lead to allegations of favouritism in deciding where to target programme-funded schemes.

FUNAE has a successful record of implementing off-grid projects, and it is expected that in the short term continued financial resources will be available to continue this work. In the longer term, FUNAE's ability to deliver rural electrification on a much larger scale will be limited by human and financial resources. A strategic approach that will create an institutional structure which can effectively engage with and promote the role of the private sector is a prerequisite for FUNAE to expand its operations.

FUNAE could also consider proactively supporting a business-led approach whereby private equipment suppliers and distributors can enter the market in partnership with micro-finance institutions, where appropriate. Enabling independent generators or "electricity as a service" enterprises to operate would also require the laying down of appropriate regulations and building the capacity of the regulator or decentralised set-up to simplify the process for tariff-setting and similar functions.

Existing plans to establish local assembly of solar modules is a positive development, which could help Mozambique, develop as a supplier to its regional neighbours. This would also provide economies of scale and help bring costs down. Efforts need to focus on enabling the private sector to catalyse local demand for their products and establish supply chains for replacements and spare parts. This would enable locally produced plant to compete better against cheaper imports.

Where available business models are not financially viable, there are a range of mechanisms that can be employed to improve project economics. For example, concessions have been used whereby a single entity is given temporary geographical exclusivity for a region following a competitive tender. This approach can help reduce the cost of sales and aggregate demand.

Agricultural residues could provide a low-cost fuel for power generation in rural areas and the RRA process identified some key

areas where biomass could play a role in off-grid electricity generation. Potential biomass sources include bagasse, coconut waste, cashew waste and municipal waste. A biomass strategy is being developed to support further development of this resource and should be ready shortly. Another important issue that emerged during the RRA process was the need for specific regulation and standards for thermal systems. It was suggested that further consultation should be pursued with a number of bodies to support a framework for the development of renewable energy technologies for thermal applications. These bodies include the Ministries of Energy, Public Works and Housing as well as local administrations; FUNAE; the Technical Council of Energy (CTA), a lobby for policy reform and a mechanism for public-private dialogue; CPI (in charge of investment promotion in Mozambique); UEM (Eduardo Mondlane University); and international partners.

C. BIOFUELS FOR TRANSPORT

Mozambique began investigating the potential of biofuels about a decade ago. Since there is no domestic capacity for refining petroleum products and almost all fuels have to be imported, the government encouraged farmers to grow energy crops in order to promote agricultural development, increase employment and income generation in rural areas, reduce dependence on oil imports (improved energy security), and reduce the country's vulnerability to unstable and volatile oil prices in the international market.

Mozambique's approach to implementing biofuels production is based on encouraging cross-sectorial cooperation through the strengthening of an inter-institutional framework (comprising the Ministry of Energy, Ministry of Agriculture, Ministry of Industry and Commerce, Ministry of Science and Technologies, Ministry for the Coordination of Environmental Affairs, Investment Promotion Centre, NGOs, banks, universities and civil society); stimulating private sector involvement notably through public-private partnerships; and reinforcing cooperation with development partners including South-South and North-South partnerships. The country aims to develop liquid biofuels for transport in a sustainable way by respecting the following principles: Transparency; Social and environmental soundness; Incremental implementation; Fiscal sustainability; and Innovation.

17
Proposals for biofuels-related projects in 9 out of 10 provinces

5
Bioethanol projects

12
Biodiesel projects

Mozambique has also engaged in resource mapping and zoning studies to identify land, water, climate and other relevant conditions for sustainable biofuels production. Land mapping began with a national land survey completed in 2008 (scale 1:1 000 000), followed by a second survey in 2009 (scale 1: 250 000), which were used to identify opportunities for new large-scale projects on 7 million ha. As a result of these studies, the government of Mozambique has officially received 17 biofuel-related proposals in nine out of 10 provinces, including five bioethanol projects, 12 biodiesel projects and other prop-

osals as expressions of interest. To further stimulate development of the sector, the government has set aside more than USD 700 million to fund biofuel research, production and promotion, and has allocated 3.5 million ha of land for the purposes of biofuels.

In 2011, several documents were approved by the government, including the regulation of biofuels, their blending sustainability criteria, and standards and specification developed by the National Institute for Normalization and Quality (INNOQ).

BIODIESEL

There are a large number of potential feedstocks for biodiesel production in Mozambique including coconut, sunflower, castor seed, jatropha, soy and African palm. However, the main crops explicitly stated in the biofuels policy for biodiesel production are jatropha and coconut. Currently, diesel accounts for 80% of national transport fuel consumption and therefore constitutes the largest market segment for liquid fuels. Diesel consumption is predicted to grow, thereby presenting an opportunity for the expansion of biodiesel production for the domestic market. Although jatropha-based biodiesel production costs are estimated to be lower than the price of imported diesel, this is not the case for coconut oil, which competes in different markets for food and cosmetic use where commodity prices are significantly higher than those for biodiesel feedstock. In addition, diesel prices are controlled by the government and there are currently no subsidies for biodiesel production.

Several companies are currently operating biodiesel projects in Mozambique. These include ESV Bio-Africa, which has a concession of 11 000 ha (including 5 000 ha planted with jatropha), and Enerterra, which operates a jatropha project aimed to eventually cover 15 000 ha.

Ecomoz is another project which has been involved in biodiesel production since 2007 by Petromoc. However, challenges have been faced by biodiesel producers due to problems with adequate feedstock availability.

BIOETHANOL

Mozambique's status as a sugar-producing nation and the presence of an established infrastructure for sugarcane cultivation and processing makes it likely that, if clear market signals were given, the sugar industry could respond positively to support domestic production of bioethanol. An increase in the production of sugarcane and the diversion of feedstock to supply the bioethanol industry would be possible. Mozambique is currently developing links with established international players in bioethanol production, notably Petrobras of Brazil.

Domestic bioethanol production could be further increased using molasses from existing sugar production. This material is currently disposed of as waste or used in animal feed production. The amount of molasses feedstock currently available could be used to produce enough bio-ethanol to meet the proposed 10% blending requirement[5]. Sweet sorghum has been identified as another potential bio-ethanol feedstock.

Two bioethanol projects have been formally approved since the end of 2006.

5 Mozambique has implemented a fuel-blending mandate, which phases in bioethanol to 10% by 2012–2015, 15% from 2016–2020, and 20% from 2021. For diesel, the blending is 3%, 7.5% and 10% over these timeframes.

The first, a 30 000 ha concession of which 22 500 ha was dedicated to growing sugarcane for ethanol in Gaza province, was operated by PROCANA. Due to financial issues the project had to be stopped in 2011 and the government has since been in negotiations with a new player. The second one is being developed by Mozambique Principle Energy and has a concession area of 23 000 ha of which 18 000 ha is for sugarcane cultivation in Manica province. The project focuses on the conversion of up to 2.5 megatons of sugarcane to 65 million gallons of ethanol and about 13 MW of installed electrical power from cogeneration.

KEY FINDINGS AND RECOMMENDATIONS

The current biofuels policy and criteria for sustainability balance the interests of export-led growth with those of rural communities so that biofuels can be developed in the national best interest of Mozambique. In the long term, Mozambique needs to take a strategic decision on whether to become a major exporter of biofuels, taking into account the potential risks and benefits of such a strategy. Although the rules regarding exports of biofuels are laid out in the National Policy and Strategy for Biofuels, this document will need to be clarified when it is next reviewed (it currently covers the period 2009-2015).

Creating a strong and competitive biofuels industry will lead to financial benefits for the country, and help fulfill its strategy to mitigate exposure to international oil price risk. But in order to encourage biofuels investment, more certainty is required regarding the ability of biofuel producers to export their products. There needs to be a dynamic mechanism for allocating the obligation to supply into the domestic market to create a level playing field between all suppliers (existing and new entrants). This mechanism needs to create a transparent price for suppliers into the national market to give greater price visibility for investment. Additionally, operational procedures for transport, storage, blending and distribution of biofuels should be established, with the aim of minimising logistics costs.

Finally, there also seems to be a definite need for technical and legal capacity-building especially in the Ministries of Agriculture and Energy and in the agency Petromoc. The necessity of building institutions with a practical understanding of biofuels, the limitations and constraints of the sector, would enable effective policy-making.

Image 7: Solar Energy Installation in Mozambique

Source: www.ericsson.com/res/thecompany/images/press/photos/millennium_villages

IV. Recommended Actions

The following schematic identifies the recommended actions from the RRA process. They are not given in any order of priority, and the list of actions from a rapid assessment is unlikely to be exhaustive. The detailed list of actions can be found in Annex.

Develop a system of feed-in tariffs for electricity generated from RE	☼ Will help give clarity to developers and incentivise independent power producers (IPPs). ☼ The design of the tariff should take into account the costs of generation, return on investment, impact on electricity prices and the costs of the support. ☼ The FiTs could reflect the positive impact of reduced transmission losses. ☼ There is international experience for formulating feed-in tariffs from which Mozambique could benefit. Further dialogue with IRENA could explore the possibility of support for the development of feed-in tariffs. ☼ The prerequisite legal powers and for the introduction of feed-in tariffs should be evaluated to identify changes and legislation that would need to be drafted to enact such a scheme and map the legislative timetable for introduction
Evaluate the cost of energy generation from wind energy in Mozambique	☼ The cost of generation from wind turbines is likely to be higher than alternatives including hydro. However, geographical and infrastructural benefits from distributed generation may increase the value of locally generated electricity. The resource mapping exercise should be used to further refine the estimates of generation costs and to inform the policies for the promotion of wind power. ☼ The outputs of the resource mapping exercise and any benefits from distributed generation should be reviewed to determine if the costs of generation from wind energy projects are acceptable. The outcome of this exercise should be to set the priority for developing further policy in support of wind energy.
Evaluate the cost of energy generation from wind energy in Mozambique	☼ Efforts should be made to take advantage of the grid extension ongoing by EDM, so as to mobilise funds to support the development of small hydro projects along the grid through distributed generation closer to consumption which could also free up additional electricity for export and/or use within the country. ☼ Reducing the uncertainty of the project revenue streams and increasing the availability of project finance would help to promote economically sustainable projects. The following measures should be employed to improve project bankability: ☼ EDM could take a small equity stake in small hydro projects to reinforce the credibility of its long-term power purchase agreement (PPA). ☼ The Ministry could work with the donor group to develop a partial risk-guarantee fund with financial institutions in Mozambique to promote lending to small hydro projects. ☼ Develop a system of feed-in tariffs to provide long-term power purchase agreements, access to the grid and attractive return on investment. ☼ Consult with stakeholders to design a simpler process for environmental impact assessment (EIA) for small run of the river hydro plants.

Include potential sites for hydroelectricity projects in grid extension planning	☼ The grid extension carried out by EDM up to the district level provides an opportunity to link in and promote distributed on-grid generation through the development of small hydro projects. There are a number of sites for small hydro projects, which would require up to only 5–10 km of grid extension to allow them to inject power into the grid. These sites could be prioritised for developed in EDM's master plan for grid extension. ☼ The development of EDM's master plan for new generation and grid extension should take into account this potential and the need to plan for grid connections for these sources. A study to assess the impact of promoting distributed hydro power generation with small hydro plants on distribution losses would provide further impetus to the sector.
Encourage private sector involvement in rural electrification and decentralised energy	☼ Introduce a role for FUNAE to engage with the private sector through creation of a private sector liaison officer post. ☼ Establishment of a private sector forum to discuss possible revisions to policies and regulations. ☼ Expansion of tender process to include management, design and maintenance activities previously undertaken by FUNAE. ☼ Provide clear policy and implementation guidelines by which private sector and community-led projects can apply for funds through FUNAE. ☼ Proactively encourage allow a business-led approach to emerge by encouraging private equipment suppliers and distributors to enter the market in partnership with micro-finance institutions where appropriate. ☼ Consider the use of a concession-based system.
Promote development of sustainable biofuel projects	☼ Clear indications of local market size and process for allocating obligations for projects to supply the local market. ☼ Balance sustainability criteria with land availability to identify available land for biofuels production. ☼ Develop a legislative and regulatory timetable to provide biofuels specification standards, compatible with international standards.
Clarify the requirements for biofuels producers to supply biofuels to the local market	☼ The biofuels strategy currently requires domestic markets to be satisfied first before companies can export. Further clarification is required regarding how the obligation to supply the local market will be allocated. There needs to be a dynamic mechanism for allocating the obligation to supply into the domestic market to create a level playing field between all suppliers (existing and new entrants). This mechanism needs to create a transparent price for suppliers into the national market to give greater price visibility for investment

It should also be noted that these recommendations will become more effective provided that the on-going sector reform process in Mozambique, which will amongst other measures make the tariff more cost reflective, is successfully completed

TO SUPPORT MOZAMBIQUE'S GROWING SOLAR MARKET; FUNAE HAS BEEN INSTRUMENTAL IN DEVELOPING PLANS TO CONSTRUCT A SOLAR MODULE MANUFAC-TURING PLANT TO ASSEMBLE MODULES FOR SALE IN MOZAMBIQUE AND NEIGH-BOURING COUNTRIES. THIS WILL CREATE EMPLOYMENT AND COULD BE THE FIRST STEP TOWARDS ESTABLISHING A DOMESTIC SOLAR MANUFACTURING SECTOR.

V. Best Practices and Future Cooperation

Identified Examples of Good Practice

GOOD PRACTICE DEMONSTRATION 1:

FUNAE AND ACCESS TO ELECTRICITY

FUNAE aims to provide access to electricity in schools, clinics and villages using PV, wind and mini-hydro systems. To date, the electrification of 115 villages, 298 schools and 300 clinics has been successfully completed.

Solar power has been used in these projects at a wide range of scales, ranging from just a few watts to tens of kilowatts. The successful deployment and demonstration of solar energy technologies have led to an upsurge in awareness and interest in their potential for rural electrification. In particular, the deployment of pico-scale solar energy systems has led to requests for kits to be sold on a commercial basis, providing income generation opportunities in the private sector.

To support Mozambique's growing solar market; FUNAE has been instrumental in developing plans to construct a solar module manufacturing plant to assemble modules for sale in Mozambique and neighbouring countries. This will create employment and could be the first step towards establishing a domestic solar manufacturing sector.

FUNAE continues to deliver sample projects and provide a range of examples of solar installations. Plans for 2012 include the electrification of a further 350 schools, 350 health clinics and 30 villages. In addition, three large solar projects, in the range of 400 to 500 kW – a size never before insta-lled in Mozambique – are planned in Niassa province.

Alongside its technology deployment, FUNAE has developed operations and maintenance capacity through both commercial arrangements and training community representatives. In 2008, FUNAE initiated a programme to train solar energy technicians in all provinces of the country.

GOOD PRACTICE DEMONSTRATION 2:

EDUARDO MONDLANE UNIVERSITY RENEWABLE ENERGY PROGRAMMES

In Mozambique, the deployment of renewable energy is motivated by the global level challenges of dwindling fossil fuel reserves and global climate change, and by country-specific problems related to excessive consumption of biomass in its primary form accompanied by very low levels of electrification. These issues can be addressed by adopting renewable energy and increased energy efficiency, but this requires that people be educated in these technologies. Mozambique is therefore supporting the development of sustainable energy through university education in the areas of science and engineering, as well as vocational training schemes for technicians.

Renewable energy studies have been included in the syllabi of a number of graduate level courses at Eduardo Mondlane University's Faculty of Science and Faculty of Engineering. This has helped provide expertise to many of the energy-related government departments and agencies.

To further increase Mozambique's capacity to support the development of internal energy resources, a PhD programme in Energy Science and Technology has also been established at Eduardo Mondlane University. The programme focuses on renewable energy and aims to create institutional capacity for research and training in socio-economic fields related to energy. A Master's programme in the field of Science and Technology is also planned for the second semester of 2012. All of these programmes benefit from and reinforce the university's research capacity in renewable energy, which dates back to the early 1990s.

This commitment to education and research in the development and application of energy technology is an example of good practice and will help provide the human capital needed to meet the energy challenges of the future.

FUTURE COOPERATION

This RRA pilot study in Mozambique has served two purposes. Firstly, it has identified a number of actions – many of which can be undertaken in the short term – to improve the country's readiness for renewable energy deployment. Bilateral and multi-lateral institutions have a crucial role to play in supporting the implementation of these actions. Secondly, the pilot study has provided valuable inputs into the development of the RRA methodology and process, and IRENA has expressed its gratitudefor these inputs.

This report can serve as a basis for the development of international cooperation on country-level and regional-level programmes. At the country level, the report opens up the possibility of piloting a multilateral initiative to support feed-in tariffs to promote renewable energy. At the regional level, IRENA could support the deployment of renewables by building a network of countries, resource people and

institutions engaged in project development. This would create a much-needed platform for sharing experience and also enable countries to build their knowledge base.

In the next phase of the RRA project, the improved methodology and process will be rolled out to a number of other SADC countries through a regional workshop session. It is very much hoped that Mozambique will be able to continue its leading role in the RRA project by supporting to this roll out and allowing other countries to benefit from its experience.

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Image 8: Sailboat off the Mozambique Coast
http://magicalmozambique.com

VII. Annex

Actions identified to scale up renewables deployment in the short to medium term

The short- and medium-term actions suggested by the RRA process, originally published in the Mozambique preliminary report (IRENA, 2012), are presented below. The actions are presented in the exact form as they appear in the preliminary report. This is because the wording of the actions were subject to discussion and debate, and so the actions listed in this form are judged to best represent the views of those involved in the process. The actions are referred to throughout the previous sections of this document. This section provides each action in the order referenced in the report, together with a description of the action, a list of key actors required for its implementation, a proposed timing for completion of the action, and some key elements deemed to be necessary for its successful completion.

Action 1

Develop a system of feed-in tariffs for electricity generated by RE technologies

Resource-Service pair(s)	On-grid electricity, wind, hydro and biomass resources.
Description	A number of tax incentives currently exist to support socially beneficial investments (Code of Fiscal Benefits, Law 4/2009). To support them, a system of feed-in tariffs could be developed to promote small hydro, wind and biomass co-generation for grid-connected electricity generation. ☼ The proposed feed-in tariffs would help give clarity to developers and incentivise independent power producers (IPPs). The design of the tariff should take into account the costs of generation, return on investment, impact on electricity prices and the costs of the support. ☼ The tariff could reflect the positive impact of reduced transmission losses. ☼ There is international experience for formulating feed-in tariffs from which Mozambique could benefit. Further dialogue with IRENA could explore the possibility of support for the development of feed-in tariffs. ☼ The pre-requisite legal powers for the introduction of feed-in tariffs should be evaluated to identify changes and legislation that would need to be drafted to enact such a scheme and map the legislative timetable for introduction.
Actors	The Ministry of Energy (National Directorate for New and Renewable Energy and National Directorate for Electrical Energy), Ministry of Finance and other potential investors (private companies, utilities and commercial banks), EDM, CNELEC, IRENA.

Timing	18 months.
Keys for success	Publish a draft proposal for feed-in tariff scheme for key technologies. ☼ Conduct a legislative review on the introduction of feed-in tariffs. ☼ Conduct a review of international experience relevant to the conditions in Mozambique.

Action 2

Evaluate the cost of energy generation from wind energy in Mozambique

Resource-Service pair(s)	On-grid electricity, wind energy.
Description	Wind power in Mozambique is at an early stage of development. A 300 kW single turbine has been installed at Praia, Inhambane. Mozambique is considered to have a good wind resource along its coastline and in the highlands, with average wind speeds close to 6–7 metres per second in some areas. A study is underway to map the wind resource across the country in more depth and produce a renewable energy resource atlas by 2013. To support this process, a number of wind monitoring stations are currently being installed at selected locations. ☼ The cost of generation from wind turbines is likely to be higher than alternative technologies, including hydro. However, geographical and infrastructural benefits from distributed generation may increase the value of locally generated electricity. The resource mapping exercise should be used to further refine estimates of generation costs and to inform policies for the promotion of wind power. ☼ The outputs of the resource mapping exercise and any benefits from distributed generation should be reviewed to determine if the costs of generation from wind energy projects are acceptable. The outcome of this exercise should be to set the priority for developing further policy in support of wind energy.

Actors	National Directorate for New and Renewable Energy, National Directorate for Electrical Energy, FUNAE, EDM, resource mapping companies.
Timing	18 months.
Keys for success	An objective review of the costs and benefits of electricity generated from wind energy.

Action 3

Support the development of large- and small-scale hydroelectricity projects

Resource-Service pair(s)	On-grid electricity, hydro resources.

Description

Hydro is an important and significant resource for Mozambique. There is potential for large (greater than 25 MW) and small (5–25 MW) generation. Large hydro opportunities are nationally significant projects developed on a case-by-case basis and are discussed directly with the group of multilateral and bilateral funding agencies. Further efforts should also be made to take advantage of on-going grid extension by EDM, in order to mobilise funds to support the development of small hydro projects along the grid, as these could offer significant reductions in grid losses (currently at~25%) through providing distributed generation closer to consumption, and could also free up additional electricity for export and/or use within the country.

- The main barriers to the development of small hydro projects in Mozambique centre around the lack of a framework to support independent power producers. Reducing the uncertainty of project revenue streams and increasing the availability of project finance would help promote economically sustainable projects. The following measures should be employed to improve project bankability:

- EDM could take a small equity stake in small hydro projects to reinforce the credibility of its long-term power purchase agreement (PPA).

	☼ The Ministry of Energy could work with the donor group to develop a partial risk guarantee fund with financial institutions in Mozambique to promote lending to small hydro projects. ☼ Develop a system of feed-in tariffs to provide long-term PPAs, access to the grid, and attractive returns on investment. ☼ Consult with stakeholders to design a simpler process for environmental impact assessments (EIAs) for small run-of-the-river hydro plants.
Actors	The Ministry of Energy (National Directorate for New and Renewable Energy and National Directorate for Electrical Energy), donors and other potential investors (private companies, utilities and commercial banks), EDM, National Electricity Advisory Council of Mozambique (Concelho Nacional de Electricidade, or CNELEC).
Timing	Take one project to contract signature within 12 months.
Keys for success	Create mandate for EDM to issue long-term PPAs and agree on standard terms for acquiring project equity. ☼ Increase capacity within EDM for working in partnership with private sector actors to deliver successful projects. ☼ Work in partnership with other actors to address financing risks.

Action 4

Include potential sites for hydroelectricity projects in grid extension planning

Resource-Service pair(s)	On-grid electricity, hydro resources.
Description	The grid extension being carried out by EDM up to the district level provides an opportunity to link in and promote distributed on-grid generation through the development of small hydro projects. There are a number of sites for small hydro projects, which would require up to only 5–10 km of grid extension to allow those projects to

	inject power into the grid. These sites could be prioritised and included in the EDM's master plan for grid extension. The development of EDM's master plan for new generation and grid extension should take into account this potential and the need to plan for grid connections for these sources. A study to assess the impact on distribution losses of promoting distributed hydropower generation using small hydro plants would provide further impetus to the sector.
Actors	EDM, CNELEC, project developers.
Timing	12 months.
Keys for success	Maintain registry of potential projects. ☼ Place obligations on EDM to consider proximity to potential projects in master planning exercises. ☼ Complete EIA for small hydro plants to create a shelf of projects for IPPs.

Action 5

Encourage private sector involvement in rural electrification and decentralised energy

Resource-Service pair(s)	Off-grid electricity, all resources.
Description	Mozambique is a large country with a widely dispersed, mostly rural, population. Despite ambitious grid extension plans, large areas of the country will not be reached by the electricity grid in the short to medium term. Mozambique has a great deal of potential for supplying electricity for off-grid applications, especially through solar PV, small hydro and biomass (including forest/agricultural waste). FUNAE is involved in identifying and tendering for projects, and in some cases,for their operation and maintenance. Although FUNAE is currently the main player, there is a strong political ambition to create opportunities for the private sector to provide these rural energy services. These would be based on business models, which could then be scaled up at lower cost to the state.

	Opportunities exist to encourage the private sector to supply equipment and finance. To promote private sector involvement in the rural electrification and decentralised energy sector the following points could be considered: ☼ Introduce a role for FUNAE to engage with the private sector by creating a private sector liaison officer post. ☼ Establish a private sector forum to discuss possible revisions to policies and regulations. ☼ Expand the tender process to include those management, design and maintenance activities previously undertaken by FUNAE. ☼ Provide a clear policy and implementation guidelines by which private sector and community-led projects can apply for funds through FUNAE. ☼ Proactively encourage a business-led approach to emerge by inviting private equipment suppliers and distributors to enter the market in partnership with microfinance institutions where appropriate. ☼ Consider the use of a concession-based system.
Actors	The Ministry of Energy (National Directorate for New and Renewable Energy), FUNAE, installers and suppliers of systems.
Timing	12–18 months.
Keys for success	Engagement of FUNAE and the private sector;willingness for collaboration between the two. ☼ Capacity-building in the private sector.

Action 6

Scaling up deployment of rural electrification and decentralised energy

Resource-Service pair(s) Off-grid electricity, all resources.

Description

FUNAE has the main responsibility for delivering the rural electrification strategy. Although FUNAE was originally set up to finance projects, it has increasingly moved into project management. FUNAE is involved in identifying and tendering for projects, and in some cases, their operation and maintenance.

FUNAE is currently in the process of implementing a 5 MW solar module manufacturing facility.

FUNAE has a successful record in implementing off-grid projects, and in the short term needs continued financial resources to continue this work. In the longer term, a more strategic approach will be required, as FUNAE's ability to deliver rural electrification on a much wider scale will ultimately be limited by human and financial resources. A review of the approach could consider the following:

- Areas of FUNAE's scope that could be delivered by the private sector.
- Scaling up alternative models for deployment by which service charges could provide a long-term income source to support FUNAE's future projects.
- Assessment of progress against targets for electrification and decentralised energy, to highlight areas where additional action is needed.
- Review import duties charged on renewable technologiesand others (notably diesel generating sets) to ensure that cleaner solutions are not being penalised; consider favouring renewable technologies over fossil fuel-based ones.

Actors	The Ministry of Energy, National Directorate for New and Renewable Energy, FUNAE, representatives of civil society, community associations, Ministry of Finance.
Timing	12 months.
Keys for success	Strategic plan for FUNAE to meet policy objectives and promote private sector growth. ☼ Engagement of local project developers and equipment manufacturers. ☼ Outreach and engagement with local communities. ☼ Discussions and identification of resources from state budgets.

Action 7

Promote development of sustainable biofuel projects

Resource-Service pair(s)	Biofuels for transport, bioenergy resources.
Description	Biofuel production in Mozambique centres on investment by mainly foreign-owned companies in land and equipment for the cultivation and processing of biofuels. The main factors influencing the success of attracting investors in Mozambique for the production of biofuels are the availability and cost of suitable land, the perceived global and local biofuels price risk, and the stability and transparency of the regulatory environment. The current biofuels policy and criteria for sustainability balance the interests of export-led growth with those of local consumers so that biofuels can be developed in the national best interest of Mozambique. In the long term, Mozambique needs to take a strategic decision on whether to become a major exporter of biofuels, taking account of the potential risks and benefits of such a strategy.

	In the short and mediumterm the following actions could be employed:
	☼ Clear indications of local market size and process for allocating obligations for projects to supply the local market.
	☼ Balance sustainability criteria with land availability to identify available land for biofuels production.
	☼ Develop legislative and regulatory timetables to provide biofuels specification standards compatible with international standards.
Actors	The Ministry of Energy (National Directorate for New and Renewable Energy and National Directorate for Fuels).
Timing	12 months.
Keys for success	Availability of land, engagement with local communities and with investors.

Action 8

Clarify the requirements for biofuels producers to supply biofuels to the local market

Resource-Service pair(s)	Biofuels for transport, bioenergy resources.
Description	Mozambique is currently entirely dependent on imports for its transport fuel, which is an incentive to develop domestic sources of supply to reduce both costs and exposure to price volatility. The country has implemented a fuel-blending mandate, which phases in bioethanol to 10% by 2012–2015, 15% from 2016–2020, and 20% from 2021. For diesel, the blending is 3%, 7.5% and 10% over these timeframes. There is currently no agreed pricing mechanism on how much will be paid for biofuels to satisfy this blending requirement.
	The biofuels strategy currently requires domestic markets to be satisfied before companies can export. Further clarification is required regarding how this obligation will be allocated. There

	needs to be a dynamic mechanism for allocating the obligation to supply the domestic market to create a level playing field between all suppliers (existing and new entrants). This mechanism should create a transparent price for suppliers into the national market to give greater price visibility for investment.
Actors	The Ministry of Energy (National Directorate for New and Renewable Energy and National Directorate for Fuels), Ministry of Agriculture, biofuel producers.
Timing	Q2 2012.
Keys for success	Clear published guidance for investors regarding the proportion of production required to meet local demand, and clear pricing formulae.

THIS REPORT CAN SERVE AS A BASIS FOR THE DEVELOPMENT OF INTERNATIONAL COOPERATION ON COUNTRY-LEVEL AND REGIONAL-LEVEL PROGRAMMES. AT THE COUNTRY LEVEL, THE REPORT OPENS UP THE POSSIBILITY OF PILOTING A MULTILATERAL INITIATIVE TO SUPPORT FEED-IN TARIFFS TO PROMOTE RENEWABLE ENERGY. AT THE REGIONAL LEVEL, IRENA COULD SUPPORT THE DEPLOYMENT OF RENEWABLES BY BUILDING A NETWORK OF COUNTRIES, RESOURCE PEOPLE AND INSTITUTIONS ENGAGED IN PROJECT DEVELOPMENT

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