

**THE POTENTIAL FOR DISSEMINATION
OF
SMALL & MICRO-HYDRO PROJECTS
IN
MOZAMBIQUE**

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TABLE OF CONTENTS

1. BACKGROUND
2. GENERAL POTENTIAL FOR THE USE OF SMALL AND MICRO-HYDRO POWER
3. EXISTING SMALL AND MICRO-HYDRO PLANTS
4. THE SUPPORT FOR DISSEMINATION OF SMALL AND MICRO-HYDRO PROJECTS
5. THE LOCAL CAPACITY TO IMPLEMENT SMALL AND MICRO-HYDRO POWER PROJECTS
6. THE GENERAL KNOWLEDGE ABOUT SMALL AND MICRO-HYDRO TECHNOLOGY AND
OPERATION
7. THE LEGAL FRAMEWORK FOR THE OPERATION OF SMALL AND MICRO-HYDRO PROJECTS
8. POTENTIAL SITES FOR SMALL AND MICRO-HYDRO PROJECTS WITH COST ESTIMATION
9. ANNEXES

1. BACKGROUND

1.1 Location, Land size and Population

Mozambique has a total area of 799,380 km² and the population is presently estimated at 18,000,000 with over 80 % people living in the rural areas, mostly on subsistence agriculture. The country is divided into 11 provinces including the city of Maputo. The provinces are in turn subdivided into districts.

1.2 Climate and Vegetation

Mozambique has three distinct seasons: the cool dry season from May to August, hot dry season from September to November and warm rainy season from December to April. Annual rainfall ranges from 1,800 mm in the mountains of Angonia in Tete to less than 600 mm in dry regions like Save river basin.

The vegetation includes mountains, forests, woodlands, grasslands and coastal sandy plains.

1.3 Energy Balance

Over 90% of the Mozambican population depend on firewood and charcoal for cooking and water heating. The major consumers of electricity are urban households (70%), followed by industry (20%), small-scale industries (10%).

The country's major power utility is Electricidade de Mozambique (EdM) whilst Hidroelectrica de Cahora Bassa (HCB) operates the country's major powerplant, Cahora Bassa.

Other large hydro plants in Mozambique have continued to operate at less than full capacity, including Mavuzi (44.5 MW effective capacity out of 65 MW nominal capacity); Chicamba (34 MW of 48.0 MW); and Corumana (14 of 16.6 MW).

Several new hydro projects are proposed for the Zambezi river, downstream of Cahora Bassa; Mepanda Uncua (1600 MW); Baroma (444 MW); and, Lupata (654 MW). Development of these projects may be carried out following power purchase agreements with neighboring countries.

1.4 Background to Micro Hydro-Power Programme

The Energising Development Partnership aims at providing 5 million people with sustainable access to modern energy services.

In Mozambique an intervention to improve the access to electricity is planned with a proposed budget of up to 2 Mio. € until the end of 2008. The objective of the planned project is the facilitation of access to electricity services for

- households (at a maximum cost of 40 € per beneficiary)
- productive use (at a maximum cost of 30 € per beneficiary)
- social infrastructure (at a maximum cost of 18 € per beneficiary)

A preliminary study has been carried out to analyse possible interventions in the field of small hydro power.

1.5 Target Area for the Small and Micro-Hydro Programme

The Central Region of Mozambique is being proposed to be the target area for this pilot project based on the following selection criteria:

- ◆ Existing provincial energy project plans that include hydro power
- ◆ Existing experiences of hydro-power projects
- ◆ Physical and geographical characteristics that are appropriate for the implementation of small and micro-hydro power plants
- ◆ Existing demand for hydro power for electricity generations as well as for agro-processing and water pumping
- ◆ Existence of a strong co-ordinating unit

The Central Region comprises of four provinces i.e. Manica, Sofala, Tete and Zambezia. The region borders with Malawi in the north, Zambia in the north-west and Zimbabwe in the west. The Central Region covers an area of 335,406 km² and a regional population that is estimated to be 5,800,000

1.6 Definitions

For the purpose of clarity and having a common understanding of the topic under discussion a number of definitions require elaboration.

Small and Micro-Hydro Power

Micro-hydro schemes range between 200W and 300KW. Typically they are installed in remote places where there is no grid and provide electricity to one community or to one industry.

At times the micro-hydro power plants are used for directly driving mechanical machines like maize mills, saw mills and water pumps.

Small-hydro schemes range from 300KW to 10MW, also referred to as mini-hydro schemes.

When the schemes are larger than 10MW then they are referred to as **full scale-hydro** schemes, e.g. Cahora Bassa.

Renewable Energy includes Energy in flowing water technically known as hydro power, Photo-voltaic and Thermal solar energy, Wind energy, Biomass energy and Biogas energy from anaerobic fermentation

Appropriate Technology is the mechanism that is suitable and acceptable in the light of economic, social and cultural criteria. They should contribute to socio-economic development whilst ensuring optimal utilisation of resources and minimal detriment to the environment on a sustainable basis.

2. GENERAL POTENTIAL FOR THE USE OF SMALL AND MICRO-HYDRO POWER

Regional Focus for the Planned Project

The geographic conditions of Mozambique pose a great potential for hydro power generation with altitudes that exceed 2000 metres in Zambezia and Manica Provinces and numerous rivers and streams that flow through out the year. Seven of the ten provinces receive more than 1000 mm of rainfall, i.e. Manica, Tete, Sofala, Zambezia, Nampula, Niassa and Cabo Delgado.

There is potential for small and micro hydro schemes in areas with perennial rivers that flow with a minimum head of 5 metres.

Mozambique is currently implementing a Rural Electrification Programme that is mainly based on connections to the national grids and electricity from diesel generators. Unfortunately the effort is far too expensive to justify the social benefits being achieved.

In the efforts of Rural Electrification, Small and Micro-Hydro power should be viewed as a more viable option because the technology is low cost, fast installation, locally manageable and maintainable.

Since the war ended in Mozambique, it is quite evident that more and more people are relocating their families to quite remote places for agricultural production reasons. Connections of most remote areas to the main electricity grid will not be feasible in near future.

The entry point for the Micro-hydro power project should be rehabilitation of old micro-hydro plants for electricity, agro-processing and water pumping before tackling new construction sites. Since food production is one of the major development issues in the country the Small and Micro-hydro projects should be linked to irrigation schemes.

3. EXISTING SMALL AND MICRO-HYDRO PLANTS

3.1 Electricity generation

There are a number of small hydro-power plants that range from three to 10MW as well as full scale hydro schemes.

In Manica there are small-hydro power stations of Central Mavuzi with five generator sets that have a capacity to produce 65MVA in total and Chicamba with two generators that have a total capacity of 48MVA.

A number of micro-hydro power plants that were once functional during the 1960s and early 70s are now defunct and could be rehabilitated back to use.

These include in Manica Province: Rotanda in Sussundenga District, Penhalonga in Manica District and in Tete Province: Capoché in Maravia District, Muze in Zumbo District, Maua in Angonia District, Chimwakhalamu in Moatize District and Solensa in Mutarara District. Currently a Micro-hydro plant of 70 KVA is under construction on the Musambizi River in Barue District for the supply of electricity to the Locality of Honde.

3.2 Mechanical Machines

Mozambique has had a long history of using Micro-Hydro power for agro and forestry processing. A number of micro-hydro mechanical maize mills were identified in Manica Province such as Nhamucuarara, Mucudo and Penhalonga in Manica District, Rotanda and Sembezeia in Sussundenga District, Nhadzonia in Barue District.

Intermediate Technology Development Group has collaborated with Kwayedza Simukai a local NGO in Manica District and some private individual entrepreneurs in upgrading and repairing these micro hydro plants in Ndirire in Manica District.

In Tete there have been a number of water pumps that were driven by water turbines e.g. in Finguè the district centre of Marávia District. Recently the mini-hydro pump was rehabilitated in Finguè to pump drinking water for about 500 households.

3.3 Challenge

Due to the ever increasing prices of oil, it is quite evident that the diesel operated water pumps and electricity generators are not going to be a long term solution. It is quite challenging to find alternatives that are less expensive in operations and maintenance. Where appropriate conditions prevail small and micro-hydro power would offer the solution.

The main challenge in the promotion of Small and Micro-Hydro Power is the capacity building of the stakeholders starting from the planners from the Government institutions, the constructors from the private sector, operators and the beneficiaries. This entails setting up and training provincial teams that carry out feasibility assessments and planning, supporting private entrepreneurs for the construction of the small and micro-hydro power plants, training of private contractors, operators and beneficiaries.

4. THE SUPPORT FOR DISSEMINATION OF SMALL AND MICRO-HYDRO PROJECTS

A number of organisations and donor programmes have been identified to have interest in promoting Small and Micro-Hydro Projects in the country. These include:

- EU under Micro Projects,
- UNIDO under the Energy Sector,
- UNDP under the programme of Clean Environmental Energy,
- Chinese Embassy under the programme of industrial linkages of Chinese technology,
- Government and donor supported development projects like GTZ PRODER in Manica who spearheaded the Honde Micro-hydro power project,
- DED e.g. in Manica Province providing expertise in renewable energy,
- Practical Action (ITDG) who have carried out a number of feasibility analysis of Micro-Hydro Power in Mozambique since mid 90s,
- FUNAE under the Energy Reform and Access Program financed by World Bank,
- GPZ under the Programme of Research and Project implementation.

GPZ has been investigating the potential of micro-hydro power in the Zambezi Valley catchment area and so far has compiled detailed proposals.

The Ministry of Science and Technology is investigating into the promotion of renewable energies that include small and micro-hydro power generation.

The University of Mondlane, through their faculties of Engineering and Geology, is researching and testing the performance of renewable energy technologies.

The Government through the Provincial Departments of Energy is currently elaborating provincial plans of operations that include the promotion of renewable energies like solar and hydro. At National level the Department of Energy has created a special sector for renewable energy that co-ordinates the provincial projects.

5. THE LOCAL CAPACITY TO IMPLEMENT SMALL AND MICRO-HYDRO PROJECTS

Since energy is a principal element of development activities in different sectors it is necessary to carry out feasibility assessment and planning in a multi sectorial approach where stakeholders from different ministries are involved. The sectors to be involved include agriculture, industry, health, education, rural development, environment, construction and public works. The multi sectorial approach is already being applied in Tete Province as indicated in their Energy draft plan. The experience so far has shown that multi sectorial approach works where there is a strong co-ordination body like in the case of the provinces in the Zambeze Catchment area there is GPZ. The private companies also play a major role in the implementation of hydro power plants. The companies that have been identified who have shown interest and potential in the small and micro-hydro power technologies include Metalugica in Chimoio and Tete, Fundacoes da Beira in Sofala. Although these companies have not yet manufactured or constructed any specific equipment for hydro machines, they are already producing similar equipment like maize mills. They will require exposure to the technologies and capacity building in terms of training and equipment. Companies like Metalugica could be involved in fabrication of turbine components that require welding, assembling and machining like runners for crossflow turbines, shafts and pulley blocks, while Fundo da Beira a Foundry company would be involved in sand casting components like turbine cups.

There are also a huge number of civil construction companies that are experienced in construction of canals, bridges, roads and houses. These companies could be involved in civil works of the Small and Micro-Hydro projects after orientation and training.

In the promotion of the small and micro-hydro projects it is important that the procedures for Operation and Maintenance (O + M) should be planned and put into action at the initial stages of the scheme in order to prevent breakdowns in the long run. The responsibilities for O + M should lie with the Design Engineers, the Contractors who would carry out installations and the administrators of the plant operations as well as the beneficiaries.

Limitations

Consultation with stakeholders has shown that the biggest limitation is the availability of finance for the small and micro-hydro projects. For example GPZ has been trying to source funds for Small and Micro Hydro power plants for the past three years with out significant success.

6. THE GENERAL KNOWLEDGE ABOUT SMALL AND MICRO-HYDRO TECHNOLOGY AND OPERATION

In Mozambique the general knowledge about renewable energy including small and micro-hydro power is still very limited. Due to the limited capacity the country currently partly relies on external expertise. Because of this scenario there is huge potential for the programme to support the country with capacity building. The provincial members of staff would require capacity building support in renewable energy technologies assessments, planning and designing.

The training should include a wide variety of energy technologies options like Hydro power plant designing, Windmill energy, Solar Energy and Biomass energy

It is highly recommended to carry out intensive hands-on- training while executing projects. The programme should therefore have a strong capacity building component.

There should also be strong linkages to other SADC Energy projects through TAU, including Solar Energy Projects and Biomass Energy Projects.

7. THE LEGAL FRAMEWORK FOR THE OPERATION OF SMALL AND MICRO HYDRO PLANTS

According to Boletim da Republica 17.Sept 1997 the Department of Energy has under other functions to:

- ◆ Promote production and distribution systems for electrical energy *particularly at district centres that are not connected to the main national grid of EDM*
- ◆ Promote development and utilisation of new and *renewable energies like hydro-power.*
- ◆ Carry out surveys for need assessments and *possibilities of small and micro-hydro power stations including rehabilitation of existing ones*
- ◆ Promote rational utilisation of new and *renewable energy (ENR) in rural areas.*

The Five Year Government Programme for 2005 to 2009 under the Resolution No. 16/2005 of 11th May 2005 also highlighted the energy issues. The Energy Department was assigned to carry out actions for implementation of electricity generation projects and increasing access to energy for the rural population through **renewable energies like solar, oil and hydro**.

The new Government policy allows private operators to generate own electricity and sell it to the main grid through EDM. In Mozambique this is a situation ideal for business operators in remote places. Government would save considerable amount of money that is currently spent on long distant transmission lines from the national grid.

8. POTENTIAL SITES FOR SMALL AND MICRO-HYDRO PLANTS WITH COST ESTIMATION

Tete Province

8.1 Fínguè

A mini hydro power plant that has recently been rehabilitated to pump water to Fínguè has been recommended to incorporate a hydro electricity generator of 250 KVA. This will be connected to about 200 consumers resident in Fínguè and the surrounding villages. This will replace a diesel generator of 80 KVA that is currently providing electricity to half of the community and is proving to be too expensive for the district to run in terms of operation and maintenance.

The required action is to

- 1) increase the capacity of the water in the reservoir;
- 2) procure turbine and generator;
- 3) construct power house and penstock for the turbine and generator and
- 4) construct power lines of 800 meters for connecting the new system to the existing electrical network.

The estimated cost will be in the range of EUR 50,000.

8.2 Ulónguè, a small town in Angonia District in Tete Province is connected to the electricity from Dedza in Malawi.

The potential to construct a small hydro power plant of 500 KVA on Capoché River that would supply electricity to this town plus the surrounding communities thereby increasing the number of households with access to electricity to 500.

The facility is estimated to cost EUR 200,000

8.3 Changara

There is potential to replace the 80 KVA diesel generator with a micro-hydro power generator for 150KVA on the Luenia River. This would provide 24 hour supply of electricity and increase the number of households to 200 including the neighbouring communities within a radius of 10 km.

The facility is estimated to cost EUR 100,000

8.4 Potential Rehabs

In Tete Province there are five additional sites that have been identified for rehabilitation as listed:

- 1) Muze river in Zumbo District
- 2) Mauá river in Angónia District
- 3) Chimwakhalamu river in Moatize District
- 4) Tsangano river in Tsangano District
- 5) Solensa river in Mutarara District

8.5 Potential sites for new plants

Other sites in Tete Province that have been identified for constructions of new small and micro-hydro plants but still need to be surveyed for design and cost estimates are:

- 1) Luia River in Chifunde District
- 2) Nkonedzi river in Moatize District for Zobue town and surroundings
- 3) Mese river in Zumbo District for the Localidade of Mese
- 4) Aruângua river also in Zumbo District for Localidade of Aruângua
- 5) Piri-piri river in Zumbo District for the Localidade of Piri-piri
- 6) Mucanha river in Zumbo District for the Mucanha Catholic Mission

- 7) Vúzi river in Zumbo for the Posto Zambue
- 8) Vúboè river in Chifunde District
- 9) Luângua grande river in Macanga District
- 10) M'Pofi river in Macanga District
- 11) Duângua river in Marávia District
- 12) Mavudezi river for Mavudezi- Chiúta Catholic Mission and community
- 13) Chipso river in Marávia District

8.6 Manica Province

A number of sites suitable for small and hydro power plants have been identified in Manica Province as listed below:

- 1) Nhamatoronge Panze 60 KVA – in Barue District as an extension of the Honde Micro Hydro Power estimated at EUR 90,000
- 2) Nhamutsana Choa Mountains 30 KVA - in Barue District – new Micro Hydro Power plant estimated at EUR 60,000
- 3) Pandangoma Choa Mountains 40KVA – in Barue District – new Micro Hydro Power plant estimated at EUR 80,000
- 4) Mavonde 20 KVA - in Manica District – new Micro Hydro Power plant estimated at EUR 60,000
- 5) Penhalonga 60 KVA - Manica District - Rehabilitation of old scheme estimated at EUR 80,000
- 6) Mucudo Mucudo 50 KVA - Manica District - Rehabilitation of old scheme estimated at EUR80,000
- 7) Bonda Sembezeia 30 KVA - Sussundenga District – new Micro Hydro Power plant estimated at EUR 140,000
- 8) Nhamangwena Sembezeia 60 KVA - Sussundenga District – new Micro Hydro Power plant estimated at EUR 190,000
- 9) There is potential to construct a small hydro power plant for Espungabera, a small town in Musorize district in Manica Province that is currently connected to electricity from Chipinge in Zimbabwe .

N.B. The estimates given above are rough estimates that require calculations after proper surveys have been carried out.

There is also potential to operate Timber Saw mills using hydro power in the Penhalonga and Mavonde area.

8.7 Zambezia Province

One rehabilitation and 6 new construction sites suitable for hydro-power plants have been identified in Milanje District in Zambezia Province

GPZ in collaboration with the Ministry of Agriculture has developed vast rice farms where the farmers are now able to produce five tons of rice per hectare. Due to this increased production there is huge potential to operate rice dehulling machines that will run on hydro power.

The generation of hydro electricity in Milanje will also see Mozambique exporting electricity to the bordering towns of Malawi.

8.9 Sofala Province

In Gorongosa two rivers have been identified for small and micro-hydro to be intergrated into irrigations schemes. The same hydro power plants can also be used for driving rice dehulling machines. The cost estimates of these schemes can be made after the technical surveys.

Sofala and Zambeze provinces have a potential to increase rice farming to 600,000 hectares. This would increase the production to about 2,400,000 tons per season. Currently Mozambique imports rice amounting to US\$ 30,000,000 and SADC imports rice amounting to US\$ 300,000,000.

Development of small and micro-hydro power machines for processing of rice would contribute to the saving of such amounts.