Policy and regulatory framework conditions for small hydro power in Sub-Saharan Africa

Discussion paper

July 2010

gtz HERA Poverty-oriented basic energy services
On behalf of Federal Ministry for Economic Cooperation and Development
EUEI PDF Partnership Dialogue Facility
euei EUROPEAN UNION ENERGY INITIATIVE for poverty eradication and sustainable development

Content

List of abbreviations

AfDB	African Development Bank
BOO	Build-Own-Operate
CIF	Climate Investment Funds
EATTA	East African Tea Trade Association
EnDev	Dutch-German energy partnership Energising Development
ESHA	European Small Hydro Power Association
EUEI-PDF	EU Energy Initiative's Partnership Dialogue Facility
FIT	Feed-in tariff
FUNAE	Fundo Nacional de Energia (The National Energy Fund of Mozambique)
GEF	Global Environmental Facility
GNI	Gross national income
GTZ	German Technical Cooperation
HERA	sector project Poverty-oriented Basic Energy Services
IEA	International Energy Agency
IPP	Independent power producer
LDC	Least developed countries
MDG	Millennium development goals
MHP	Micro hydropower
MW	Megawatt
PPA	Power purchase agreement
PV	Photovoltaic
SCF	Strategic Climate Fund
SHP	Small hydropower plant
SPSP	Small private service providers
SREP	SCF program on Scaling-Up Renewable Energy in Low Income Countries
SSA	Sub-Saharan Africa
SWAp	Sector wide approach
UNDP	United Nations Development Program
VAT	Value Adding Tax
WHO	World Health Organization

1 Background: why dealing with SHP in Sub-Saharan Africa

Access to modern energy services is one of the basic preconditions for economic and social development and thus an important requirement for poverty reduction. It is therefore substantially interrelated to most of the MDGs. The increased use of renewable energies sources in the supply system also helps to reduce CO_2 emissions and thereby contributes to the global fight against climate change.

In Sub-Saharan Africa[1], biomass energy is still predominant in the national energy balances, with 625 Mio people (83%) relying on solid biomass for cooking and heating (UNDP/WHO, 2009). Still 560 Mio people (74 %) live without access to electricity – Sub-Saharan Africa is the region with lowest coverage in the world. Electrification rates are particularly low in rural areas (with the exception of South Africa); in most of the countries below 10%. In most Sub-Sahara African countries electrification is not only hindered by the high costs of extending the grid, but also by limited generation capacities and a dependence on imported fossil fuels. The following table shows basic parameters for the development and the status of the energy sector in selected Sub-Sahara African countries:

Table 1: Key indicators and electrification rates in selected SSA countries

Country data (2008)	Ethiopia	Kenya*	Mozambique	Nigeria*	Rwanda	South Africa*
Population (million)	80	39	22	151	10	48
Total Area (km²)	1,104,000	580,000	800,000	924,000	26,340	1,221,000
Density (person per km²)	72	67	27.5	163	380	40
GNI (US$/per capita)	280 US$	730 US$	380 US$	1170 US$	440 US$	5820 US$
Share of population below poverty line	44.2%	47%	55%	34.1%	56.9%	22%
Electrification (national)	15.3%	15%	11.7%	46.8%	4.8%	75%
Electrification (rural)	2.0%	5.0%	6.3%	26%	1.3%	55%
Power consumption (kWh per capita)	40 kWh	151 kWh	472 kWh	137 kWh	20 kWh	4986 kWh

* Kenya, Nigeria and South Africa are not classified as Least Developed Countries.

Source: World Bank 2010, IEA 2009

Renewable energy technologies have a high potential to contribute to a modern rural energy supply. Amongst them, small hydro power is one of the most feasible options wherever the geographical conditions permit the use of the hydrological potential. It does not only provide electricity for lighting and communication (as solar PV does), but can deliver enough capacity to supply mini-grids and thus constitute the basis for various forms of productive use of electricity including small industrial applications.

[1] By UNDP definition Sub-Saharan Africa comprises 45 countries, of which 31 are currently classified as Least Developed Countries (LDCs) by the UN ECOSOC. The total population of SSA has been 759 Mio in 2007.

Within the context of GTZ, several projects are related to small hydro power. The sector project Poverty-oriented Basic Energy Services (HERA), together with the Dutch-German energy partnership Energising Development (EnDev) and the EU Energy Initiative's Partnership Dialogue Facility (EUEI-PDF) are jointly planning to develop a guidebook providing practical recommendations (best practice guidelines) for decision makers in Africa aiming at the promotion of small hydro power in their particular countries. As a first step, this paper analyses the policy and regulatory framework conditions under which small hydropower can be developed in Sub-Saharan Africa.

There are different classifications of small hydropower[2]: This paper focuses mainly on micro hydro schemes (MHP) below 200 kW and to a smaller extend also includes mini hydro plants (below 1 MW). This size is suited to furnish insular grids providing electricity to rural villages (which is a main focus of technical cooperation) but also to feed into public grids. Bigger plants are in most cases out of the range of technical cooperation and require a much longer planning period and different constructive characteristics such as dams etc.[3]

The paper first outlines the potential of MHP and its current positioning in terms of existing and planned MHP projects in Sub-Saharan Africa. As a second step, the main barriers for MHP sector development are briefly described and wherever possible underlined with some examples from the field. For each main barrier, several potential and existing mitigating strategies are outlined and good practices are identified. The report concludes with some preliminary recommendations of how the gap between existing top-down regulation and regulatory needs of MHP projects can be overcome in order to deploy MHP in Sub-Saharan Africa on a larger scale.

[2] Most common is the classification: pico: < 5-10kW, micro: 10 – 100 kW, mini: 100 kW – 1 MW, small: 1 – 10 MW (ESHA/IT-Power, 2006).

[3] The remaining report will refer to micro-hydro power (MHP) sector development, even if this partly incorporates small-hydro and mini-hydro power sector development.

2 Relevance of small hydro power in Sub-Saharan Africa

2.1 Relevance for energy supply: Big potential untapped

12 % of the world's hydro potential is found in Africa – and due to geographical conditions most of it is located in the Sub-Saharan part. But in no other continent the gap between actual hydropower generation and the technologically exploitable potential is bigger than in Africa, where only 5 % of the potential is currently tapped (ESHA, 2006). Looking at small and micro hydro schemes, the gap is probably even bigger, but there are no estimations about the potential. While China alone has developed more than 45,000 plants below 10 MW, in the whole of Africa there are not more than a few hundred MHP plants in operation[4].

Small and micro-hydro power plants have a long tradition in Africa, but never reached a massive dissemination, although the geographical conditions in some regions are favourable. There are some early electrification projects comparable to European development (e.g. in 1895, in Cape Town the first South African hydropower station was constructed), consisting of hydro systems which powered large farms and industries and a number of plants operated by church missions as well as mechanical mills. In most of the countries the existing MHP plants were funded by international donors or NGOs and remained isolated projects, which are rarely well documented and were never scaled up. In addition to electricity generation, mechanical water mills are commonly used in some countries.

In the last decade, however, some countries have made progress in promoting MHP more systematically, moving away from demonstration and pilot programs to large-scale initiatives. In most of these countries, amongst them Rwanda, Kenya, Ethiopia and South Africa, decentralized renewable technologies such as MHP have been mainstreamed in regional and national policy documents. Incentives like tax reductions and feed-in tariffs have been established or are at least in discussion. In Rwanda, small hydro is contributing a significant portion to the installed capacity, and even micro hydro is becoming a significant contribution. Key to the Rwandan success has been a sector wide approach (SWAp) by various donors, lead by a strong Ministry for Infrastructure who sets clear targets and provides a policy framework and own budgets for the electrification of the country. While governments and donors in some countries bundle their efforts to push electrification, also private project developers are taking an increasing interest in decentralized renewable technologies. The pioneers have given way to larger, more sophisticated companies with strong links to international players. The European Small Hydro Power Association considers Uganda and Kenya as countries with promising short-term SHP markets, while countries such as Mozambique, Zambia and Rwanda offer good medium-term perspectives (ESHA-IT 2006).

Small hydropower offers a chance to tackle the three major challenges of the African energy sector development by

- Helping to increase rural electrification rates
- Installing additional capacity for the national and local grids, independent from imported fuels
- Promoting productive use of energy in structurally underdeveloped areas

[4] In a desk survey conducted for 15 SSA countries, the authors could identify a total of 218 existing SHPs (below 10 MW) and 600 – 1000 mechanical water mills (see annex for the referenced documents).

Unfortunately there is not much evidence regarding impacts of MHP in Sub-Saharan Africa. As in other countries, productive uses of energy in rural areas can only be expected if complementing measures are included in the project design, such as micro-credits for machines, better linkage to markets and SME promotion.[5]

2.2 Existing plants and small hydro projects: scattered information

It is difficult to elaborate a baseline for small hydro development in Africa, as information is found in scattered form and only for some countries. This is valid even more for mini and micro hydro sites, which are documented only in a few well-known cases. Furthermore, different sources of information provide inconsistent data about exiting plants. Even where detailed baselines studies have been elaborated (like in South Africa), there are no reliable figures about exiting plants.

In many countries, most of the existing plants still date back to colonial times; many of them were implemented by church missions. For example in Tanzania, more than 16 small systems were installed by church missions in the 1960s and 1970s. In Kenya, SHP plants from the 1950s are still in operation. On the other hand, in South Africa alone there are hundreds of de-commissioned plants, waiting for rehabilitation, while only a few new plants have been constructed in the last years. Many of the old sites mentioned in historic reports are forgotten and cannot even be located today. Figures about recent projects are easier to obtain because government action plans and information of ongoing donor funded projects allow for more accurate estimations. For example, in Rwanda, currently 15 MHP plants are under construction and another 21 are planned.

The estimated potential is mainly based on a rough analysis of water catchment areas and does often not consider whether there are potential consumers nearby or possibilities to feed in existing grids. Another proxy for the micro and pico hydro power potential of a country is the availability of mechanical hydro mills. These sites often allow an upgrading for power generation, as the people are already experienced with the use of hydro power. Examples are found in Ethiopia, where this technology was introduced by Arabs some hundred years ago, and other examples can be also found in Mozambique and Tanzania.

The following table shows potential and existing sites / capacity based on a desk research and interviews.

[5] One example of how the usage of MHP can support productive uses of energy is a MHP project which is mentioned in a report about the East African Greening Tea project. Allegedly the concept of “Hydro-Powered Multi Functional Platforms” is successfully implemented in a 13 kW MHP project by Practical Action. Now being in operation for about 6 years, the plant supplies a welding shop, a bar restaurant, various shops and a charging station for mobile phones. At night the systems pumps drinking water to the houses of the community (de Bakker, 2006)

Table 2: Current situation of MHP development in selected SSA countries

Hydro power	Ethiopia	Kenya	Mozambique	Nigeria	Rwanda	South Africa
Total installed capacity	662 MW	677 MW	2136 MW	1983 MW	27 MW	653 MW
MHP potential	> 600 sites[6]	3000 MW	Unclear	277 sites, 734 MW	333 sites, 96 MW	5.5 MW (< 1 MW)
Existing MHP plants / installed capacity	Unclear	3 - 60 (1-80 kW)	6 (10-80 kW)	7 SHP (1-10 MW)	6	45 - 96 MHP[7] 8 - 35 MW (< 1 MW)
MHP plants under construction	5 (7-200 kW)	Unclear	None	Unclear	15	Unclear
MHP plants planned	None	20	3 (23-600 kW)	Unclear	21	Unclear

Source: WEC 2007, GTZ Regional Reports 2009, interviews

One of the early non-governmental promoters of MHP in Africa is the British NGO Practical Action, who presented in 2000 two of the few well documented pilot projects[8]. At the moment they are implementing a regional micro hydro project with 15 installations in Malawi, Mozambique and Zimbabwe (Klunne, 2010). In Kenya, for example, over the past 3 – 4 years 60 MHP plants have been installed in the Mt. Kenya region, following a pilot project.

MHP development in SSA is also funded and supported by multilateral donors like World Bank, AfDB, GEF or UNDP. One example is the “Greening the Tea Industry in East Africa” program, funded by UNEP/GEF and AfDB and executed by East African Tea Trade Association (EATTA).[9] Besides multilateral development cooperation, small hydro power deployment is also supported by several bilateral initiatives (e.g. from Belgium, Germany, Japan, Netherlands, UK and Sweden). Besides the OECD country-based donor organizations, the Chinese government, with its decade-long experience in hydro power development, is supporting several African countries to set up various hydro power schemes. Although Chinese-African cooperation focuses on large hydro, the “Light-up rural Africa”-project aimed to install 100 pico and micro hydro projects between 2007 and 2009.[10]

[6] There are more than 600 mechanical water mills which can be upgraded for electrification.

[7] DoME, 2002, Baseline study. Within the study, different sources show different numbers of existing MHP plants. Generally, most of the counted sites are not longer in operation.

[8] Tunga Karibi (Kenya), 4 projects in Zimbabwe and Mozambique

[9] By establishing 6 small hydro power demonstration projects (0.2 – 5 MW) in at least 4 of the EATTA member countries, the project aims at reducing greenhouse gas emissions and at increasing power supply reliability in tea processing industries. Having village electrification components attached, the project proves that large productive consumers can be a nucleus for rural electrification.

[10] Information about the outcome of this project could not be found by the authors.

3 Main barriers and good practices for MHP development

Although progress has been made in certain areas, the low number of existing MHP shows that there are still many barriers hampering the dissemination of this technology. In general, the lack of supportive policies, funding and payment abilities restrict investment incentives for private companies in the MHP sector (Hankins, 2008). The following barriers have been mentioned in interviews and in other reports:

- ***Policy and regulatory framework:*** Partly related to the lack of financing and capacities is the inadequate regulatory framework for the MHP sector in many countries. In many cases, sufficient policies and regulations governing MHP development simply do not exist. MHP development is either not regulated at all or it is part of a broader regulatory framework made for rural electrification which, however, leaves many aspects relevant for MHP unclear and intransparent. This insufficient regulatory framework leads to situations in which e.g. MHP project developers often do not know which requirements apply and work in an unreliable grey area of regulation.

- ***Financing:*** The lack of funds for MHP projects has been mentioned as one of the most severe barriers to sector development. So far, most of the MHP projects have to rely on donor funding, which will only be able to finance a small portion of the available hydro power potential. To become less dependent on public funding, the big challenge for further MHP sector development is therefore to tap other sources of financing, especially from the private venture capitalists and local banks, and ultimately to bring down MHP costs (currently costs are approx. 3,000 US$/kW).

- ***Capacity to plan, build and operate MHP plants:*** Another serious challenge is the missing knowledge and awareness on MHP potentials for rural electrification; political decision-makers still tend to go for the "modern" and visible large hydro power schemes; political institutions from ministries via regulatory authorities to district administrations often posses only minimal capacity to design, implement and revise MHP supportive policies and regulations; and at a technical level, local capacity is often missing to plan, build and run MHP projects. The lack of a ready supply of affordable turbine parts and the lack of domestic manufacturing capacity for hydro systems of all sizes also poses a barrier to a swift and cost-effective MHP project development.[11] For a sustainable and long-term MHP sector development, much effort has to be made to increase MHP-relevant capacities in Sub-Saharan African countries in order to reduce the dependence on foreign assistance.

- ***Data on hydro resources:*** As politicians and the power utility often lack interest in MHP deployment and also lack the appropriate capacities and budgets, public data on potential MHP sites is often not available. Such a lack of sound basic data (e.g. on mid-to long-term hydrological, geographic, geologic data and figures on the current and future demand for electricity and social infrastructure, but especially on effects of seasonal and long-term river flow variations), poses a major barrier for private investors in MHP. Increasing climate variability and the destruction of rainfall catchment areas are making investment in hydropower systems a risky venture[12].

[11] See various reports (e.g. Klunne, 2007), Goverment of Kenya etc.

[12] In Kenya, the estimated hydro potential has already decreased due to deforestation and reduced precipitation (GTZ Regional Report, 2009).

3.1 Policies and strategies: progress in the last decade

Clear targets and transparent planning

A clear energy strategy with a strong focus on rural electrification is an important precondition for a significant dissemination of small hydro power. Besides a long-term vision, such a strategy should set concrete targets and include strategies for key areas as well as implementation plans with budget allocations, not only for the national investments but also incorporating the main international donors. There are, however, only a few notable rural electrification strategies that put a special focus on renewable energy deployment. For example, in Rwanda, a sector wide approach (SWAp) of all donors, based on a national energy policy with clear targets and poverty orientation, could mobilize US$ 400 million to increase the electrification rate from 6 % in 2005 to 16 % in 2012.

Almost all Sub-Saharan African countries now have rural electrification plans but mainly focus on grid extension and hardly focus on renewable energies or even MHP deployment. For example, the Master Plan for Electrification of Mozambique aims to achieve an access ratio of 20% by 2020. Out of the US$ 850 million, US$ 200 million are earmarked for rural electrification projects. Although the rural electrification agency FUNAE has renewable energies in its portfolio, there are so far only three MHP plants in the pipeline. Some countries experience problems with the reliability of rural electrification plans. The availability of long-term grid extension plans enables the MHP investor to assess financial project viability. These plans provide useful information on whether a locality will soon enjoy grid extension or whether the set-up of an independent (MHP) mini-grid makes sense. There are, however, some countries like Ethiopia in which existing off-grid electrification plans are being revised almost on a yearly basis due to political reasons which severely diminishes their reliability for investors.[13]

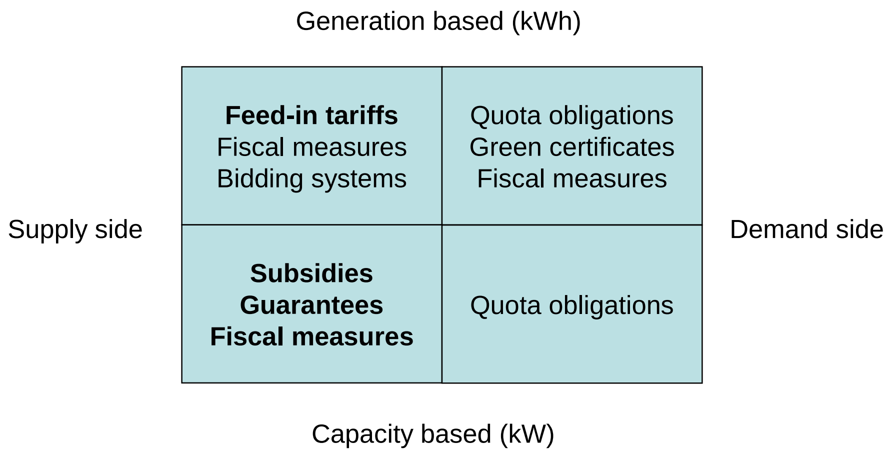
In other countries, rural electrification is often not considered in any sector reform at all, and adequate regulations for small and independent power producers are not in place. In this situation, MHP projects have to rely on site-specific funding by foreign donors, creating project islands which are difficult to scale up (and many times not even financially self-sustainable).

Incentives and promotion

Generally, there are different policy options for the promotion of renewable energies, which are shown in the figure below. In the case of MHP in Sub-Saharan Africa, so far only some have been applied (highlighted in bold letters). Most incentives are given on the supply side, based on the installed capacity. Besides direct subsidies on the installation of plants, in some countries fiscal measures enhance the purchase and imports of certain equipments. Guarantees are only applied in one case in Rwanda, where a donor funded project promotes the financing of MHP through local banks (see chapter 3.3). Most prominent generation based instrument to promote the use of renewable energies are feed-in tariffs, which have recently been introduced in some SSA countries (see page 13).

[13] In one example, after finalising the planning period for a MHP, the grid was extended to this particular village. Fortunately, the on-grid generation is now a viable option. In countries without this option, e.g. in Tibet, large numbers of MHP have been shut down when the grid reached the area.

Figure 1: Incentives for MHP development:



Source: ESHA 2006

Quota obligations which force utilities and/or the demand side to deploy a certain percentage of RET have so far been introduced only in five countries (Australia, UK, Thailand, Poland, Japan), but not in Africa.

Most of the existing MHP in SSA have been subsidized either by donor agencies or public funds. If local governments are given the mandate and the budget, they are more prone to experiment with small-scale and cost-effective solutions like MHP than the planners in national-level agencies who like to "think big". However, even if local governments decide to pilot MHP schemes, they often lack capacity and experience in choosing the appropriate contracting partner and in supervising the MHP deployment process. This linkage between rural electrification and decentralization is often not acknowledged - only South Africa, Madagascar and Sudan explicitly refer to energy issues in their decentralization process.

3.2 Supportive regulation and institutions for MHP development

In many African countries, a general legal framework for renewable energy deployment is in place. The opening up of electricity markets to independent power producers has been an important step. However, the regulatory system is in most of the cases not adequate to promote decentralized solutions such as MHP. In many countries, it was established to regulate one or more large utilities. To be compatible with MHP, the system would have to be adjusted to regulate a large number of different entities, including small private power producers and community based cooperatives. In Kenya, for example, a MHP project (Thunga Kabiri) was at first not allowed to supply electricity directly to households due to legal requirements (although this problem could later be resolved). Another example is Ghana, were three different institutions have to give their permission to independent power producers to allow them to generate and distribute electricity. Based on the experiences made, the following paragraphs identify the main regulatory challenges in relation to MHP.

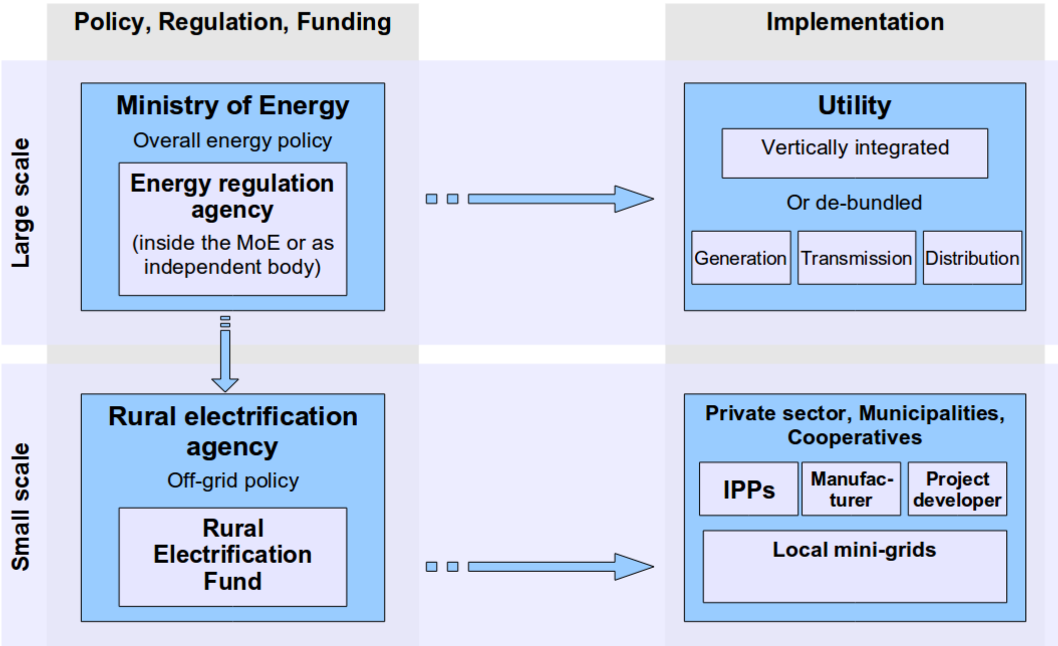
Setting of clear institutional arrangements

A supportive institutional arrangement is crucial for MHP sector development. Due to the World Bank driven reorganization of the energy sectors, most of the Sub-Saharan African countries have a similar institutional set-up (see figure 2):

While the overall energy policy is made by the Ministry for Energy, often an additional regulatory body exists (sometimes even independent from the Ministry) in order to watch over the implementation of energy laws and regulations. Additionally, a rural electrification agency (REA) has the mandate to plan and implement smaller off-grid electrification projects. In some cases, the REA also manages a Rural Electrification Fund for off-grid electrification projects.

The utility, either as a vertically integrated public unit or already unbundled and partially privatized as several independent service companies for generation, transmission and distribution, usually remains responsible for grid extension. Small scale generation and mini-grids are implemented either by private companies, municipalities or community cooperatives.

Figure 2: Relevant institutions for MHP Sector development



In many countries large, usually monopolist power utilities (either still state-owned or already privatized) hamper instead of support the dissemination of decentralized technologies. A 2008 study of the Southern African power sector by market researcher Frost & Sullivan, found out that national power utilities showed only limited interest in developing such projects. Where funds are available - and South Africa's Eskom is the utility most actively raising capital - investment is usually geared towards large-scale projects which promise to deliver power at a lower short-term cost per unit. As most countries follow this approach, off-grid MHP plants have to be shut down as soon as grid extension reaches their local mini-grids, instead of being allowed to feed power into the grid. Even in countries where feed-in-tariffs exist which oblige the utility to connect IPPs to the grid, there are examples, e.g. from Uganda, where IPPs still need to negotiate conditions with the utility.

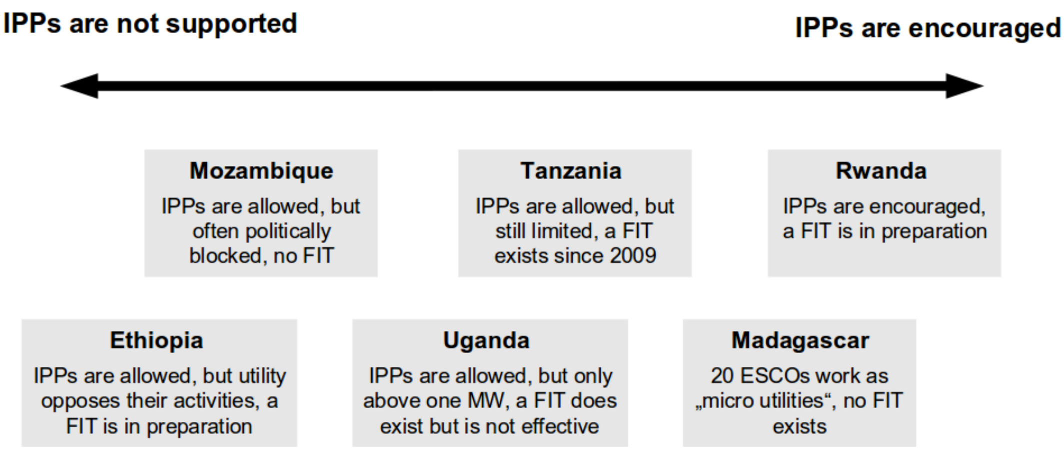
In opposition to Asia, were the number of small private service providers (SPSPs) in the energy and water sector has doubled between 1995 and 2005, SPSP activity in Africa was taking place on a much smaller scale due to their limited access to financial markets, high transaction costs and monopolistic structures of national utilities. Within Sub-Saharan Africa, a World Bank study identified only Kenya as a country with high incidence of SPSP (approx. 500,000 or 21 % of all households were electrified through a SPSP), but identified also an increasing trend of SPSP activities for Mozambique, Ethiopia and Uganda. There are also some countries like Senegal or South Africa, where SPSPs play hardly any role in offering electrification services (Kariuki 2005). A progress in the sector reforms might boost their number in the future and make them important intermediaries in the efforts of MHP dissemination. Successful small private hydro programs are mostly based on a Build-Own-Operate (BOO) concept, i.e. there is no transfer of the asset to the state at the end of a specified contract period or water use concession.

Setting of tariff levels and structures

Guaranteed favourable tariffs for independent power producers to feed in public grids is the most common policy instrument to promote renewable energies in industrialized countries. But there are also encouraging examples in developing countries: in Mauritius feed-in tariffs were the key drivers for increased bagasse cogeneration. In Sri Lanka feed-in tariffs boosted MHP plant rehabilitation and development of new plants in the last decade (AFREPREN, 2009).

In some SSA countries, it is now also possible to feed independently generated electricity into an isolated or public grid. South Africa, Kenya, Tanzania and Uganda are the first countries which have established feed-in tariffs; others are just starting to draft respective schemes. However, in most SSA countries IPPs still have to negotiate individual power purchase agreements (PPA) with the utility (see figure 3 for an overview). Because most utilities are not obliged to buy electricity from IPPs, they either oppose power purchase right away (especially from small installations) or come up with tedious PPAs which in some countries have to be renewed annually. Under such conditions, MHP project development is not profitable for small sites.

Figure 3: Overview on regulation for IPPs and feed-in laws



For Tanzania it is yet too early to evaluate the impacts of the new law. In Kenya and Uganda, the feed-in-tariffs don't seem to be effective, because – at least in Kenya – the feed-in-tariff is only a ministerial-level policy and not an Act of Parliament, so that enforcement is restricted. The following table shows the system from Kenya with different tariffs for different sizes of SHP plants:

Table 3: Feed-in system for small hydro in Kenya

	Size	Firm power tariff	Non-firm power tariff	PPA duration
Small hydro power	< 1 MW	12 c/kWh	10 c/kWh	15 years
	1 – 5 MW	10 c/kWh	8 c/kWh	
	5 – 10 MW	8 c/kWh	6 c/kWh	

Source: AFREPREN, 2009

Utilities often do not feel obliged to grant the specified tariffs to the IPPs, so that tariffs still need to be negotiated for each individual site. Many countries such as Rwanda and Ethiopia are already in the drafting process for feed-in-tariffs for renewable energies and it remains to be seen whether these also incorporate tariffs especially set for small-scale renewable energies or MHP in particular.

Setting of quality-of-service standards

A similar situation exists in most countries in regard to quality-of-service requirements, which are often too tedious for MHP projects because e.g. large-scale and small-scale hydro power projects have to abide to the same regulation. This undifferentiated rule application pushes requirements for MHP projects unrealistically high. There are also countries which have no standardization of quality requirements at all or where its applicability for MHP is unclear.

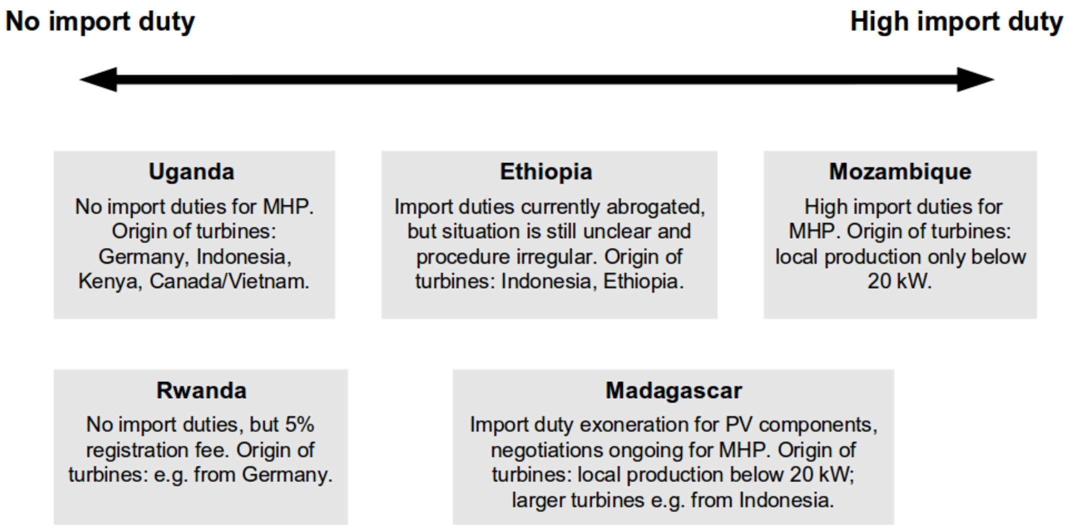
Setting of entry requirements

In many Sub-Saharan African countries, MHP project site developers are faced with an unclear and in-transparent regulation concerning MHP requirements. In order to get permission for the set up of a MHP project, developers usually have to acquire land and water usage rights, conduct an environmental impact assessment, and they often have to obtain industrial permits and permissions from the local government authorities. Furthermore, generation concessions and feed-in contracts or distribution concessions are required. In countries where requirements are not clear, project developers often prefer to “not wake a sleeping dog” and to go ahead with project development without inquiring about actual requirements. While such a strategy seems to work out for individual projects which are backed politically, a large-scale MHP sector development cannot rely on such an in-transparent system. A streamlining of requirements and a differentiation of requirements according to project type and size (like in feed-in-tariffs) is therefore recommended. One positive example can be found in Tanzania, where requirements are differentiated for MHP plants larger than 1 MW (which then need a concession from the regulatory authority) and plants smaller than 1 MW (which only have to inform the regulatory authority). In Madagascar, the ministry issues permits for plants larger than 1 MW and smaller plants are handled by the Rural Electrification Agency.

Setting of requirements for subsidies or other incentives

High import duties and value-added taxation can also be cumbersome for MHP sector development. If import duties and taxes are too high, MHP projects will not be able to import good quality turbines and other equipment, which can lead to project closure in countries where local alternatives are not available. One example for such a situation is Mozambique, which still has high import duties on turbines, but which also has a capacity bottleneck in-country to produce turbines other than simple cross-flow turbines. Some countries give import duty exonerations for equipment for development-oriented projects (see figure 4 for an overview). MHP projects in these countries can choose among local or international turbine manufacturers. This freedom of choice enables project implementers to choose e.g. turbines from more advanced developing countries, which are of good quality but still less expensive than European models. Interesting to note in this context is also an attempt for South-South technology transfer between Indonesia and Ethiopia in the field of cross-flow turbines, supported by a GTZ project in order to enable the set-up of a local turbine production site.

Figure 4: Overview on import duty exonerations



3.3 Financing SHP: private investment needed

The fact that MHP requires high initial investments underlines the importance of adequate and accessible funding schemes. The specific investment costs of MHP varies, ranging from 1,000 to more than 10,000 US$ per kW. Costs depend on the site conditions, availability and quality of equipment and construction and the mode of operation (off-grid or grid-connected). Local contributions can reduce these costs significantly.

In Sub-Saharan Africa, MHP projects today rely mainly on public and donor funding. As the demand is high and public budget in most of the countries very much limited, a sustainable long-term sector development must involve increased private sector investment. Public and especially donor-based funding of entire MHP schemes should be complemented by creating conditions which make MHP projects attractive to private investors, including financial incentives and smart subsidies. This way the public funds can develop a leverage effect for private investment.

However, especially in remote rural areas, electrification rarely is a profitable market (as rural consumption is low and connection costs are higher than in urban centres). Comparable to the primary set-up of transmission and distribution grids which require public funding, the development of MHP-fed mini-grids in rural areas also depends on a certain degree of public support. Current experiences with off-grid MHP show that it is very difficult to develop schemes with less than at least 50% public funding (considering investment and labour cost but excluding the technical assistance!). For a viable scaling-up approach for MHP, there are the following possible good practices of diversifying funding sources and bringing down costs.

Public funding should mainly support the primary investments in non-local components of mini-grids and infrastructure, while costs for local material, labour and all operation and maintenance costs should be covered by a local business model. One option to increase the availability of government funds for such kind of support is to impose a levy on on-grid electrification prices for larger consumers. The additional revenues gained can then be earmarked for rural electrification. The new energy law in Kenya includes such a cross-subsidy scheme by asking a 5% levy on the electricity sold to finance the rural electrification fund. Madagascar has a comparable scheme in which electricity consumers with a consumption of more than 20 kWh per month have to pay a levy into a rural electrification fund which is administered by the Rural Electrification Agency.

Most of the Sub-Saharan countries are currently undergoing a decentralization process. In the (still few) cases in which the central government transfers budget allocations to the local government, these funds can also be used to develop energy infrastructure including MHP at the district level. While there is so far little evidence that energy has been prominently included in official decentralization policies and documents (UNDP, 2009), there are examples e.g. in Mozambique, where local governments show a strong interest to start activities in the energy sector.

Although **local banks** are not yet knowledgeable about the technical aspects and financial viability of MHP projects and thus lack interest and sufficient insight to provide loans on favorable conditions, there are some promising pilot projects aiming to raise local banks' interest in MHP. For example, the GTZ PSP Hydro project in Rwanda shows that the local private and financial sector can contribute significantly to the financing of MHP (Pigaht, 2009). In this arrangement, private banks are asked to finance MHP at competitive conditions, using the electro-mechanical equipment as guarantee, combined with guarantee facilities of multilateral development banks. However, the GTZ program provides still 30 – 50 % investment subsidy, technical assistance and business support. Probably the best argument in this dialogue is to showcase the projects' profitability by referring to successful MHP demonstration projects in the country.

Bringing down costs is another option of making MHP projects more attractive for private investors. One potential good practice is to set up MHP projects with an integrated ownership model: a private investor is responsible for the upfront-capital, the set up and the technical O&M of the MHP plant; the community is, however, involved in collecting payments, dealing with payment delay, theft and in organizing community contributions. Having a community committee or cooperative responsible for tariff setting can also help to ensure that a tariff system is set up which allows for enough income to cover costs, maintenance and repairs, to offer reliable revenues for the private investor and to ensure that tariffs are still within the local range of willingness and ability to pay. If MHP systems are grid-connected, a reliable and attractive feed-in-tariff is the best option to ensure the long-term financial viability of a MHP system.

Other sources for MHP investment

A large number of small hydropower projects have globally been financed under the Clean Development Mechanism (CDM). While hydro power projects make up the majority of project types of the large CDM markets in China and India, SSA countries have so far only been able to develop 12 out of the currently 1436 hydro power CDM projects in the pipeline (UNDP Risoe Center 2010). None of the 12 CDM projects falls into the category of MHP, but they have installed capacities between 1,5 MW and 262 MW (see table 4). One major barrier to the further usage of CDM capital for MHP projects development are the limited structures and experiences of SSA countries to promote CDM projects at large scale. Although the global future of CDM after 2012 is still unclear, there are several donor-financed programmes that address the lack of CDM capacity in SSA countries.

Table 4: CDM Hydro power projects in Sub-Saharan Africa

Country	Project name	Project type	Capacity (MW)	Status
Kenya	Redevelopment of Tana Hydro Power Station Project	Existing dam	19,6	Not yet registered
	Optimisation of Kiambere Hydro Power Project	Existing dam	20	Not yet registered
Madagascar	Sahavinotry Hydro Power Plant	Run of river	15	Not yet registered
Mali	Félou Regional Hydropower Project	Run of river	62,3	Registered
Nigeria	Kainji Hydropower Rehabilitation Project	Existing dam	262	Not yet registered
South Africa	Bethlehem Hydroelectric project	Run of river	7	Registered
	Clanwilliam Hydro Electric Power Scheme	Existing dam	1,5	Not yet registered
Tanzania	LUIGA Hydropower Project in Mufindi District	Run of river	3	Not yet registered
Uganda	West Nile Electrification Project (WNEP)	Run of river	3,5	Registered
	Bugoye 13.0 MW run-of-river Hydropower project	Run of river	13	Not yet registered
	Ishasha 6.6 MW Small Hydropower project	Run of river	6,6	Not yet registered
	Buseruka Mini Hydro Power Plant	Run of river	9	Not yet registered

Source: UNDP Risoe Center, June 2010

A new climate-related source for financing has recently been set-up with the program on Scaling-Up Renewable Energy in Low Income Countries (SREP), of the Strategic Climate Fund (SCF), within the framework of the Climate Investment Funds (CIF) that is implemented by the multilateral development banks. The SREP shall stimulate economic growth through the scaled-up development of renewable energy solutions.[14]

3.4 Building of local capacity: at all levels

An important factor for the sustainable dissemination of MHP is the local capacity to plan, build and operate the plants. Without feasibility studies of good quality there will be no investment, and without a proper maintenance and the capability to repair and replace broken parts the life span of a plant will be reduced. Project developers play a crucial role in undertaking various forms of intermediation to involve the different local stakeholders. Locally-manufactured components can contribute to reduce the initial costs of a MHP (as is

[14] www.climateinvestmentfunds.org/cif/srep

the case e.g. in Indonesia) but usually requires long-term commitment and does not necessarily lead to short-term results. In the detailed analysis of 4 African MHP plants, Barnett and Khennas pointed out that the lack of knowledge about financial management and utilization of electricity to generate revenues is a main deficit for a successful operation in SSA (Khennas, 2000).

Due to the lack of specific projects in Sub-Saharan Africa, few people have knowledge – and particularly practical experience – with MHP technology. In the frame of some internationally-funded pilot projects, local engineers and technicians have been trained, but few countries can count on good consultants who are able to carry out feasibility studies or build and operate plants. There are four approaches to address this deficit:

1) Establish international or regional knowledge networks and induce foreign expertise by training local technicians. In 2006, UNIDO and the International Network for Small Hydropower (IN-SHP) established the Regional Centre for Small Hydro Power in Abuja, Nigeria. The aim is to build local capacity in the ECOWAS region. So far more than 50 technicians have participated in 40 days courses in MHP related subjects. Earlier efforts to establish a knowledge network, like the African Microhydro Knowledge Network which was established in 2004 by 10 countries with the support of UNDP-GEF, UNIDO and AfDB, have not survived.

2) Strengthen technical schools and science institutes to build up local capacity. In Rwanda, for example, new vocational training courses at colleges are offered. In most of the countries, R&D facilities like the KIST in Rwanda or the CSIR in South Africa are counting on some researchers who work on the subject of micro hydro.

3) Project-driven approach, involving local engineers in the planning and implementation of projects and at the same time building up their skills. Most of the few "experts" in micro hydro in a country have been somehow involved in the history of the first pilot projects. Good examples are the ITDG-implemented MHP in Kenya and Zimbabwe.

4) Technology transfer. In Ethiopia, first attempts have been made to set up local companies to produce MHP equipment. A transfer of knowledge from Indonesia, supported by GTZ, has started two years ago. But still most of the installed turbines and generators used are imported from abroad.

Besides the lack of technical capacities, MHP sector development in Sub-Saharan African countries is also severely hampered by the lack of governance capacity. This incorporates the ability of rule-making and rule-enforcement for MHP project development. There are several examples, e.g. there exists a feed-in-tariff in Uganda, but PPAs still need to be (re-)negotiated with the utility; in Rwanda, requests for SHP permissions are simply given by the regulatory authority (RURA) without any cross-checking, as there is not enough capacity for proper project evaluations; and in Mozambique communication and coordination between ministries and national- and local-level government is sometimes lacking leading to e.g. a situation where a school project received energy appliances from three different government institutions.

One possible good practice of how to increase governance capacity and coordination between different government institutions is to support the set up of local energy plans. By including the local governments in the energy infrastructure planning process, awareness, capacities, and accountability for successful implementation of energy policies can be strengthened. There are several countries which are launching such local energy plans on a pilot scheme. In Madagascar, the rural electrification agency is currently developing local energy plans in 4 out of 22 regions and will have covered the whole country by the end of 2010. In Uganda, energy officers are going to be trained for 5 pilot provinces. Their mandate will be to be the focal point of the local government for energy issues, including energy demand and supply planning for their area. Also in Mozambique, there are initiatives at the district level governments to set up energy plans. Their purpose would be to identify potential sites, use these plans to apply for a corresponding budget and thereby to create more ownership among the district governments for rural electrification issues. Another strategy to develop local capacities is to keep well-qualified people at the local level by raising the attractiveness of their jobs, e.g. in Mozambique, the rural electrification fund and the utility provide good salaries so that well-skilled local people are motivated to work at such institutions.

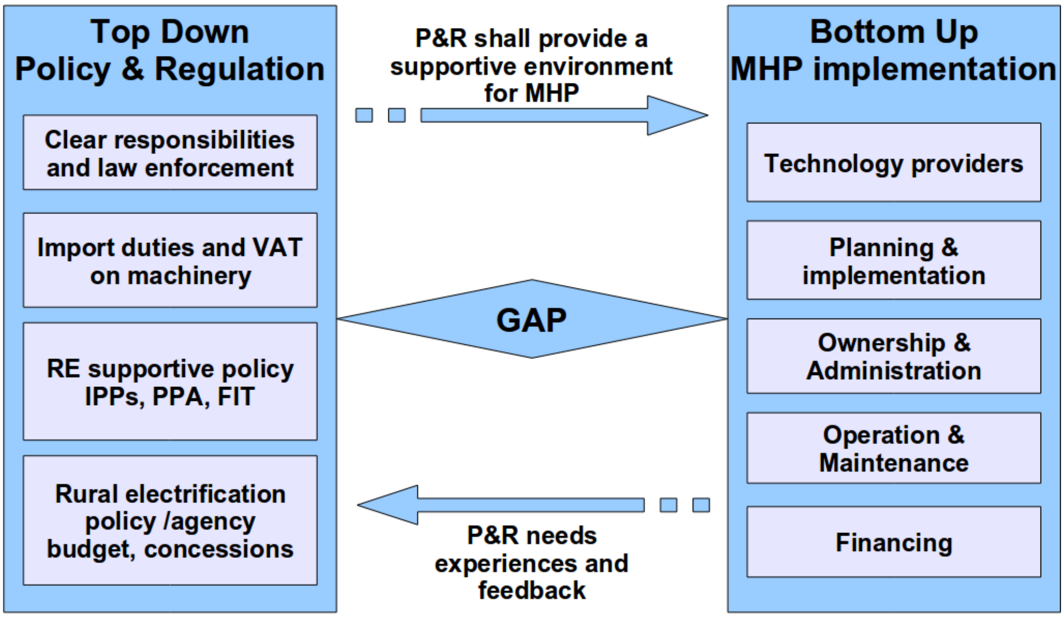
4 Conclusions and recommendations

The vast potential of small hydro power in Sub-Saharan African countries is one promising option to cover increasing energy demand and to enable electricity access for remote rural communities. This opportunity has only recently been acknowledged and awareness among political decision-makers is still weak. MHP sector development is therefore only slowly taking up speed and is still facing a broad range of challenges. This report has shed light on some of the main barriers for MHP sector development, but has also identified some promising practices employed in several Sub-Saharan African countries of how to overcome these barriers. Also some successful MHP demonstration projects exist that can be the foundation for up-scaling initiatives.

Closing the gap

Due to the small-scale character of MHP projects, MHP sector development relies not only on good national-level policies, regulations, capacities and financing schemes, but needs to incorporate the local level. This is likewise a chance and a challenge as the national and the local framework conditions have to match each other in order to create an enabling environment for the MHP sector (see figure 5).

Figure 5: The role of policy and regulation for MHP sector development



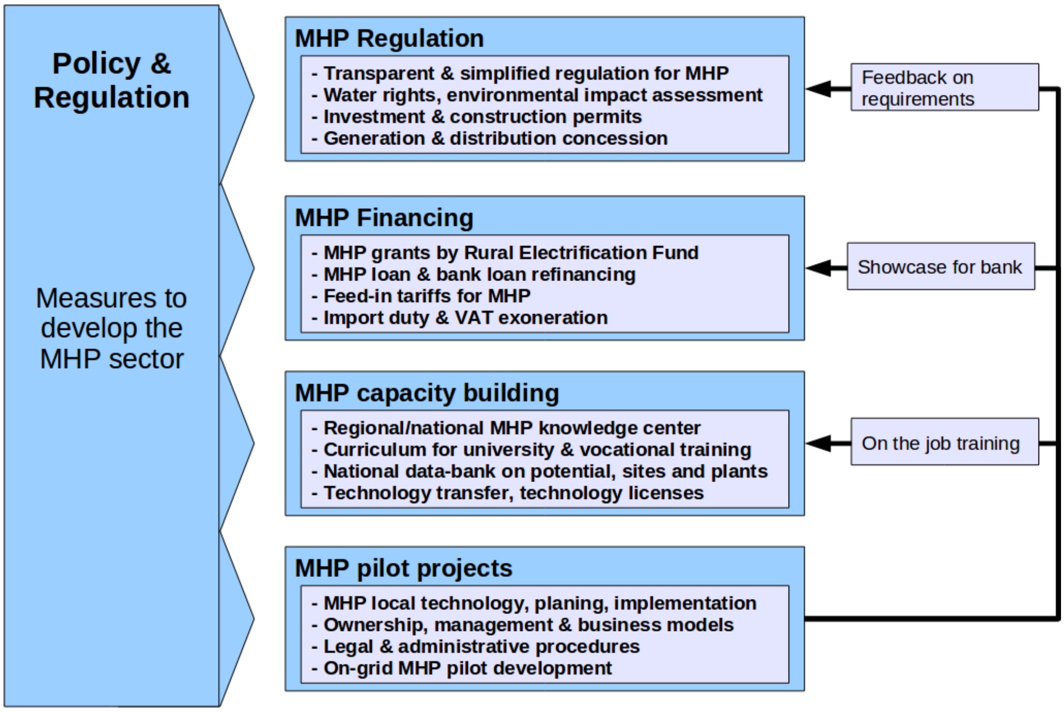
The MHP situation in most countries is characterized by a gap between the national-level policies and regulations and local MHP project implementation. As long as this gap exists, framework conditions for MHP sector development will persist to be unclear and unreliable and therefore hinder a dynamic development of MHP dissemination. Experience from OECD countries reveals that closing the gap can take decades and requires a continuous negotiation process between government institutions, private companies, communities and consumers.

Addressing the interfaces of regulation and sector development

An effective policy for the promotion of MHP should not only focus on the legal framework. It must also address the need for capacity building and financing at all levels: “There is a need to support renewable energy champions and to target education and awareness-raising among power companies, consumers, regulators, government, and renewable industries. Policy makers require assistance developing regulatory structures and incentives. Those implementing projects require technical training, and assistance in project planning and financing" (Hankins, 2008).

While an inappropriate regulation can pose a serious barrier to MHP dissemination - a smart and integrated policy and regulative framework can support MHP sector development on all levels. In this context, the cooperative and communicative aspects of regulation need to be understood and highlighted. As shown in figure 6, there are many linkages and feedback loops which can be strategically used but which can only have an effect if the stakeholders and institutions involved cooperate with each other and continuously adjust their strategies and activities.

Figure 6: Addressing the demand for capacity and financing with regulative measures



In order to achieve a significant scaling up, the creation of a "critical mass" of MHP deployment is necessary and to this end the private sector should be more involved: "Once frameworks are in place and legal obstacles are removed, private sector partnerships between local and international companies can result in profitable ventures that are good for African economies (Hankins, 2008)". As shown in the figure above, rather than relying only on direct subsidies for investment costs, profitability of MHP systems can be more adequately achieved with an enabling environment which guarantees access to resources, to the required licenses and to long-term financing, grants exemption from customs duties, VAT and income tax, and capacity building – all important steps in attracting private investors. However, due to the remote areas and the limited ability to pay of the communities where electrification by MHP takes place, it cannot be expected that private investors can profitably finance the set-up of rural MHP mini-grids without at least some public support for the initial investments.

In Sub-Saharan-Africa – as elsewhere in the world - the “golden rules” of regulation should be considered: “…Regulation is a means to an end – what matters is the outcome in terms of supplied household…The benefits of regulation must exceed the costs. (Reiche et al., 2006)” Good policies and regulations usually reflect the public interest (e.g. rural electrification) but also take up the concerns of private investors (e.g. streamlining permit requirements). It has therefore turned out to be conducive for policy making if regulators “delegate” certain tasks to more operative institutions, such as rural electrification agencies or funds, because they normally know better the requirements of the involved actors. In addition, regulations should consider the character of the entities which are regulated. In rural electrification a “one size fits all” approach is not suitable.

A Guidebook for the integrated development of MHP policy and regulation

For the development of a guidebook for MHP policy makers, the authors recommend to incorporate the following subjects:

- Incorporation of MHP development in national policies and sector strategies
- Establishment of a data base (existing projects and pipeline, potential projects, funding options, operators, service and equipment providers)
- Analysis of existing regulatory framework and adjustments to promote MHP development
- Smart subsidies and other incentive schemes
- Strategies of how to incorporate the private sector
- Best practice for operating schemes
- Capacity building for involved institutions

5 Literature

5.1 Interviews

During the preparation of this background paper the following persons have been interviewed and contributed their insights and experiences:

Name	Organisation / function	Date of the Interview
Albert Butare	Former Energy Minister, Rwanda	29/3/2010
Valentin Schnitzer	Consultant for GTZ	12/05/2010
Peter Schragl	GTZ Uganda	13/05/2010
Ivan Karau	GTZ Uganda	13/05/2010
Dirk Van Eijk	GTZ Mozambique	11/05/2010
Zana Crispen	GTZ Mozambique	11/05/2010
Jemusse David	FUNAE Mozambique	13/05/2010
Joachim Gaube	GTZ Ethiopia	12/05/2010
Bart Jan van Beuzekom	GTZ Ethiopia	12/05/2010
David Soeren	GTZ Madagaskar	12/05/2010
Mario Merchan	GTZ Rwanda	13/05/2010
Wim J. Klunne	CSIR South Africa	15/05/2010

5.2 Literature

AFREPREN/FWD. 2009. "The Role of Feed-in Tariff Policy in Renewable Energy Development in Developing Countries: A Toolkit for Parliamentarians". Kenya 2009. www.e-parl.net/eparlimages/general/pdf/090911FITDevCountries.pdf [03/05/2010]

Bajaj et al. 2007. "Grid-connected Small Hydropower (SHP) Development: Regulatory Issues and Challenges". International Conference on Small Hydropower - Hydro Sri Lanka. 22-24 October 2007.

Bakker, P. 2006. "More power for small hydro in East Africa!" ADB FINESSE Africa newsletter, April 2006

Cuvilas, C.A. Jirjis, R. Lucas, C. 2010. "Energy situation in Mozambique: A review". In: *Renewable and Sustainable Energy Reviews* xxx (2010) xxx–xxx (under proof).

Department of Mines and Energy (DoME), 2002. Baseline Study – Hydropower in South Africa. COWI / DANIDA report September 2002.

ESHA/IT-Power. 2006. "Small Hydropower for Developing Countries", European Small Hydropower Association. Belgium 2006. www.esha.be

Feibel, Hedi. 2003. "An Interdisciplinary Approach to the Dissemination of Mini and Micro Hydropower - the Case of Ethiopia". PhD thesis at the Technical University Darmstadt.

***Fischer, G. 2009.** "Field Visits during 1st. EnDev East Africa Micro Hydro Power Workshop,Observations and Suggestions".* PT Entec Indonesia

Gpower. 2008. "Rural Energy Access Model (REAM) - An innovative approach to sustainable rural development in Africa", http://gpower-africa.org/GBIGeneralFundingProp_031209.pdf [04/05/2010]

GTZ. 2007. "Energy-policy Framework Conditions for Electricity Markets and Renewable Energies 23 Country Analyses. TERNA Wind Energy Programme, Eschborn.

GTZ. 2009. "Regional Reports on Renewable Energies, 30 Country Analysis on Pontential Markets in West Africa, East Africa and Central Asia". Germany 2009. www.gtz.de

GTZ. 2009b. "Target Market Analysis Ethiopia's Solar Energy Market". Project Development Programme East Africa. http://www.gtz.de/de/dokumente/gtz2009-en-targetmarketanalysis-solar-ethiopia.pdf [03.05.2010]

GTZ. 2009c. "Projektentwicklungsprogramm Ostafrika: Fact Sheet – Ethiopia". http://www.gtz.de/de/dokumente/gtz2009-de-factsheet-aethiopien.pdf [03.05.2010]

IEA. 2009. "The Electricity Access Database", International Energy Agency, www.worldenergyoutlook.org/database_electricity/electricity_access_database.htm, accessed on 06/05/2010

Khennas, Smail, and Barnett, Andrew. 2000. "Best Practices for Sustainable Development of Microhydropower in Developing Countries". ITDG report. UK 2000.

Hankins, 2008. "Taking A Fresh Look: Why Africa Is Re-Examining Renewables". Renewable Energy World International Magazine, Sept./Oct. 2008, Volume 11 Issue 5.

Kariuki et al. 2005. "Small-Scale Private Service Providers of Water Supply and Electricity". World Bank Policy Research Working Paper 3727. The World Bank. Washington, DC. http://econ.worldbank.org

Kenya Ministry of Energy. 2004. "Draft Sessional Paper on Energy".

Kenya Ministry of Energy. 2006. "The Energy Act". http://www.energy.go.ke/index.php?option=com_jdownloads&Itemid=17&task=finish&cid=4&catid=3&m=0

Kenya Ministry of Energy. 2008a. "Feed-in-Tariffs policy for wind, biomass and small hydros". http://onlinepact.org/fileadmin/user_upload/Axel/Kenya_FIT_2008.pdf [03/05/2010]

Kenya Ministry of Energy. 2008b. "Feed-in-Tariffs for Renewable Energy Resource Generated Electricity - Guide for Investors". http://onlinepact.org/fileadmin/user_upload/Axel/Kenya_guidelines_2008.pdf [03/05/2010]

Klunne, Wim Jonker. 2010. "Sustainable implementation of microhydro to eradicate poverty in Africa". Unpublished. wklunne@csir.co.za

Mulder, Peter. Tembe, Jonas. 2008. "Rural electrification in an imperfect world: A case study from Mozambique". In: *Energy Policy* 36, p. 2785– 2794.

***Muriithi, J.** 2006. "Developing small hydropower infrastructure in Kenya".* 2nd Small Hydropower For Today Conference IN-SHP, Hangzhou, China on 22-25 April, 2006. http://www.unido.org/file-storage/download/?file_id=52403 [28/04/2010]

Pigaht, Maurice, and Robert J van der Plas. 2009. "Innovative private micro-hydro power development in Rwanda". *Energy Policy.* 37 (11): 4753.

Reiche et.al. 2006. "Electrification and Regulation: Principles and a Model Law". Energy and Mining Sector Board Discussion Paper No. 18. The World Bank. Washington, DC.

Scanteam. 2005. "Alignment, Harmonisation and Coordination in the Energy Sector, Mozambique". Final report. Oslo.

UNDP. 2009. "Energy in National Decentralization Policies: A Review Focusing on Least Developed Countries and Sub-Saharan Africa". United Nation Development Programme, New York 2009.

Legros et al. 2009. "The Energy Access Situation in Developing Countries". United Nation Development Programme, New York 2009.

UNDP. 2003. "Affecting Electricity Policy through a Community Micro Hydro Project". Kenya. http://sgp.undp.org/download/SGP_Kenya1.pdf [03/05/2010]

UNEP. 2006. "*Kenya: Integrated assessment of the Energy Policy - With focus on the transport and household energy sectors".* www.unep.ch/etb/areas/pdf/Kenya ReportFINAL.pdf [03/05/2010]

WEC. 2007. "2007 Survey of Energy Resources **-** Promoting the sustainable supply and use of energy for the greatest benefit of all" World Energy Council. London 2007.

World Bank. 2010. "Open Data initiative". Data base to to over 2,000 indicators from World Bank data sources. http://data.worldbank.org/country . accessed on 05/05/2010.

5.3 Further sources

Literature

EAC. 2006. “Strategy on scaling up access to modern energy services”, East African Community Secretariat, Tanzania 2006. http://www.eac.int

ECA. 2006. “Sustainable Energy: A Framework for New and Renewable Energy in Southern Africa”. Economic Commission for Africa (ECA). Southern Africa Office (SRO-SA).

ECN. 2001. “Accelerating the Market Penetration of Renewable Energy Technologies in South Africa”. The Netherlands Energy Research Foundation. Http://www.uccee.org/RETSouthAfrica

ECOWAS. 2005. “White Paper for a Regional Policy for increasing access to modern energy services”. Economic Community of West African States.

ESMAP. 2001. “Best Practice Manual: Promoting Decentralized Electrification Investment”. Joint UNDP/World Bank Energy Sector Management Assistance Programme. The World Bank. Washington, DC.

GNESD. 2004. “Energy Access theme results - Energy services for the poor in Eastern Africa”. Regional reports on East Africa, West Africa and South Africa. Global Network on Energy for Sustainable Development. UNEP 2004.

GTZ. 2004/2007/2009. "Energy-policy Framework Conditions for Electricity Markets and Renewable Energies: 16 Country Analyses”. Energy-policy Framework Papers (TERNA). Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. Division Environment and Infrastructure. Eschborn 2009.

IEA. 2004. “Deploying Climate friendly Technologies through collaboration with Developing Countries”. International Energy Agency. Paris 2004.

IEA. 2008. “Deploying Renewables – Principles for effective Policies”. International Energy Agency. Paris 2008.

IEA. 2010. “Comparative Study on Rural Electrification Policies in Emerging Economies”. International Energy Agency. Paris 2010.

International Institute for Energy Conservation. 2004. Transitioning to Renewable Energy: An Analytical Framework for Creating an Enabling Environment. Global Issue Papers No.10. June 2004.

REN21. 2007/2009. “Global status report on renewable energy”. Paris: REN21 Secretariat.

Savin, Janet L. 2004. “National Policy Instruments - Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World”. WWI. Thematic Background Paper for the International Conference for Renewable Energies. Bonn 2004.

UNDP. 2000/2004. “World Energy Assessment- Basic Energy Facts”. United Nation Development Programme, New York 2009.

UNEP Risoe 2010: CDM/JI Pipeline Analysis and Database, June 1st 2010.

Valencia, A. and Caspary, G. 2008. “Barriers to Successful Implementation of Renewables-based Rural Electrification, Briefing paper”. German Development Institute (GDI).

World Bank (2006) Renewable Energy Tool Kit. The World Bank, Washington.

Water for Agriculture and Energy in Africa. 2008. “Hydropower Resource Assessment”.

Internet Resources

www.microhydropower.net
Website with relation to ITDG / Practical Action projects, technical literature, not much about policy

www.small-hydro.com
Small hydro atlas with a description of small hydro situation in a large number of countries, data from 1998/1999

http://www.esha.be
The European Small Hydropower Association (ESHA) is a non-profit international association

representing the sector of small hydropower.

http://www.inshp.org/main.asp
The International Network on Small Hydro Power (INSHP) is an international coordinating and promoting organization for the global development of small hydro power

http://www.ieahydro.org
The Hydropower Implementing Arrangement is a working group of IEA member countries that have a common interest in advancing hydropower worldwide.

http://www.mbendi.com
African business information service covering also the energy sector.

http://www.worldenergyoutlook.org/database_electricity/electricity_access_database.htm
IEA database on electricity access based on data for 2008

http://onlinepact.org/537.html
Overview on countries where feed in tariffs have been implemented (not up to date, for Africa only Uganda, Kenya, South Africa are mentioned.

http://www.iea.org/Textbase/pm/grindex.aspx
IEA database on global policies and measures for renewable energies (focus on OECD but also some African countries).

6 Country profiles

6.1 Ethiopia

General information

Ethiopia is a land-locked country of 79.2 million people at the Horn of Africa. Geographically, the country is divided by the Great Rift Valley and has a diverse landscape coving mountains and plateaus in its highlands and deserts and steppes in its lowlands. The large differences in altitude provide a good potential for hydro power. However, rainfall patterns in Ethiopia are fluctuating and droughts are common. The country covers an area of more than one million km2 and has temperate to tropical climates depending on the location; the rainy season is in July and August, but there are also rains throughout the year. Precipitation reaches up to 2400 mm/year in the South-West, but less than 150 mm/year in the North.

Ethiopia is still one the poorest countries in the world with 44% of its population living under the poverty line and a per capita GNI of USD 280 in 2008. 52% of the national income is generated by the agricultural sector with coffee as the main export product. Ethiopia has also the lowest rates of energy consumption in the world: Only 15% of Ethiopians, mainly the urban population, had access to electricity while only 1% of the rural population has electricity access. Traditional biomass usage is thus the only energy source for the rural population. Rural electrification is a very large challenge due to 80% of Ethiopians living in rural areas although urbanization is taking place rapidly. The average per capita electric energy consumption is only 25 kWh a year, which is far below the world average of 2,200 kWh (Feibel, 2003) and also low in an African context (compared to average per capita annual consumption of electricity in Sub-Saharan Africa of 478 kWh).

International assistance is very important to Ethiopia, especially in the energy infrastructure sector. In 2004, development assistance payments accounted for 22.3 % of gross domestic product (GTZ, 2007). The major donors in the energy field include GEF, World Bank, African Development Bank and bilateral agencies such as GTZ, DGCS (Italy), Energy for Sustainable Development (UK) and the Austrian Development Agency.

The Ethiopian Electric Power Corporation (EEPCo) is the state-owned corporation for power production, transmission, distribution and supply. IPPs are allowed by law, but the utility is not interested and blocks IPPs. Important government players are the Ministry of Mines and Energy, which is the leading ministry for national energy policy and expansion of electricity provision, and the Ministry of Rural Development, which is involved in matters of rural electrification. On the regulatory side, the Ethiopian Energy Agency (EEA) is the regulating agency for the electricity market and is supposed to take care of price regulations, power purchase agreements, licensing of independent power producers, and regulating access to the grid by private producers. The Ethiopian Rural Energy Development and Promotion Centre (EREDPC) is a mostly donor-funded institution which promotes renewable energy technologies for rural areas.

Potential of hydro

At the beginning of 2010, Ethiopia has an installed hydro power capacity of 870 MW with an additional 3,270 MW under construction. Large hydro power makes up 98% of Ethiopia's power production. The government has large expansion plans for large hydro power (4,300 MW up to 2013) to stop energy shortages and to eventually become an energy exporter in

2010 (GTZ 2007). Concerning rural electrification, the Ethiopian government has set the targetto connect 50% of the households to the electricity grid (GTZ, 2007).

The theoretical potential of hydropower in Ethiopia is estimated to be 30,000-45,000 MW which would enable an annual 160,000 GWh (GTZ, 2009c). The estimated economically exploitable hydropower potential ranges between 15,000 and 30,000 MW (Feibel 2003). There seems to be large potential for MHP in areas which are remote to the grid but close to consumers (GTZ, 2007). Over 600 traditional hydro mills have been identified that could be used for MHP. There is, however, no reliable data on small- or micro hydro power potential, so GTZ is currently supporting the Ethiopian government to build a data bank on hydro resources and potential sites. NGOs and churches are also active in MHP but no private sector company is so far involved.

Small and micro hydro power is not yet developed on a large scale. There exist three smaller hydropower schemes in Yadot (350 kW), Dembi (750 kW) and Sor (5 MW). Currently GTZ is supporting 4 off-grid sites (7, 30, 35, and 50 kW) and 1 grid-connected site (200 kW). For example, the Gobecho I micro hydropower plant is built on a small river in Bona *Zuria* woreda of the Sidama zone in SNNP state with over 50,000 Euro; this EnDev project can generate about 7 kilowatts of energy and provides electric power to more than 5,000 residents of the woreda. The construction of Gobecho II and Erete micro hydropower plant is underway.

Policies and strategies to promote SHP

One major barrier to further MHP deployment is the lack of support policies for MHP and renewable energies in general. The government of Ethiopia , has launched the Rural Electrification Strategy in 2002 as a large government programme for electrification. This consists of three parts: grid extension by the public utility (EEPCO), private sector led off-grid electrification, and promotion of new energy sources. The Rural Electrification Fund (REF) with its loan programmes for diesel- and renewable energy-based projects is the main implementing institution.

An institutional focal point for the deployment of renewable energy technologies is the Rural Electrification Fund (REF) which operates as part of the Ethiopian Rural Energy Development and Promotion Centre (EREDPC) of the Ethiopian government. The main activity component of the REF, endowed with an initial budget of € 29 million, consists of supporting 180-200 rural MHP and PV mini-grids for educational and health care facilities (GTZ 2009b).

Laws and regulations

An additional programme, the “Universal Electricity Access Program” (UEAP), was launched in 2006 for grid-based rural electrification. Its goal is to connect 7,542 towns, villages and public institutions to the grid within ten years. It aims to raise per capita electricity consumption from the level of 24 KWh per year in 2007 to 128 KWh by 2015 and it strives to have 50% of the population becoming connected to the EEPCo power system by 2010 (GTZ 2007; GTZ 2009b). The major challenge is the implementation of the rural electrification plan as it is politically adapted every year so that a reliable off-grid planning is not possible.

A feed-in-tariff for renewable energies (now in the 4th draft) is under preparation by the electricity regulatory agency (Ethiopian Electricity Agency) with support by GTZ (GTZ 2009b).

Figure 7: Hydropower potential of Ethiopia

Source: www.africa-energy.com

An EIA is theoretically needed for all hydro power plants, but the regulator does not enforce it for MHP. The EIA and an approval from all neighboring upstream and downstream countries are required if the MHP plant shall be supported by a loan (7.5%, 10 payback period) from the rural electrification fund (regulation by World Bank). Other requirements for off-grid mini-grids are a distribution license, which can be obtained from the regulator. Although rules are not transparent, the regulator is supporting the procedure. An investment license is also required (except for cooperatives) and water rights have been concessioned by the ministry (if the owner is not the community which normally already posses the water rights).

Financing SHP

Private investments in the Ethiopian power sector are so far hampered mainly by low energy prices and a market dominance of the state-owned enterprises, mainly the Ethiopian Electric Power Corporation (EEPCo). According to a regulation from 1997, investments from domestic private companies into power infrastructure are only permitted up to 25 MW installed capacity; only foreign private companies may invest in power infrastructure larger than 25 MW. This regulation, the low energy prices and political and economic instability, corruption and institutional weaknesses seems to make investments into the power sector unattractive for private companies (GTZ 2007).

The Rural Electrification Fund (REF) provides loans up to 85% of investment needs with an interest rate of 7.5% for diesel projects and loans up to 95% of investment needs with a zero interest rate for renewable energy projects. Renewable energy technologies that receive support under this program include solar PV, mini and micro hydro, and biomass co-generation. Nevertheless, 14 out of 15 projects funded by the REF rely on diesel generators (GTZ 2007).

6.2 Kenya

General information

Kenya is an East African country on the Indian Ocean that borders Ethiopia, Somalia, Sudan, Uganda and Tanzania. With over 580,000 sq km Kenya comprises low plains near the coast and highlands in the interior including Mount Kenya, with 5199m the second highest mountain of Africa. Its population has been estimated at 39 Mio. inhabitants in 2008. Kenya climate is characterised as tropical at the coast, temperate in the highlands and arid in the North and North-east parts of the country. There are two raining seasons, a strong one between March and May, and moderate one in October and November. In 2009 Kenya suffered its worst drought since decades.

Kenya is considered as one of the most stable and economic strong countries of East Africa but at the same time as one of the most corrupt states (place 146 of the CPI index[15]). In 2008 the GNI per capita has been US$ 730 (GDP per capita US$ 783, GDP growth 1.7%) with 47% of the population living below the poverty line. The inflation rate of consumer prices has been 26.2%. The per capita consumption of electricity is at a low level of 151 kWh per capita per year (compared to average per capita annual consumption of electricity in sub-Saharan Africa of 478 kWh)[16]. The household electrification rate has been in 2008 on 15% at the national level with a large discrepancy between urban (51.3%) and rural (5%) areas[17].

Since 1999, the 51% state owned Kenya Power and Lighting Company (KPLC) is only responsible for electricity and transmission, while power generation is liberalised and split between the state owned Kenya Generating Company (KenGen) with a 83% share in 2002, and several IPPs. UNEP describes the Kenyan “current energy system ...as... not sufficiently reliable and affordable to support high economic growth … available data shows that the cost of electricity in Kenya is four times that of South Africa, the country’s main competitor in the region, and more than three times that of China” (UNEP 2006).

Potential of hydro

The theoretical hydropower potential of Kenya has estimated at 6000 MW installed capacity or 30,000 GWh/year, while the technical potential is estimated at only 9,000 Gwh/year (2100 MW). However, a more conservative estimation for the economic potential has been made, foreseeing 4710 GWh/year of which 62% have been already developed, with 14 large dams in operation (677.3 MW, generating 2869 GWh in 2005). Another 440 MW is under construction and further 70 MW are planned[18].

For small hydropower up to 10 MW the Ministry of Energy estimates a theoretical potential of 3000 MW *(*Muriithi, 2006*),* but the technical and economical potential can be expected to be far lower*.*

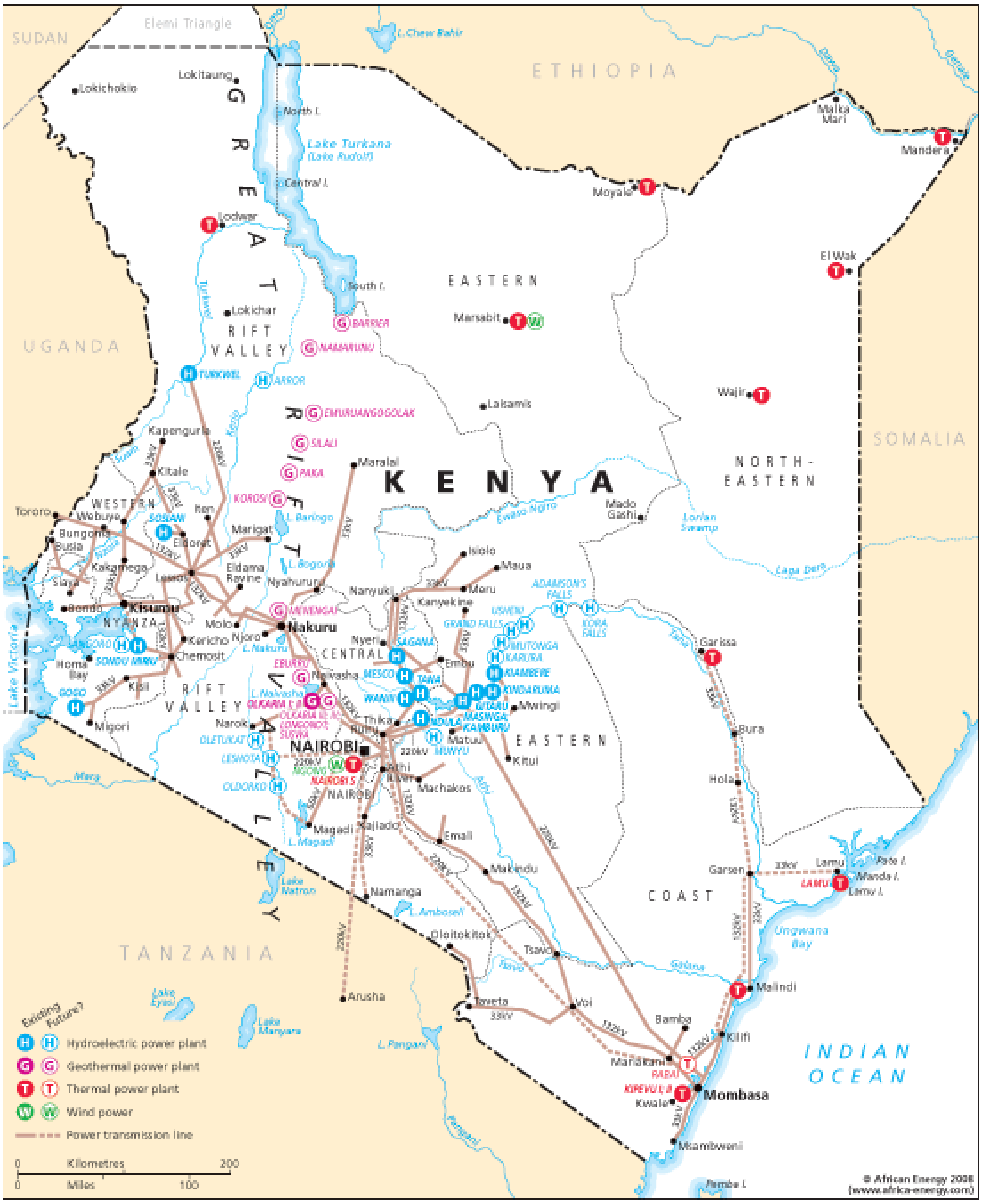
[15] www.transparency.org/policy_research/surveys_indices/cpi/2009/cpi_2009_table, accessed on 5/5/2010.

[16] World Bank Open Data Initiative website, http://data.worldbank.org/country/kenya, accessed on 5/5/2010.

[17] IEA electricity access database, http://www.worldenergyoutlook.org/database_electricity/electricity_access_database.htm, accessed on 6/5/2010.

[18] www.small-hydro.com/index.cfm?fuseaction=countries.country&country_ID=49, accessed on 6/5/2010 and *[World Energy Council 2007]*.

Figure 8: Hydropower plants in Kenya



Source: [*www.africa-energy.com/*](http://www.africa-energy.com/)

Existing plants and SHP projects

The experiences with SHP plants go back to 1925 when the first 2 MW turbine has been installed in the Thika river. However, after several installations further deployment of MHP stopped in 1954 and only took up again in the late 90ies. 5 small hydropower projects from before 1954 with an installed capacity of 6.3 MW have been in operation in 2006 *(Muriithi 2006)*. Between 1999-2002 three MHP have been developed as pilots of which the Tungu-Kabiri Community Micro Hydro Power Project is the best documented. It has been implemented between 1998 and 2001 by Practical Action in cooperation with the MoE and supported by an UNDP SGF contribution (*UNDP, 2003)*.

After a first prototype test for 200 households in Thiba, Kirinyaga District, central Kenya in 2005, the Kenyan NGO Gpower (with support of the Université du Québec à Montréal - UQAM) installed the first of three planned 80 kW turbines in Kiangurve village to supply 800 households. Ten more similar MHP schemes are planned for this region in the coming years. In a second phase a SHP (>1MW) shall be build and the different MHP shall be interconnected by a local minigrid (Gpower, 2008). GPower also conducted pre-feasibility studies for 10 more projects in western Kenya in cooperation with the Kenya Research & Development Institute (KIRDI), the Lake Basin Development Authority (LBDA) and the German Technical Cooperation (GTZ).[19]

Policies and strategies to promote SHP

After the energy crisis in 2000, a national energy policy was established in October 2004[20]. It spelled out Kenya's national energy approach with specific strategies and their implementation modalities for the period 2004 to 2023. Regarding small hydropower, the policy specifies the potential (p.13), and barriers (p.22) for small hydropower, and frames a rural electrification policy to double access from 20% in 2010 to 40% in 2020 (p 38) (Kenya Ministry of Energy 2004).

Laws and regulations

The Kenyan energy sector is regulated by the Energy Act of December 2006. The Energy Act establishes an energy regulatory commission (part 2), also regulates rural electrification (part 3) and mentions renewable energy (part 5). A Rural Electrification Authority is in place that administrates a rural electrification programme fund, develops the rural electrification master plan, promotes renewable energies, and provides licences and permissions for rural electrification. Specific targets and activities for rural electrification and small hydro power are defined in inferior regulations such as the feed-in policy of the Ministry of Energy. The Minister of Energy can set a 5% levy on the electricity sold to finance rural electrification via the rural electrification programme fund (Kenya Ministry of Energy, 2006).

Beside South Africa, Kenya is the only sub-Saharan country with a feed-in regulation. In the regulation for small hydropower (here defined as between 500 kW and 10 MW) the following feed in tariffs are set as shown in the table below.

Table 1: Small Hydro Power Feed in Tariffs in Kenya

Power Plant Effective Generation capacity (MW)	Firm Power Tariff (¢/kWh)	Non-Firm Power Tariff (¢/kWh)
<1	12.0	10
1–5	10.0	8.0
5 – 10	8.0	6.0

Source: Kenya Ministry of Energy *2008*

The tariffs shall apply for 15 years from the date of the first commissioning of the small hydro power plant. The firm power tariff shall apply to the first 100MW of small hydro firm power

[19] Kiang'ombe Hybrid Energy Kiosk of UNIDO, 2x1kW pico hydro (both projects have been visited by GTZ in 2009 and technical feedback has been given by Gerhard Fischer (*Fischer, 2009)*.

[20] A final draft was transmitted for printing as Sessional Paper No.4 on Energy (Energy Policy) and has been not completed since than.

generating stations developed in the country, while the non-firm power tariff shall apply to the first 50 MW of small hydro non-firm power generating stations developed in the country. The feed-in-tariff includes interconnection costs – transmission, substations and associated equipment – and requires grid system operators to connect plants generating electricity from renewable energy sources specified in this document. Where necessary, the grid system operator shall construct or upgrade its grid at a reasonable economic expense to facilitate interconnection. The interconnection costs including transmission/distribution lines and substations. Construction or upgrading costs shall be recovered by the grid operators by charging from electricity consumers the portion of the feed-in tariff that is in excess of US cents 2.6 per kWh or as may be directed by the Energy Regulatory Commission at the time of the approval of the PPA or review thereafter. This means that the grid operators shall treat the differential between the agreed tariff and US Cents 2.6 per kWh or the figure approved by the Energy Regulatory Commission after a subsequent review as a pass-through cost. (Kenya Ministry of Energy, 2008).

However, while the amount of planned renewable energy development under the FiT policy is significant (about 42% of current national installed capacity), the legal status of the FiT as a policy jeopardizes the realization of the 500 MW of renewable energy. This is because a policy does not enjoy the same level of protection that an act of parliament does. Unlike an act of parliament, if a policy does not have significant political support, it could be changed, put on hold or scrapped altogether. Therefore, the feed-in-tariff policy should be transformed into an act of parliament to ensure that any changes to its original intentions and design are only made after a significant amount of scrutiny and deliberations in parliament (AFREPREN/FWD, 2009).

Financing SHP

On-grid SHP shall be financed via the regulated feed-in tariffs as defined by the MoE in 2008, while for off-grid MHP extra financing is required by donors or the rural electrification program.

6.3 Madagascar

General information

Madagascar lies in the Indian Ocean east of Mozambique. With a surface of approx. 580,000 km² it is the 46th-largest country and fourth-largest island worldwide, its population is currently estimated at 20.5 m.

Covering approx. half of the island's surface, the central highlands constitutes a plateau region ranging in altitude from 747-1,341 m above sea level. Towards the east, a steep escarpment leads down into a ribbon of rain forest with a narrow coastal further east. The descent from the central highlands toward the west is more gradual, with remnants of deciduous forest and savannah-like plains. The central highlands are characterised by terraced, rice-growing valleys lying between barren hills. The island's highest peak, Maromokotro, at 2,876 m, is located in the far north of the country. The Ankaratra Massif is in the central area south of the capital Antananarivo and hosts the third highest mountain on the island with an altitude of 2,642 m. Further south is the Andringitra massif which has several peaks over 2,400 m including the second and fourth highest peaks.

Madagascar has a tropical maritime climate which is characterised by two seasons: a hot, rainy season from November to April, and a cooler, dry season from May to October. South-eastern trade winds predominate, and the island occasionally experiences cyclones. The average annual precipitation varies from 1,000 - 1,500 mm. The coastal region has a tropical climate with no completely dry season where the heaviest rainfall occurs between May and September with average annual precipitation from 2,030 - 3,250 mm.

Agriculture, including fishing and forestry, is a mainstay of the economy of Madagascar. Major exports are coffee, vanilla (Madagascar is the world's largest producer and exporter of vanilla), sugarcane, cloves, cocoa, rice, cassava (tapioca), beans, bananas, peanuts and livestock products. Recently, also large mining projects (bauxite, copper and coal) have gone underway with mainly international investors entering the scene.

The estimated GDP per capita for 2009 is US$ 412 and with an HDI value of 0,543 Madagascar is listed among the poor countries of the world (ranking: 145). 68.7 % of the population are considered to live under the poverty line. The per capita consumption of electricity is at a low level per capita and the household electrification rate is currently at about 23 % with a large discrepancy of more than 60 % in urban and less than 10 % in rural areas while more than 80 % of the population live in such rural areas. In the African context, Madagascar has an untypically low level of urbanisation and an equally low increase of urbanisation.

The activities of JIRAMA, the fully state-owned utility responsible for the provision of electricity and water services in the whole country, have not yet been unbundled. However, as far as rural electrification is concerned, JIRAMA has ceded its activities to the Rural Electrification Agency in 2004.

The installed capacity of electricity production in Madagascar does only account for some 650 MW, the largest portion being provided by 6 hydro power plants. The currently utilised capacity is even lower due to the poor efficiency following the lack of rehabilitation of some of the large hydro power plants.

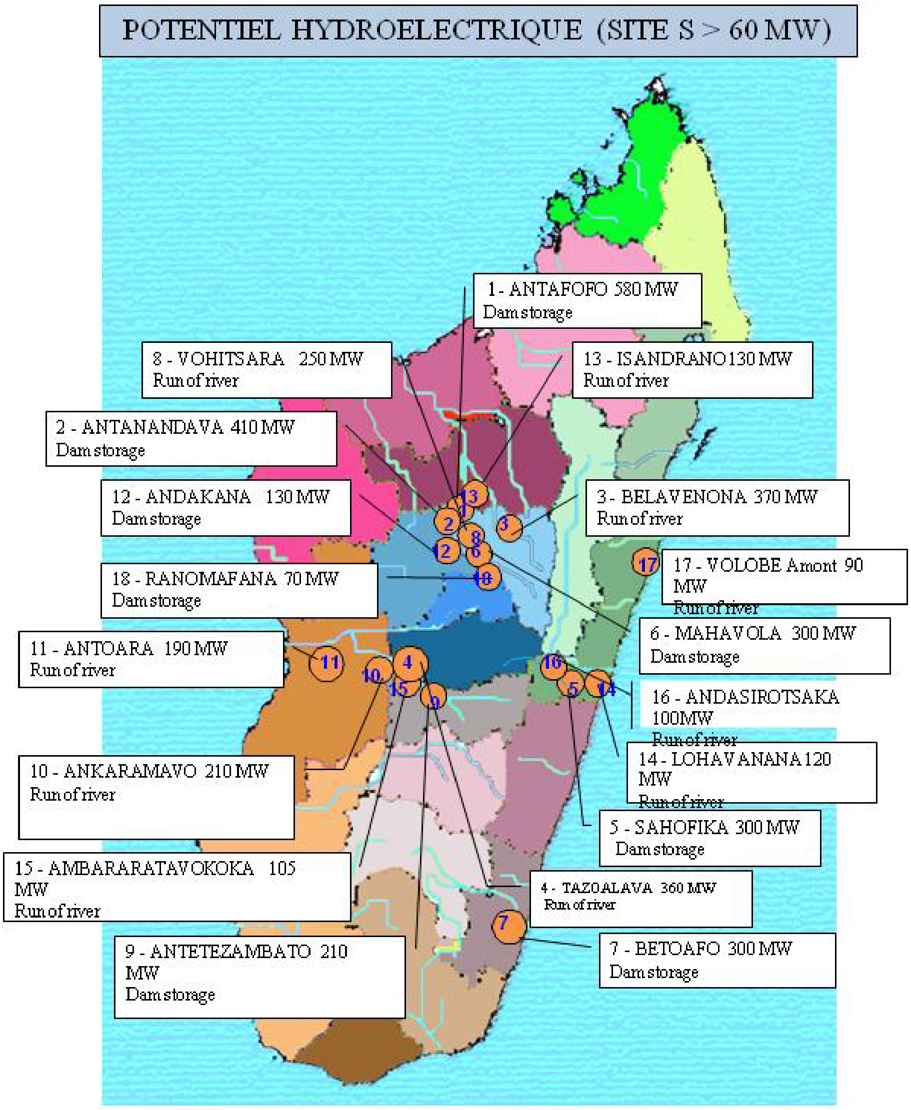
Madagascar does not possess a countrywide electricity network. JIRAMA is operating selected grids only around major towns with the longest stretching between the capital

Antananarivo and Antsirabé with an overall length of approx. 180 km. Thus, SHP projects will at least for the coming decade typically not be able to feed into a grid which is detrimental to the financial viability of such projects.

Potential of hydro

The theoretical hydropower potential of Madagascar has been estimated at 7,000 GW of installed capacity. A more conservative estimation in terms of the economically exploitable potential has not been established so far but a couple of potential large hydro power sites have been identified and are currently in various stages of feasibility studies.

Figure 9: Madagascar hydropower sites above 60 MW



Source: www.africa-energy.com

There is no reliable data on small hydro power potential in Madagascar and also no database for existing SHP plants. On the basis of a pure desktop study, GTZ-PERER (Promotion of Rural Electrification by Renewable Energies) has recently assembled data on at least 700 potential sites, but the technical and economical potential can be expected to be far lower.

Existing plants and SHP projects

The experience with SHP plants dates back to the beginning of the 20th century when the French colonizers installed insular systems to provide electricity to run sawmills and other appliances to profit from natural resources. In the 1960ies, several SHP plants have been put into place by private initiatives to accommodate tourist locations.

The Rural Electrification Agency has focused its project pipeline towards renewable energy projects in 2006, focusing mainly on SHP plants. So far, the agency has sponsored 7 SHP plants which are grouped in a radius of not more than 120 km around the capital. With the support of GTZ-PERER a larger project pipeline is currently under way with some 50 feasibility studies established until the end of 2010. These activities are linked with the introduction of the software GEOSIM to establish energy investment plans on a regional basis prioritizing sites for realisation on the basis of demand and accessibility of SHP sites.

There are currently 2 local turbine manufacturers, AIDER and Vitasoa, who produce Banki and Pelton turbines with a capacity of up to 30 kW. Larger turbines and all generators need to be imported.

Policies and strategies to promote SHP

On the basis of a World Bank initiative dating back as far as 1995, several donors have accompanied the government of Madagascar to unbundle and ultimately privatise the activities of JIRAMA. These activities have been far from successful but have had some side effects from which the SHP sector is now profiting: with the establishment of the Rural Electrification Agency in 2004, it was decided to promote the private sector participation in the sector of rural electrification. Until now, some 20 operators – mainly small and medium-sized companies have realized approx. 80 projects. While they were initially exclusively diesel-run electrification schemes, the sector has since 2007 shifted towards renewable energy projects with by now 4 operators having established SHP plants.

Laws and regulations

As stated above the significance of the possibility to feed-in electricity to existing grids is rather limited due to its small size. Nonetheless, where such projects have been developed, JIRAMA has proven to be reluctant to offer favourable feed-in tariffs. Only 2 operators of SHP plants have managed to conclude individual feed-in contracts with JIRAMA on the basis of a 10 years' tenure and a pretty low feed-in tariff of approx. € 0.04 / kWh. A feed-in-law is not in place and not on the current policy agenda.

Financing SHP

Together with the establishment of the Rural Electrification Agency in 2004, Madagascar has introduced a consumer tax on electricity consumption which is provided to the Rural Electrification Agency to co-sponsor rural electrification projects. The agency offers a maximum of 70 % of investment costs to private operators who contribute the remainder and receive the concession to exploit the plant for 10-20 years.

Local commercial banks are also interested to partially finance SHP projects and could provide approx. 30-60 % of the investment costs.

6.4 Mozambique

General information

Mozambique is a coastal country of 800,000 sq km with mountainous highlands bordering South Africa, Swaziland, Zimbabwe, Zambia, Malawi and Tanzania and consists of a coastline of 2470 km. Mozambique is rich in rivers, the largest and most important being the Zambesi, other large rivers such as the Limpopo, Rovuma and the Save.

Mozambique's climate is tropical. There is a wet season from October to March and a dry season from April to September. Precipitation patterns vary: rainfalls tend to be heavy at the coastline and are little in the North and South. The average precipitation is approximately 590 mm with variations between 500 to 900 mm depending on the region.

Although Mozambique shows rapid economic growth in a stable political situation after its first democratic elections after civil war in 1994, the country is still one the poorest countries in the world. 55% of its population is living under the poverty line, the country has a per capita GNI of USD 380 in 2008 (World Bank 2008) and is ranked on place 156 out of 177 countries on the Human Development Index. Out of the 20.4 million inhabitants, 63% live in rural areas. The agricultural sector provides 80% of all jobs in the country, most of them in subsistence agriculture. Mozambique is still highly dependent on foreign aid as development assistance comprises approximately half of the government budget.

Energy consumption in Mozambique is heavily dominated by mining industries with a high energy demand, which consume about 5-8 times as much electricity as the rest of the country. Therefore, Mozambique has an average per capita electricity consumption of 77 kWh/year in 2006. Excluding the consumption by large industries, however, residential electricity consumption comes down to 29 kWh per capita/year (compared to average per capita annual consumption of electricity in sub-Saharan Africa of 478 kWh). 80% of the population relies entirely on traditional biomass to meet their energy needs (Mulder and Tembe 2008).

Mozambique has a corporatized but state owned national utility, *Electricidade de Mocambique* (EdM), which is responsible for power transmission, distribution and supply. It itself has only an installed power generating capacity of approx. 200 MW and thus buys most of the electricity from the HBC (the private company running the large Cahora Bassa hydro power plant) or imports it from abroad. Although IPPs are allowed in Mozambique, their activities are often politically blocked because there is no consensus yet within the government of whether private or public actors should lead the small hydro power deployment.

The Ministry of Mineral Resources and Energy (*Ministério dos Recursos Minerais Energia*, MIREME) is responsible for all other energy resources and mineral resources of the country. As a central technical body within the ministry, the *National Directorate for Energy (DNE)* is responsible for the analysis, preparation and elaboration of energy policies. The National Energy Fund (*Fundo Nacional de Energia,* FUNAE) has been set up to fund new energy projects by providing funding for financing sustainable energy projects in rural areas; by managing funds for on-lending and by promoting opportunities for the private sector, and by promoting renewable energy technologies. FUNAE works by providing loans, grants, and mixed financing and subsidies, each depending on project type, which also include mini- and micro-power schemes in stand-alone rural projects. FUNAE receives funding from the EU, but has to provide 25% of own funding for its projects. FUNAE also has programmes for rural electrification using renewable energies, e.g. PV, biomass and SHP. FUNAE is always tendering its projects. FUNAE follows a procurement policy for realizing its projects, most partners come from Mozambique, Portugal, South Africa and other countries.

Potential of hydro

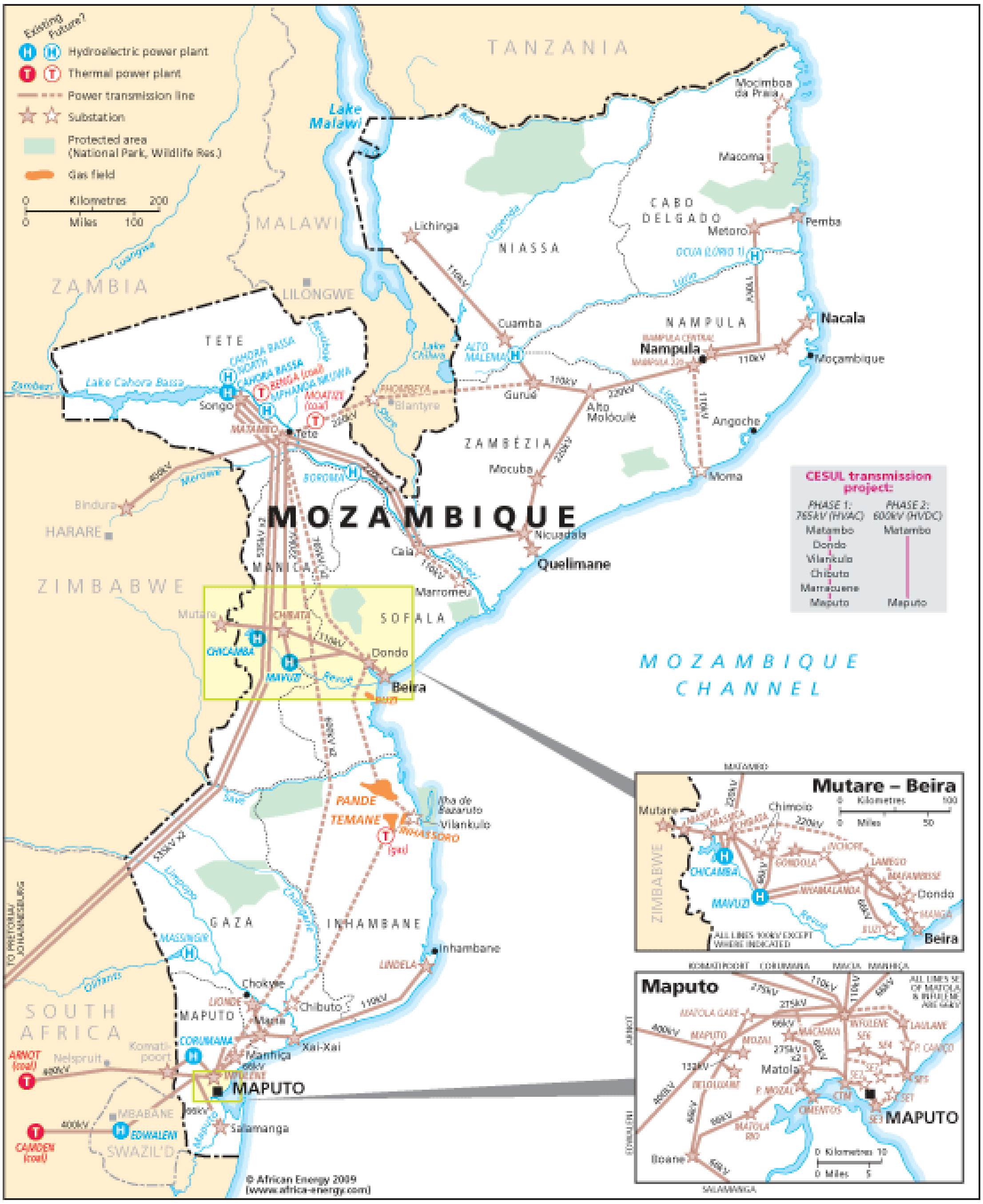
Mozambique has a theoretical hydro power potential of annually 95 TWh, an technical feasible potential of more than 38 TWh and an economically viable potential of 32 TWh (WEC 2007). Approximately 80% of Mozambique's hydro power potential is located in the Zambezi valley, in which a 2075 MW hydro power plant, the Cahora Bassa dam, already exists (Cuvilas et al, 2010). However, about 70% power produced by the Cahora Bassa plant is exported to South Africa. At the end of 2005, Mozambique had an installed hydro power capacity of 2136 MW and was able to generate 11,548 GWh in 2005. It is planned to increase the hydro power capacity by 2898-3898 MW (WEC 2007). Allegedly, the Mozambican government has plans to build MHP with a potential of up to 1000 MW (Cuvilas et al, 2010).

There is no reliable data on small- and micro hydro power potential in Mozambique, but the Ministry of Energy has identified some potential sites. There is also no database for existing MHP plants. Water mills could be taken as proxy for MHP potential, e.g. in Manica district (not Manica province) there are 20 traditional hydro power mill operators. There are only very few small hydro power plants in Mozambique, e.g. the 38 MW plant in Chicamba and the 52 MW plant in Mavuzi, but both plants require rehabilitation. There are also plans to set up a similar sized hydro power plant in the Massingir dam on the Elephants river. The following SHP projects by FUNAE are under construction:

- Manica-Rotanda (600 kW), status: contractor identified
- Chiurairue, Manica (23 kW), status: tendering
- Majaua, Zambezia (630 kW), status: tendering.

FUNAE conducts feasability studies for MHP in regions near Maputo, Tete and Niassa. Other MHP power plants in Mozambique are mainly set up with the help of foreign NGOs and donors. Examples include: a 15kW micro-hydro power station in Ndirire village to directly provide power for approximately 80 families (set up by The Koru Foundation).

Figure 9: Mozambique's actual and planned generation and transmission structure



Source: www.africa-energy.com

Policies and strategies to promote SHP

General support policies for renewable energies and rural electrification are still in the making. The Ministry of Energy has published a new draft on new and renewable energies in December 2009. There exist three different electrification plans – a situation which makes off-grid project planning very difficult, because each plan has been supported by a different donor and there is no clarity yet on implementation. Allegedly KPMG's electrification plan also mentions renewable energies like PV, MHP, wind power etc. Therefore, all MHP projects should refer to this electrification plan. The utility EdM has master electrification plan which mainly focuses on grid extension. The plan aims to achieve an access ratio of 20% by 2020. Although there are plans to set up more small and isolated grids in rural areas (there exist already 90 isolated grids with an average of 150 subscribers each in different parts of the country), the main focus of the plan is on extending the national grid. This intention seems to be partly motivated by the availability of low-cost hydroelectricity. Out of the US$ 850 million, US$200 million are earmarked for rural electrification projects. The national power utility EdM finances 30% of the total investment needs, the remaining part comes from government and donor funding.

Although Mozambique has by now a sufficient legislative framework for the power sector, its main weaknesses in implementation and rule enforcement still need to be overcome (Scanteam, 2007).

A loan of US$ 14 million has been secured from the African Development Fund (ADF) to finance Electricity III, Mozambique's rural electrification project. The project aims to enable rural communities to increase their economic activity and improve their standard of living through grid extension. 19 towns have been identified to benefit from the project in Gaza, Inhambane, Tete and Nampula provinces.

Laws and regulations

For the implementation of SHP and MHP projects, the following permits can be asked for, but there is no transparency and clearness which documents indeed required:

- A water license is required since three years, but procedures are not clear, e.g. about which level of the Ministry of Public Construction and Water is responsible.
- An EIA is required by the Ministry of Environmental Issues at the provincial level. It is, however, not specified from which size of a MHP onwards an EIA is required, so that micro, mini- and pico- projects usually do without an EIA.
- An industrial license for the project operator which is usually obtainable without many problems at district level
- Mini-grid concession from the Ministry of Energy might be required for some projects, but there is no clear indication whether and how the concession can be obtained.

Import duties on technical equipment are very high and hamper MHP development in Mozambique. There is one local turbine manufacturer, Metallogica from Chimoio, who can produce turbines up to 20 kW. Large turbines and all generators need to be imported.

Financing SHP

There are currently no financing schemes for small- or micro hydro power plants in Mozambique. However, the current electricity prices for household consumers may give a first impression what consumers may be able and willing to pay. The 2005 prices charged by the national utility EdM were 7¢ per kWh for grid-based electricity and 15–20¢ in areas relying on diesel-generated power. In areas not covered by EdM, people had to pay as much as 40¢ per kWh for energy from alternative sources such as kerosene or batteries (Scanteam, 2007).

6.5 Nigeria

General information

Nigeria is located in Western Africa, bordering the Gulf of Guinea between Benin and Cameroon. With more than 150 Mio inhabitants, Nigeria is the most populated country in Africa. Important source of income is the gas and oil industry, which account for 25 % of the GDP. Although the average income has increased significantly in last decade, large parts of the population live in poverty, and the human development index is still low. Major causes are bad governance, neglect of the agricultural sector, insufficient social and economic infrastructure and unstable political environment with frequent ethnical and religious conflicts. Nearly 60 % of the population have no access to modern energy services.

Naturally, oil and gas dominate the energy mix of the country. Hydropower accounts for only 7 % of the primary energy generation. Natural gas covers two thirds of the national power generation, which has 3400 MW installed capacity, the rest is mainly hydropower. In 2005, the Electric Power Sector Reform lined out the new structure of the power sector, creating out of the former monopoly NEPA a set of 18 generation, transmission and distribution companies. The Act provided also the creation of an independent regulatory body (NERC) and a Rural Electrification Agency (REA), which is supervised by the Federal Ministry of Energy, and the Rural Electrification Fund. In some regions, electricity supply is provided now by Rural Electrification Boards or IPPs, such as NESCO or the AES corporation.

Figure 10: Nigerias generation and transmission structure (www.africa-energy.com)

At the moment, blackouts are frequent due to irregular water levels in hydropower stations and gas disruptions. The main consumption is in the residential sector (63 %). Energy prices are relatively low (about 3 - 5 € cents / kWh).

Nigeria has a National Energy Policy (drafted in 1993) as well as a National Energy Master Plan and a Renewable Energy Master Plan. Main targets are to expand the electricity supply to 75 % of the population and a stronger participation of the private sector. It also foresees a promotion of renewable energies and their incorporation in the national energy mix.

Potential of hydro

With an estimated technically exploitable 20,000 MW, the hydropower potential of Nigeria is high and hydropower currently accounts for about 32% of the total installed commercial electrical power capacity. As of today, of all the renewable energy resources, only hydro energy is being meaningfully exploited. It is expected that the contribution from renewable energy sources (specifically SHP) to the total energy mix will grow. Government's plan, "Energy strategy for 2010" envisages a modest target of 5 – 10% for RET against the then energy requirements of 10,000 MW. At present, the major hydro sites are at Kainji and Jebba on the river Niger and Shiroro on the Kaduna River, with generating capacity of 760, 640 and 600 MW respectively. The identified SHP potential for Nigeria is about 732 MW, of which only 19 MW has been developed. In addition to these sites, there are a large number of identified sites with potentials for supporting micro hydro (less than 100 kW), mini hydro (between 500 kW and 5,000 kW) schemes, in over 50 small rivers in the country. In a projection of the Government, small hydropower shall provide 9.9 % of electricity supply by 2023, increasing the existing capacity from 30 to 3400 MW.

Existing plants and SHP projects

In total, 8 SHP with 37 MW are documented. The international hydro-atlas from 1999 estimated 41 sites with 32 MW installed capacity. Most small-scale schemes are around Jos in Plateau State, developed by a private sector operator, National Electricity Supply Company (NESCO). A study from 2006 identified 278 yet undeveloped sites for small hydropower production, with the total capacity of 734 MW. There also some sites in the range of 3 – 9 MW which need rehabilitation.

The country has now on-going, different phases of rural electrification to link its entire Local Government Headquarters. The national organization NEPA and Rural Electricity Boards (REBs) use at the moment only the national grid and diesel generators for their rural electrification programmes. There are pockets of capacity and study results available all over Nigeria, which can easily be harnessed for studies and development initiatives on hydro energy. With the set up of the Regional Centre for Small Hydro Power in Abuja in 2006, Nigeria counts for one of the few places for systematic capacity development in SHP technology in Africa. It should serve not only for domestic needs but also for giving guidance to other countries in Africa. China offered the donation of two turbines. Sites for pilot projects were identified in Abia and Bauchi state.

Main barriers

Generally, price distortions, poor regulatory environment and inadequate infrastructure characterize the energy markets in Nigeria. As main barriers for MHP development, Nigeria has deficits is following aspects:

- SHP skills and data base
- Lack of feasibility studies
- Information and awareness building in rural areas
- Energy infrastructure financing
- Sustainability of SHP
- Lack of energy service companies
- No R&D and local fabrication of MHP equipment

Policies and strategies to promote SHP

In the main policy documents, the Government of Nigeria has expressed the will to develop renewable energies and small hydropower in particular. However, there are no specific incentives for RE sources, but huge subsidies for conventional energy. There is no body in the country directly responsible for the RE promotion. In rural electrification, the government promotes – besides the expansion of the main grids – also the establishment of mini-grids, including small hydro. This includes the funding of pilot projects. In April 2010, the Federal Ministry of Power has established a standing committee to work out ways of developing the country's capacity in the hydro energy sector as part of its strategy to tackle the endemic problems of the power sector.

Laws and regulations

Generally, on the paper the conditions for foreign investment are good: For example, investments in the energy sector are rated as pioneer initiatives entitled for tax liberation of 5 – 7 years. Permissions for small energy projects can be obtained directly from REA, who also recommends a funding through REF. REA has formulated minimum criteria for safety, technical standards and services, which have to be fulfilled by the projects. So far there is no feed in regulation in place.

6.6 Rwanda

General information

Rwanda, a small land-locked mountainous country lying south of the Equator in Central Africa, borders the Democratic Republic of the Congo (DRC), Uganda, Tanzania and Burundi. It characterised by a mountainous landscape, a temperate climate with two rainy seasons, and a high density of population with 10 Mio inhabitants (UN 2009) at only 28,000 sq km. Average precipitation varies across the country from 800 mm/year in the eastern plains to 2000 mm in the northwest.

After the genocide and civil war in the 90th, the country is striving to rebuild its economy, with coffee and tea production being among its main sources of foreign exchange. However, GNI per capita is still low (US$ 410, World Bank 2008) and nearly two thirds of the population live below the poverty line. The per capita consumption of electricity is at a very low level of 20 kWh per capita per year (compared to average per capita annual consumption of electricity in sub-Saharan Africa of 478 kWh).

Energy policy focuses mainly on the electrification of the country, which has – through the electrification roll-out program - increased significantly from 6 % in 2005 to 12 % in 2010. The ministry for Infrastructure (MINIFRA) has bundled the activities of several donors and pushed the promotion of renewable energies.

Potential of hydro

A recent Hydropower Atlas project has identified 333 hydro sites in the country with a combined capacity of 96 MW. The technical potential for small hydropower is estimated at 10 MW. However, the countries share of hydropower potential on border rivers is at least 115 MW. There are some older sites which could be rehabilitated. In general, the potential for MHP is good due to geographical conditions and the density of population.

Existing plants and SHP projects

In 2009, hydropower contributed 20 of the 55 MW installed capacity (but only about 15 % of the total electricity consumption).at four small hydroelectric stations, and a number of independent micro-hydroelectric stations. In the National Energy Policy (2009) only one MHP is listed (Nyamyotsi with 75 kW). However, 21 projects are in planning, with a total capacity of approximately 13 MW by the Government, bilateral donors and private investors; EU is financing 3 MW over the period 2008 to 2011. GTZ-EnDev program is recently supporting 6 projects with 1.5 MW; UNIDO supports 4 projects (1.8 MW) and ACP-EU Energy Facility supports rural electrification projects with 10 million €.

Name of hydrostation	Size	Implementer
Gashashi	200 kW	Government of Rwanda
Janja	200 kW	Government of Rwanda
Nyabahanga	200 kW	Government of Rwanda
Ruhwa	150- 200 kW	Government of Rwanda
Nyamyotsi I	75 – 100 kW	UNIDO
Nyamyotsi II	100 kW	UNIDO
Mutubo	200 kW	UNIDO
Gatubwe	200 kW	UNIDO
REPRO	105 kW	PSP hydro (GTZ-EnDev)
ENNY	250 kW	PSP hydro (GTZ-EnDev)

Table 2: Recent MHP developments (< 300 kW) (data from MINIFRA, 2010)

The different donor agencies assisting the country in its efforts to build a local small hydro industry do follow different approaches. While UNIDO has followed the route of village level management of the four hydrosystems they are supporting, experience gained in implementation has forced them to revert to management models in which the systems are operated through private businesses (Ali Mohamed 2009). Contrary, the Dutch/German funded EnDev program followed a pure private sector approach from the outset. Under this program five business consortia have been contracted (out of 20 proposals received in two calls) to implement small hydro systems. Typical participants in these consortia are local business men, NGOs, social institutions (hospitals), local and foreign investors. The EnDev program provides 30-50% investment subsidy, technical assistance, business support, etc., while the developer is responsible for financial closure (15% equity and loans), construction, permits, etc. (Raats 2009). The main indicator used by the donors of the EnDev program is "people newly supplied with modern and sustainable energy services", i.e. households, institutions and companies who receive their first ever electricity connection. Experience to date however indicates a very strong preference of private investors to supply at least a portion of the electricity generated to the national electricity grid (and hence existing customers, contrary to the objectives of the donors) as the interconnection gave great comfort to the banks, who appreciated a guaranteed sale of electricity produced (Pigaht, van der Plas 2009)

Policies and strategies to promote SHP

In the frame of the National Energy Policy, hydropower plays an important role in the electrification of the country. This includes explicitly micro hydro and isolated mini-grids, which should be encouraged by simplified legal and regulatory framework and Government investments.

Laws and regulations

Government owned utility RECO (former ELECTROGAZ) will, in the short to medium term, still be the dominant player in the electricity market, which is regulated by the independent authority RURA. However, independent power producers (IPPs) are also encouraged in the generation sector. Self-contained off-grid schemes are encouraged: these can be owned and operated by RECO or by private developers. The National Energy Policy foresees three types of licensing issued by RURA:

- ***Single buyer licence:*** RECO is to be licensed as the single buyer of electricity. It will enter into agreements with private developers of generation projects for the purchase of electricity. Feed in tariffs (FIT) for MHP are not yet defined.
- ***IPP licences***: All generation projects or concessions involving private investors are to be licensed by RURA.
- ***Off-grid licences:*** Where concessions are granted by RURA to private companies to generate, supply and distribute electricity within an area of the country not covered by RECO, the tariff and other supply provisions are to be regulated by RURA.

On imported capital goods such as MHP equipment no VAT has to be paid.

Financing SHP

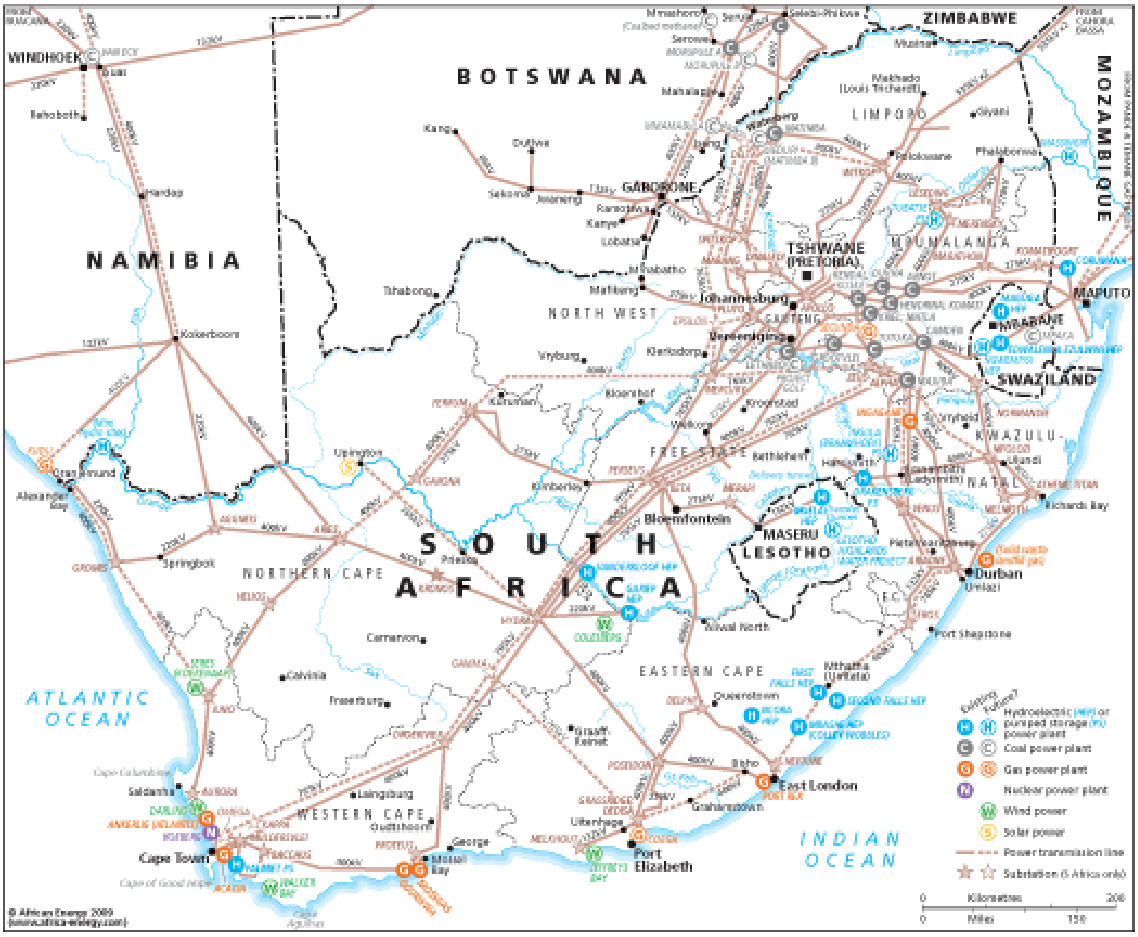
Within the electrification roll-out programme, the Government of Rwanda and various donors provide funds for a number of SHP projects. Different donors are funding MHP under different schemes, amongst them UNIDO, World Bank and AfDB. A part from this, the EnDev PSP program involves private investor schemes. The program finances 50 % of the total costs, while private developers cover the remaining 50 %. The program motivates banks to lend for MHP investments.

6.7 South Africa

General information

The Republic of South Africa is located at the southern tip of Africa. By UN classification South Africa is a middle-income country with an abundant supply of resources, well-developed financial, legal, communications, energy, and transport sectors, and a modern infrastructure supporting an efficient distribution of goods to major urban centres throughout the entire region. South Africa is ranked 25th in the world in terms of GDP (2008) and around 10,000 USD per capita (2009). Critical problem to the countries development is the spread of HIV/AIDS with up to 31% of pregnant women found to be infected in 2005 and the infection rate among adults estimated at 20 %.

South Africa's energy sector is critical to the economy, contributing about 15% to the country's gross domestic product (GDP). Thanks to its large coal deposits, South Africa is able to offer cheap electrical power by international standards - the country is one of the cheapest suppliers in the world. South Africa has no significant oil reserves, and relies on coal for most of its oil production. The country has a highly developed synthetic fuels industry, as well as small deposits of oil and natural gas. In 2008 it had 43,000 MW installed power.



Source: www.africa-energy.com/

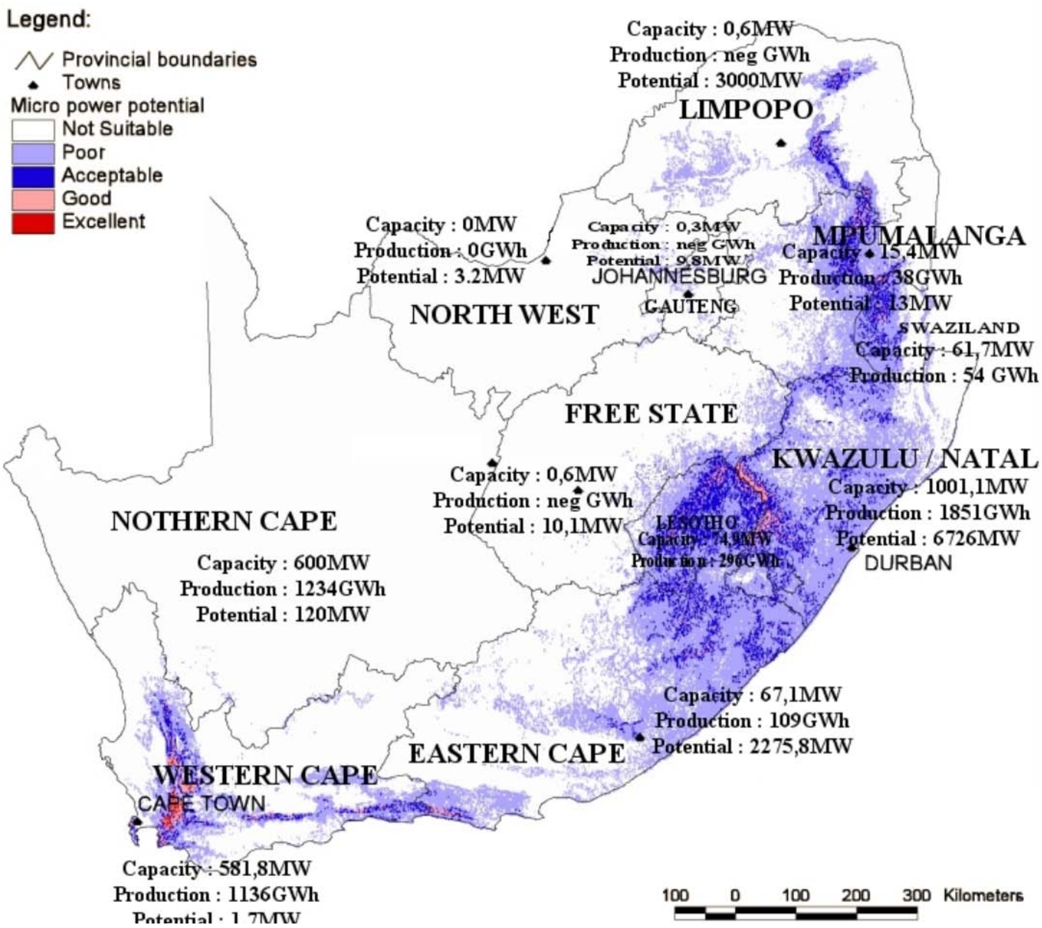
Figure 11: South Africa's generation and transmission structure

The parastatal company ESKOM generates 94 % of the country's electricity, and exports power to Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe; it also owns and operates the national transmission system. Electricity is primarily coal-fired (92 % electricity is produced from coal); there is one nuclear power station, two gas turbine generators, two conventional hydroelectric plants and two pumped storage stations. The remaining capacity is provided by municipalities (2.5 %) and IPPs (3.5 %), which hold most of the existing small hydropower stations. In 2007, the country faced a electricity crisis due to a lack of generating capacity, and the margin between national demand and available capacity is still low.

Rural electrification has made impressive progress after the end of Apartheid, increasing the rate of electrified households from 21 % (1995) to 73 % in 2008. In 2001, the Integrated National Electrification Programme (INEP) has been established, carried out by ESKOM and the National Electricity Regulator (NER). Off-grid electrification is based mainly on solar home systems, but not on pico or micro hydropower.

Potential of hydro

A detailed baseline survey carried out by the consultancy company COWU in 2002 on behalf of the Department of Minerals and Energy (DoME) showed that the hydropower potential in RSA is big but mostly untapped. The Eastern Cape and KwaZulu/Natal provinces are endowed with the best potential for the development of particularly small (< 10 MW) hydropower plants. The following map shows the regions with acceptable micro hydro potential:



Existing plants and SHP projects

South Africa has a long history of using small hydropower, but most of the old sites are no longer in use. The following table shows MHP capacity installed in South Africa between 1917 and 1977. In recent days,

Province	Hydroelectric capacity installed between 1917 and 1977 (kW)	Average head (m)	Average flow (m^3/sec)	Size and number of turbine units installed between 1917 and 1977
Eastern Cape	280	27	0,652	Mini (2)
Gauteng	71	36	0,435	Micro (2)
Kwazulu/Natal	1247	22	0,519	Pico(6), Micro(4), Mini(3)
Limpopo	40	64	0,187	Pico(1), Micro(1)
Mpumalanga	2538	68	0,650	Pico(2), Micro(5), Mini(10)
North West	45	24	0,241	Micro(1)
Western Cape	554	37	0,290	Pico(5), Micro(1), Mini(2)
Total	4772	40(avg)	0,425(avg)	Pico(14), Micro(14), Mini(17)

Sources: SAICE (1982) and Searle (2002)

Actual SHP in operation have a total installed capacity of 33.9 MW. Klunne (2010) estimates a firm potential of 69 MW and a long-term potential of 94 MW (www.microhydropower.net/). The following sites are documented:

- Ceres (1 MW)
- Densa (500 kW)
- First Falls (6 MW)
- Freidenheim (3 MW)
- Glenwilliam (1.5 MW)
- Hectorspruit (1100 kW)
- Kaapmuiden (Stentor estate) (750 kW)
- Lydenburg (3 MW)
- Malalane / Lomatipoort (1 MW)
- Ncora (2 MW)
- Piet Retief (1 MW)
- Second Falls (11 MW)
- Troske (500 kW)

RSA accounts for several institutes and consultants with experience in MHP, and there is a micro hydropower association in place (SESSA).

Main barriers

A 2008 study of the Southern African power sector by market researcher Frost & Sullivan, found national power utilities showed limited interest in developing such projects, and this is valid in particular for ESKOM, which is the African utility most actively raising capital. Investment is usually geared towards large-scale projects which promise to deliver power at a lower cost per unit (van den Bosch, 2010). Although the energy policy has created a framework for IPPs to produce electricity in decentralized units, many projects are hindered by the old structures. Generally there is a low awareness amongst decision makers and public about the potential contribution of small hydropower to the electricity supply.

Policies and strategies to promote SHP

The White Paper on the Energy Policy from 1998 and the complementing White Paper on Renewable Energy from 2003 set out the path for RE development in South Africa, targeting a generation of 10,000 GWh of renewable energy in 2013.

Although the Government aims at increasing the share of IPP in power generation to 30 %, the monopolistic structure with ESKOM owning the grid is hampering the development of independent decentralized units. Based on long-term PPAs, all IPPs have to sell their power to ESKOM.

Laws and regulations

Fundament is the National Energy Act 34 from 2008. The Act foresees minimum contributions of RE to the national energy supply and measures and incentives to promote the respective technologies. The recently established Renewable Energy Finance and Support Office (REFSO) offers capital subsidies of 1000 R/ kW (with a maximum of 20 % of capital costs) only for projects above 1 MW. There is a tax relief and accelerated write-off periods for small hydro projects

In March 2009, NERSA has approved the Renewable Energy Feed-in Tariff (REFIT) Guidelines and a regulatory instrument, guaranteeing the power producers 0.94 R (0.084 €)/ kWh in a 20 years PPA. The Renewable Energy Power Purchase Agency (REPA) is obliged to buy the electricity in a single buyer model and distribute it to the consumers. Beside Kenya, South Africa is the only sub-Saharan country with a feed-in regulation.

Amongst the registered CDM projects of South Africa there is only one small hydro project (another is planned).

Imprint

Authors:
Mirco Gaul, Fritz Kölling, Miriam Schröder

Editors:
Michael Blunck, Ingmar Stelter

EU Energy Initiative
Partnership Dialogue Facility (EUEI PDF)

c/o Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH
P.O. Box 5180
65726 Eschborn / Germany
T + 49-6196/79-0
F + 49-6196/79-806312
E-Mail: info@euei-pdf.org
Internet: http://www.euei-pdf.org

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

Poverty-Oriented Basic Energy Services (HERA)

P.O. Box 5180
65726 Eschborn / Germany
T + 49 61 96 79 – 0
F + 49 61 96 79 – 11 15
E hera@gtz.de
I www.gtz.de/hera