

Federal Ministry of Economics and Technology





Project Development Programme East Africa

Rwanda's Micro-Hydro Energy Market

Target Market Analysis

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Currency

1 USD = RWF 575 (May 2010) 1 € = RWF 708 (May 2010)

Measurement

W	Watt	Wp	Watt peak	Wh	Watt hour
kW	Kilowatt	kWp	Kilowatt peak	kWh	Kilowatt hour
MW	Megawatt	MWp	Megawatt peak	MWh	Megawatt hour
GW	Gigawatt	GWp	Gigawatt peak	GWh	Gigawatt hour

List of Acronyms

BOO	Build Own Operate
BOOT	Build Own Operate Transfer
BOT	Build Own Transfer
BTC	Belgian Technical Cooperation
EnDev	Energising Development, Collaboration between DGIS and GTZ
Eol	Expression of Interest
EU	European Union
GEF	Global Environment Facility
HFO	Heavy Fuel Oil
HSD	High Speed Diesel
ICT	Information Communication Technology
IPP	Independent Power Producer
IRST	Institute of Research and Technology
KIST	Kigali Institute for Technology
MININFRA	Ministry of Infrastructure
NUR	National University of Rwanda
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PSP- Hydro	Private Sector Participation in Micro-Hydro
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Agency
RPSF	Rwanda Private Sector Federation
RURA	Rwanda Utlilities Regulatory Authority
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation

1 Status Quo of the Micro-Hydro Sector

1.1 Brief Micro-Hydro Sector Overview

About 85 % of the primary energy balance is made up of biomass, 11 % of imported petroleum fuels, and 3 % of hydro power. Households consume 81% of the final energy balance, mostly in the form of biomass (85 %). Therefore, biomass plays a major role in the energy supply and demand of the country, simultaniously it provides relatively good energy security. Much of the electricity generated in the country comes from hydro power plants ranging from 3-30 MW. Micro-hydro power has a good chance of providing low-cost electricity in the near future that will be needed for the accelerated development of the country that is envisioned by the government.

A "Hydro power Atlas" was prepared in 2007 and is available from the Ministry of Infrastructure (MININFRA); it describes all 333 known hydro sites between 50 kW and several MW. It may be possible that a few additional sites are still uncharted, but these certainly are not among the most promising sites. At the moment some 21 sites are under development using different financing schemes through the Government of Rwanda, donors such as the Belgian Technical Cooperation and the European Commission, and public-private-partnerships (PPP). The latter are being promoted under the Energising Development (EnDev) Programme that is carried out by GTZ with financing from the Netherlands Ministry of Foreign Affairs¹. Micro-hydro is certainly on the radar screen of the government that sees it as a good solution to quickly provide power to rural areas, even if the concerned plants may be interconnected to the national electricity grid later in the future.

The two largest national hydro projects that are currently being developed by the Government of Rwanda are Rukarara (9,5 MW) and Nyabarongo (27,5 MW). The Rukarara construction is 30% finished and a construction contract for Nyabaraongo has recently been signed. In addition, there are a number of potential regional hydro power projects for which feasibility studies are being carried out. In cooperation with Burundi and the Democratic Republic of the Congo (DRC) two sites are being studied on the Rusizi River with 140 MW and 205 MW potential capacity respectively. On the border with Tanzania and Burundi the Rusumo Falls Project is currently being studied which would have a potential capacity of 62 MW. It is expected that by 2020 some 195 MW of additional hydro electricity capacity is available in the country.

Particularly the PPP-activities are interesting as their sizes are not too big $(50-1000 \text{ kW})^2$ that one requires having a project or a dedicated financial mechanism in place. German turbines are already used in Rwanda for this type of activity and have a very good reputation. Moreover, for this scale activity it is possible to find local equity and sources of debt financing to realise commercially viable micro-hydro projects. United Nations Industrial Development Organisation (UNIDO) recently installed four systems (75-125 kW each), the European Union (EU) through the Energy Facility will install four to ten systems (100-250 kW), under the Private Sector Participation in Micro-Hydro Project (PSP Hydro) private local entrepreneurs are finalising the installation of five (75 – 500 kW) systems and will install another four to six in the near future. The average observed cost of the PSP Hydro systems is USD 3600 per kW including the generation equipment, civil works, and low-voltage distribution network.

¹ Private Sector Partnership Hydro Programme (PSP Hydro)

² There is no universal definition for micro-hydro; in this document a capacity range of 50-1000 kW will be used. Some institutions maintain that micro-hydro is below 100 kW; above 100 kW but below 10 MW is called mini.

Global warming is not go unnoticed in Rwanda and the physical climate is changing there too. However, it appears that some of these changes are in favour of hydro electricity: the same quantity of rain that previously fell during the concentrated rainy season now falls over a more extended period. Although no scientific evidence has been presented, this conclusion is being reported by the micro-hydro entrepreneurs of the PSP Hydro Project who keep statistics on this to better evaluate the viability of their plants.

The state of the market for hydro electricity in Rwanda is not typical for the Region and different opportunities exist that do not (yet) exist elsewhere. First of all, the "Land of a 1000 hills" has a larger number of physical opportunities than less mountainous countries. Second, even though there is not so much historical experience with micro-hydro in Rwanda, as a result of the PSP Hydro project the local capacity to design, build and operate such systems is rapidly increasing. Although aforementioned donor-financed projects have all relied on international consultants for the design and construction of their micro-hydro plants, the PSP hydro project entirely relied on local consultants with success. Finally, local debt and equity financing is available even in the absence of special programmes or projects to promote hydro electricity. This is available from financial institutions as well as from individuals and firms. For the time being all equipment and all components are imported, which is an expensive and time consuming affair due to the landlocked position of Rwanda and the long distance from the sea border.

1.2 Major Market Segments

There are three main market segments for hydro power opportunities in Rwanda, divided by *size* and by *type of organisation*. An overview of these market segments and the opportunities is presented in the next chapter.

The largest market segment represent plants of several MW per project to supply electricity into the national electricity grid; most of these plants are currently operated by Electrogaz, the parastatal National Power Utility, but soon this will be done through independent power producers (IPPs) under a Power Purchase Agreement (PPA) The client and financier of such projects is usually the government or Electrogaz, in combination with or without a donor such as the World Bank.

The second segment is made up of hydro-power activities of less than 1 MW each, financed by the government and/or donors or private investors, possibly co-financed by local entities. In the overall energy sector picture, they do not contribute much - yet. Activities cover design and construction of the plant in combination with a local distribution grid, developing own clientele, and possibly interconnecting to Electrogaz. About 30 of such opportunities are being considered now by a variety of organisations.

Table 1 gives an overview of the current generation mix, including installed capacity and the part that is realistically being generated at the moment.

Production unit	Installed power (MW)	Current production (MW)
Hydroelectric power plant		
Ntaruka	11.5	5
Mukungwa	12	5-7
Gisenyi	1.8	0.5-0.9
Gihira	1	0.9
Thermal power plant		
Gatsata	4.7	0
Jabana	7.8	6
Gikondo Rental Power	10	10
Mukungwa Rental Power	5	5
Imported Hydro		
Rusizi I	2.5	
Rusizi II	6-8	
TOTAL	62.5 - 64.5	40 - 44.4

Table 1: Rwanda Installed Electricity Generation Capacity

The third segment is pico hydro (<10 kW); this segment has not been developed, although local companies recently started offering locally manufactured equipment. See Annex 1 with a Map for an overview of all identified and developed hydro sites in Rwanda.

1.3 Local Capacities

The national power utility is Electrogaz, a parastatal company that is now operated on a commercially basis and that needs to fully cover its operating and investment costs. For a limited time it was managed by Lahmeyer under a management contract.

The following Table 2 shows a list of expertise needed for realising hydro projects and the extent to which this is available for micro-hydro plants in Rwanda.

	Rwandan private firms or individuals	International firms present in Rwanda	Government institutions
Hydrological study	+	++	-/+
Site survey and rough system design	++	++	+
Demand & willingness to pay surveys	++	++	-/+
Technical plant design	+	+	+
Feasibility study	++	++	-/+
Construction work	++	+	-
Engineering work	+	+	+
Electrical work	+	+	+
Business development advice	++	+	+
Audits & book keeping advice	+	++	-

Table 2: Existing Capacity for Studies and Works (Micro-Hydro)

- not available; -/+ limited; + can be found; ++ there is choice

Specific expertise such as carrying out hydrological studies is available through small firms or individuals who worked before for the Ministry, Electrogaz, etc. The Kigali Institute for Technology (KIST), the National University of Rwanda (NUR), and the Research Institute of Science and Technology (IRST) are able to provide limited services on a case by case basis. Numerous construction companies exist that can carry out civil works and possibly design the civil works outlay. Electrogaz has experience and expertise throughout the list.

There are several business development oriented companies or government institutions, to provide assistance in setting up viable private activities that could be applied to hydro power as well. Numerous companies can realise feasibility studies, surveys, etc. At least three international companies with offices in Rwanda (two Belgian and one Sri Lankan) are involved in a wide range of hydro services. A Chinese company is active in civil works. Finally, banks and financing institutions are now acquainted with micro-hydro power projects and are willing to look at providing necessary financing for viable activities, whether through debt financing or leasing contracts (turbine). They have developed the expertise to evaluate and assess such activities as well. The German company "Ossberger" has a local representative and its turbines are already or will be used in several micro hydro plants.

Although some donors require all expertise to be imported, in the case of Rwanda this is not necessary as a lot of the expertise is locally available. It may be necessary to locate the right person or firm for a particular job, but the PSP Hydro Project has demonstrated that designing and installing a micro-hydro power plant can indeed be a Rwandan affair.

2 Market Potentials

2.1 Overall Sector Outlook

Rwanda intends to become the number one country of Africa in Information and Communication Technology (ICT). For that it requires an extensive electricity infrastructure and indeed ambitious plans exist and are being put in place, with fibre optic cables connecting all larger towns. The vision of the government is that by 2020 close to 500 MW of generating capacity will be available. This requires almost a ten fold increase of the current generation capacity. Since the reliance will be mainly on IPPs, limited public funds are required. There is little reason to doubt that at least for the largest capacity increasment – more than 50 % is expected to come from methane gas in Lake Kivu - there is a choice of private companies willing to become involved.

The government reckons that the distribution of the 2020 generation capacity is as follows:

- 250 MW from Lake Kivu methane
- 195 MW hydro
- 30 MW geothermal
- 20 MW heavy fuel oil (HFO) (back up system)

Therefore hydro will play a major role in the near future for the development of the country. Not only is it the technology that can provide the lowest cost electricity, it can also largely be developed through partnerships with local companies.

The large high speed diesel systems currently operate with a production cost of around 12 – 15 US cents/kWh, mainly because of the high diesel price and the fact that these are emergency generators that are temporarily rented rather than owned or leased. It is expected that the diesel will be phased out as soon as the first 100 MW of electricity generation capacity from Lake Kivu methane gas is realised or when the heavy fuel oil (HFO) plant becomes operational, as early as 2009 (see www.contourglobal.com/rwanda.html for more details about Kivu gas)³. The production costs from methane gas are projected to be about 10US cents/kWh. This will need to be confirmed through the pilot operations. Large-scale hydro is likely able to provide the lowest cost electricity in Rwanda, at 3-6 US cents/kWh and micro-hydro at 5-8 US cents/kWh. In summary, prospects for using and expanding hydro-power generation in Rwanda are good.

The main risk that may deter the capacity expansion deals with the solvable demand for electricity. Can indeed the demand for electricity become high enough to absorb the projected generation capacity? Put it in an other way, will the incremental capacity lead to a lowering of the long run marginal costs of electricity? Lower end-user tariffs will certainly increase the solvable demand. Although the government plans to triple the number of connections in the next few years, for the moment electricity remains expensive compared to other forms of energy. It may well realize the number of connections only to see that the average consumption per connection decreases considerably. The rich now have a connection and they may use electricity in part for cooking, but this is not necessarily so for newly connected households and consequently, their consumption may be limited. The government expects tariffs to decrease when electricity from Kivu comes online, but what if the production costs are higher than foreseen and the tariff cannot be lowered?

Electricity is now about 37 RwF/MJ⁴ and charcoal 7 RwF/MJ; corrected for the efficiency of the stove, cooking with electricity is about twice as expensive as with charcoal; cooking with LPG

³ Pilot operation of 4-5 MW is in progress.

⁴ € 0.05 per MJ for electricity and €0.009 per MJ for charcoal

would be three times as expensive. Thus, electricity will be used mainly for lighting and the information and communication technology (ICT), and industrial applications. The experience of PSP Hydro is that rural households are very much interested in obtaining electricity and that they are ready to pay a (low) connection fee and normal tariffs for their consumption, but consumption immediately following the first connection will be low: 3-5 kWh per month is not uncommon for the poorest households.

According to Electrogaz, the water, gas, and electricity divisions will soon be separated into new separate companies. Rwanda was the first in the East African Region to apply the cost-recovery principle to public services such as electricity and water supply, although Uganda and Kenya now have higher end-user tariffs for electricity than Rwanda. End-user tariffs are about USD 0.24 per kWh and USD 0.225 per kWh for industrial customers⁵. The gas resources from Lake Kivu are mainly developed by private foreign investors. Given its supply constraints, Electrogaz is keen to have more capacity installed, particularly if this comes on-line without investments on their part.

Recommendations for German RE companies include the following:

- team up with a Rwandan company; the company profile should likely be that of an investor/ entrepreneur; several examples can be observed today.
- decide in which field you want to be active as a risk taking entrepreneur: IPPs, for supply to Electrogaz (capacity is 60 MW now, in a few years it is planned to exceed 300 MW); electricity provider with own generation capacity and small distribution network (>300 micro-hydro sites identified, of which some are being developed now), with or without interconnection to Electrogaz; or the industrial market (captive power, supplying to own factory/industry only).
- decide to tender for opportunities occurring in the various public electricity sector programmes.
- The generation of funds from climate programmes could possibly to help finance part of your investment costs.

2.2 Undeveloped Market Opportunities

As has become clear from the above, there are numerous undeveloped market opportunities and the total potential of micro-hydro sites to be developed is large. Only 6% of the Rwandan population currently has access to electricity and these are in addition mainly located in urban areas, leaving rural areas totally voided of electricity. However, the demand for electricity in the residential sector will be limited to lighting, the information and communication technology (ICT), and refrigeration, whereas in the industrial sector there are plenty of opportunities for productive use of electricity and power that are determined by the economic development prospects. The cost of auto-generation is very high due to the specific conditions: high prices of petroleum products due to land-locked position and the small market for petroleum products, dispersed population, size and accessibility of the country side.

⁵ Excluding 18 % VAT; € 0.178 per kWh and € 0.167 respectively.

Table	3: Current	Op	portunities i	in H	vdro F	ower.	Rwanda
						••••	

	> 1 MW	< 1 MW
Capacity installed MW in Total / (nr)	26.3 (4)	0.4 (4)
Potential additional capacity MW in total / (nr)	100 (5-10)	75 (>100)
Under development	2 / (38 MW)	+/- 5 / (2-3 MW) PSP
nr / (www.in.total)		8 / (6.5 MW) HPI
		4-10 / (3-4 MW) EU
Expected financial volume (million USD)	200	300
Type of equipment	Medium head set-up (50-150 m) dam, possibly small reservoir, channel, penstock, generator house, turbine, generator, control system, medium/high voltage transmission line	Medium head set-up (50-150 m) small dam without reservoir, channel, penstock, generator house, turbine, generator, control system, low voltage distribution network optional: medium/high voltage transmission line
Organisational set-up/operator models	Installation as contractor or as IPP; normally the full package (above) is required from the contractor although he can subcontract things like construction, studies, etc.	Contractor or as project developer and IPP/micro-utility
Planning	5+ year time horizon	1-3 year time horizon
Constraints/obstacles	Financing availability	Small turbines have >15 month delivery times
Recommendations for German companies; (see also next chapter)	Look for opportunities in Development Business and local newspapers	Look for opportunities in Development Business and local newspapers,
		Develop links with local partners and pursue commercial activities in the absence of a project

Source: MININFRA

Hydro is certainly an interesting option under Rwandan conditions. The current market that is under development is about USD 48 millions for the two types of hydro combined. There is room for new players in these fields. There is a growing shortage of electricity in Rwanda, particularly in rural areas are not covered by the national electricity grid. There are signs that private companies are increasingly willing to co-invest in generation capacity. The PSP Hydro Project is a good example as it demonstrated that local parties could arrange for 15 % equity for the co-financing of their micro-hydro project.

On the other hand, Rwanda's economy has been booming over the past decade and although this is mainly visible in urban areas through large-scale construction and the popping up of many small businesses, rural areas have seen positive developments as well. The lack of electricity however, slowed down immediate and the most visible rural progress but even there one can see changes such as an infrastructure for leisure (hotels, restaurants, bars).

Potentials

It is good to explain what is meant by this potential so that there is no confusion:

- Theoretical potential: This is the highest level of potential that only takes into account restrictions with respect to natural and climatic parameters; there are about 330 sites where hydro plants can be developed and this is the minimum theoretical potential. It is likely that a few sites are overlooked, but this will not change much as all important sites have been covered already.
- Geographical potential: Hydro power, like most renewable energy sources, has geographical restrictions, e.g. land use that reduce the theoretical potential. However, for the case of micro-hydro this is very limited and the geographical potential is almost equal to the theoretical potential. Micro-hydro plants can be developed in urban settings without problems and even in parks or reserves if needed as the impact on the surroundings is minimal.
- **Technical potential**: The geographical potential is further reduced due to technical limitations as conversion efficiencies, resulting in the technical potential. This would be so if the potential were explained in terms of kW rather than in terms of number of sites. However, for micro-hydro it does not make much sense to express the potential in terms of overall capacity as the specific capacity that will eventually be developed depends on the exact design of the system. There is a theoretical potential for 330 sites with a capacity between 50 kW and 1 MW; the technical potential could be larger or smaller, depending on the level of accuracy applied during the preparation of the Hydro Atlas.
- Economic potential: The economic potential is that part of the technical potential that can be applied at cost levels considered competitive. However, this is where a difference in opinion exists and where the practical economy differs from the theoretical. It is not economically possible to provide rural areas with micro-hydro plants compared to grid extension. However, it is possible when compared to auto generation using diesel generators, even though this is a more expensive option. Grid extension, although the lowest-cost option, will in reality not happen in most of the cases because there are other priorities. The exception dictated by the real economy is that *political reasons* are often the base for decisions to actually extend the grid in a particular location or finance a hydro plant. These decisions are not based on economic prospects and it is not possible to estimate the extent of this in the future.
- **Market potential**: The market potential is the total amount of renewable energy that can be implemented in the market taking into account the demand for energy, the competing technologies, the costs and subsidies of renewable energy sources, and the barriers. The market potential could in theory be larger than the economic potential, but usually the market potential is lower because of all kind of barriers. In Rwanda this means at least 30 interesting micro-hydro sites that can be commercially developed in the short run.

Developing the potential therefore depends foremost on the support mechanism to be used by entrepreneurs. There are several support mechanisms in place:

- Programmes to finance development of hydro sites through the government and through donors, notably the EU, the belgian Technical Corporation (BTC), and the Global Environment Facility (GEF) (see section 3.2).
- (ii) The GTZ implemented PSP Hydro project has created a mechanism to assist investors and project developers to develop their own, commercially viable micro-hydro projects and create micro-utilities (see section 3.2).
- (iii) Most local banks are interested in hydro projects and are willing to consider financing of viable activities through existing financial mechanisms. The initiative to develop the five to

ten larger sites is mainly with the public sector, which also provides the financing and determines the timing; for the > 100 smaller sites own initiatives and funding will speed up realisation of these sites although public support programmes can be used as well.

For all own initiative projects, it is recommended that a substantial client is identified who confirms his commitment, either through providing equity or by agreeing to buy a certain quantity of power and energy at a set tariff. Electrogaz is one example of such clients, but any commercial operation currently using firewood or petroleum could be taken into account, too (depending on the actual viability of the conversion), such as tea factories, brick and tile factories.

At the moment the unmet demand for electricity is high, and there are numerous institutions and firms that provide their own electricity at high costs. Micro-hydro power could provide electricity at lower costs, but for most locations there is no IPP in the neighborhood and Electrogaz has other priorities. One of the PSP Hydro examples is a new tea factory in the South West of Rwanda. It is too far from the grid to be able to get a connection in the near future, so it co-invested in the development of a micro-hydro power plant. Another example is a regional hospital in the North West that is too far from the grid to get a connection soon. It co-invested in a micro-hydro plant to obtain an electricity connection faster than Electrogaz could provide. For micro utilities it is therefore important to identify productive users of electricity, who use electricity mainly during the day when household consumption is low, and/or arrange for an interconnection with Electrogaz so that all excess electricity can be sold.

It is noted that developing micro-hydro sites as an IPP is an interesting possibility that does not depend on donors for as far as site selection and equipment procurement concerns; there is no need to launch a more formal project but the entrepreneur could realise his project immediately as a commercial activity following own initiatives. The plants could be configured as any combination of own distribution grid and interconnection to Electrogaz, depending on the projected demand in the neighborhood.

German firms can be involved in both of the aforementioned three types of hydro power market segments in Rwanda; it will mainly depend on the intended level of own initiatives and willingness to take risks. For companies that want to limit their risks it is recommended that they simply subscribe to public tenders, mainly for the larger hydro power plants but also for the EU initiatives. If and when selected, they will then need to submit their technical and financial proposals in response to a formal call for proposals. The support mechanism will have its own bureaucratic rules to deal with. More adventurous companies could look into the lessons learnt from the PSP Hydro Project and privately develop a site of their own choice. They would need to locate a local partner and develop a viable business plan for the construction and operation of a micro-hydro plant. With such business plan and some limited equity to be shared between the Rwandan and German companies, it will be possible to find venture capital equity and debt financing in Rwanda to realise the investment.

Three of such plants with a combined capacity of 1 MW will become operational later during 2009 or early 2010. Each of the project developers has created a private micro-utility to construct their hydro plant and operate it. These utilities own the plants and will sell electricity to their own clients in the immediate surroundings of the plant. If they have chosen to be interconnected they can sell any excess to Electrogaz. It is likely that they will be able to pay back their own investments within a two-year period, although they will continue to repay their loan for few more years. A short write-up of the project and its early results is presented in Annex 2.

The pico hydro electricity market segment is totally undeveloped in Rwanda. This means run of the river plants in sizes less than 10 kW. No or minimal civil works are needed, a simple diversion through a plastic pipe is sufficient or even the generator simply floats in the river. Such plants provide more benefits at lower costs than wind or PV power can: the power output of a pico-hydro plant is steady, certainly compared to the stochastic output of a PV panel or wind turbine, and the investment costs are much lower. The Hydro Atlas does not include pico-hydro sites there are numerous sites. The main criterion that determines the viability is the end user: For

what purpose does he need electricity, and is the investment in a pico hydro generator feasible for him?

2.3 Discussion

Rwanda is a small country and densely populated compared to many other African countries. This creates a risk environment that is different from elsewhere. Unlike other countries, it is quite likely that most - if not all – Rwandan rural areas in the medium future will indeed be grid connected and this changes the way investment opportunities should be evaluated.

Nevertheless, the decision to electrify a particular area through micro-hydro should not depend so much on the long term plans of Electrogaz, but on the level of economic activities in the zone to be electrified. Even if Electrogaz comes along to a site that already has a private stand-alone micro-hydro plant, the plant can be interconnected through an IPP arrangement and provide benefits for both the plant owner/clients and Electrogaz; the particular area has earlier access to electricity, and could spur economic development as a result of it.

3 Micro-Hydro-Specific Regulation and Framework

3.1 Policies and Regulations

Vision 2020 portrays the government's medium term goals. A copy can be found here: www.moh.gov.rw/docs/VISION2020.doc. Being land-locked, Rwanda has a keen interest in reducing its dependence on foreign energy imports and it placed a high emphasis on renewable and/or locally produced forms of energy. The use of biomass will be brought back to 50 % of the energy balance, from 86 % now. This is expected to be done through the use of modern fuels such as LPG and kerosene, and the use of electricity. In the short term, the government committed itself to increase electricity access from the current 100,000 clients in the country (6 % of the population) to over 350,000 by 2013 (13 %), and eventually more than 35 % with access in 2020. Large deposits of methane gas estimated at 60 billion m³ are embedded in the deep waters in Lake Kivu. Although the resource is shared with Congo, Rwanda is ahead in developing the site, it is expected that Rwanda will apply these resources of about 350 MW (electric) for some 50 years, of which 250 MW is earmarked for electricity production and 50 MW for production of liquid fuels; the remainder is considered for fertiliser production and direct use.

The country has strong private sector laws and a drive for privatising public services and promoting private sector involvement. Benefits are provided to foreign investors, in terms of tax holidays, import tariff reductions, etc. Although not necessary, it helps to register with the Rwanda Private Sector Federation (www.rpsf.org.rw) that can help with possible bureaucratic tangle. In addition, it can assist obtaining import duty and tax privileges. In addition, the Rwanda Investment and Export Promotion Agency can be helpful too (www.rwandainvest.com) with registration, licensing and obtaining tax incentives. The country developed a strong regulatory environment, which on the one hand seems overly bureaucratic, but on the other hand creates clarity and transparency. Another result of the regulatory environment is that the Rwanda Revenue Authority is well aware of all commercial activities and monitors this closely. Its mandate is to "Mobilise revenue for economic development through efficient and equitable services that promote business growth." (www.rra.gov.rw). Recently a Rwanda Development Board has been created that should be contacted before any new activity starts in reality.

IPPs and micro utilities are allowed to operate in Rwanda, under certain conditions of course:

A licence from the Rwanda Utilities Regulatory Agency (RURA) is needed to operate a
power plant; see www.rura.gov.rw for more details and contact information. The
experience shows that serious project developers have no difficulty obtaining this licence
in a limited time of a few weeks. In case a private network is considered, tariffs for

businesses and individual customers needs to be discussed with RURA. Until now, the PSP Hydro Project developers have established their own retail tariffs that are slightly below the ones applied by Electrogaz; these tariff levels have been approved, although RURA indicated that they will monitor performance and will review if needed.

- An Environmental Impact Assessment (EIA) and possibly an Environmental Mitigation Plan are needed prior to the construction of the plant. These are to be submitted to the Rwanda Development Board although the actual assessment and evaluation work is carried out by the Environment Management Agency (REMA); see www.rema.gov.rw for more details and contact information. The micro-hydro sector issues are relatively clear and well regulated. It should be possible to obtain such clearance within a period of one to two months, if the submission is well prepared.
- The Ministry of Infrastructure (MININFRA) coordinates activities in this sector, which
 means that a project developer discusses first with the Ministry if the site he wants to
 develop is covered under a future or ongoing project and whether other developers have
 earlier made a claim on developing the same site.
- District authorities on whose land the site is located will need to enter into a long-term
 agreement with the project developer for the development and user rights of the site.
 Usually this is not a problem as the authorities prefer to have their hydro sites operational
 rather than those of neighbouring districts.

Technical standards for (micro-) hydro electrical installations are the same as used by Electrogaz (www.electrogaz.co.rw). For any interconnection to the national transmission and distribution network, these standards need to be adhered to. Procedures for an IPP to conclude a PPA with Electrogaz are the following:

- (i) For small capacities such as micro-hydro, a standard PPA contract exists under which the provider obtains payment per kWh delivered. The value will be determined on an annual basis and depends on the average generation costs for Electrogaz. At the moment Electrogaz offers USD 0.10 per kWh (60 RWF)to such smaller IPPs; Electrogaz can review the level of the tariff on an annual basis; and
- (ii) For larger capacities a non-standard agreement will be negotiated on a case by case basis until a framework agreement will be in place in 2010. A comprehensive tariff study will be carried out by the Rwandan Utilities Regulatory Agency (RURA) in 2009 that looks at end-user as well as produced tariffs, including generation, transmission, and buy-back tariffs.

3.2 Applicable Public Sector Support and Financing Mechanisms

At the moment, two mechanisms exist:

(i) Subscribe to any tender as and when organized by the government or a Donor. MININFRA has plans for developing some ten sites (200-3000 kW) in the near future and will issue one or more calls for Expressions of Interest (EoI) in due course. The European Union, through the Belgian Technical Cooperation (BTC) will develop another four to eight sites and will issue similar calls. In addition, The Global Environment Facility (GEF) and The United Nations Development Programme (UNDP) is expected to develop an as yet undetermined number of sites under a Regional Project (Burundi, Rwanda, Uganda, Tanzania). Specific support or financing mechanisms depend on the source of financing, but in general the work is carried out on a contractual basis. The contractor simply responds to the Terms of Reference stipulated in the Bidding Documents.

The second mechanism is quite different:

(ii) Project developers propose to develop a particular hydro site of their own choice and arrange for commercial financing. Under the PSP Hydro Project, GTZ will assist project developers to realise their business plans by linking the project developer with local partners and financing institutions. A limited equity grant of some 15 % of total project costs is available on condition of a matching equity contribution by the project developer and obtaining a bank loan for the financial closure of his investment. The investment will then be paid back through the sale of electricity. In short, the project developer needs to prepare a business plan (including financing plan) for the construction and operation of a hydro plant. He can configure the plant as he sees it, including the location, size of the plant, his own local distribution grid and own clients, and/or interconnection to Electrogaz. Five plants are near completion and another eight are being discussed. This option is particularly interesting for equipment manufacturers as they can use this mechanism to sell their own equipment.

Depending on the company's willingness to engage and take risks beyond the normal price/quality bids prevailing in Call for Proposals, there are certainly commercial possibilities in Rwanda that do not exist elsewhere. Table 4 below gives the salient details of the different mechanisms.

	MININFRA	EU/CTB	PSP Hydro
Expression of interest	Respond to brief TOR	Respond to brief TOR	Submit brief business plan
Call for proposals	Respond to detailed TOR	Respond to detailed TOR	Submit full business plan with financing plan showing own equity and debt financing
Selection criteria	Price/quality considerations	Price/quality considerations	Acceptable if business plan viable and financing plan acceptable
Payment	100% of costs are paid as per disbursement schedule in Call for Proposals	50% of costs are paid as per disbursement schedule in Call for Proposals and 50% are earned back through sale of electricity over a number of years	Equity grant will convey to the project developer as soon as the plant becomes operational; main earnings from sale of electricity to pay off the loan and reimburse own investments
Risks	None other than usual when replying to a Call for Proposals	Some 50% of the costs are paid back only if the plant operates for a number of years	Setting up a micro-utility and operating it comes with its own risks
Benefits	If selected for the contract, quick pay off at margins set by the contractor		Longer-term income generation

Table 4: Different Mechanisms to Promote Hydro Power in Rwanda

3.3 Campaigns and Others

Whether or not there will be more programmes promoting small or larger hydro projects is not known. It is certain however, that the electrification rate in Rwanda is low and there is pressure to increase this rapidly. The government projects that an additional 175 MW will be in place by the year 2020. This may or may not be realised.

4 Business Partners and Competitors

Note: the business of micro-hydro can be broken down into project developers, construction companies, installation companies, equipment suppliers, and consultants. There are many construction firms, ranging from small to large, but not one has a particular advantage in relation to designing or constructing micro-hydro. There are very few individual consultants specialized in micro-hydro, and those are all taken up by the ongoing programs. There are also several installation firms, but not one specializes in micro-hydro.

4.1 Overview of Micro-Hydro Key Market Players

Table 5: Key Market Players in the Micro-Hydro Sector

	Full name	Core business and market position	Products	Location	Turnover	Contact details
Project developers	SOGEMR	Micro-hydro electricity utility		Musanze		Caleb King Email: calebkking@yahoo.com
	ENNy	Micro-hydro electricity utility		Nyamagabe		Firmin Mutabazi Email: firmin_mutabazi@yahoo.fr
	REPRO	Micro-hydro electricity utility		Musanze		Gregory Tayi Email: tayi@rwanda1.com
Programmes	MININFRA			Kigali		Yussuf Uwamahoro Email: yussuf.uwamahoro@gmail.com
	СТВ	EPRER		Kigali	USD 21.4m	Eric van Malderen: Email: erik.vanmalderen@btcctb.org
	EU	IREARPPP		Kigali	USD 9m	Nacer Hamammi Email : nacerhammami@gmail.com
	PSP	PSP		Kigali	EUR 3m	Mario Merchan Email: mario.merchan@gtz.de

	UNIDO	SHP		Vienna, Austria	USD 1.8m	Fatin Mohamed: Email: E.AliMohamed@unido.org
Consultant firms	SHER	Hydro consultant		Kigali		Michel-Henri Bourge Email: bourge@rwanda1.com
	Enco Co.	Energy consultant		Kigali		Nishantha Nanayakkara
	RIEX	Rural electrification Contractor, representative of OSSBERGER	Installation, equipment	Kigali		Gregory Tayi Email: tayi@rwanda1.com
Other	Local Banks: Banque Populaire ; Banque Rwandaise de Développement ; Banque de Kigali Banque de Commerce ; Grofin ; REIC	Provide debt financing, equipment leasing, commercial loans, venture capital	All financial instruments	Kigali		www.bpr.rw www.brd.rw www.bcr.co.rw www.bk.rw www.grofin.com www.reic.co.rw

Please note that potential key market players are the various Banks in Rwanda. They are interested in micro-hydro investments and already have issued either debt financing or leasing contracts to micro-hydro project developers. It is beyond the scope of the present report to explain all possible mechanisms, it is sufficient to state here that the financial sector players in Rwanda are keenly aware of the opportunities in micro-hydro investments and in principle are willing to support project developers. The terms and conditions are different for each of the financial institutions.

4.2 Overview of Major and Most Emblematic Micro-Hydro Projects

Location	Size	Project participants	Success factors	Main features
Rural Rwanda	EUR 3.5 million	Private firms	Three privately cofinanced projects become operational; seven to eight more projects are in the pipeline.	using local technical and financial resources only
Rural Rwanda	USD 1.8 million	ENCO co	two plants operational as result of 100 % foreign involvement, two more plants are being developed.	some technical and operational problems
Rural Rwanda	USD 4.5 million	EU delegation	tens of plants are expected to be developed through international tenders and already identified local project developers.	Financing arrangements are not entirely clear. It appears that international companies need to pre- finance 50 % of the investment costs, that will be paid back through the sale of electricity over a number of years.

4.3 Highlights in Local Micro-Hydro Market Developments

The four ongoing projects that employ a support mechanism are the following:

- SHP UNIDO, with two plants of about 75 kW each completed and two plants under development. A contract was tendered and awarded to one Sri Lankan company for all aspects of the work.
- IREARPPP EU, with some 20 proposals initially identified for a total of about 3 MW. Strict
 international tendering rules for which EU projects are known will be used. A specially hired
 team at the Ministry of Infrastructure (MININFRA) will prepare bidding documents that include
 a feasibility study for each of the plants.
- EPRER CTB, which will develop ten plants with a total of about 3 MW through international tenders; the CTB will prepare bidding documents that include a feasibility study for each of the plants.
- PSP Hydro EnDeV GTZ//DGIS partnership, with three plants almost operational (combined 1 MW) and ten proposals awaiting further development (another 3 MW); this is entirely done by the Rwandan private sector, with some limited financial and technical assistance from GTZ. There is no tendering, private firms propose a business plan and provide part own financing. Financial instruments from local banks will be used to realise their business plans.

The second phase intends to continue providing support for the next four years (start early 2010).

For the first three support mechanisms, the initiative is with the donor and/or the Ministry of Infrastructure (MININFRA), which also determines the design of the individual projects, including layout, interconnection or not, and number of clients. For the fourth support mechanism, the initiative is with the private firm that intends to develop a particular site. The design of the plant is entirely up to the project developer. He can team up with any local or foreign company. The main criterion is the business plan, as long as this is sound, he will be able to obtain the necessary debt financing. Of course it helps enormously if some grant money can be obtained.

Annex I – Map of Hydro Sites in Rwanda

Figure 1: Map of Hydro Sites in Rwanda



Annex II – PSP Hydro Project



Dutch-German Partnership Energising Development

Context

Access to electrical energy is generally regarded as a precondition for the social and economic development of a country. The electrification rate in Rwanda is particularly low at 4 % (less than 1 % in rural areas). While large companies rely on expensive diesel generators, most of the small- and medium-sized enterprises (SME) in rural areas have no electricity supply, which hampers productivity and limits expansion. At the same time, a large proportion of social infrastructure cannot provide effective services due to a lack of energy. Therefore, the Rwandan Government has declared energy security and rural electrification a national priority.

Project summary

In the project "PSP Hydro" six Rwandan companies are being awarded a 50 % subsidy to build and operate six micro-hydro plants and mini-grids supplying rural areas with electricity. In addition to financial support, the companies are supported through:

- Technical advice and supervision by a team of experts in the state utility. Electrogaz
- Business development advice and training through the Rwandan NGO, CAPMER •
- Business development, political support and institutional guidance through GTZ and an • international consultant based in the Netherlands.

Additional training and supervision organised as and when needed by GTZ.

This project is supported through the Dutch-German Partnership, "Energising Development".

The Ministry of Infrastructure (MININFRA), Electrogaz, the Government of the Netherlands and GTZ have repeatedly agreed that the PSP Hydro project is of strategic importance for the Rwandan energy sector because:

- These pilot projects will build capacity in Rwanda for the construction and operation of micro-. hydro plants without heavy reliance on foreign expertise. It is important to promote the use of Rwandan expertise in future hydro projects.
- The project developers are contractually required to serve poor rural communities and rural • enterprises, and so contribute to poverty-reducing economic development.
- These projects are pilot projects that will be used to overcome unforeseen barriers. This • justifies the subsidy by the Dutch Government and favourable electricity tariffs.
- PSP Hydro will support the development of the Rwandan private sector by creating six companies that will construct and operate micro-hydro plants and mini-grids.

Next phase

Rwandan companies have been informed that a new approach will be used in the future whereby a 15 % equity subsidy will be provided from GTZ through a venture capital provider who will also insert the same equity. The project developer will also input a similar equity contribution and will need to obtain a commercial loan to close the financing of his business plan. Some seven to eight micro-hydro plants and mini-grids supplying rural areas with electricity have been proposed by different local project developers. There are two venture capital providers in Rwanda, GROFIN and REIC, and both are very much interested in developing micro-hydro projects.

Procedures

Project developers under the first phase of the PSP Hydro Project found it difficult to deal with banks, and GTZ found it difficult to monitor subsidy disbursement. Under the second Phase of the PSP project, a new approach is proposed building on the experiences so far and overcoming aforementioned difficulties. As a reminder, the objective of the PSP Hydro Project is not only to develop successful projects, but also to develop a mechanism that has a chance of continuation when GTZ funds dry up. To further develop this approach, a banking and financing specialist was asked to discuss this with the various financing institutions in Rwanda. As a result, it is now proposed to have a two stage procedure to identify new project developers and find financial closure for their proposed activities:

- In Stage 1, GTZ will request Expressions of Interest (EoI) from potential project developers whereby the focus will be on their management experience and ability to provide equity for a new micro-hydro project. Information required for this Expression of Interest is:
 - A fact sheet demonstrating where the applicant wants to develop a micro-hydro site and the major features of the proposed micro-hydro plant.
 - Evidence of a preliminary Memorandum of Understanding with the District authority to develop this site.
 - An estimation of the potential clients and approximate costs
 - Descriptions and references showing experience in project development and management (not necessarily in micro-hydro or energy projects)
 - A plausible demonstration that at least 10 % of the project equity can be provided.

In the EOI it will be especially recommended to discuss potential activities with banks and/or Venture Capital providers. GTZ will evaluate the EoIs jointly with GROFIN and REIC against a set of criteria (to be developed) and will grant the most successful project developers an amount of money to develop a full business plan under Stage 2.

2. In Stage 2 project developers need to develop their business plan in which detailed costs and benefits are described and financial closure should be achieved. Project developers can count on GTZ providing matching funds to the bank or venture capital provider pari passu with its contribution in the form of a no-interest loan. GTZ will sign a contract with the capital venture provider or Bank for the matching funds and ceding its shares. GTZ will also sign a contract with the project developer describing its technical and financial assistance and committing the project developer to reach certain goals in terms of kW installed, nr of clients, etc.

This method in fact kick-starts micro-hydro development activities using available innovative financing mechanisms; so far, under the ongoing PSP Hydro Project there is some discussion but no deals are closed yet. The second Phase PSP Hydro Project assists both project developers and the venture capital provider in such a way that the latter could continue even without GTZ continued inputs.

Tentative second phase PSP hydro procedure

It is hoped and expected that at least four locally based project developers will be awarded financial incentives and technical support to each build and operate a micro-hydro plant and mini-grids supplying rural areas with electricity. Plants are likely to be 150 – 500 kW each although a larger size cannot be excluded a priori. The financial support will be structured as follows:

- Companies will be selected in a Two-stage call-for-proposals. At the end of the first stage, a
 maximum of ten project developers can be awarded with a 5000 EUR award to further
 develop their ideas.
- Companies re-submitting for the second round can apply for a reduced-return venture equity investment. GTZ would support a locally based and revolving equity fund to be lodged at a local financial institution. This equity fund would provide matching no-interested loan funding to serve in reducing the return expectations and repayment rate of the venture equity provider's investment. This would mitigate both the project risks and the project developer's risk exposure.
- The project financing structure would then be:
 - o 5 % in-kind equity from the local project developer
 - 10 % equity from the local project developer
 - 15 % venture equity from the local venture fund
 - 15 % matching subsidy from GTZ
 - 45 % bank financing from either a (commercial) bank or the venture capital provider
- GTZ would cede its shares resulting from the Equity Fund Contribution to the bank or venture capital provider; the bank or venture capital provider and the project developer agree on the repayment terms of the GTZ subsidy back into the Equity Fund.

In addition a selective grant might be considered for distribution lines and grid connections (up to 10 % of the total investment costs of the project). This would be optional and the details are yet to be sorted out. This grant would allow households to connect at lower costs and will increase the economic viability of distribution grids and increase the connection rate of low-income households who would otherwise not be able to pay the 50-150 EUR connection costs.

In addition to financial support as outlined above, project developers will be supported by GTZ through the following intervention along the lines of the ongoing PSP project:

- Technical advice by a team of Electrogaz experts during business plan drafting, as well as advice and supervision during planning and implementation
- Technical review by international consultants at key junctures in the project: business plan completion, completion of engineering designs, turbine selection and plant commissioning
- Financial management advice for business planning and implementation, through a national auditing company
- Business development, political support and institutional guidance by GTZ
- Additional training and supervision organised as and when needed by GTZ.

Annex III: Status of the Individual PSP Hydro Activities, April 30, 2009

Table 7: Status of the Individual PSP Hydro Activities, 2009

Project developer	River /district /village	kW	Clients	Financing (FRW)	Status	Operation start
REPRO	Rutsiru district, Murunda, river	105	160 households, 5 institutions, 15 small businesses	Total: 282.3 m RWF Own equity: 56.5 m RWF Subsidy: 141.2m RWF Loan: 80.7 m RWF (from BRD) Community: 165.6 m RWF	REPRO is renovating a 105 kW plant in Murunda in the District of Rutsiro. Renovation of the civil works is completed. The main remaining works involve the interconnection with Egaz. The total planned investment is approximately 350 thousand Euros. Modalities for the interconnection and the relationship with the existing local distribution network are being negotiated. The turbine arrived in March 2009.	July 2009
SOGEMR (ATEFPM)	Gakenke district, Musarara river	438	1500 households, 10 institutions, 144 businesses + EGaz	Total: 740.1 m Own equity: 109.5 m RWF Subsidy: 247.0m RWF Loan: 380.0m RWF (From BCR and REIC)	SOGEMR is constructing a 438 kW micro-hydro plant in the District of Gakenke in the Northern Province of Rwanda. Construction on the site still to be carried out is the intake channel and the dam. SOGEMR will also construct a local grid to sell electricity to the local population and an interconnection to the national grid. The turbine has arrived.	January 2010
ENNY (Adenya)	Nyaruguru district, Mazimeru river	250	972 households, 34 institutions, 219 small businesses	Total: 956.1 m RWF Own equity: 184.2 m RWF Subsidy: 259.1 m RWF Loan: 512.8 m RWF (from BK) Community: 165.6 m RWF	ENNY is constructing a 500 kW plant in the District of Nyaruguru in the Southern Province of Rwanda. Construction on the site is progressing fast. The turbine arrived in March 2009-	September 2009

Former RES	Gicumbi district, Kavumu village, Kavumu-Mwange River	105	300 households, 17 institutions, 20 businesses + Parish and surrounding clients	Total: 285.2 m RWF	The grant contract with RES has been cancelled and new project developers have been identified: ENEDOM and AFRIBUS (which wants to develop a construction workshop as well).
Former GTR	Musanze district, Mpenge river	128	300 households, 7 institutions + EGaz	Total: 208.3 m RWF	The grant contract with GTR has been cancelled and new project developers have been identified: ENEDOM and SEFIK; the latter could include the site in its current proposal, which is to develop sites # 3 and # 4 on the same river.
Calimax, ENNy, SEFIK, SOGEMR	Various	900	tbd	1700 m RWF	Requested to contact GROFIN, REIC and any other bank to arrange for financing and finalise business plan

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