

ADVANCING SMALL HYDROPOWER IN AFRICA

By Wim Jonker Klunne

About 10% of the world's hydropower potential is found in Africa, most of which is located in the sub-Saharan part of the continent.



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However, on no other continent is the gap between actual hydropower generation and the technical exploitable potential larger than in Africa where only 5% of the potential has been exploited (ESHA, 2006; *Min Conf Water for Agriculture and Energy in Africa, 2008*). For small and micro scale hydropower the gap between the potential and the actually developed sites is most probably even bigger, although no proper statistics are available.

To indicate the low rate of development of small hydropower on the African continent, *Gaul et al (2010)* compare the 45,000 plants below 10 MW in China with a total of a few hundred developed sites in the whole of Africa. The European Small Hydropower Association (2006) is even referring to a number of 100,000 units in the micro

spectrum being installed in China.

Small hydro is a proven technology that can adequately contribute to the electricity needs of African countries, either as part of the national electricity generation pool or as standalone units in isolated mini grids. The technology has a long history in general, but also in Africa. The gold mines at Pilgrim's Rest, for example, were powered by two 6.0 kW hydro turbines as

early as 1892, complemented by a 45 kW turbine in 1894 to power the first electrical railway. All over Africa church missions were particularly active in implementing small scale hydropower installations. In Tanzania, more than 16 small hydropower systems were installed by church missions in the 60s and 70s of the last century and are still operating, while in Zimbabwe commercial farmers in the eastern highlands of the country installed hydro stations as early as the 1930s.

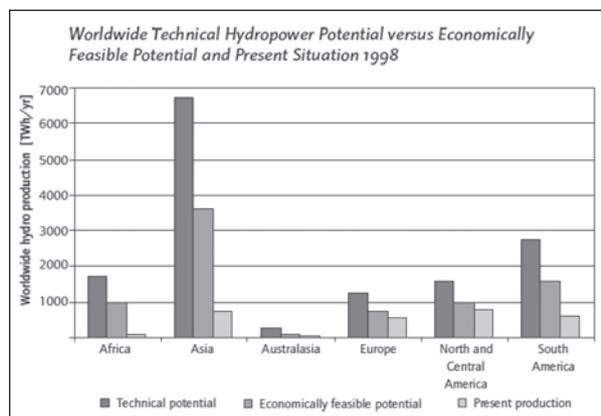
Many countries in Africa do have a rich history of small hydropower, but over time large numbers of these stations have fallen into disrepair; some because the national electricity grid reached their location and delivered electricity more cheaply and reliably, others because of lack of maintenance or pure neglect.

Recently initiatives to revive the hydropower sector have seen the light in a number of African countries, either through international development agencies or private sector led initiatives. In particular, in Central Africa (Rwanda), East Africa (Kenya and Tanzania) as well as Southern Africa (Malawi, Mozambique and Zimbabwe) new initiatives are focusing on implementing small scale hydropower projects.

BARRIERS

Although several projects and programmes have seen the light in recent years, the low number of existing hydropower stations shows that there are still many barriers hampering the dissemination of this technology.

The challenges facing small hydropower exploitation in general are many and most of them are part of the larger picture of general barriers for the uptake of renewable energy and independent power producers. These generic barriers can be summarised into the lack of clear-cut policies on renewable energy and associated requisite budgetary allocations to



Hydropower potential worldwide (IEA, 2003).



Spillway being opened at the Tunga-Kabiri hydro project in Kenya.

create an enabling environment for mobilising resources and encouraging private sector investment, and the absence of lost-cost, long-term financing models to provide renewables to customers at affordable prices while ensuring that the industry remains sustainable.

Specifically for small hydro, large scale implementation is hindered by:

Policy and regulatory frameworks: The policies and regulations needed to govern the development of (small) hydropower do not exist. Sometimes hydropower developments are either not regulated at all or are part of a broader regulatory framework made for rural electrification in general. Generic frameworks might lack clarity on a number of hydropower specific issues like access to water and associated payments.

Financing: The lack of funds for hydro developments is a major bottleneck. Currently most of the hydro projects in Africa

are relying in one form or another on donor financing. Tapping into alternative funding sources is needed to upscale the uptake of hydropower.

Capacity to plan, build and operate hydropower plants: Another serious challenge is the missing knowledge and awareness on small hydro potential for rural electrification. This includes knowledge at political, government and regulatory entities, as well as knowledge on local production of parts and components.

Data on hydro resources: Linked to the limited knowledge about the technology is the lack of proper resource data on which hydro developments can be based. An example in this respect are the many dams in Africa built for water provision purposes (irrigation and/or drinking water) for which in most cases no information is available as to whether the available water flow could sustain hydropower based electricity generation.

Selection of current initiatives on small hydro in Africa

Country / region	Project	Implementer	Description	Important component
East Africa	Greening the tea industry	UNEP/GEF	Development of small hydroplants at tea factories, including rural electrification component.	Linking rural electrification with existing industrial activity.
Kenya	Tungu-Kabiri hydro project	Practical Action / UNDP/GEF-SGP	Community owned system to power micro enterprises centre.	Legislative framework prohibited connection of households.
	Rural energy access model	GPower	11 small hydroplants initially off-grid, later to be interconnected. Includes local turbine production.	Long term planning, integration with grid, part of larger development plan, local turbine manufacturing.
Malawi, Mozambique, Zimbabwe	Catalysing modern energy service delivery to marginal communities in Southern Africa	Practical Action / EU	Rehabilitating existing systems, development of local/regional capacity.	Inclusion of capacity building component.
Nigeria	UNIDO Regional Centre for Small Hydro Power, Abuja	UNIDO	National and regional capacity building.	Capacity building, linkages with International Centre for Small Hydro Power, Hangzhou, China. Current status unclear.
Rwanda	Energising development	GTZ	Support to private sector to develop hydroplants.	Need to incorporate requirements of financial sector.
	Rural energy development in Rwanda	UNIDO	Rural energy development.	Learning-by-doing project – increased role of private sector in construction and O&M.
Tanzania	Kinko Village hydro, Lushoto	UNIDO / MoEM / TANESCO / TaTEDO	Establishment of village hydro scheme.	Integration of productive uses (grain milling and ICT centre).
South Africa	Bethlehem hydro	NuPlanet	7.0 MW of hydro capacity at Sol Plaatjie and Merino sites.	CDM project.
Uganda	Kisiizi Hospital hydropower	Kisiizi Hospital Power Limited	300 kW cross flow turbine serving hospital and local community.	Hospital as anchor client.
West Africa (Cameroon, Mali, Central African Republic, DRC, Gabon, Congo, Rwanda, Equatorial Guinea, Togo and Benin)	First regional micro/mini-hydropower capacity development and investment in rural electricity access.	UNDP/GEF	Regional integration project aiming at developing 36 small hydropower stations. Included a network on small hydropower.	Establishment of regional network. However, important to note, this project has been subsequently cancelled.

FUNDING OF HYDROPOWER SCHEMES

Funding of small hydropower developments in Africa can be distinguished in three broad categories:

Private funding for systems that serve one household or farm with or without commercial activities attached to it: These systems tend to be designed to supply a small load consisting of domestic energy use and more power demanding applications like milling or grinding and typically are not designed to harness as much energy as possible at their specific site. As these systems typically do not supply outside entities their existence is quite often not publicly known. Funding of these systems normally does not involve external parties. An example is the Horseshoe Falls system in Sabie in South Africa, which was designed and built by farmer Pieter Weber in the 1960s and operated till 1990 when the national grid reached the farm.

Public funding, often through the national or municipal power company, for grid connected systems: This typically involves larger systems like the 2.0 MW Mantsonyane plant in Lesotho. Such systems are typically funded by bilateral donors (e.g. from Austria, Belgium, China, Germany, Japan, Netherlands, UK and Sweden) and multilateral donors (World Bank, AfDB, GEF, UNDP, etc). These systems will often form part of a national programme on energy access / rural electrification.

Financial incentives for hydropower systems can be provided through generation based incentives or capacity based incentives: A good example of the first is a renewable energy feed-in tariff paying the owner of the system a premium based electricity tariff. In Africa only Kenya, South Africa and Uganda have specific feed in tariffs for hydropower.

Capacity based incentives do provide up front funding to offset the high investment needed for hydropower and are typically modelled as once-off investment subsidies. Particularly for off-grid systems, capital investment support is considered a preferred form of support as long as it is

supplemented by a business model to operate the facility in a sustainable way.

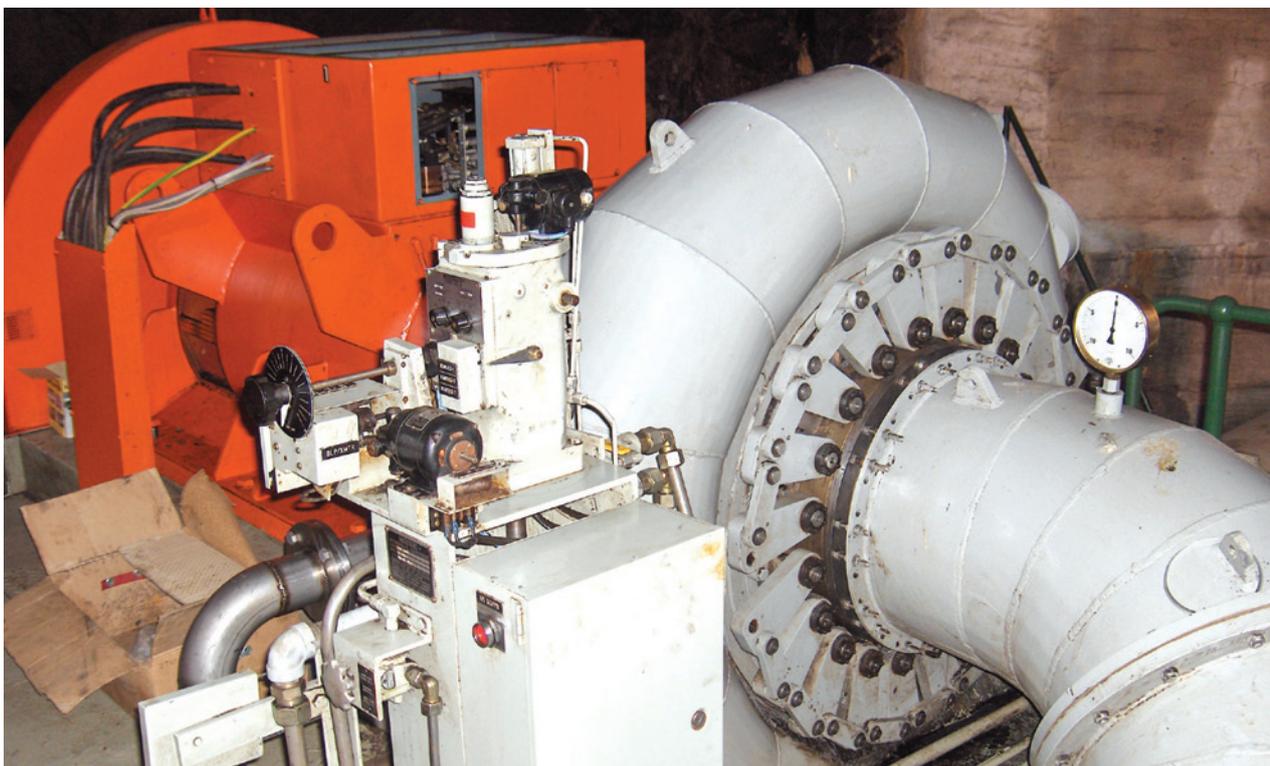
A specific form of financing is provided by the Clean Development Mechanism (CDM) under the Kyoto protocol. Most of the hydropower projects worldwide that benefit from CDM funding related to avoided carbon emissions are in Asia (India and China) while very few can be found in Africa. The uncertainties around the CDM funding after the end of the Kyoto protocol in 2012 make investors hesitant to follow this route. Coupled with a general lack of CDM project development capacity in Africa it is not likely that the list of CDM funded projects will increase dramatically in the (near) future.

CAPACITY BUILDING

Essential towards the successful operation of small hydropower in countries in Africa is the establishment of local capacity to plan, design, build, operate and maintain hydroplants. Without proper resource assessments and associated feasibility studies no project will be developed. Similarly, without proper maintenance and technical capabilities to repair systems, sustainable operation will not be possible.

National and regional capacity to plan and design systems has been and is being built by (international) NGOs funded by development assistance funds from developed countries. Also, local production of turbines and other components of hydroplants have been piloted by in particular Practical Action, but with the limited regional markets these efforts have not seen widespread local production.

In an analysis of best practices on microhydro developments, including detailed descriptions of four installations on the African continent, *Khennas and Barnett (2000)* pointed out that the lack of knowledge about financial management and utilisation of electricity to generate revenues is a main deficit for a successful operation in sub-Saharan Africa.



Part of the 2.0 MW Mantsonyane plant in Lesotho.

The limited number of microhydro projects in Africa has resulted in few people with practical experience in the technologies involved. *Gaul et al. (2010)* identify four approaches to address this deficit:

- Establish international or regional knowledge networks and induce foreign expertise by training local technicians.
- Strengthen technical schools and science institutes to build up local capacity.
- Project-driven approach, involving local engineers in the planning and implementation of projects and at the same time building up their skills.
- Technology transfer either north – south or south – south. Particularly, the small hydro expertise in countries like Nepal and Indonesia could be targeted for technology transfer.

OPPORTUNITIES FOR REHABILITATION OF OLD SITES

With the renewed interest in the technology of small hydropower, partly fuelled by recent electricity shortages and the introduction of favourable feed in tariffs for electricity generated by hydro, it is becoming more and more viable to look at old disused sites. Although proper statistics are not available, discussions with local experts do reveal large numbers of old hydro sites that could be reinstated. Some sites might only have (part of) the civil works still in place while others might be more or less complete. In any case they do share the benefit of a new hydro resource that can be used.

An example is the hydrostation that is incorporated in the Hartbeespoort Dam in South Africa, which serves as storage for a large irrigation scheme. This 37 kW hydroelectric plant was installed in 1924 when the dam was built and operated and delivered electricity around the dam for about 40 years. The system was finally decommissioned in the mid 1960s. Although out of operation for almost 50 years, all infrastructure in terms of civil works is still in existence. In rudimentary form

the mechanical and electrical installations are still in place as well, but are certainly outdated. The irrigation scheme does guarantee the supply of water and with new equipment and a possible slight adjustment of the location of the plant, hydro generation at a much higher rate than the old station will definitely be possible.

CONCLUSIONS

Although a limited number of small hydro stations are operating on the African continent at the moment, several initiatives are on the way to change this situation. With the creation of an enabling environment that deals with the barriers identified in this article it is anticipated that more developments will see the light. This could be either new, greenfield stations or the rehabilitation of old stations that are currently out of operation.

Critical in the development of any hydro scheme is attention to the model applied for the operation of the scheme to ensure the sustainable provision of energy to the beneficiaries. [ESI](#)

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References

- 1) ESHA, I. P. (2006). *Small hydropower for developing countries*. Brussels: European Small Hydropower Association.
- 2) Gaul, M., Kölling, F., & Schröder, M. (2010). *Policy and regulatory framework conditions for small hydro power in sub-Saharan Africa*. Eschborn: EUEI PDF.
- 3) IEA. (2003). *Renewables for power generations. Status & prospects*. Paris: IEA.
- 4) Khennas, S., & Barnett, A. (2000). *Best practices for sustainable development of micro hydro power in developing countries*. Washington:
- 5) Min Conf Water for Agriculture and Energy in Africa. (2008). *Hydropower resource assessment of Africa*. Sirte: Water for Agriculture and Energy: the challenges of climate change.



Interior of the old hydroelectric station at the Hartbeespoort Dam in South Africa.