

SUSTAINABLE IMPLEMENTATION OF VILLAGE LEVEL HYDROPOWER IN EASTERN AND SOUTHERN AFRICA

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ABSTRACT

This article looks into recent developments in small hydropower as well as investigating existing schemes in Africa. The main focus of the article is stand-alone, non-grid uses of hydropower with a typical size of less than 300 kW.

The article concludes that careful planning during preparation and construction, a proper technical support scheme and linkages to productive uses are essential for the long term survival of micro hydro schemes. If embedded in a multi-sectoral programme that includes the creation of small business, micro hydro schemes can contribute to local sustainable development in rural areas of Africa.

1. INTRODUCTION

Particularly in Africa, with large rural areas far away from the national electricity grid that will not see this grid reach there in the near future, stand alone hydro power plants can play an important role. Through local mini grids micro scale hydropower plants can serve local business and households with electricity essential for their economic development.

The large knowledge base on technical aspects of micro hydropower does suggest a proper understanding of the technology. However, the relatively small number of hydropower projects implemented in Africa does not reflect the enormous potential for the technology on the continent, suggesting that other barriers than the technology itself are still persistent.

Although micro hydropower projects have been implemented in several countries on the continent, information on the current state of affairs is scattered and incomplete. To a limited extent information is available on technical details of implemented projects, however, information on implementation models followed and their success is not available in most cases [1,2].

Information on existing small hydrostations might be available, but is definitely not complete nor consistent over the different information sources. This lack of information does severely hamper the possibility to learn from past experiences and is a barrier to large uptake of microhydro on the continent.

This article is a contribution to enlarging the knowledge base on microhydro implementation in Africa. It looks into

possible implementation modalities to ensure sustainability of microhydro interventions in Africa by first looking into the (potential) role of microhydro in serving energy needs of isolated rural communities in Africa, followed by an analysis of a number of projects and programs currently under implementation. Based on this analysis the article will conclude with characteristics of successful projects and define areas that need further investigation.

The traditional way of providing electricity to rural areas through the extension of the national electricity grid becomes prohibitively expensive due to geographical barriers (distance and terrain) and due to initial low demand for electricity. A viable alternative for grid extension is provided by renewable energy sources that use local resources.

Substantial numbers of projects and programmes have been implemented in Africa providing solar systems to rural populations. However, the costs of photo-voltaic systems are very high and that they do not provide households with the level van energy services they aspire [3].

Micro scale hydropower, often implemented through local isolated mini grids, is able to offer a higher level of energy services than solar PV. In the case of Kenya, research by Maher et al [4] revealed that hydro stations in the pico range (in this case defined as less than 5 kW) are able to supply electricity to households at a fraction of the cost to the end-user compared with solar PV or using car batteries charged at grid connected charging stations.

2. VILLAGE LEVEL HYDRO IN AFRICA

There is enormous exploitable hydropower potential on the African continent, but despite this massive potential for large and small scale hydropower, Africa has one of the lowest hydropower utilisation rates. While large-scale hydropower development is becoming a challenge due to environmental and socio-economic concerns, and more recently its vulnerability to changing climates and hence water availability in the main water bodies, micro hydropower development continues to be an attractive resource especially in remote parts of Africa. The fact that microhydro installations tend to use only part of the available water in rivers makes them less vulnerable to changes in water quantities due to climate change.

Microhydro is a proven technology that can adequately contribute to the electricity needs of African countries.

Micro scale hydropower has a long history in general, but also in Africa. For example the first system in South Africa was a 300 kW station on the slopes of Table Mountain, which was inaugurated in 1895 [5]. 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 60's and 70's of the last century that are still operating [6], while in Zimbabwe for example large scale commercial farmers in the Eastern Highlands of the country installed hydro stations as early as the 1930's [7]. Many countries in Africa do have a rich history of small scale hydropower, but over time large numbers of these stations have fallen in disrepair. Some because the national grid reached their location but others because of lack of maintenance or pure neglect.

Recently initiatives have seen the light in a number of countries in Africa to revive the hydropower sector, either through international development agencies or through private sector led initiatives. Particularly 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.

3. DEFINING MICRO HYDRO

Although there are no internationally agreed definitions of the different hydro sizes, a common distinction is between "large" hydro and "small" hydro. The upper limit of "small" is usually taken in line with the World Commission on Dams as 10 MW of installed capacity, although large countries such as China and India tend to put the limit higher at 50 MW and 25 MW respectively.

Within the range of small hydro, the distinction can be made between mini hydro (often defined as with an installed capacity below 1 MW), micro hydro (below 300 or 100 kW depending on the definition) and pico hydro (below 20 or 10 kW), each with its own specific technical characteristics. Micro and pico hydro installations are typically used in developing countries for energy provision to isolated communities where the national electricity grid is not available, whereas mini hydro tends to be grid connected. Micro and pico hydro can also differ from mini hydro due to the extended possibility of using local materials and labour in the case of the first two, while mini hydro typically involves more traditional engineering approaches and will usually need for example heavy access roads for delivery of materials and electro-mechanical equipment.

Also in the mini, micro and pico hydro ranges no uniform definitions exist. In this article the term microhydro is used to refer to hydro installations which are typically used for village electrification using a local distribution network. In line with the definition used by Fraenkel et al [8] it is assumed that these hydroplants have an installed capacity below 300 kW.

4. CURRENT EXPERIENCES

At the moment several initiatives are ongoing to assist developing small hydropower in Africa. A number of UN agencies (UNDP, UNEP and UNIDO) are running programmes to remove barriers towards the uptake of small hydro. Small hydro support centres are established or in the process of being established in a number of countries and a number of national rural electrification programs include electricity generation by small hydro. Also bilateral donors and NGOs have embraced small hydropower as a means to provide energy to rural areas.

The United Nations Environment Programme (UNEP) is implementing a Global Environment Facility (GEF) funded project that looks at the possibilities of applying small hydro at tea estates to generate electricity in the Eastern Africa region. Starting from the premises that tea does need altitude and water to grow, which incidentally are requirements for hydropower as well, a collaboration of the East African Tea Trade Association (EATTA), UNEP, the African Development Bank and the GEF has set up a facility to accelerate the uptake of hydropower. The project received huge interest by the tea estates due to the current unreliable power supply from the national electricity grids. The project aims to establish 6 small hydro power demonstration projects in at least 3 of the EATTA member countries, preferably with an attached rural electrification component, as well as to prepare additional pre-feasibility studies. Both studies and planned installations will serve as training grounds for the entire tea sector in the region. The project includes a special financing window to assist individual tea processing plants to move into "green power generation". A key feature of this Greening the Tea Industry in East Africa project is linking the energy requirements of the tea industry with the available hydro resources and using this as a basis to develop viable projects that preferably do include a rural electrification component.

In Rwanda the Ministry of Infrastructure is rolling out a large program of developing micro and small hydropower stations in the country with installed capacities from 100 kW to 9.5 MW. The Ministry is assisted in this effort by international support from Germany, the Netherlands, Belgium and UNIDO [9]. Upon completion, some of the hydrostations developed will be grid connected and managed by the local electrical utility, while others will be off grid and managed by local authorities through association of consumers or in the beginning by the utility or any other private company while building capacity of local associations of consumers wherever possible, although this is clearly seen as a challenge by the ministry [10].

The different donor agencies assisting the country in its efforts to build a local small hydro industry 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 [11]. Contrary to this, the Dutch/German funded EnDev program followed a purely 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. [12]. 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 appealed to the banks, who appreciated a guaranteed sale of the electricity produced [1].

As part of the EU funded project "Catalysing Modern Energy Service Delivery to Marginal Communities in Southern Africa", the British NGO Practical Action is implementing a regional micro hydro project in Malawi, Mozambique and Zimbabwe. The project seeks to promote the use of renewable energy through creating micro hydro expertise in poor communities by equipping community members with micro hydro scheme management skills, such as installations, fabrication of equipment, etc. The project aims at the installation of 15 micro hydro units in the three countries concerned. The project is in the initial phases of its implementation and currently supports three hydro systems in different phases of implementation. The project looks into the development of a regional pool of microhydro expertise, including local manufacturing, quality standards and work on removing of political barriers. Also management and ownership models will be tested and evaluated under the project [13].

A recent evaluation of existing micro hydro systems in Tanzania [14] looked at the cases of three isolated mini grids in Tanzania using microhydro technology to serve a total of 1100 households, 32 institutions and 84 commercial loads with electricity. Careful planning procedures catering for technical capacity, good institutional arrangements, managerial capacity and economic considerations, as well as multi-stakeholder involvement from the planning phase onwards, have resulted in the sustainable operation of the three hydro plants. The analysis suggests that village level scale hydro stations are best managed in a business-like fashion, although it also concludes that community engagement/involvement is crucial in all phases of the hydro site development.

In Kenya, Practical Action developed the Tungu-Kabiri hydro project using funds of the Global Environment Facility (GEF) Small Grants Program (SGP). This 18 kW

hydro scheme powers a micro enterprises community centre with a battery charging station, barber shop, welding facility and the likes, It was intended to provide power to local households as well, but unfortunately local regulations prohibited the community to connect local households to the electricity network. The community did fully participate in the development of the hydro station and is, through a community power committee, responsible for the day-to-day management of the installations. The experiences gained in this project resulted in two pico hydro schemes being developed, but the capacity building activities linked to the project did not result in more micro hydro being implemented due to the restricting national legislation.

5. CONCLUSIONS

Microhydro has the technical capability of providing electricity to rural areas of Africa that are currently not supplied with electricity. Several initiatives are currently ongoing on the continent that are aiming at installing a large number of microhydro schemes to serve rural populations. Although quite some information is available on the technical aspects of these projects, little has been published on the implementation models used in these projects.

From the analysis of a number of the current initiatives, as described in this article, it has been very clear that microhydro can bring sustainable development to rural areas provided a proper legislative framework is in place that allows local production and distribution of electricity. Linked to the development of individual hydro schemes a national program for capacity building and industrial development will need to be developed to foster a new industry to emerge. Particular attention needs to be given to governance issues related to hydro stations as experience from the described projects suggests that linkages with ongoing economic activities will ensure proper management of the system.

Very clearly the inclusion of entrepreneurs / private sector developers could benefit the sustainability of the systems, although this does in most case also come with requirements from the financiers of these private developers which have shown in the case of Rwanda a tendency to favour developments that feed in to the national grid as this ensure a steady income stream for the enterprise. However, it should also be emphasised that entrepreneurial involvement does not necessary mean that the hydro system itself needs to be owned by a commercial entity, as the experience in Kenya of a community owned hydro system that serves micro enterprises only has demonstrated.

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7. AUTHOR

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Presenter: The paper is presented by Wim Jonker Klunne.