Kavuzi: pico-hydropower schemes, a people's initiative

Clean energy mini-grids (10 kW to 10 MW) are increasingly seen as a viable solution. Systems of 10 to a few hundred KW are also referred to a 'micro-grids'. These can be a viable and cost-effective route to electrification where communities are far from the national grid or where population is not dense enough to justify a grid connection, but demand of households and local businesses is at such a level that cannot be provided by off-grid solar home or pico-solar system. The challenge has been to provide adequate financing and management and operation models for mini-grid systems, that range from the pure utility or government agencies model, to private sector companies, community-driven ownership-operator models and hybrid combinations of these.

To address issues and options in clean energy mini-grid implementation and business models in Malawi, UNDP is supporting the project, "*Increasing Access to Clean and Affordable Decentralised Energy Services in Selected Vulnerable Areas of Malawi*" with co-financing support from the Global Environment Facility (GEF).

Sites: Kavuzi area (Nkhata Bay District)
Business and financing model: local private with no subvention

This case study in one of five that seeks to understand the possible role of energy mini-grid systems in Malawi.

1. Kavuzi area

The Kavuzi pico-hydropower schemes are found in Nkhata Bay District in the Northern Region. Kavuzi is situated at 15 km distance from Mzuzu city in the area under Traditional Authority Timbiri and Traditional Authority Kabunduli. In these two Traditional Authorities there are about 150 pico-hydropower schemes that are using the Kavuzi and Kadeti Rivers as the hydro resource. Most of these schemes service one house.

The origin of these schemes lies in the development of micro hydropower scheme by the Malawi Industrial Research and Technology Development Centre in the area which was used by a youth organization to provide power to its youth centre building for lighting and a computer. However, after some time the youth organization disbanded and the equipment of the micro-hydropower scheme was scavenged. Fortunately, the knowledge of generation of power by utilizing water was not lost. One technician started generating power from the Kavuzi River using a bicycle dynamo and supplied power to the house of his parents. This gave impetus to other artisans in the area to start their own pico-hydropower schemes, using hands-on technology, that now supply electricity to several houses in the area.

The systems visited for the case study are in three villages of the above-mentioned Traditional Authorities, covered by the traditional leaders Group Village Head Chipimbininga, Village Head Yavimba, Village Head Moseni, and in which about 25 pico-hydroelectric systems are operating. Currently, there are four to six artisans in the area who are developing pico-hydropower schemes for households. Business is booming. An artisan can set up a pico-hydropower plant in about one month and the craftsmen interviewed mentioned that they receive about five orders a year, implying that about 20 new hydro schemes are installed each year on average.

Pico hydropower schemes in Kavuzi

Turbines smaller than 10 kW are usually called "pico". Pico turbines can provide power for small clusters or even single households to power one or two fluorescent light bulbs and a TV or radio. The hydropower generation is run-of-the-river, i.e., it requires no water storage but instead diverts some of the water from the river which is channelled along the side of a valley before being 'dropped' into the turbine via a pipe. The pico-hydro power schemes in Kavuzi usually utilize one forebay. There can be more than four turbines utilizing one forebay each having its own penstock.

The Kavuzi schemes have readily available water which is perennial and the catchment areas of the rivers are not heavily affected by deforestation due to charcoal production and shifting cultivation. In Kavuzi, the artisans typically build the pico-hydropower plant from scratch, using starter motors of cars or broken-down motors from factories, and rewind the motors by getting conductors from old compressors of refrigerators. The turbines are made out of fans from cars, rims of cars as well as metal caps made from pipes.

Number of 100W bulbs	Pen stock size (diameter in mm)	Cost in WMK
4	50	60,000
7	70	80,000
8	70	90,000
10-15	90	110,000
20	110	150,000

2. A bottom-up approach and business model

The system is owned by the user. The artisan sells the system to the user at one-off cost, the size of which depends on the number of 100 W bulbs that it can handle (as described in the table in the text box above). Most pico-hydro schemes service one house only and can provide a basic power service (for one or two lights, TV, phone charging, and for haircuts). However, the users are free to extend their power to their neighbours and there are a few pico-hydro schemes which power two or even five houses. It should be mentioned that the extension to the other houses does not attract an additional cost, but some users do charge those who come from outside their neighbourhood for charging phones (costing about MWK 50 each charge).

The maintenance of the system involves worn-out bearings, conductor, magnets and pipes. The cost of maintenance depends on the part that has been damaged and needs to be replaced. The labour cost ranges from MWK 1,000 to MWK 2,000, while worn-out parts can cost as much as MWK 6,000. For example, replacing bearings will cost MWK 4,000 and changing magnets will be at MWK 6,000 each.

The users and non-users have formed a Committee to look into the more organised development of the pico-hydro schemes with the objective of looking at regulatory issues (see 'Challenges') and of encouraging bigger schemes that can cater for several households. The Kavuzi Committee started in September 2017. The basic idea is that the bigger scheme will be owned by the community and managed by the Committee. Every household that likes to join the Committee is requested to contribute MWK 1,000 per household per year. There are already 42 contributing members at this moment.

Home-made wind mills in Malawi

In October 2009, the story of William Kamkwamba appeared in news channels such as BBC and CNN, who build an electric windmill out of junk to provide electricity for his family and his village. Frustrated by the lack of light after sunset and the inability to pump water to irrigate his family's maize plants, he saw a picture of a windmill in a book and decided he would build one himself. He managed to put together a machine from spare bicycle parts, a tractor fan blade and an old shock absorber, and fashioned blades from PVC pipes (flattened by being held over a fire) and a bicycle for gearing, and thus was able to provide power for his family. Before long, locals were queuing up to charge their mobile phones. After that, he installed a solar-powered mechanical pump, donated by well-wishers, above a borehole, adding water storage tanks and bringing the first potable water source to the entire region around his village.

Source: CNN (5 Oct 2009), BBC (10 Oct 2009), Community Energy Malawi (CEM)

The Committee functions as a communication bridge between the community and any stakeholder such as Department of Energy, Malawi Electricity Regulation Authority (MERA), the District Assembly and UNDP. It is the vision of the committee that the District Assembly will assist the Committee's formalization into a Kavuzi electricity generation trust or cooperative (depending on the available funds from interested stakeholders).

The Committee also looks after environmental issues, such as protection of the watershed area. For example, the District Assembly has already pledged to donate tree seedlings to the committee to plant trees in the catchment areas so as to reduce environmental degradation of the catchment areas of the two rivers Kavuzi and Kadeti.

3. Lessons learned, challenges

Lessons learned

The Kavuzi pico-hydropower and Kamkwamba small windmill examples clearly show that local people are able to initiate an energy project to reduce energy poverty in the area without waiting for Government or donors to reduce their energy poverty (by granting funds and/or installing an energy scheme).

The Kamkwamba windmill is situated in one of the windiest parts of Malawi, while the Kavuzi area has sufficient water resources year-round. But, as long as the resource for energy production is within their reach, the examples reveal that communities have innovative ways of managing their resources and solving energy problems, and show that scattered or far-flung settlements can organise their own basic energy services.

Purely demand-driven, these locally-built schemes are able to organise access to electricity much faster than the conventional grid electricity, provided by the Malawi Rural Electricity Programme (MAREP), and at much lower cost. In reality, the villages are considered to be too far away from the nearest transmission line for the power company or the households too scattered to consider connecting.

The availability of artisans at local level provides the technical sustainability of the scheme. This is often a reason of failure of many mini-grids around the world (that often lack local operators and technicians and do

generate sufficient revenues to cover operation and maintenance expenses). As all the investment cost are paid upfront, there is no issue of lack of fee collection, which often poses difficulties in community-managed energy schemes.

Challenges

As the power is used by household situated at a distance from the generator, the transmission becomes an important issue. The distribution of power from the generators to the houses in Kavuzi is through very thin, bare, conductors with strands of wires, of which the ground clearance is not in line with the standards of electricity distribution (the wires are just hanging on poles as shown in the photo). Apart from the safety issue, there are heavy distribution losses as the power goes to the houses.

Inspection by MERA led to the conclusion that the systems should be upgraded to a certain quality and safety level or otherwise would need to be dismantled. Therefore, the provision of practical training to the village artisan is urgently needed to be able continuing producing hydropower and distribution systems that are really people-owned, affordable and that can meet minimal safety standards.

Local manufacturing of small energy systems – dream or reality?

- Installers need to have the capacity and know-how to install the small energy unit and village distribution systems so that these can provide power in a reliable and safe way according to national technical standards. This includes basic knowledge on civil, mechanical and electrical systems and low-voltage power distribution.
- The Kavuzi pico-hydropower systems and the Kamkwamba wind mill are made from scrap materials. A better-quality product could be made if some parts could be manufactured in a batch process meeting certain quality standards. This would mean local manufacturers need to be incentivised to manufacture the products through having sufficient orders to be able to cost effectively manufacture the products
- Further research is required to ensure that pico-technology can be used well in the future. This includes synchronising multiple pico units, distribution systems, storage for load peaks and low power matching equipment such as LED lighting or low-power labour-saving machines. Customised packages can be designed that are attractive to different types of end-users/stakeholders
- Rural communities in Malawi need to be made aware of pico-technology through village mobilisation and technology demonstration and be made familiar with subsidy and financial support options at local and national level.

4. Concluding remarks

The UNDP-GEF Clean Energy Mini-grid Project will be instrumental in organising and providing training to local artisans and technicians in Kavuzi to enable them to build locally designed small energy systems in a safe way and will encourage the mobilisation of communities. The Project should also create awareness amongst energy policy-makers on the potential of the pico-technology as a bottom-up, community-owned approach to local energy supply that supplements national electrification efforts at low cost.

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> Kavuzi: pico-hydropower schemes, a people's initiative
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The series was drafted by Jan van den Akker and Diliza Nyasulu, and coordinated by Emmanuel Mjimapemba and Etta Mmangisa (UNDP Malawi). Editing was done by……. We are grateful for MEGA and other contributors for the information shared.
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