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Abstract

Electrification coverage in rural Uganda is very poor with less than 1% of the rural population having access to the national grid. Rural people are still an important majority in Uganda with about 88% of the population residing in rural areas (UIA[1], 2009).
Small hydropower development is one solution to bridging this electricity supply gap. Some of the potential sites can be developed for isolated grids and others for electric energy sales to the grid.
This paper describes the successful development and operation of such a plant at Kisiizi Hospital in western Uganda with an installed capacity of 294Kw and how the lessons learnt are being applied by CREEC to Design a 3kW Pico[2] hydro scheme.
Keywords: Rural Uganda; Small Hydropower.

Background

The population of Uganda stands at 32.4 million out of which 95% do not have access to electricity. The annual population growth is about 3% and the electricity demand growth is rated at 7-8% per year (DR[3], 2005). The role of small hydropower as a renewable energy source, in addressing energy gaps in rural Uganda is substantial. Feasibility studies have been carried out for 10 small hydro power plants which are expected to add 50MW to the grid in the medium term (GTZ[4], 2010). Many of the installed small hydro plants are not operational. This is attributed to inadequate feasibility studies, poor designs, lack of local manufacturers and poor maintenance culture. Some of the small hydropower plants that are still operational are shown in table 1 below.

Table 1: Some of the operational small Hydropower plants in Uganda

Site	District	Installed capacity (MW)
Mobuku 3	Kasese	10
Mobuku 1	Kasese	5.4
Bugoye	Kasese	13
Kuluva	Moyo	0.12
Kisiizi	Rukungiri	0.294

Particular reference is now made to the technology adopted in the operational small hydropower plant of up to 294 kW at Kisiizi hospital.

Kisiizi Electricity

Church of Uganda Kisiizi Hospital is a Private Not for Profit (PNFP) Health Care Provider which is rurally situated deep in the mountains of North Kigezi in Rukungiri district South West of Uganda. The hospital has 14 medical departments and 8 support departments including a primary school and a nursing school which all require electricity.

The hospital at Kisiizi began in 1958. The site had previously been a flax factory. This factory used water power from the River Rushoma by means of a weir on the river just above Kisiizi falls and a turbine wheel with mechanical drive to the machinery. The plant was built in 1944 and the weir has been used for all the hydro-electric plants including the new one.

The Small Hydropower plant at Kisiizi has been operational since 1964 to date with two major phases of capital reinvestment to increase installed capacity in 1986 and 2009. The first plant was a small one of 14kW installed in 1964 and the second was of 60kw using a francis turbine installed in 1986. By the year 1997 this was proving inadequate and plans were made for a larger one. Measurements of the river flow indicated that for much of the year there was sufficient water for a 300kw plant. Support was gained from the World Bank through the Ministry of Energy and Mineral Development and the Rural Electrification Agency.

Work began in May 2005 and was commissioned in April 2009 and by May 9th was providing power to the hospital. Since then, the plant has been running continually except for minor problems and maintenance.

Approach

Efficient Electromechanical design

For a sustainable approach, Kisiizi power plant installation adopted the use of proven technology for the electromechanical components to ensure efficiency of the scheme. The new turbine is Crossflow and is made by Ossberger, a German firm with a long and sure track record in the manufacture of these particular machines. The turbine/generator technical specification is: (i) 294kW maximum expected output (ii) Crossflow runner in Stainless Steel (iii) Direct drive to a special build, low speed alternator (iv) Vane type flow control for slow acting speed regulation (v) Electronic Load Control by Thomson & Howe (Canada) for fast acting speed

[1] Uganda Investment Authority
[2] Hydropower of up to 5kW
[3] Developing Renewables – European Union
[4] German International Cooperation

regulation. The rationale behind the specification is that the major service intervals on bearing changes should be few and far apart, under normal conditions not less than 12 years. It was decided to opt for the Crossflow rather than a Francis type because the latter is not capable of handling a wide spread of flows while maintaining efficiency as illustrated in the figure 1 below.

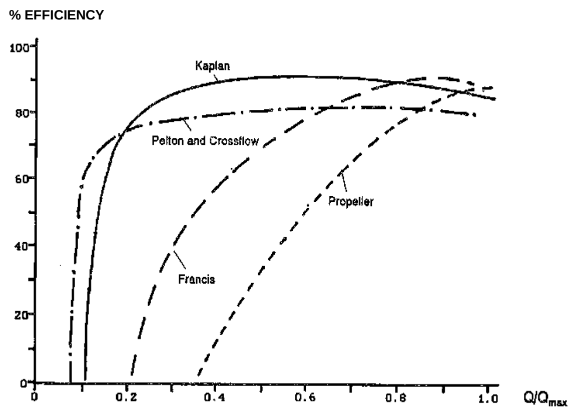

Figure1: Comparison of turbine Part-flow efficiencies (Mason[5], 2010)

Minimal costs on civil works

Involvement of local labour in the civil works rather than external contractors reduced installation costs by 85% and increased the sense of ownership of the local community. The entire civil infrastructures were designed in house, with checking by some volunteers (Kisiizi Friends) engineers who visited the Kisiizi site. With the exception of the pipes for the penstock, all civil works equipment were sourced or fabricated locally. Local metal fabricators and carpenters were employed and the machine shop at Nakawa Vocational Training Institute, in Kampala was utilized.

All construction was carried out by a team of masons, carpenters and porters drawn from the immediate area. The installation of the penstock was a good example of "lo tech" techniques. Rather than hiring an expensive crane for an unpredictable amount of time, Kisiizi went for the construction of a ramp and sledge to lower the pipes downhill.

Quality assurance

A fault detection and switch for the 11kv lines was provided free by Scottish and Southern Energy of the UK whose engineers also helped with supervision of the overhead network and commissioning the plant for quality assurance.

Power sales

Connecting customers outside the hospital began in October 2009. The local community had been anxiously waiting for this for some years. By mid-December 78 customers had been connected and average weekly sales were 500,000 Shillings. By mid-December 2010 there were 200 customers and weekly sales were 1 million shillings. Electronic pre-paid meters are used and customers have to buy a token. This is a slip of paper with a series of 20 digits which are entered into the meter to give credit for electricity (Wadsworth[6], 2010).

Environment

The main criterion was to preserve the waterfall as much as possible as it is a tourist attraction and a Kisiizi focal point. This included designing a bypass in the weir to ensure a minimum flow of 150 litres/second over the Falls at all times, and a specially designed headrace and water saving turbine specification so that when power consumption is low, the excess water goes back over the falls.

Lessons learned

As a result of the scheme installation, Kisiizi hospital and its affiliated institutions have their own isolated grid with enough power to light; operate hospital equipment, domestic appliances and capacity to sell electricity to 10 schools, 100 small shops and about 200 households

The successful experience of the Kisiizi hydro power scheme is now used by CREEC to plan for the implementation of a 3kW Pico hydro power plant at Rwenzori Mountaineering Services (RMS) to boost its tourism sector. A cross flow turbine is chosen for its capacity to work with the low head of 10m and to handle a range of flows. The possibility of manufacturing the turbine locally could reduce maintenance costs. Local labour will be employed.

Small Hydropower is still a viable approach for rural electrification in Uganda and the use of cost effective approaches like local manufacturing and labour cannot be overemphasized.

Research demands

The use of cost effective approaches like local manufacturing of turbines, generators and other electromechanical components reduce costs of importation which is currently the predominant way of procuring components for most small hydro power plants in Uganda.

CREEC in collaboration with GTZ manufactured a pelton turbine as a first step in this research. In future projects, CREEC will consider using locally manufactured turbines like the crossflow for the pilot plant at RMS. More research should be done to investigate the best finance options and effective community involvement framework.

[5] Dr. Peter Mason – Presentation on dam construction, Manitoba Hydro International

[6] George Wadsworth – A report on Kisiizi Electricity