Community Pico Hydro in Sub-Saharan Africa: Case Study 1

Site: **Kathamba**, Kirinyaga District, Kenya

Background

This scheme was installed as part of a program implemented by The Micro Hydro Centre at Nottingham Trent University to demonstrate Pico Hydro technology in Sub Saharan Africa. The cost of the penstock, turbine and generator equipment was met by the project funders (European Commission) and all other costs were contributed by the 65 households which the scheme now supplies with electricity.

Technical Summary

This case study describes a pico hydro plant using a Pelton turbine directly-coupled to an induction generator which has an electrical output of 1.1kW. The penstock is 158m in length, 110mm diameter PVC pipe. The net head is 28m and the flow into the turbine is 8.4 l/s. The electrical output of 1.1kW corresponds to a turbine-generator efficiency of 48%. The water source is a small spring with a flow rate of at least 5l/s during 90% of the year and has never been known to run completely dry. Approximately 80m³ of storage has been provided at the intake to ensure that the turbine can be kept running for long periods. The generator output is regulated by means of an Induction Generator Controller to ensure that the voltage and frequency are held at the correct values during conditions of changing consumer load. Excess power is fed to a ballast load. A 2kW cooking ring was used for this. There are 65 households within a 550m radius of the turbine house and these are all being connected to the generator using a single-phase distribution system and insulated copper conductors. It is possible to do this cost-effectively since the current drawn by each house is small and restricted by a current limiter so the distribution cables are also small in diameter. Each house has a 230V supply which is sufficient for one or two energy-saving lamps and a radio. The locations of the generator and consumer houses were recorded using a GPS system so that a distribution plan could be developed. The average cost per house for all equipment and materials was around $58 and more than 50% of this cost was contributed by the consumers.

General Description of the Site

Kerugoya town lies 130km north of Nairobi on the southern foothills of Mount Kenya (Kirinyaga in Kiswahili). Kathamba is located on the eastern side of the Mukengeria River near to Gaghigi approximately 4km north of Kerugoya. Travelling time from the town is approximately 20 minutes along unmade roads. The spring, which provides the hydraulic power for the pico hydro system, flows into the Mukengeria River approximately 300m from the source. There are 65 houses within 550m of the junction between the stream and the river and two sites for new houses. The principle source of income in this region is through farming and the crops grown include tea, coffee, maize and fruits.

Community Participation

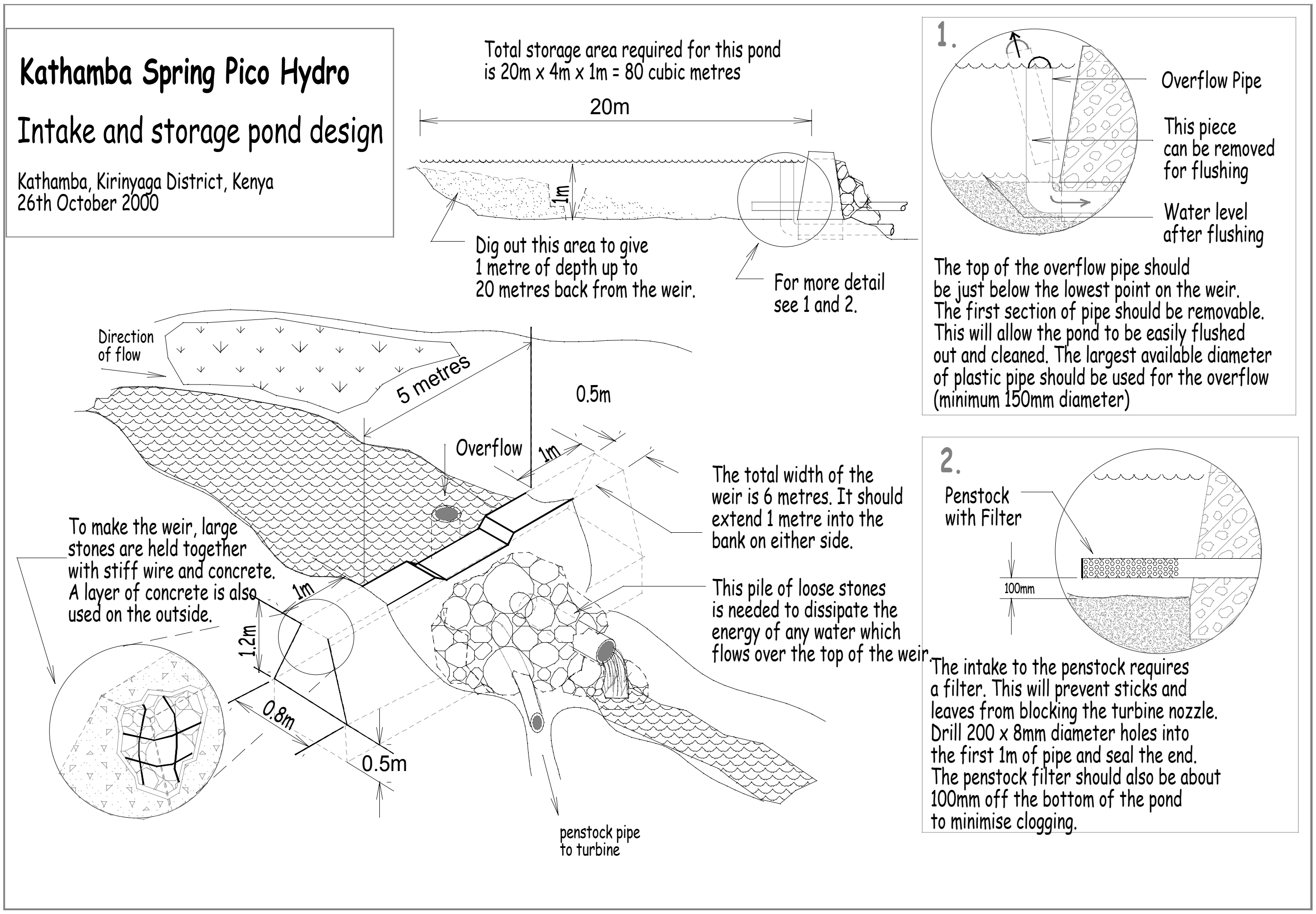
One of the principle elements which lead to the successful implementation of this project was community participation. This was necessary both to lower the installation cost and to foster a sense of local ownership. Once it was established that there was sufficient hydro potential at this site, the first community meeting was held to discuss the project concept. A Community Electricity Association was formed and a committee elected to manage the installation of the project and oversee the operation of the scheme. A written agreement was subsequently signed between the community and the implementing partners. It was agreed that all labour for the project was to be provided by the community in addition to the building materials required for the intake and the turbine house. The consumers also were required to pay a connection fee once the turbine was commissioned. This covered the costs of the distribution cables, house-wiring and energy saving light bulbs. The community association was also required to register with the local government office and to open a bank account in order to save the local contributions towards the project costs.

Community members assembled to begin the installation

Intake and Storage Pond

The design flow for this scheme was just over 8 litres per second. This flow will normally be available throughout most of the year although during the driest periods when it can fall to 3 l/s. A small concrete weir was designed which would provide sufficient depth of water to ensure that the penstock is fully submerged at all times. The natural storage area behind this weir was also enlarged by widening of the banks to 4 –5 meters width and 20m length. This provides sufficient storage to supply the extra flow required for 4 hours of evening lighting during the driest part of the year when the shortfall is at a maximum of 5.5 l/s.

5.5 x 60 x 60 x 4 hours = 79,200 litres storage capacity required (79.2 m^3).
Storage provided = 4m wide x 20m length x 1m depth = 80m^3



Preparing foundations for the weir

A wire mesh gabion filled with stones and clay

Shuttering in place during application of cement layer to seal the weir

Completed intake with storage pond

Penstock

The penstock pipe conveys water from the intake to the turbine and provides the pressure required at the nozzle. The length required was 158 metres. This was the shortest measured distance between the intake and the turbine. PVC pipe with a diameter of 110mm was selected. This gave 2m head loss with a flow of 8 l/s and provided a net head of 28m. Class B PVC (6bar pressure rating) although a lower pressure rating could have been used if available. The increased wall thickness however improves the reliability and lifetime of the penstock. A trench was dug from the intake to the turbine house so that the pipe could be buried to anchor it in place and to protect it from damage by the sun.

Digging the penstock trench

Laying the pipe from the intake to the turbine house.