DEVELOPMENT OF SIMPLE PICO-HYDROPOWER GENERATOR FOR RURAL AREA

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Abstract:

Small-scale hydropower electrical generator plays an important role in providing the basic necessity to the off-grid rural area community. The advantages of this type of generator include cost effective, reliability, ease of operation and environmentally friendly. Most of small-scale hydropower generator (generally below 5 kW) can be manufactured locally and operated at a wide range of water flow rate. In this study, the AC washing machine motors were modified to be utilized as the electrical generator. The testing site of the setup was located in the province of Yala, Thailand. The results showed that the generator was capable of producing up to 800-1000 W of AC power at the water differential height of 1.4 m and motor rotational rate of 650 rpm. The generated power was sufficient to power household 40-60 W fluorescent lamps, an 85-100 W Television, a 45 W electrical fan with approximately 100 W for extra usage.

Introduction:

Pico-hydropower refers the one that generates of up to 5 kW output *(table 1)*. Water flow rate and the available heads often determine its power output. With low heads (e.g. of less than 10 m), lower water pressure is compensated by a greater flow rate[1-4]. Regardless of their sizes, rivers in Yala are capable of producing such hydropower. Remote sites with low head are worth looking at for their potential. This paper is focusing on developing pico-hydropower for such area, which have no dam or water plant. Once developed, such hydropower is cost effective, and environmentally friendly. In addition, water turbine seems simple as it is readily manufactured locally.

Table 1. Classification of hydropower by size[2,3].

Power	Class
More than 100 MW	Large
15 MW - 100 MW	Medium
1 MW - 15 MW	Small
100 kW - 1 MW	Mini
5 kW - 100 kW	Micro
A few hundred watts up to 5 kW	Pico

Methodology:

Power potential of flowing water was determined by the water flow rate and the water-to-turbine head distance. The flow rate is the quantity of flowing water passing a point in a given time. Typical flow rate unit is liters per second or cubic meters per second, whereas the head is the vertical height, in meters, from the turbine up to the point where the water enters the intake pipe or penstock. The potential power can be calculated as follows[3]:

$$P = Q \times H \times g \qquad (1)$$

When P is theoretical power (kW), Q is flow rate (m^3/s), H is head (m) and g is gravity (m/s^2)

Pico-hydropower set up involved use of materials in and nearby river(s). Maize sacks filled with clay soil were used to re-enforce the channel leading to the intake, and boulders were positioned to form a pool with sufficient depth to ensure that the penstock is kept full. The edges around the boulder were sealed with more stones and soil sacks. Our pico-hydropower used an AC washing machine motor as generator with electrical output of 800-1000 W, and penstock of PVC pipe with 18 m long and 15.2 cm wide. The net head is 1.4 m *(Figure 1)*.

Figure 1. A set-up of pico-hydropower

Results, Discussion and Conclusion:

As one of the most efficient renewable energy sources, hydropower is particularly suited to small scale applications. In comparison, it produces electricity far cheaper per unit (kWh) than wind power and solar power. Successful design and construction of pico-hydropower system at Banlakosukae, Tambon Talingchan, Bannangsata district, Yala province, might be regarded as a local invention and innovation. The alternator as a generator produced a maximum of 217 V / 48 Hz at speed of 650 rpm. The generated output powered about 40-60 W fluorescent lamps, 85-100 W TV, 45 W electrical fan and about 100 W total *(Figure 2)*.

As regard to its economic value, the system cost B 8,000-12,000. Materials were of local origin except for pipe system, control and electricity system, and generator and turbine (30, 20 and 50% of total expense). Moreover, use of washing machine motor as a generator in pico-hydropower system had been found to be better technology with all potentials for further improvement to suit local applications, particularly for communities in remote areas. With its low investment, local setting compatibility, and easy operating and managing, pico-hydropower is thus much more suitable and affordable by the rural communities.

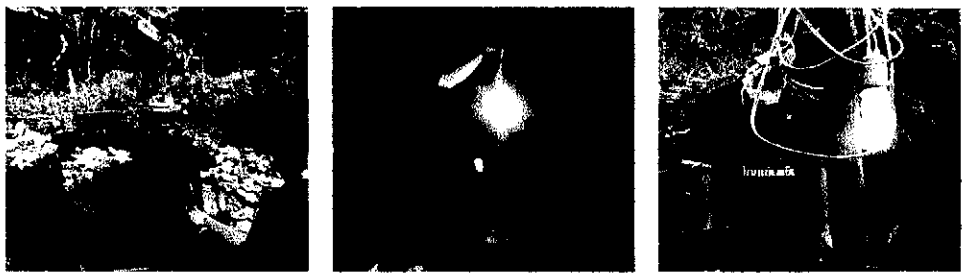

Figure 2. Pico-hydropower output at 1.4 m head

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Keywords:

pico-hydropower, electrical generator, washing machine motor

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