HYDRO FOR REMOTE LOCATIONS ON THE THAI/BURMA BORDER

By Lon W. House, Ph.D.
Hydropower Co-Director, University of California at Davis Energy Institute

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ABSTRACT

This paper describes the investigation and selection of a small hydroelectric generating technology for a remote area on the Thailand/Burma border accessible only via foot. It discusses the selection process, the characteristics of the small hydroelectric generator selected, and some of the lessons learned.

The hydroelectric system selected was a small (200Watts), light (16kg) system composed of an alternator/generator and turbine, a water intake canal, a water outlet pipe (suction tube), an electronic load controller, and a heat sink manufactured in Hanoi, Vietnam that can be backpacked into the area. Seventeen of these systems were installed in health clinics along the border. Another in stream system, manufactured in England, is due to be evaluated in late 2011 and is briefly discussed also.

There exist technologies that can provide hydroelectric power in remote areas of the world not traditionally accessible except by foot. In these remote areas, there has always been a need for lighting at night, and for communications. With the ever increasing penetration of wireless phones and other electronic devices there is an increased need to recharge batteries, even in remote locations.

The main drawback to these hydroelectric technologies is cost. In these remote areas, the people are generally living at a subsistence level, and obtaining the necessary capital for installation and maintenance of these systems could be a significant hurdle. However, the burgeoning demand for recharging of small electronic devices may make their recharging a viable local business option.

INTRODUCTION

The Thailand/Burma (Myanmar) border area is a very remote, desperately poor area that is the site of one of the longest civil conflicts in recent history, going on since the close of World War II. There is no virtually infrastructure in the area, and the population survives on a subsistence level.

The author was approached by a couple NGOs (non government entities) operating in this area and asked for assistance. These NGOs (the Free Burma Rangers and Partners Relief and Development) support and operate health clinics in the conflict area, and asked if there was a way that electricity could be provided at some of these clinics. The electricity would be used for lighting (hence the name of this project – No More Surgeries by Flashlight) and to recharge their flashlights and communications devices. This paper describes the process, issues, and outcomes of this activity.

THE PROBLEM

The sites that needed electricity had several characteristics. First, they were very remote, days to weeks via footpath from the Thai/Burma border. Everything that was brought in had to be backpacked in. Additionally, the technology had to be robust, and very simple to operate and maintain - the population in these areas had no or very limited experience with machinery or electricity.

There were several potential candidates for electricity generation at these remote sites that were investigated.

<u>Internal Combustion Generators</u>
Internal combustion generators were evaluated and rejected as viable options for electricity generation because they were: 1) heavy to transport in; 2) noisy; 3) difficult for the locals to maintain; and 4) required a constant input of fuel to be brought in.

<u>Solar</u>
Solar is quite prevalent right on the border, but was rejected for the more remote locations. It is: 1) very awkward, cumbersome, and heavy to transport into the area via backpack; 2) it requires an unrestricted view of the sky - which can be a problem in the dense canopy jungle in this area; 3) it doesn't operate as efficiently in cloudy conditions – this area typically experiences a six month monsoon season; and 4) it doesn't provide electricity at night, necessitating the use of large batteries which are heavy to bring in and maintain.

Small Hydro

Small hydroelectric generators were chosen as the preferred technology. All these small clinics are associated with local villages, which are located next to a water source such as a stream or small river. The challenge was to find a small hydro generator that was simple to install, did not require materials that were unavailable in the area (like piping for penstocks) or significant civil work, were light enough to be backpacked into the area, and were easy to understand and maintain.

SMALL HYDRO SELECTION

The hydroelectric generation system chosen for installation was a small (200 watts) reaction type turbine common in other areas of SE Asia, particularly Vietnam (Figure 1). This system requires a 1.5 meter (5 feet) head, a water flow 35 liters/sec (9.2 gallons per second), and a water flow rate of 0.54 meters per second (1.8 feet per second).

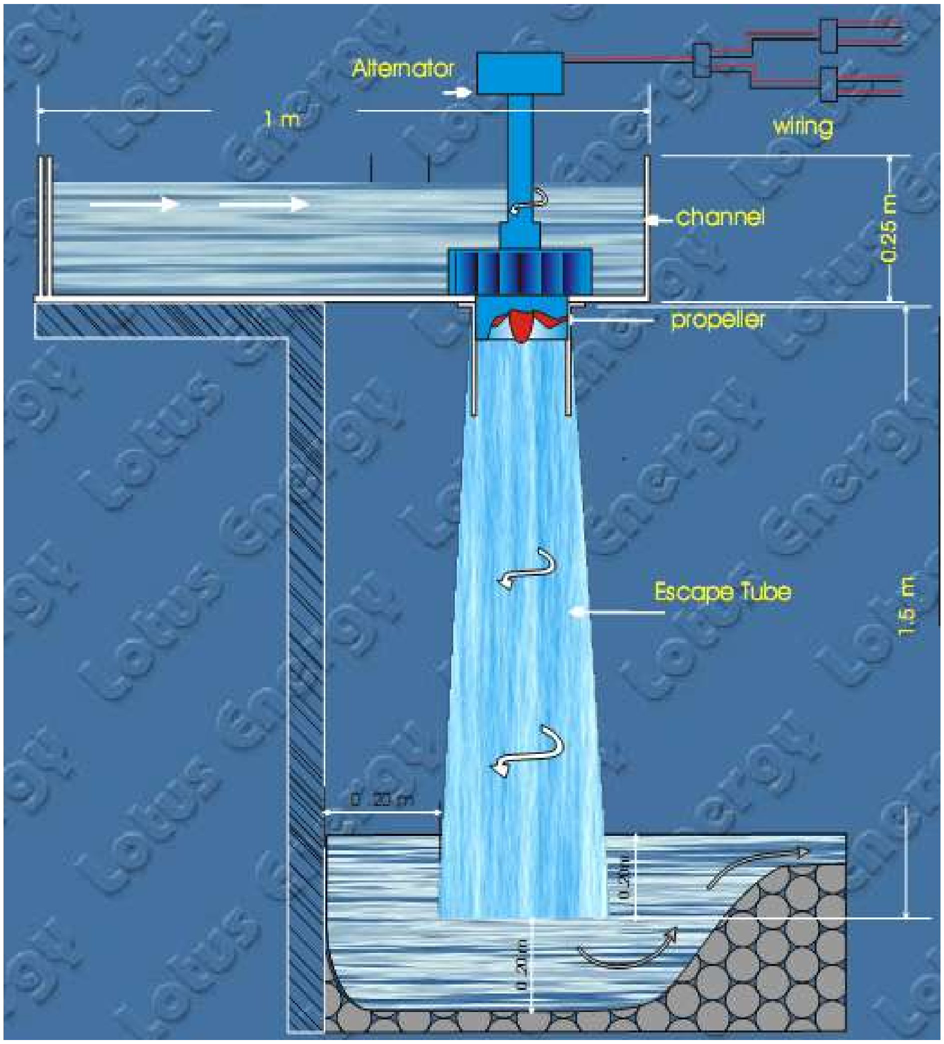

Figure 1. 200W Small Hydro Turbine/Generator

The system chosen was manufactured in Hanoi, Vietnam, and was purchased from Asian Phoenix Resources, Ltd.[1]. Characteristics of this family of generators is found in Table 1 (MGH-200LH was the generator used).

[1] (www.powerpal.com).

Table 1. Small Hydro Turbine/Generator Characteristics

TECHNICAL SPECIFICATIONS

		MHG-200LH	MHG-500LH	MHG-1000LH
1	Rated power output	200W	500W	1000W
2	Maximum allowable load	250W	650W	1200W
3	Intended voltage	110 / 220V~	110 / 220V~	110 / 220V~
4	Frequency at rated power output	50-60 Hz	50-60 Hz	50-60 Hz
5	Frequency at runaway speed	75 Hz	75 Hz	60Hz
6	Rotor runaway speed	1500rpm	1500rpm	1200rpm
7	Weight	16kg	32kg	75kg
8	Height	68cm	78cm	92cm
9	Diameter	20cm	30cm	42.5cm
10	Generator	Single phase permanent magnet alternator		
11	Rotor characteristics	NdFeB 3-pair pole permanent magnet		
12	Stator wire size	0.5mm	0.7mm	1.0mm
13	Load controller fuse	1.0A	2.5A	5.0A
14	Upper Bearings size – greased	2 x 6203	2 x 6204	1206
	Upper bearing size - sealed			6004-2Z
15	Recommended cable	0.50sq.mm/A	0.75 sq.mm/A	1.50 sq.mm/A
16	Operating temperature	5 to 50 ° C	5 to 50 ° C	5 to 50 ° C
17	Operating humidity	0 to 90%	0 to 90%	0 to 90%

Notes:

1,2. Rated power output is the manufacturer's specified output for the given head and flow conditions. A higher output is possible if the head is greater or the flow is faster than recommended. If the maximum allowable load is exceeded then permanent damage to the stator may occur.

3. Is approximately 110 / 220V when the ELC is used.

5,6. Runaway speed is the speed of the rotor if no load is applied. This speed is reduced under load.

The system consists of: an alternator/generator and turbine, a water intake canal, a water outlet pipe (suction tube), an electronic load controller, and a heat sink (Figure 2).

Figure 2. Components of Small Hydro System

IMPLEMENTATION/INSTALLATION

Ten of these 200W systems were ordered and shipped from the manufacturer in Hanoi to Bangkok in 2009 for a delivered cost of approximately $450US per system. In August the author met with six teams composed of two native individuals each and provided tools and training on basics of electricity and safety, and demonstrated the installation of the hydroelectric turbine (Figure 3) and wiring of a health clinic (Figure 4). In March of 2010 another seven generator systems were ordered and shipped to Bangkok, and four additional teams were trained on installation and operation of the hydroelectric generator and hut electrical systems. In total, seventeen generators have been installed and ten teams of local individuals are responsible for their operation and maintenance

Figure 3. Installation of Small Hydro System

Figure 4. Lights in Remote Jungle Health Clinic Provided by Small Hydro Generator

OBSERVATIONS/LESSONS LEARNED

Transportable – The turbine generator weighted approximately 16 kg (35 lbs) and was fairly easily backpacked into remote locations. The water intake canal (made out of fiberglass) and the draft tube (made out of plastic) were awkward but light and were easily carried into remote areas.

Robustness – During the demonstration installation, the turbine/generator was dropped into the river. Retrieved, the top cover was opened up and allowed to air dry. By the next day it appeared to have dried out sufficiently, the cover was put back on, and the turbine/generator worked fine, with no apparent ill effects.

Ease of Maintenance - This particular machine has a grease zerk fitting for the upper bearing that requires regreasing every 3 months or so (the lower bearing is submersed in water), which is easy to do. Other version of this type turbine/generator require the turbine/generator to be disassembled for regreasing, a much more complicated process.

Suction
This system requires the use of a suction tube to create the draft for the operation of the turbine. It is very important that the suction tube be carefully attached (sealed) to the water intake channel. The lack of a seal between these two components will allow air into the water stream, greatly reducing the efficiency of the turbine.

Type of loads
This machine is designed to supply mainly resistive loads (lighting, recharging small batteries). It produces less than 1 amp. It is not very useful for reactive loads (charging large batteries) and using it for this purpose will severely shorten the life of the generator.

Use of Local Materials
Wiring: The wiring available in this border region (to run from the generator to the clinic, and inside the clinic) was composed of much more aluminum than is typical in North America, and resulted in higher resistance (and greater losses) than would be expected from copper wiring. In subsequent installations we went to larger sized diameter wire than initially calculated in order to reduce losses.

Lighting: For the demonstration installation, tube type fluorescent lights were installed (Figure 4). Although rated at 18 watts, we could not get more than three to operate simultaneously. Further investigation found that the ballasts for these lights required between 0.3 and 0.5 amps to fire and the generator produced less than 1 amp. In subsequent installations we switched to compact fluorescent lights (screw in type) or LED lights, which worked fine and we were able to get 180-190 watts of lighting operating simultaneously.

IN STREAM GENERATOR

The generator systems described above are semi fixed installations. The NGOs involved expressed a desire for a truly portable hydroelectric system that can be carried from location to location. The technology selected for this application is shown in Figure

5. It is a derivative of the technology used for recharging batteries on sailing yachts. Made in England by Ampair[2], it is rated at 100 watts, 8 amps, and weights 11.4 kg (25 lbs). It is made to be dropped into relatively fast moving stream (1.8 meters per second [4 mph] or more). The main drawback is these generators are expensive – systems approach $2,500US delivered, too expensive for extensive use in developing countries. These in stream generators scheduled to be demonstrated and evaluated on the Thai/Burma border in late summer of 2011.

Figure 5. In Stream Hydroelectric Generator System

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[2] (www.ampair.com).

CONCLUSIONS

There exist technologies that can provide hydroelectric power in remote areas of the world not traditionally accessible except by foot. In these remote areas, there has always been a need for lighting at night, and for communications. With the ever increasing penetration of wireless phones and other electronic devices there is an increased need to recharge batteries, even in remote locations.

The main drawback to these hydroelectric technologies is cost[3]. In these remote areas, the people are generally living at a subsistence level, and obtaining the necessary capital for installation and maintenance of these systems could be a significant hurdle. However, the burgeoning demand for recharging of small electronic devices may make their recharging a viable local business option.

Author

Lon W. House, Ph.D., is the Co-Director Hydropower for the University of California at Davis Energy Institute and has operated his own company, Water & Energy Consulting (www.waterandenergyconsulting.com) for over 20 years.

[3] While the author has seen variations of the 200W hydro generator being sold for a little as $50US, the quality of these generators is not the same technology installed in this project, and the purchase of the generator alone will require the fabrication of an acceptable water channel and draft tube out of locally available materials in addition to the need to have to procure an electronic load controller.