Project report – Huai Kra Thing Micro-hydro project

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After a couple weeks of concentrated work we have a fully functional micro-hydropower plant at Huai Kra Thing village. The project uses a completely new technology for us: an off-the-shelf centrifugal pump running backwards as a turbine, and running the pump's induction motor backwards as a generator. It sounds a bit crazy, but with properly sized capacitors to provide excitation for the motor/generator, it works surprisingly well!

In the village we're getting a steady, regulated 228 volts output at 54 Hz. While we found we could generate up to 3 kW (7.5 amps at 400 volts at the generator), we've throttled it back to about 1.6 kW to keep more water in the stream.

This project involved collaboration by a lot of different groups: residents of Huai Kra Thing village, the Border Green Energy Team[1] (BGET), ZOA Refugee Care, students from the Engineering Study Program (ESP) in Mae La refugee camp, students from the Institute for Village Studies and Spring Street high school in the USA, Bikash Pandey (Winrock Nepal) and Robert Landau. The project was funded with contributions from the UNDP/GEF small grant program, the Robert & Patricia Switzer Foundation, Green Empowerment, and the Institute for Village Studies.

Work on site started on the last week of January 2006 with villagers (under the direction of Surat, Watit, Polchai, Andrew, and Yoteen (BGET)) clearing two different possible headrace/penstock routes. Villagers, Polchai (ZOA), and Chris (Palang Thai) made the final selection based on concerns that the other option would have required construction on an unstable slope that risked pipe breakage in the long term. The final choice did require considerable civil works: a 5-meter deep trench through about 30 meters of hillside, and an extended pipe elevation section for 50 meters that also crossed over the stream.

Every day 20 villagers came out to work. We also had 6 wonderful students from the Mae La Refugee Camp Engineering Studies Program (ESP). Chris arrived with a group of 8 US college students from the Institute for Village Studies on 1 Feb, and halfway through the week the college students were replaced by an equal number of high school students from the Spring Street high school in Washington State, USA.

Polchai and Andrew directed work on the dam. Surat directed work on the pipeline. Yoteen led a group doing village wiring. Watit provided logistics, coordination, and political relations support. Chris worked on the power house with BGET volunteer Stephen Brink.

Power house work was slowed by a 2-meter diameter log wedged from bank to bank just upstream from the planned powerhouse site. We felt that there was a significant chance

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[1] BGET is a joint project of the Taipei Overseas Peace Service (TOPS), Palang Thai, Green Empowerment, the Karen Network for Culture and Environment.

the log might come loose in a wet season flood and crush the powerhouse. Villagers and students worked together to cut the log in half with a two-person cross-cut saw and an axe. We were able to push one of the pieces downstream somewhat, but the other remained a hazard. We decided to move the powerhouse slightly downstream to avoid getting crushed during a flood by the remaining section of log, which was still wedged somewhat precariously.

Drawing on Charley's (group leader from the Institute for Village Studies) and the villagers' cement expertise we made a cement pad roughly 1.5 meters * 1.5 meters for the generator/turbine, and built a powerhouse around it. The generator/turbine was bolted to six 7/16" diameter bolts sunk in the concrete.

Power is produced by the 4 kW motor run as a generator. To provide excitation we used two capacitors, one valued 50 uF and the other 25 uF in a "C-2C" wiring arrangement with 50 uF on one phase, 25 uF on another, and none on the third (Figure 1). We then drew single-phase 380 volt power off of the 25 uF phase. We transmit the 380 volt electricity about 500 meters to a "control house" near the village school. There, the electricity is transformed by a custom-made 380 volt-to-235 volt 3 kW transformer. A Nepali-made electronic load controller (ELC) shunts excess power to a bank of three 1 kW ballast resistors (heating elements). The regulated 220 volt power then is transmitted throughout the village to the clinic, school, community center, two churches, and village headman's house on a set of single-phase, insulated aluminum wires.

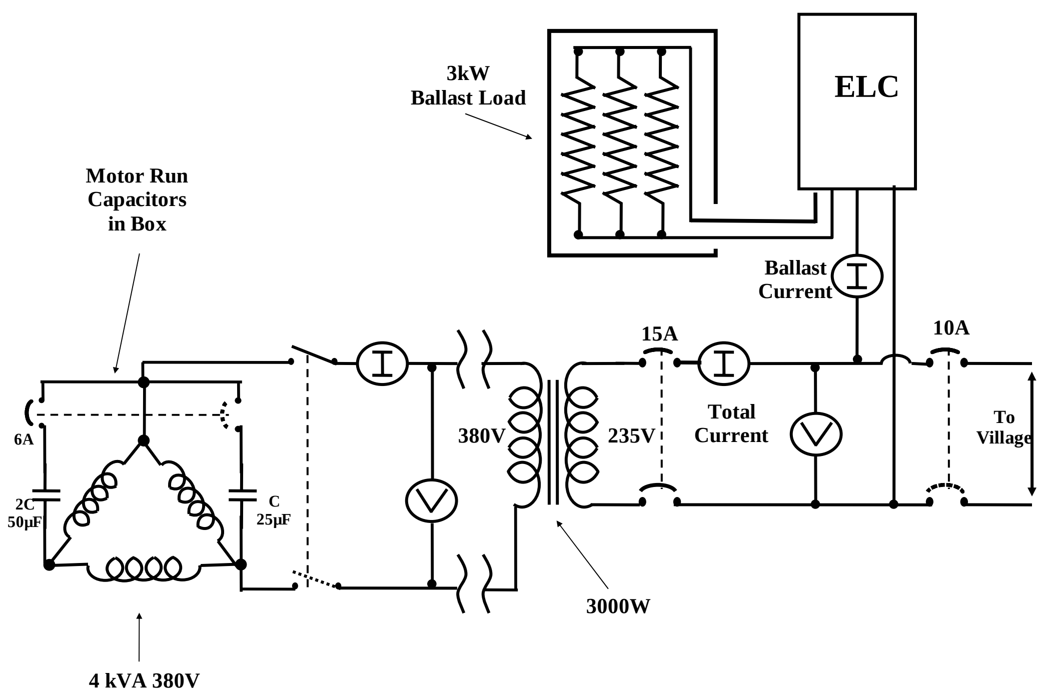

Figure 1: System schematic. The system uses a "C-2C" capacitor arrangement to provide single-phase power from a 3-phase generator. We transmit power at 380 volts, and step it down to 235 volts near the village. A diversion load controller ensures that voltage is constant.

The final evening after the project was commissioned we had a big party with Karen villagers, American students, Swedish volunteer Fredrick Bjarnegård, Sam Lai (TOPS), local Forestry Department officials, and a group of Taiwanese computer university students. Amid the festivities, we lit up by the micro-hydro project, the villagers successfully powered a 4-inch power planer using electricity from the project.

The photos below tell the story better than words:

Figure 2: Trench for headrace pipe cut by villagers. The trench extends for about 20 meters.

Figure 3: Sediment trap

Figure 4: Villagers carrying the >100 kg turbine/generator about 0.6 km to the site.

Figure 5. Surat sets bamboo form boards for cement pad that will hold the generator/turbine.

Figure 6: Chris poses by generator/turbine, now bolted to the cement pad. Chris' left hand rests on the pump <u>outlet</u>, which will serve as the <u>inlet</u> when operated as a turbine.

Figure 7: Saw Sunday and Naw Gigi from the Mae La refugee camp ESP program wire the three-phase 400 volt motor/generator terminals.

Figure 8: Spring street students and volunteer Stephen build bamboo walls at the powerhouse.

Figure 9: Completed dam. The dam is just high enough to ensure that the pipe inlets are submerged.

Figure 10: Surat, Polchai and Chris connecting turbine to penstock pipe

Figure 11: Connecting the penstock to the generator required careful alignment and some tricky angles.

Figure 12: Andrew Pascale and Fahren hold the bucket for a flow measurement, while Alice uses a stopwatch to measure how long it takes to fill up.

Figure 13: Poor communication and a bad glue joint led to a nearly disastrous pipe rupture inside the powerhouse, completely drenching all the electronics and tools. Amazingly, no one was hurt and almost of all of the electronics were unharmed.

Figure 14: Water outflow at tailrace (10 liters/second) when turbine is generating 1.6 kW.

Figure 15: capacitor box and switch box at the power house. When the photo was taken the generator was generating 4 amps at 400 volts. We were able to push it to 7.5 amps (3 kW) but have decided at this point to let more water flow in the stream since the village does not yet need more than 1.6 kW.

Figure 16: ELC and ballast load in metal cage.

Figure 17: Andrew worked with Mae La refugee camp Engineering Studies Program (ESP) students to build solar ovens tested on the final day of the project.

Figure 18: Lights in the community center powered by micro-hydro

Figure 19: Post project party