Lao
Institute for
Renewable
Energy

Vientiane Capital

Shared Pico-Hydropower in Huaphan Province

Report

December 2009

IMPLEMENTATION REPORT

Shared Pico-Hydropower in Huaphan Province

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About us

LIRE is a non-profit organisation dedicated to the sustainable development of a self sufficient renewable energy sector in the Lao PDR. The institute offers agronomical, technological and socio-economic research services, and works to provide a free public resource of information and advice on the use of renewable energy technologies in Laos. LIRE strives to support the development of the country by exploring commercially viable means to establish renewable energy technologies in rural parts of the country, in areas without connection to the national grid and with little access to technical expertise.

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Introduction

The shared pico-hydropower project aims to demonstrate how a rural community can use pico-hydro in a collective, sharing the financial costs and workload, to provide a safer and more reliable service. Whereas familial sharing is fairly common in Laos this is limited to small numbers of households. Using a best practice installation the demonstration site will provide power to community of houses and provide a model for this sharing system to be sustained. As well as being a demonstration the project will investigate the technical and operational issues required for such a sharing system to exist. It is envisaged that this configuration could potentially fill a niche between individual pico-hydropower installations and larger micro-hydropower projects.

This demonstration project is part of the LIRE pico hydro programme, which aims to improve the quality, reliability and safety of the technology for rural communities in the Lao PDR. A market-oriented approach is taken to affect these changes, with technical capacity building activities at the province level. Demonstrations and trials of technical improvements are a vital component of providing resources adapted to the local context. For more information, refer to www.lao-ire.org

This report will review the construction that was carried out between the 16th and the 30th of November 2009, detailing the problems of the previous pico use and the improvement the new system offers. The first major element of the construction was to introduce a new mini power grid, safely running power from the turbines into households. Improvements were made to the function and safety of household wiring and finally, on a future visit, improved civil works and draft channels will be installed to add to the operation of a new turbine.

Village Overview

Angsang village, in Huaphanh Province, was selected as the location for this demonstration site. Located 22km from the district capital, Viengxay, Angsang is in an inaccessible and remote setting, meaning no plans are in place to provide a grid connection, at least not within the next 10 years. . The main village contains 24 households, separated into two clusters on either side of the river.

Pico is well established in the village but experiences the same problems seen throughout Laos. The safety and reliability of the pico in use, as well as the cost of maintenance and labour requirements are all factors the shared pico project aims to address. The LIRE installation will demonstrate best practice installation and display a model whereby sharing the cost a whole village can benefit from a better system. The previous problems and the associated elements of the LIRE construction to address them are presented in turn in this report.

Overview of the system

Our demonstration system will provide power to the 24 households in the main village as well as three teachers accommodation and a communal office. The households are divided into two different tariffs reflecting the different energy needs; a low tariff provides only lighting (30W limit) and a higher tariff is introduced for those users who require power for TV's and stereos (100W).

Two separate turbines on separate lines will provide power to these houses, 5 high and 8 low each. The operation of the system will be run by the village, with village technicians responsible for maintenance and collecting fees.

Assessment of Household Energy Usage

Previous visits by LIRE had established the energy needs of the village to aid in the design of the demonstration site. Lighting is by far the most important requirement as it allows housework, schoolwork and commercial activities such as weaving to continue after dusk. TV's and stereos represent the other main electricity uses. TV's provide a valuable connection with the outside world whilst traditional dancing is a popular Angsang activity.

Authors: Sam Stamp

10 households will run on a high tariff (100W allowance) and the remaining 18 on a low tariff (30W). Although all households put electricity for lighting as a desired use almost half wanted electricity for other appliances. Details of other current electrical usage are shown below. Most households stated they would buy more electrical appliances if the extra power was available.

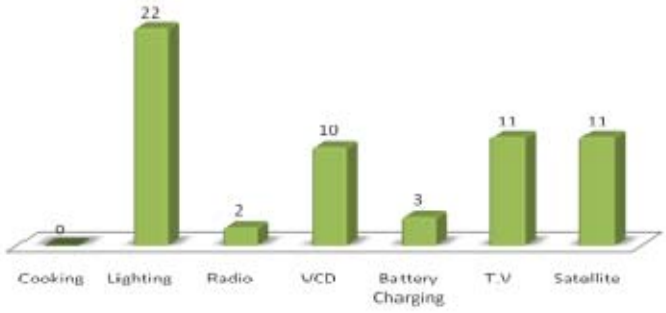

Figure 1: Energy use for households in the village

Whilst Pico is a major source of power in Angsang the use of kerosene is also present and to a lesser extent batteries. These sources are often used as back up for a turbine. The estimated cost, per month, of lighting for villagers is given below[1].

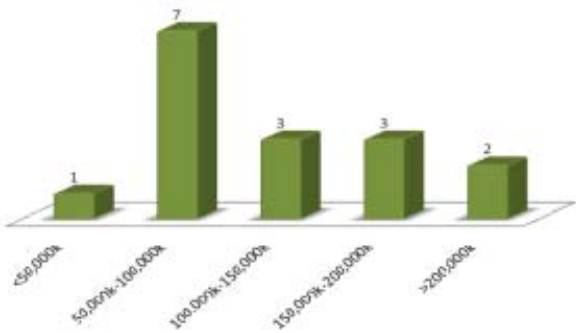

Figure 2: Summary of lighting expenses for households in the village in Lao Kip

The level of the tariff does mean an increase for some users but they should experience an increase in the quality of service and a decrease in maintenance labour.

Elements of construction

Main Grid

Similarly to the installation of the turbines the wiring to the households had been carried out by the villagers themselves, having no prior knowledge or electrical experience. Techniques seem to be developed by word of mouth and copying as no manual or advice is available. This lack of

[1] Note: these costs include broken light bulbs, which should be limited by the use of an ELC (electronic load controller) which is to be incorporated in the system.

understanding and technical capacity, as well as an absence of the right equipment, inevitably leads poor construction and therefore safety issues. Additionally users will normally opt for the cheapest and simplest solution, which is invariably neither the safest nor most reliable.

In Angsang, although the use of bare wires has largely been stopped, there still exists several stretches around the village. Cables run simply from the turbine to the household with no safety features. Where wire is insulated it runs low, as little as 1m above the ground, across the rice fields where people work, children play and livestock are free to wander. Amongst the houses the cabling is precariously hung from short bamboo poles or trees, easily within reach. Moreover connections between successive lengths of cable are primitively tied together, with bare wire remaining exposed. These all represent serious safety concerns and affect the reliability and effectiveness of the system. Each turbine is separately connected to its respective household, meaning these dangers are multiplied and a significant amount of wire needed. The demonstration system eliminates all these safety risks and providing a more reliable and durable system.

Figure 3: (Left Top & Bottom) Examples of previous bad wiring. (Right Top & Bottom) New wires provide a much safer and reliable system

Constructed by LIRE staff, the new mini grid utilised local materials and labour provided by the villagers. Local trees were gathered from the local forest and sawn by villagers whilst gravel and sand had been collected for use in the concrete foundations. Good quality trees were selected, with heights at least over 4m, and given a protective paint coating. They were then set into concrete foundations before wires were fixed onto suspension clamps. A total of 38 poles were installed catering for the two turbines and running to the separate clusters of households.

The new grid traverses the field at a safe height and navigates through the houses above windows and balconies. A main distribution board includes earth current leakage circuit breakers (ELCB) and circuit breakers (CB) as fail safes for the grid. Earths and lighting protection as well as guys provide additional safety measures.

Household Wiring

Household connections again meant low cables and messy wiring. Inside the houses wires hung loose, stretched across rooms, and rafters. LIRE staff, with the assistance of village technicians, put in new wires, neatly pinned to the walls and ceilings of the houses, clear of obstruction and danger. Distribution boards equipped with ELCB's and CB's provide added safety catches to the system. The distribution board also acts as a tidy and practical housing for sockets and switches, allowing users to have switches for all lights. Previously light switches were only present on the bulbs themselves. Villagers on the whole used cheap Chinese light bulbs of various wattage. Our system replaces these with more efficient, longer lasting compact fluorescent light bulbs.

Figure 4: (Left) Showing old wires hanging loose (black) and new wires (grey) neatly pinned against beam. (Right) New household connection from power poles, using suspension clamps and steel rack

Household connections from the main grid were also dramatically improved. These connections normally entered households by doorways and balconies. The LIRE staff installed new household drops, entering the houses high and out of danger. The connection could then be neatly made to the distribution box.

ELC

Problems exist throughout Laos where damage has been caused to light bulbs, electrical appliances and to the turbine itself through the varying voltage supply of the turbines. Voltage stabilizers are sometimes used but these do not protect the turbine or the appliances. In most cases the turbine connects directly to household lights and appliances.

LIRE is conducting a project focusing on the benefits of an ELC (Electronic Load Controller) which can prevent overload voltages using a dump load. The inclusion of an ELC is a good example of how sharing the costs can allow for extra benefits. The cost of an ELC can represent a significant investment for an individual user, but only a small amount when shared between 14 households. The protection offered by the ELC should decrease long term costs by reducing the replacement of light bulbs and reduce the wear to the turbine and generator components.

Turbines & Civil Works

Civil Works

A common problem reported by villagers with their current pico use was a lack of water, particularly in the dry season. Although it is impossible to stop the effects of seasonal variation our system will essentially provide power from two turbines instead of 17, meaning more available flow. The two new turbines are located at a site where there were originally six; furthermore the flow has been increased through the modification and improvement of an upstream dam. The new dams position utilizes two sources of the upstream river, further increasing the available flow. A plan of this can be seen below.

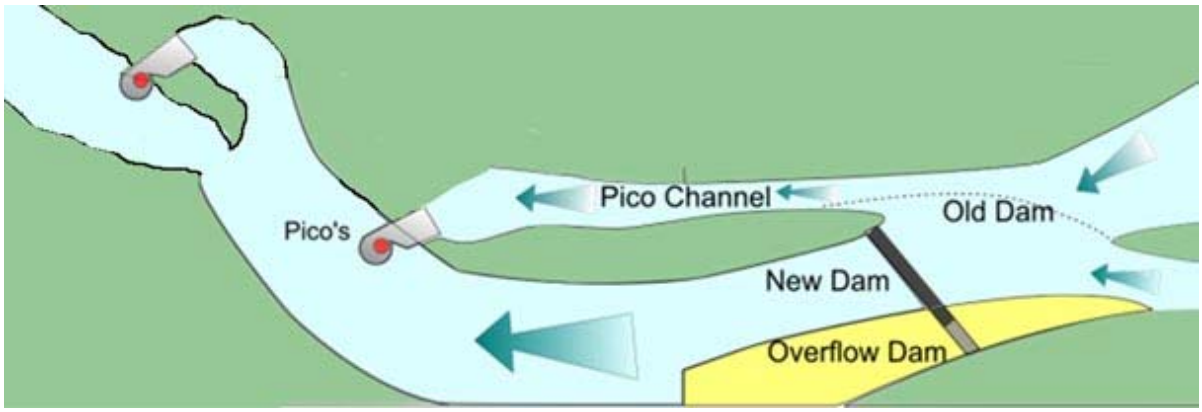

Figure 5: Plan of civil works and pico installation

The dam was constructed by the villagers under LIRE's supervision. Local rocks were used, mainly from a previous dam, and palm leaves will provide a waterproofing layer. A small section of the dam, which is slightly lower, acts to prevent flooding.

Turbine

Almost all pico-turbines in Laos are cheap Chinese models either imported directly from China or via Vietnam. Although available at various ratings, up to 1kW, they perform significantly below this. The windings, magnets and bearings all often need to be replaced as the turbine burns out. The demonstration project uses two high quality 1kW turbines produced by hydrotech in Vietnam. These should be of a superior quality and not only are significantly more efficient but also more durable. The demonstration will also significantly improve the way the turbine is installed.

Draft tube and channel

In addition to low quality turbines, the draft tube and channels of pre-existing pico-hydro installations were inadequate in their design, and failed to effectively drive the turbines. This is a common feature of pico turbine systems found in the province, and thus the Angsang project can also serve as an example for improving these components.

A draft channel and tube were constructed from sheet steel to the specifications shown in the figure below. The improved draft channel and tube greatly increase the efficiency of turbines and also, since they are constructed from sheet steel rather than wood, should experience a longer lifetime. The material was also chosen as it could be made using locally available material and technical

capacity: for Angsang village, the steel was purchased in the province and shaped by a welding shop in Sam Neua[2].

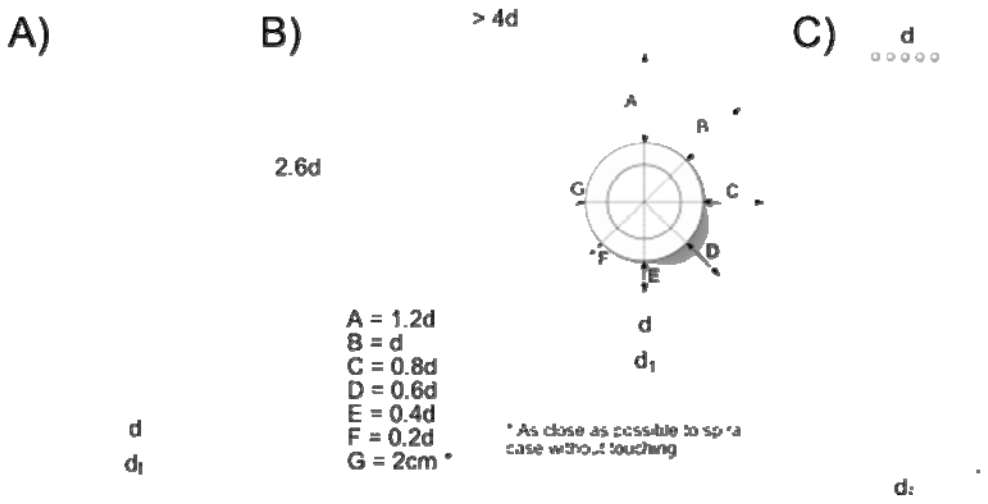

Figure 6: Schematic diagram of turbine A), draft channel B) and draft tube C).

Training of Village Technicians

Quite simply by reducing the amount of turbines needed, from 17 to just two, the cost of repairs, cables and maintenance will be reduced. Previously each household has to take care of their own turbine. This means checking the turbine, on an almost daily basis and they must also fully bare the financial burden of repairs and replacement parts. Replacement parts are easily available in local markets, perhaps in itself an indication of the poor quality of the turbines and the need for regular repairs.

The operational model for the demonstration site includes two teams of two village technicians per turbine. It will be their responsibility to maintain and look after the system; in return they are not required to pay fees. The training of the technicians commenced during the construction phase, where they were given on the job training in all aspects of the system. This will be consolidated with future training at a later date.

The benefit of the technician scheme is that it provides the village with a trained, knowledgeable team to look after the system. It also means those who struggle with the technical or labour requirements of maintaining a turbine can still benefit, as well as reducing the overall time spent by the village at a whole.

[2] The LIRE pico hydro innovation programme aims to provide manuals and technical capacity building to facilitate such activities. For more information, see www.lao-ire.org

Implementation

Schedule of work

Implementation of the demonstration project was carried out during two site visits in December. Prior to this phase, pre-feasibility and feasibility assessments of the site entailed a further three visits to the site and to district and province level authorities.

In total 19 days were spent at the village during the implementation phase, in which time all technical components were installed and training was undertaken to enable the village to operate and manage their service. Construction of the grid, household connections, turbine/generator and civil works were undertaken in close cooperation with members of the community, and the activity was utilised as additional training for those who would become the technicians of the system.

Following implementation of the system, LIRE will provide additional capacity building and technical support for the village, and critically shall undertake a detailed monitoring and evaluation of the service, in order to optimise the operational model and formulate lessons learned to later be disseminated to other communities via the LIRE pico hydro programme. Additionally the site shall be used to produce promotional materials to raise public awareness of the issues of pico-hydro power in the Lao PDR, and the opportunities for improvement.

Conclusions

Despite the benefits pico was offering the village there were serious safety and reliability concerns. The construction of the new grid means the power delivery is much safer and reliable. It has eliminated the danger seen in the old wiring and introduced new safety measures. Similarly the same safety enhancements have been implemented into people's houses.

The new turbine and civil works will replace the many old, less efficient devices. This allows us to tackle issues of low flow and the price of repairs. Improved design of draft tube and channel, and superior construction materials, will result in a more efficient, reliable and durable system. Village technicians, who were trained during construction, will manage the maintenance reducing the workload of the village as a whole.

The construction process itself was from LIRE's side was a success. Support from the village in general was excellent. They provided labour and materials which were essential to the construction. The technicians in particular were enthusiastic and LIRE were able to provide good training as a result.

Socio-Economic Benefits

Lighting is the most important use for the pico generated electricity. Previously light bulbs had short lifetimes and could provide poor light. School children are required to do homework in the evenings so good quality light is essential. Darkness falls on the village early and the provision of light makes a

significant difference to people's lives. Pico is a clean and cheap source providing 24 hours of electricity.

The majority of households are also involved in weaving as a commercial activity. Providing additional, higher quality and more reliable light will allow these women to work longer and thus generate more income for their families.

It is not just the lighting that is important. TV's give the village a connection to the outside world and provide entertainment. Telephones also allow the village to communicate with their families and the local towns while stereos provide the music for traditional dance.

Figure 7: Children watch TV and study at night

The improved efficiency and design, achievable through the shared mode, means higher performance and reliability. This allows all these activities to continue without disruption, with better quality light. A more durable system combined with trained technicians and a payment model to cover costs should safeguard the use of pico into the future.

The system will be owned and run by the village itself, keeping control in the hands of the end users. The sharing of costs protects villagers from the price of repairs and replacement parts, which, for the individual user, could otherwise end their pico use. The technician scheme also allows those families without the skills or the capital to gain access to pico. Additionally it frees up time for the village as a whole, allowing them to pursue their many other activities.

Although a full economic analysis can only be conducted after the system has been running for a significant amount of time the combination of factors such as lower repair costs, less labour and improved durability should improve the economic situation of the villagers. Collected fees not used for repairs will be able to provide expansions to the system or be used for community projects. All the advantages offered at the system are provided at no extra expense to the villagers. Finally, and perhaps most important of all, the village will be a safer place to play, work and live.