Lao
Institute for
Renewable
Energy




Shared Pico-hydropower

Shared Pico-Hydropower in Long District, Luang Namtha Province

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Lao Institute for Renewable Energy (LIRE)

Detailed Feasibility Report
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Shared Pico-Hydropower In Luang Namtha Province

Report for Norwegian Church Aid (NCA)

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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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1 Introduction

This project will see the installation of pico-hydro electricity systems in 2 – 3 villages in Long District, Luang Namtha Province, Laos. These systems will be communally owned, with village technicians responsible for operating the system, and a village committee responsible for managing the system operation and accounting. The project has 4 main phases:

1. Pre-feasibility study – briefly visiting each village in the target area to assess whether it would be possible to install pico-hydro systems.
2. Feasibility study – a more detailed look at a few selected villages to speak to the villagers about the project in depth and take all design measurements required.
3. Design and procurement – designing systems and ordering the necessary equipment.
4. Installation – putting the system into the village and training the villagers on its proper use and maintenance.

2 Feasibility visit

On a third eight day trip, the team returned to the 4 selected sites in April 2011 to carry out a detailed feasibility study. This included meetings with the villagers to ensure they would be happy with the project and willing to help install and manage the system, as well as detailed measurements of the stream and system site.

3 Systems overview

The potential system sizes are shown in the table below:

Data	Bormai	Aiseng	Donchai	Subloi highschool
Theoretical power	5.9 kW	2.85 kW	1.2 kW	0.9 kW
Deliverable power	3 kW	1.5 kW		
Number of households	35	25	41	4 buildings
Power per household	85 W	60 W		
Headrace length	500 m	10 m	245 m	93 m
Transmission length	1018 m	413 m	647 m	720 m

Bormai has a high flow, low head stream. This means that the required canal must be large enough to contain the flow and long enough to ensure an adequate head is achieved. As a result, this part of the system will be relatively expensive, but the potential power relatively high. The villagers here would be happy to help us install the system and willing to operate it themselves. The current systems serve all households but must be removed for 4 months each year to avoid flooding.

Aiseng has many small streams nearby, which can all be combined through existing irrigation canals to provide sufficient flow. The irrigation canals can still be used for irrigation when they are needed since there is a surplus of water during the growing season. Again, the villagers here would be happy to help us install the system and willing to operate it themselves. The current system serves around 60% of the village.

Donchai is a large village and was found to not have adequate flow during the dry season, even if two streams were combined. A good canal was already in place and would require relatively little work to modify for this project. Construction materials are also easily transported to the villages using the Mekong River. The village is comprised of two ethnic groups that each have their own language and village head. Very little is shared between these two communities and forcing them to share a limited electricity source could be problematic. The systems currently in place can only serve around half of the village.

Meeting (left) and gradient measuring (right) at Donchai

Subloi highschool has a very limited source. However, since the electricity would only be for the school and dormitories, it will be possible to provide them with enough electricity for lighting. A fairly long canal needs to be dug to take the water around the side of the hill where a larger head is

available. After the water flows through this system it would join one of Aiseng's irrigation canals and eventually flow through the Aiseng system. Since the system is for a school, the students would help install the system and the teachers or a parents committee can manage it. The current school system does not provide any electricity for around 4 months of the year due to insufficient flow.

4 Bormai

There are currently three pico hydro systems in this village serving 28 households (out of a total of 35 households and a primary school). These systems would all be replaced by the new system. The nearest healthcare centre and highschool are at Jamai (around 20 km away).

4.1 Meeting notes

The villagers were happy to provide free labour (around 5 – 10 workers each day) in exchange for the system, though at first they were a little worried because they are also building a bridge nearby. They claimed sand and stones could be collected from the river, but for the quantities required for the project it is more likely that this will have to be brought in from outside and transportation will need to be provided.

They are happy to share responsibility for managing the system, and to pick two people to be with us while we install the systems. These people would then know exactly how to maintain and operate the system. They said that they would have to provide these two people with a small salary for their time training with us.

They are willing to pay 5,000 – 10,000 LAK as a monthly fee. Even when we explained that they would not have to change light bulbs (they currently use 1 – 3 each night), and that any money saved could be used for other projects, the upper limit still seemed to be around 10,000 LAK. Most households have 1 lightbulb, although current turbine owners have 2.

When we told them that this electricity would not be like city electricity and should be reserved for useful things, they said that people who wanted to watch televisions could use their own systems for the extra power required. If people start using TVs they will be told to stop and if they fail to do so their TV will be taken away.

Our proposed location seemed fine, and they were happy to help with space and support. Although only 6 families were represented at the meeting, we were told that a previous meeting had taken place (between our pre-feasibility and detailed feasibility study visits) during which some of these issues were discussed. One of the people present at the meeting currently owned a pico hydro turbine and he said this project posed no problems to him.

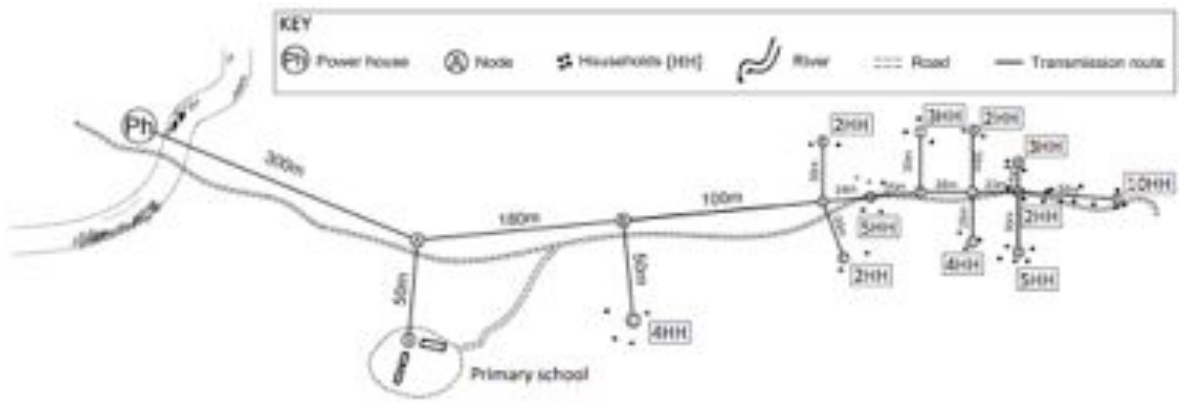
They mentioned they need a water supply for the school (since it is slightly removed from the village) and an NCA meeting will take place to discuss this. A pump powered by the pico hydro system could be used to supply the school with water.

4.2 System design

Bormai features a large stream that moves relatively slowly and has a low head. The required canal route climbs quite a lot before finally dropping at the end. This could significantly increase the cost of the system because a deep trench will need to be dug, and a large buried pipe used for some sections.




The canal winds through fields before dropping a few meters at the end. A plan view of the transmission route can be seen in the figure below. Early on in the route a branch goes towards the primary school. This and other design drawings can be found in Appendix A.



4.3 Costing

Description	Cost (LAK)	Cost (USD)
Pico hydro system	-	-
Electrical works (Non Local)	6,500.00	0.81
Civil works (Non Local)	5,805,685.04	725.71
Tools	220.00	0.03
Spare parts	135.00	0.02
Transportation	9,250.00	1.16
Installation	5,250.00	0.66
Testing and Commissioning	1,500.00	0.19
Sub-total	***5,828,540.04***	***728.57***
VAT (10%) (Non Local)	*581,254.00*	72.66
Contingencies (5%)	*291,427.00*	36.43
Total	***6,701,221.05***	***837.65***
Civil works (local)	106,286,960.12	13,285.87
Electrical works (local)	2,400,000.00	300.00
Total Project Cost	***115,388,181.17***	***14,423.52***
Cost Per KW	*38,462,727.06*	4,807.84
Cost Per HH	*3,296,805.18*	412.10
Kind equity	*108,686,960.12*	13,585.87
cash equity	*6,701,221.05*	837.65

5 Aiseng

There is currently 1 pico hydro system in this village serving 17 households (out of a total of 27 households and a primary school with grades 1 – 3). This system would be replaced with the new system. The nearest healthcare centre and highschool are at Subloi (around 2 km away) Kerosene users currently use around 1 litre every week. There is a heavy reliance on opium cultivation in the area.

5.1 Meeting notes

The villagers said they were happy to help with labour and land required for the system, however, materials are difficult because they have to come from the Mekong which is around 10 km away. They are willing to pay a monthly fee of around 5,000 – 10,000 LAK (this started at 5,000 and moved to 10,000 when they realised they would not need to constantly replace light bulbs). They also highlighted the fact that they only represented 5 households and could not speak for everyone.

They are happy to manage the system as a group. Currently whoever is not busy will take on responsibility for checking the system on a given day, though it appears as though only 1 or 2 people actually fix the system. They were not present but it was expected that they would be happy to operate the systems for a small salary.

There are currently 7 TVs in the village. When we explained that not everyone would get a TV and suggest that the people who did have one should be charged more for electricity, they replied that most people watch TV at a few people's homes and if anything those households should pay less for electricity. It seemed as though they would be able to manage this themselves. Each household had

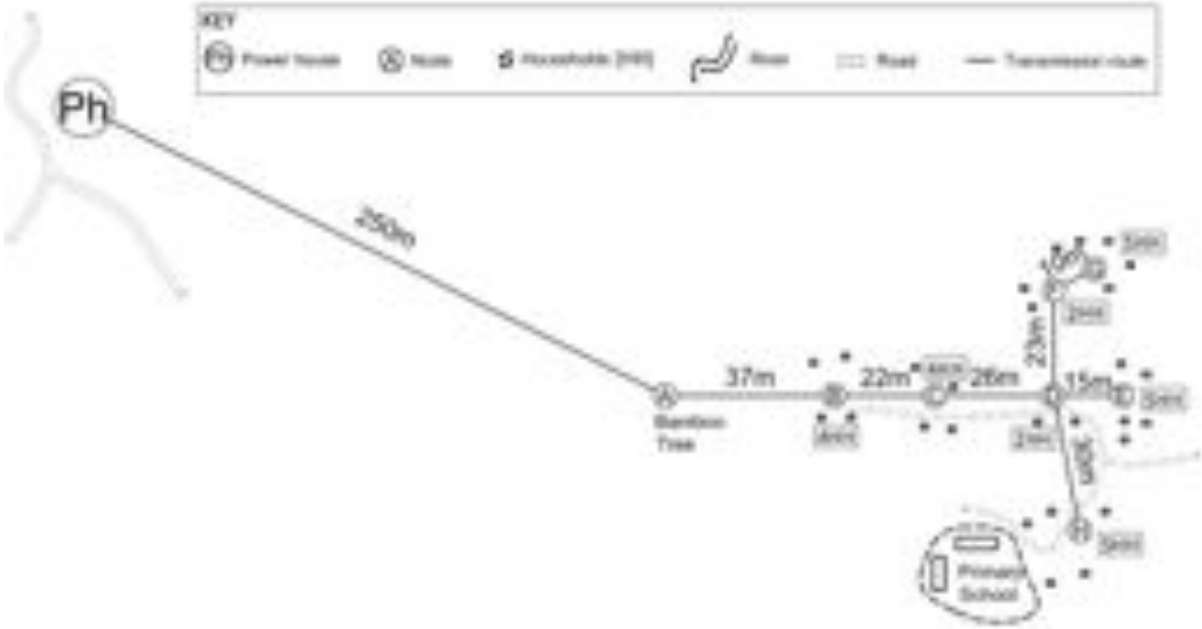
1 light bulb. The village chief also had a couple of 60 W bulbs that were used as a dump load. They did not mind the fact the old system would be removed.

5.2 System design

This system is more complicated because 2 streams must be combined in order to supply enough water (and each of these 2 streams is actually a combination of 2 other streams). One is near the system and is the one currently in use, but the other is around 1 km away. This second stream has already been the site of some development work, a flushing tank is used to collect water from two sources before it is sent to fields via a combination of pipes, earthen canals, and cement canals. Finally, a small gully takes this stream to join the first. By improving these canals using low costs methods (such as plastic sheeting), the pico-hydro system could utilise significantly more water.

The stream further away is added to the first which already flows past the place with the best drop. Once combined, the water is sent down a pipe towards the generator

The transmission system required for the Aiseng system is relatively short. A plan of this can be seen below. This and other design drawings can be found in Appendix B.



5.3 Costing

Description	Cost (LAK)	Cost (USD)
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Electrical works (Non Local)	6,500.00	0.81
Civil works (Non Local)	5,805,685.04	725.71
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Testing and Commissioning	1,500.00	0.19
Sub-total	***5,828,540.04***	***728.57***
VAT (10%) (Non Local)	*581,254.00*	72.66
Contingencies (5%)	*291,427.00*	36.43
Total	***6,701,221.05***	***837.65***
Civil works (local)	106,286,960.12	13,285.87
Electrical works (local)	2,400,000.00	300.00
Total Project Cost	***115,388,181.17***	***14,423.52***
Cost Per KW	*38,462,727.06*	4,807.84
Cost Per HH	*3,296,805.18*	412.10
Kind equity	*108,686,960.12*	13,585.87
cash equity	*6,701,221.05*	837.65

6 Donchai

There are currently 3 pico hydro systems here serving 15 households during the dry season, and 26 during the wet season (out of a total of 41 and a primary school with grades 1 – 4). The nearest health post is at Somphan Kao. They have a police post here to keep order within the community and because of sporadic unrest on the Mekong (the village is very near Burma and a large Chinese run port, piracy is common in the area).

The village contains two communities, the Leum and the Akha. Both are roughly equally represented in the village. During the meeting it became clear that there was distance and possible tensions between the two communities. They spoke little of each other's language, making communication between the two communities difficult. Each community also had its own village chief. The Akha moved to this village around 8 years ago, and although the Leum do not seem to mind, the two communities have not integrated. Forcing them to share a pico-hydro turbine (currently the communities have their own) could be problematic.

6.1 Meeting notes

They are happy to provide labour, and materials are not a problem because the Mekong is nearby. However, if stones need to be collected the village needs to be informed before the rainy season. After the river level rises, they cannot collect stones again until December.

They currently only collect money when they need to repair a system, but are willing to have a montly fee of perhaps 5,000 LAK for low usage, and 10,000 LAK for higher useage. It is difficult to say

if this was agreed between the two communities. There were around 20 people at the meeting, but because of the two different languages it was unclear whether both groups agreed everything.

While 2 of the existing pico-hydro system owners were happy for us to remove their systems in order to put a new one in, the owner of the third (a system that serves 16 households during the rainy season). Once all the benefits of the project had been properly explained and discussed he seemed to come round to the idea, but this could have simply been because of peer pressure.

They seem happy to share management responsibility for the system, but again, this could be difficult because of the two languages. They were also happy to set up two people to operate the system – these people would be with us during installation and would take around 20% of the monthly pico-hydro fee collection as their salary. There are currently 4 TVs in this village, though most families only have 1 light bulb. There are some rice fields near the current systems that we have to avoid using (which should be fine).

6.2 System design

This system will use a combination of two streams. Both of these streams meet where a pico-hydro system is currently installed. Instead of sending stream 2 down this existing system, we will make it flow into stream 1, significantly increasing the flow rate. The earthen canal currently used from here can then be improved to reduce seepage. The site of a second system can then be used for this project.


From a preliminary look at the system design it appears as though the maximum power available is 500 W. Due to the village size this power would be insufficient due to the village size. A combination of this and the difficulties between the two communities in the village this system was not designed in further detail.

7 Subloi highschool

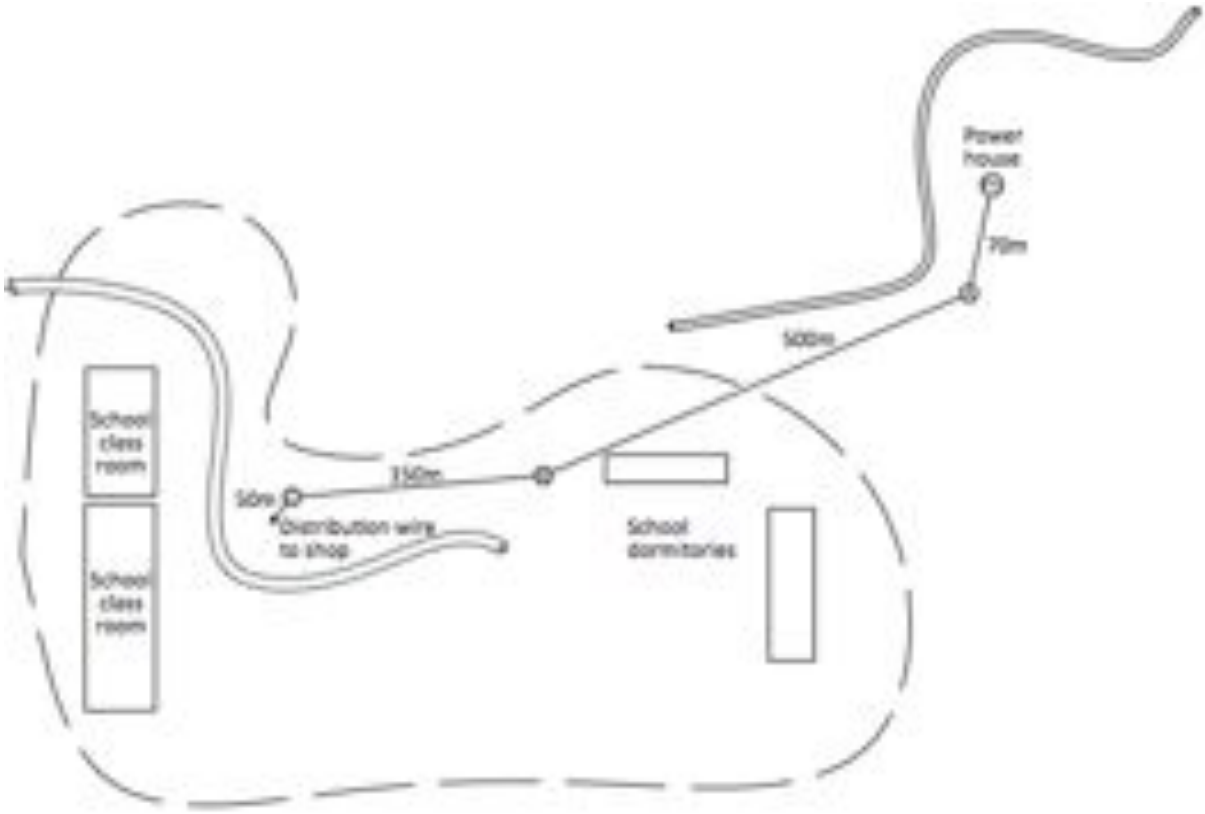
Subloi highschool has 68 students, many of whom stay in dormitories.

7.1 Meeting notes and system design

During the pre-feasibility survey it seemed as though the potential around the highschool was insufficient (they were only running 1-2 lightbulbs). However, based on the streams at Aiseng and Jakamthan, it seemed like there could be potential further downstream.

Currently, the stream flows through a small system owned by a shop before it flows through the highschool system. After clearing a path through the jungle it became clear that if both of these systems were bypassed and the canal extended around the side of a hill a significant drop could be achieved. This would then feed into the canal leading from the flushing gate near Aiseng (currently, this stream leads straight to the flushing gate after passing through the highschool system).

The distribution system required can be seen in the figure below. This and other design drawings can be found in Appendix C.



In exchange for removing the shop owners system we offered to provide him with free electricity, he agreed to this. Labour can be provided by the highschool students (although they seem somewhat work averse so might need some encouragement from their teachers). Materials need to be transported from Phayaluang Khamping, this can be difficult (though not impossible) during the

rainy season due to the condition of the roads. It would take 10 people 1 hour to fill a pickup truck with sand or stones, and 3 trips to Phayaluang Khamping could be made in a day.

7.2 Costing

Descriptions	Cost (LAK)	Cost (USD)
Pico hydro system	-	-
Electrical works (Non Local)	6,500.00	0.81
Civil works (Non Local)	7,113,262.53	889.16
Tools	-	-
Spare parts	-	-
Transportation	-	-
Installation	7,000,000.00	875.00
Testing and Commissioning	4,000,000.00	500.00
Sub-total	***18,119,762.53***	***2,264.97***
VAT (10%) (Non Local)	*711,976.25*	89.00
Contingencies (5%)	*905,988.13*	113.25
Total	***19,737,726.91***	***2,467.22***
Civil works (local)	50,688,652.10	6,336.08
Electrical works (local)	880,000.00	110.00
Total Project Cost	***71,306,379.01***	***8,913.30***
Cost Per KW	*23,768,793.00*	2,971.10
Kind equity	*51,568,652.10*	6,446.08
cash equity	*19,737,726.91*	2,467.22