APRACA FinPower Programme

Completion Report

A Preliminary Assessment: Prospects for Micro Hydropower Development and Financing in Lao PDR

Narayan Chaulagain

Thakur Devkota

An APRACA FinPower Publication with the Special Sponsorship of the International Fund for Agricultural Development (IFAD)

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Acronyms and Abbreviation

AEPC	: Alternative Energy Promotion Center
REDP	:Rural Energy Development Programme
ESAP	:Energy Sector Assistance Programme
APRACA	:Asia Pacific Rural and Agricultural Credit Association
IFAD	:International Fund for Agriculture Development
RLIP	:Rural Livelihood Improvement Project
FinPower	:Regional Program of Financial Empowerment of Poor & Rural Communities
DDC	:District Development Committee
VDC	:Village Development Committee
MHUG	:Micro Hydro Users' Group
DEF	:District Energy Fund
CEF	:Community Energy (micro hydro) Fund
MH	:Micro Hydropower
kW	:kilowatt
MW	:Megawatt
km	:kilometer
lps	:liter per second
amsl	:above mean sea level
mm	:millimeter
GPS	:Geographic Positioning System
ACSR	: Aluminum Conductor Steel Reinforced
RCC	:Reinforced Cement Concrete
MCCB	:Molded Case Circuit Breaker

Acknowledgment

This pilot testing programme to assess the prospects and possibilities of installations of micro hydropower plants provided us a very good opportunity to gain a better understanding of the people, topography and the water resources in Lao PDR, especially in Attapeu Province. It also gave us a chance to learn more about the culture and traditions of the different ethnic groups living in highlands of Attapeu Province of Lao PDR. We have experienced a lot from this field study about the people, the natural resources and the different interventions being taken in Attapeu Province to bring about positive changes in the lives of the people and would like to thank all who made this possible and cooperated wholeheartedly during the entire study period.

We would like to extend our sincere thanks to Asia Pacific Agricultural Credit Association (APRACA)-FinPower and IFAD for entrusting us the task for the pilot testing of MH in Attapeu of Lao PDR. We would also like to extend our heartfelt thanks to Rural Livelihood Improvement Project (RLIP- IFAD) for taking the lead role and extending all supports possible for the successful pilot testing works.

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Narayan Chaulagain
Executive Director, AEPC, Nepal

Introduction

About IFAD

The goal of the International Fund for Agricultural Development (IFAD) is to reduce rural poverty through sustainable improvements in household food security and incomes. In order to contribute to this goal, one of IFAD's strategic objectives is to provide improved financial and related non-financial services in rural areas. In fact, two-thirds of the Fund's current projects have a rural finance component and approximately one-fifth of the Fund's resources are dedicated to rural finance. Hence, IFAD aims at providing sustainable access of the rural poor to financial services, to be enhanced by institutional diversity and a supportive rural financial infrastructure. IFAD's rural finance policies focus on four focus areas:

- Building sustainable rural finance institutions with outreach to the rural poor;
- Fostering stakeholder participation, including the poor, in the development of rural finance;
- Building a diversified rural financial infrastructure; and,
- Promoting a conducive policy and regulatory environment.

About APRACA

Since 1977, APRACA has aspired to work for rural growth and development, with priority emphasis on the uplift of rural poor. It has pursue**d** the promotion of efficient and effective rural financial systems and broadened access to rural financial services. It established among its members, a machinery for systematic interchange of information on sustainable rural and agricultural financial services, encouraged inter-country studies, provided forums to discuss matters of common interest in the field of rural finance, and provided training, consultancy, research and publications services.

APRACA, with its wide network of member rural financial institutions and central banks, is a viable and strong partner for IFAD to engage with senior policy makers and central banks on key policy issues. IFAD had collaborated with APRACA between 1996 and 2001 under the APRACA MicroServ programme, implemented with IFAD's funding support, wherein replicable rural finance models were disseminated to member institutions and to a wider audience. The program showed that the replicability of innovative models was further enhanced when conducted through an organization with an existing, wide geographic network such as APRACA, thereby yielding more cost-effective results, broader geographic reach, and assured project continuity.

About the FinPower Programme

In 2007, the International Fund for Agricultural Development (IFAD) provided APRACA with a five-year Technical Assistance Grant to implement the Regional Program of Accelerating the

Financial Empowerment of Poor Rural Communities in Asia and the Pacific through Rural Finance Innovations, dubbed as the APRACA FinPower Program.

The goal of the five-year FinPower program is to promote the financial empowerment of the rural poor in Asia-Pacific countries through policy dialogue, innovative pilot programmes, and knowledge-sharing among actors in the rural finance sector. The activities undertaken by the programme are expected to further consolidate rural finance knowledge and replicate successful approaches among beneficiaries in the Asia-Pacific region.

The three programme objectives, which correspond to the three central components of the FinPower Programme, are:

> **Component 1: Participatory Dialogue and Policy Forums:** Foster an enabling, pro-poor and client-friendly policy environment and regulatory framework for sustainable rural financial systems;
>
> **Component 2: Pilot Programmes, Exposure Visits and Documentation**: Encourage innovative approaches to rural finance through the adoption of reforms and improvement of rural finance mechanisms that empower the rural poor; and
>
> **Component 3: Training, Regional Study and Sharing of Innovative Practices:** Extract lessons from the wealth of rural finance innovations promoted by IFAD-supported projects and APRACA initiatives to promote information sharing and replicate successful approaches in the region.

In line with the sharing of rural financial innovations, APRACA FinPower conducted, in collaboration with Nepal Rastra Bank, the Green Finance Forum in Kathmandu, Nepal on March 1-5, 2010. The forum focused on innovations pertaining to the design, financing and implementation of agricultural projects using alternative energy: bio-gas, solar, wind and hydropower, among others.

Representatives from the IFAD Rural Livelihood Project in the Province of Attapeu, People's Democratic Republic of Laos (Lao PDR) participated in the forum and showed keen interest in replicating the development of a micro hydropower (MH) system which was showcased during the forum.

Thus, the APRACA FinPower Programme commissioned to the Alternative Energy Promotion Center (AEPC) of Nepal to conduct a preliminary assessment for the development of micro/mini hydropower (MH) systems in the Province of Attapeu, Lao PDR, in collaboration with IFAD RLIP on September 9- 17, 2010.

The Alternative Energy Promotion Center (AEPC) of Nepal was established in 1996 as an autonomous institution to work as a nodal agency of the Government of Nepal for the promotion, regulation and institutionalization of the development of the rural renewable energy solutions in the country.

Amongst the various rural renewable energy technologies, the micro hydropower system is the principal technology to cater to basic rural energy services, mostly to the poor and economically disadvantaged community members residing in far-flung localities of the country that do not see any prospect for the extension of the national energy grid system in the foreseeable future. The micro hydropower systems are decentralized and based on renewable resources, provide electricity power to isolated settlements to meet two types of basic rural energy needs viz. electricity for household lighting, running household appliances like TV, refrigerators, fans, computers, radios, charging mobile phones and the like, especially during the evening hours and dawn and running electric motors for operating small businesses and enterprises such as agro-processing mills, rural bakery, carpentry, poultry, etc. during off-peak hours (day and night time) for income generation, local employment generation, drudgery reduction and value addition.

The use of alternative energy in Nepal is successful and widespread due to scattered settlements in villages, mostly far from urban centers, that do not see any prospect for grid extension due to requirement of vast investment costs. Further the upkeep of the transmission lines would also be quite challenging in the rugged mountainous terrain. However, due to the topographical configuration and existence of numerous streams and rivulets that possess high gradient, development of the micro/mini hydropower systems in decentralized way, have been proved quite far-sighted, practical solutions to provide access to electricity to a large mass of rural population for supporting the Government of Nepal's objective of poverty reduction, local environment conservation and empowerment. The AEPC is mandated to formulate policy frameworks, standardize the technology, provide technical inputs, mobilize resources and act as a regulatory body for the development of the micro/ mini hydropower systems in the country.

The AEPC, with the assistance from the Government of Nepal and donor agencies, namely the United Nations Development Programme (UNDP), the World Bank, Norwegian Agency for Development Cooperation (NORAD) and Danish International Development Agency (DANIDA) has been executing two major programmes for the development of micro hydro systems in the country, namely the Rural Energy Development Programme (REDP) and the Energy Sector Assistance Programme (ESAP). The former supports the installation of community managed micro hydropower systems with social mobilization package following the holistic approach and

the latter supports the development of even private entrepreneur installed and operated micro hydropower systems. The REDP is operational in some selected VDCs of forty districts whereas the ESAP covers the entire country. Thus far, about 12000 kW (12 MW) electric power has been generated in Nepal benefiting some one hundred thousand households.

It is hoped that this preliminary assessment would be successful and contribute to further developing the livelihood and income of rural communities in the IFAD project areas in Lao PDR, preserving the natural environment and to creating a model for replication in similarly situated communities in Asia.

Won-Sik Noh
Secretary General
APRACA

1. Purpose of Pilot Testing

The main purpose of the ***pilot testing*** is to conduct the preliminary assessment for the development of micro/mini hydropower (MH) systems in the Province of Attapeu, Lao PDR and explore/investigate a suitable testing site for the piloting of a demonstration scheme in at least one of the identified localities. In addition, the testing also aims at suggesting the implementation modality, possible sources of finance and implementing partners.

Despite so much potential, not a single MH plant has been developed in the province. Thus, the pilot testing programme envisages the installation of a demonstration plant as a milestone to the future dissemination of the technology in the Attapeu province that would also play catalytic role for the development of MH in Lao PDR as a whole. The ultimate goal of the pilot testing remains to demonstrate the successful impact of a decentralized electricity source on the enhancement of rural livelihood and preservation of the natural environment in the pilot testing area.

2. The Lao PDR, Attapeu Province and Prospects for Micro Hydropower Development

2.1 Geographic and Demographic Profile of Lao PDR

Lao PDR is situated in south-east Asia, surrounded by China in the north, Myanmar in the north-west, Thailand in the south-west, Cambodia in the south-east, and Vietnam to the east. It has an area of 236,800 sq. kilometers and a population of about six million. The capital city is Vientiane, located on the bank of Mekong River with a population of some 640,000. Other major cities are Savannakhet, Luang Prabang, Pakse and Thakhek. The literacy rate is about 53%. The official language is Lao. Buddhism is the main religion practiced.

The country has three distinct regions: rugged mountains in north, plateaus and alluvial plains. The Phou Bia is the highest peak in Xieng Khouang province, which is 2,800 meters above mean sea level (amsl). The Lao PDR has three seasons- tropical monsoon (March to June), rainy season (July to October); dry season (November to February). The main natural resources that the country possesses are tropical forests, timber, hydropower, gypsum, tin, gold and gemstones. The main agricultural products are rice, sweet potatoes, vegetables, corn, coffee, sugarcane, tobacco, cotton, tea and peanuts as well as water buffalo, pigs, cattle and poultry. While there are no large industries in the country, tourism and hydropower have been emerging and hold huge prospects. Other small industries include tin and gypsum mining, timber, agricultural processing, construction and garments.

Most Laotians depend on subsistence farming and rice is the principal crop. Barter still is the prevalent method of exchange in rural commerce. The unit of currency in Lao PDR is the new kip. (Source: Laos WWW.Virtual Library)

According to the World Bank Economic Monitor for Lao PDR (October 2005), the per capita income in Laos is US$390. This puts Lao PDR at number 23 on the United Nation's list of Least Developed Countries, after Afghanistan (1), Cambodia (8), Ethiopia (17) and Haiti (21). According to official statistics, seventy percent of the population of Lao PDR live on less than US$2 per day and 23 percent on less than US$1 per day though income is not necessarily a sufficient indicator of poverty by itself.

Map 1: Lao PDR and surrounding countries

2.2 Lao PDR Energy Scenario

The number of household with access to electricity has increased from 16% in 1995 (World Bank Group 2006) to 47 % in 2005 (Mataykham 2006). The Government of Lao PDR (GoL) aims at providing electricity to 70% of all households until 2010 and 90% until 2020 (Araki 2005, Mataykham 2006). Since the extension of the national grid is very expensive, the GoL believes that renewable energy sources are necessary for rural electrification (World Bank Group 2006). Still there is a part of the population in the most remote areas that will be almost impossible to electrify (Mataykham 2006).

The most important source of electricity in Lao PDR is hydropower, which accounts for 97% of the total electricity production. There are no gas or oil resources in use for electricity production (World Bank Group 2006), but important resources of lignite (generating capacity 2000 MW) and coal (generating capacity 500 MW) have been discovered. In the future, there will be exploration for oil and gas (Tait et al., 2004). A small portion of the electricity comes from diesel and solar photovoltaic (PV) systems (Mataykham 2004). Lao PDR is estimated to have a hydropower potential of 18 GW, but only a small portion is explored. The total production is 627 MW, of which 624 MW comes from nine major hydropower plants and 3 MW from small hydropower plants (MIH n.d.). The energy produced is divided between domestic use and export to Thailand. In 2003, the domestic use of energy was at most 250 MW and surplus energy was exported to Thailand (World Bank Group 2006). The Nam Theun 2 hydropower project has just been completed and has increased the export to Thailand with 1 GW and for domestic use with 73 MW (Nam Theun 2 Power Company Ltd. 2006). Lao PDR also imports electricity from Thailand, Vietnam and China to districts close to their border, since this is a cheaper alternative than to extend the national grid to each corner of the country (Tait et al. 2004). The 22 kV transmission lines cost between US$10,000 and US$ 15,000 per km, depending on the availability of access road (Mataykham 2006).

2.3 Micro Hydropower in Lao PDR

Since 1970, 38 micro hydropower plants have been installed with a total capacity of 5-250 kW. In December 2005, only 14 of these micro hydropower plants were still working and some of them were in poor condition (MIH 2005). The reason why many of the plants broke down was that they were constructed with second-hand equipment that did not fit with the site. Since the equipment was not optimized for the site, this also meant that site capacities were not fully used (Mataykham 2006). With lack of money and insufficient knowledge, the maintenance work could not be carried out in a good way and the plants were damaged. Another reason of failure was the underestimation of floods (Tait et al. 2004). The majority of the plants were

situated in the northern part of Lao PDR, whereas only three plants were situated in the southern part. Surveys had been made on 34 new potential locations for small/micro hydropower plants (capacity: 50-2000 kW), 13 of which were considered more suitable. Reconstruction of broken plants are supposed to be cheaper than installing new ones, but in some districts new installations were required with the view of meeting the target of electrifying 90% of the population until 2020. But actual implementation of the plants would all depend on the resources from donors (Mataykham 2006).

Small hydropower plants are less cost effective than large plants since they do not give any direct income from power export. The Government is nevertheless positive towards the use of micro hydropower since it gains many advantages for the community, like education, health and security. This is good in theory but since money is needed in many sectors, such as road building, agriculture and forestry, the budget for rural electrification is limited.

In Lao PDR, the installation cost for a micro hydropower plant varies from US$4,000 per kW to more than US$ 10,000 per kW. An acceptable price is US$ 7,000-10,000 per kW and above US$ 10,000 is considered expensive (Mataykham 2006) in the context of Lao PDR. Before installing a new micro hydropower plant, a socio-economic survey is normally performed. The government does not seem to be in a position give any subsidies to poor districts for electricity, but in general villagers save on costs when they get access to electricity. Households without electricity need to buy gasoline, diesel, candles, battery for the torch, when they go hunting, battery for the radio, etc. Most of the households with electricity pay only US$ 1-1.5 per month (Mataykham 2006).

2.4 Attapeu Province

2.4.1 Geographic and Demographic Profile

Attapeu Province lies in the far south of Lao PDR, nestled among the slopes of the Annimite Mountains and the border of Vietnam to the east and Cambodia to the south. Compared to other provinces, Attapeu is one of the least densely populated areas of Laos. The UNDP National Vulnerability Report (2001) ranks two thirds of Attapeu as most vulnerable. The proportionately small lowland area is classed as least vulnerable, underlying the severe disparities across districts.

Average life span is on par with the national average and the maternal mortality rate is graded ‘medium’. Net school enrolment is among the lowest in the country. Seventy percent of the population have no access to safe water and nearly 90% have no access to adequate sanitation. In contrast, much of the province is ranked as High Priority Biodiversity Area. These contrasts

are the central theme of the 'situation' in Attapeu. High biodiversity is considered in at least some official government documents, a key to poverty alleviation.[1]

Attapeu province covers the transition zone between the Annamite Mountain Range in the east and the Mekong Plains in the west. The 'rice bowl' of Attapeu is the Xe Kong River valley, in which the river flows through the middle of the province. Despite the valley being one of the larger rice growing areas in the country, yield per hectare is extremely low by international standards. Sixty percent of Attapeu is mountainous and seventy percent of the mountains are classified as 'very steep'. Acrisols make up 41% of the soil types. Soils in the south and east of the province are heavily leached and acidic with low water retention capacity and generally low soil fertility. In contrast, soils in the Bolaven Plateau in the northwest along the border between Attapeu and Champasak are deep, well-structured and less acidic and have relatively good water retention and drainage capacity. The Xe Kong River floodplain is a mix of alluvial sediments and sedimentary rocks and, as a result of regular flooding, has highly fertile agricultural soil.[2]

2.4.2 Rivers and Wetlands

The Xe Kong River is one of the largest tributaries of the Mekong River in Lao PDR. Its 28,815 ha. watershed includes all of Attapeu province and parts of neighbouring provinces in both Lao PDR and Cambodia. The Xe Kong Basin encompasses a small part of Viet Nam, northern Cambodia and southern Lao PDR. In Lao PDR, the Xe Kong River valley includes sections of Samakkixay, Xaysetha and Sanamxay districts, in Attapeu province.

The Xe Kong River has seven major tributaries: Xe Kaman, Xe Pian, Xe Khampho, Nam Kong, Nam Ngon, Xe Xou, Nam Xou, Xe Namnoi, and Xe Katham. The lowland plains of the Xe Kong River valley experience seasonal flooding with the arrival of the tropical monsoon. Many parts of these districts see water level increases of 8-10 meters during the wet season. The wetlands of the Xe Kong watershed play an integral role in local livelihoods strategies. In addition to the critical support that these wetlands provide to local communities, Attapeu province has at least two wetland regions of global significance.

In Attapeu, the Xe Kong Plains, the Xe Pian - Xe Khampho wetlands and Nong Patomkeen have long been considered the 'major' wetland areas. The Mekong Wetlands Biodiversity Programme demonstration sites are located within these boundaries.

[1] Government of Lao PDR. 2004. Biodiversity Country Report. Ministry for Agriculture and Forestry, Science Technology and Environment Agency, Danida, UNDP. Vientiane, 2003

[2] Biodiversity Profile for Attapeu Province. 2003. Government of Lao People's Democratic Republic, with support from Danida, Government of Laos Science, Technology and Environment Agency, Ministry of Agriculture and Forestry, World Wildlife Fund, and United Nations Development Programme. Vientiane, Lao PDR.

Attapeu at a glance
Area: 10,320 km^2
Population: 104, 465 (census year 2001)
Population density: ~9.2 persons/km^2
Annual growth rate: 2.7%
Birth rate: 3.7%
Mortality rate: 1.6%
Average life expectancy: 52 (men)
55.5 (women)

Table 1: Attapeu at a glance

Map 2: The Xe Kong & its tributaries in Attapeu

2.4.3 Rainfall

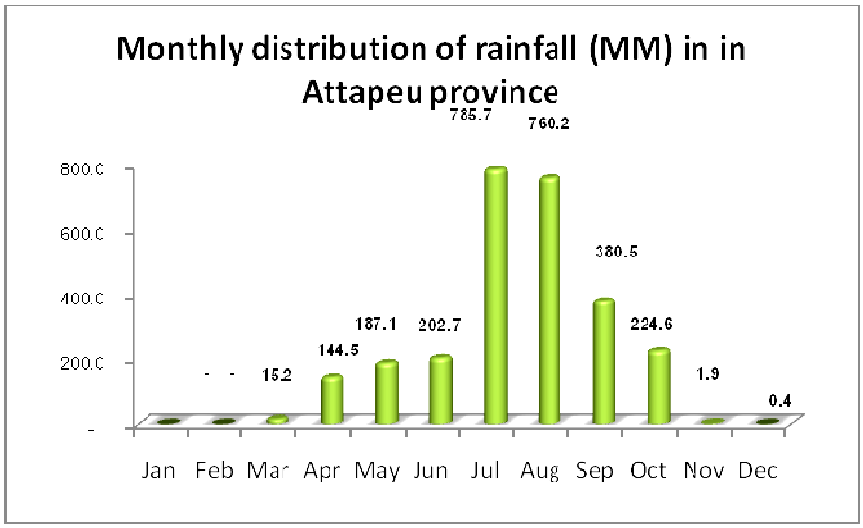

Table 2. Monthly distribution of rainfall in Attapeu Province

Attapeu normally receives an average annual rainfall of about 1,800 mm distributed mainly from April to October. Slight showers occur in November and March. Months from December to February are dry. The climate is highly influenced by the Annamite Mountain Range, which forms the border between Lao PDR and Vietnam and acts as a barrier to weather systems. Regions of the Annamites where the crest is relatively low, allow rain-laden clouds to cross from Vietnam and generally receive more rain over a longer season.

2.4.4 Temperature

Average monthly temperature in Attapeu province ranges from 20 to 38 degree Celsius which may allow cultivation of crops throughout the year, subject to availability of irrigation.

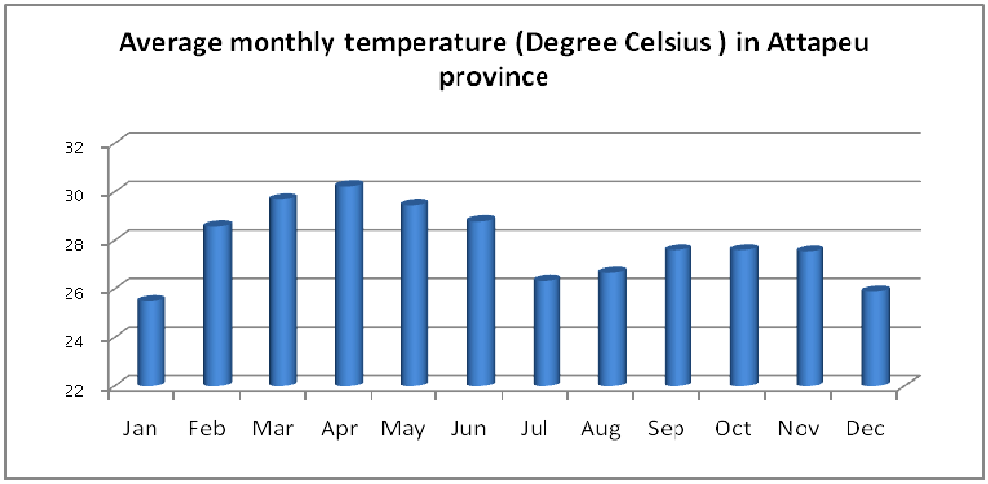

Table 3. Average monthly temperature in Attapeu Province

2.4.5 Water Resources

Attapeu province has significant water resources. The Xe Kong River is one of the largest tributaries in Lao PDR. Its watershed covers 28,815 ha and includes all of Attapeu Province as well as parts of Saravane, and Xe Kong in Laos and part of Stung Treng Province in Cambodia. The Xe Kong River has seven tributaries of significance that flow through Attapeu namely, Xe Kaman, Xe Pian, Xe Khampho, the Nam Kong, the Xe Sou, the Xe Namnoi, and the Xe Katham. These rivers are important resources for agriculture, energy production, fisheries, and irrigation. They also provide a range of aquatic and terrestrial habitats and play a large role in the extent of biodiversity in Attapeu province.

2.4.6 Road Connectivity

At present, Attapeu is well connected with the national highways that lead to Vietnam. Attapeu is well connected with Sekong, Salavanh and Pakse province with good opportunity to get connected with national and international markets. Recently, ADB supported 10 road projects from Saysettha to Xansai already completed and Xansai to Jalernxai remain under construction. Rural Livelihood Improvement Project (RLIP) also constructed rural access roads from Jalernxai to Dak Mor, Jalernxai to Thonglek in Xansai district which can open very good avenues for agricultural development in Xansai district. RLIP also constructed road from Vongsamphan to the Sesu river and the Sesu river to Ban Somkhot and now Hong Aeng Zalai Company from Vietnam is

constructing bridge on the Sesu river with 40 MT capacity which can connect the Phouvong district with the rest of the province and can open opportunity for agricultural development.

2.4.7 Prospects for MH Development in Attapeu

The topography of Attapeu shows the huge elevation variance within the province and possesses rich watershed for the Xe Kong and its tributaries. Although the months from December to April are mostly dry without mentionable precipitation, however, the low-flow discharge in most of the rivulets and streams in Attapeu province are still sufficient for harnessing of micro/mini hydropower to satisfy the basic electricity needs of the nearby settlements. In view of the topography with hills, valleys and basins, settlement pattern not so scattered and located mostly near to some rivers / streams having high to moderate gradient, far from central grid systems, the Attapeu Province could be considered to have very good prospects for the development of decentralized micro/mini hydropower schemes.

Map: River system in Attapeu Province

3. Development of Micro Hydro- Some Experiences of AEPC in Nepal

3.1 The Micro Hydro and its Working Principle in a Simplistic Way

A Micro hydro system is a complete system of various components of micro hydropower project that is required for the end-user to get energy (electricity) services. The micro hydro system components include:-

1. Diversion structure (normally made locally in the stream to divert water to the proposed intake,
2. Intake structure (to channel in the required discharge)
3. Canal /waterway for water conveyance (includes canal, gravel trap, de-sanding basin, cross-drainage structures, spillways etc)
4. Forebay (a small pond at the end of the canal from where the water enters into the penstock)

5. Penstocks Pipes (generally steel pipes but could be HDPE pipes also, that take the water from forebay tank to the turbine, laid along the drop from forebay tank to the turbine in power house)
6. Power House (Power generating and governing equipment are housed in power house. They include turbine, generator, governing systems, safety equipments and sometimes agro-processing units also)
7. Tailrace Canal (This canal is meant for conveying the outlet water from turbine to be disposed in the nearby stream)
8. Overflow/spillways (This structure is made just beside the forebay tank to dispose the water safely when the power plant is in non-operating condition)
9. Transmission /distribution systems (the power generated is normally transmitted through the overhead transmission lines, 400 volts, to the villages. Requires ACSR conductors, insulators, stay sets, electric poles etc. When the village lies too far from the power house, in that case, transformers are used).

3.2 The Operating Systems

The water from the stream is channeled through a simple intake (to regulate water) into the conveyance canal (normally open channel) up to the forebay basin. The forebay basin is located upstream of the power house from where the water enters into the penstocks (generally steel pipes) for pressure flow to eventually hit the turbine blades. The mechanical power thus produced is converted into electric power through the use of generators, which is connected to the turbine shaft either directly or with the use of belts. Unlike in large hydropower systems, the flow is not regulated as per consumption of power but is constant. Thus the load is regulated with the use of electronic load controllers. When there is less power utilization in the villages, in that case the unused power is dumped in the ballast tanks that house electric heaters. The generated power is transmitted to the villages through transmission/distribution system consisting of electric poles, wires and related accessories.

3.3 The Micro Hydro Electric Power

The generated electric power is off-grid (decentralized, renewable based on water resources) to benefit directly the local village people (or small town also) which are far off from the national grid systems. Thus, the power plant needs to be managed and operated by the local beneficiary community people themselves that leads to ownership development, sustainability and social integrity amongst beneficiaries. The electric power could be utilized for running small businesses and enterprises in the locality. If the power is not sufficient to carry out all the works at a time, then the running of the enterprises / industries could be done during off-peak hours (night and day time). For this, the beneficiary community people need to work out plant

utilization and business plans. The community mobilization process educates and empowers them to carry out all the activities viz. planning, implementation, installation of plant, operation and management, and end-use promotion. Various aspects like gender, social inclusion and environment are also taken into account during the community mobilization process.

3.4 The Development of MH Concept to Commissioning in Nepal

The development of the MH system takes the following process:

- It starts normally from the placement of request for potential beneficiaries to the district level institutions of the two programs- the District Energy and Environment Sections (DEES) of the respective District Development Committees or the Rural, Renewable Energy Service Centers (RRESC), the local NGOs supported by AEPC/ESAP.
- The pre-feasibility study is conducted by these district level institutions to assess the technical and financial viability.
- If the project is found feasible, the beneficiaries (who would be the potential developers of the systems) are supported to the conduct feasibility studies by AEPC pre-qualified private consulting firms.
- The consulting firms prepare the Detail Project Report (DPR) that encompasses the technical, financial, environmental and social aspects and submit it to the Technical Review Committee (TRC) of AEPC for approval of the report.
- The TRC scrutinizes the report through all the above mentioned parameters prior to approving the project.
- This Technical Review Committee is also mandated to approve the amount of government subsidy which is about 50% of the total project cost.
- The community proceeds towards the actual implementation of the MH scheme by making contractual agreements with one of the pre-qualified prospective MH suppliers/ installer companies for supply and installation of electro-hydro mechanical equipment and commissioning.
- The community people also get involved in the construction of the waterway and other civil works.
- The district level institutions, either DEESs or RRESCs support and facilitate the community members during the entire process of implementation.
- Prior to the kick-start of the field level implementation, the community people/ developer acquire the water use right, land use right from the concerned agencies, persons and complete the mobilization of the remaining resources other than the subsidy amount, which is provided by the AEPC.

- The beneficiary communities normally provide all the unskilled labour in the form of voluntary labour including transportation of the electro-hydro mechanical equipment where necessary.
- The installation of generating equipment and erection of transmission /distribution line is carried out by the contracted supplier/installer company, along with the support from beneficiaries and monitoring and supervision from DEES /RRESC technical personnel.
- The *Testing and Commissioning* of the scheme is carried out by the supplier /installer company following prescribed norms and procedures in the presence of all the concerned stakeholders, normally the AEPC /DEES/RRESC representative, representative from local bodies, beneficiary community and other partners.
- Within one year from the date of commissioning, the *Power Output Test and Household Verification* is conducted through pre-qualified Inspectors to ascertain the power output and household connected to mini-grid as the subsidy is linked to the households served and kW generated.

3.5 Key Elements for the Success of MH-The AEPC Experience

The micro hydropower scheme is a system of multidisciplinary functionality that needs to be taken care of for the success and sustainability. The most important aspects include technical, social, environmental, financial and institutional. In Nepal, the MH technology is considered an indigenous technology, evolved from the traditional water wheels, although most of the electro-hydro-mechanical equipments are manufactured by different companies outside of the country also.

The success of MH, like any other infrastructural works, lies in the technical soundness of the system installed, which makes the primary base for the smooth operation and management of the plant. Within the technical aspect, the site planning of MH, that is the identification of best suitable locations of MH components viz. intake and waterway, forebay, spillway, penstock profile and location of power house, disposal of tail water and the route of transmission line to the villages plays the key role for efficient and cost-effective design and implementation leading to minimal repair and maintenance costs after installations. The site planning is an iterative process that demands vigorous exercise from well experienced technical personnel and participatory views and ideas from the potential beneficiary communities as it is always a challenging task to find well configured components of MH systems. The site planning, which is some sort of a preliminary survey, lays the foundation for the conduct of the feasibility studies and detail survey works. The detail feasibility study holds immense importance as it provides the final shape to the MH project, in terms of technical, financial, institutional and operation and management. Design optimization, participatory planning and implementation remain the

core for MH systems development; however, without regular, systemic and effective provision of technical input and supervision, one cannot expect the installation of a sound and durable MH system.

The environmental aspects are taken care of through the conduction of a simple Environmental Impact Assessment study, though legally, it is not mandatory for MH systems development. The mitigation measures mostly include the bio-engineering, provision of gabion for slope retaining structures, 'gully' protection works that could be carried out through the utilization of local resources and skills.

The social aspects seem quite sensitive during the implementation of MH scheme as the provision of equity in the form of labour and cash as well as equitable benefit sharing are complex tasks. Moreover, the creation of awareness amongst the beneficiaries, mainstreaming of all the potential beneficiaries in the development process, promotion of local governance systems for transparency and social justice are deemed quite imperative for the long-term functionality and overall sustainability of the systems. To address the social issues and also help build social capital for effective mobilization of the community people in the development process, launching of location specific 'Social Mobilization' package is highly desirable.

Amongst the various institutions required for the smooth planning, implementation, operation, management and maintenance of the systems at all levels viz. central, district/provincial and local level, the key grass-roots institutions need to be constituted and strengthened for the smooth implementation of the project and management of the plant. Constitution of Users Group /Committee encompassing representatives from diverse strata of beneficiaries (gender, economic condition, geographic locations, ethnicity etc), formation of local fund like MH Fund are the basic institutions suggested at the community level. Formation of MH cooperative would be an ideal institution for development and operation and management of MH systems. However, for the sectoral development of the MH in any country, various institutions at all levels are a must.

The financial viability is a must for the success and sustainability of the MH systems. Technically, MH might be feasible when there is water source for power generation and village for electrification, however, the cost of the scheme to be developed remains the decisive factor. In Nepalese context, the cost /kW should be normally below US$ 3,000 to be approved for implementation in view of financial viability and about 50% of this cost is met by the subsidy from GoN (AEPC). The remaining resources are mobilized from the local bodies, financial institutions and the beneficiary community in the form of voluntary labour and even some cash in some circumstances. All the funds are deposited in a basket fund operationalized by the community people themselves. Once the system is installed, the community people fix the electricity tariff to meet the operational cost, cost for debt servicing and future replenishment.

The financial viability of MH scheme and the enhancement of the livelihood of the community people are intertwined. The more the people would be instrumental to utilize the generated power through the establishment of multifarious productive end-uses, the more the avenues for revenue generation and concomitantly the access to various services by the people to the path of enhanced livelihood. There is a need for policy to support the community people financially and technically for the establishment of electricity-based end-uses /enterprises.

4. Methodology

The methodology applied for the pilot testing of site included different steps and activities, specifically the pre-testing (preparatory) activities in Nepal and field works in Attapeu. The pre-testing/preparatory works included works ranging from desk study to preparation of sensitizing materials to prospective communities, preparation of power point presentation to district /provincial and programme officials in Attapeu on MH development, power point presentation on community mobilization and resource mobilization, preparation of formats for conducting site investigation (site planning) and development of related questionnaires.

The on-site testing works included mainly the field visits for site investigation/planning (technical works related to flow assessment, identification of location for different components of MH, assessment of community's needs, capacity, perception etc, assessment of the energy requirement and use, accessibility and ease in implementation, legal and institutional frameworks and the like). The field work was also meant for participatory discussions /interaction with the community people with the objective of elucidating them about the technology and acquiring relevant information on energy use pattern, local resources, community's socio-economic status, local institutions and infrastructural development etc. For the purpose, semi-structured interviews with the prospective beneficiaries and key informants were also organized. The works also included discussions /interaction programme with provincial and central government personnel of Lao PDR associated with renewable energy systems development with the objective of acquiring the views from GoL and plans on MH development, status of institutional capacities and policy frameworks.

In the end, a detailed report for way forward with regard to MH pilot demonstration scheme implementation as the final output has been aimed.

5. Conceptual Framework

The preliminary assessment done through the desk studies and field visit showed high prospects for the installations of numerous micro/mini hydropower systems in Attapeu province and other areas of the Lao PDR, mainly in consideration of the hilly terrain, location of settlements far from national electricity grid systems, need for modern form of energy (electricity) to fulfill basic rural energy needs and existence of numerous streams and rivulets suitable for harnessing to produce micro hydropower.

Although the MH is a proven robust technology, however, several parallel activities and capacity building measures need to be conducted for the long-term sustainability of the MH systems. The first and the foremost importance lies in the assessment of the technical feasibility that takes into account the soundness of different technical parameters that could result in system simplicity, cost optimization and future ease in repair and maintenance. Along with the technical works viz. pre/ detail-feasibility study, MH implementation /installation, the community people need to undergo through some sort of social mobilization process with the objective of organizing community people, raising awareness and familiarity of the technology and assisting/supporting the beneficiary community people to develop future plan of actions on implementation and expansion of services and benefit sharing. Through this process, a MH cooperative or simply a Users' Committee with their own MH Development Fund could be constituted to forge the activities related to demonstration scheme implementation.

The Rural Livelihood Improvement Programme (RLIP) needs to play the guiding, supporting and facilitating roles in all events of project cycle for the implementation of the project (pre-, during and post-implementation). Capacity and needs assessment of the community people with the view of harnessing their potentials and enhancing the latent skills needs to be carried out, specially for installation, repair and maintenance and management of the systems and promotion of multifarious enterprises besides forging activities that pertain to empowerment and mainstreaming of vulnerable communities, management of local environment and engagement of community people in feasible income generating activities such that the pilot demonstration scheme is implemented encompassing some sort of a holistic approach to development.

The development of MH should also be viewed with the possible integration of MH with irrigation, fishery and river training and flood control. Resources and supports from different line agencies could be mobilized by the responsible programme implementer /facilitator (RLIP) to carry out various other associated activities like bio-engineering, catchment area development, road /trail improvement and literacy programs.

During the installation process, the selected persons to work as MH plant Operators /Managers should be provided thorough on-the-job training. Prior commissioning of the plant, the villagers need to be provided awareness training on safety of electricity use, training on tariff fixation and business plan development. The whole process need desirably to go within the framework of specifically designed *Community Mobilization Process*.

The end-use promotion and enterprise development play crucial role in the livelihood enhancement, revenue generation for MH system and socio-economic transformation at the community level with the anticipated access by the community members to information and communication technologies, use of modern household appliances and extra hours for work and entertainment, especially during evening and night.

The key activities that need to be carried out at the community level (***Village Entry to Village Exit***) are listed below.

- Pilot testing of site (assessment of potentiality and exploration/investigation of potential MH piloting site, preparation of conceptual framework for way forward
- Conduct of detailed feasibility study of MH site(s)
- Preparation of ground works and associated activities
    - -Community mobilization process
    - -Formation of Users' Committee /MH Cooperative
    - -Acquisition of water and land use right
    - -Mobilization of financial resources (by the project)
    - -Capacity needs assessment and conduction of trainings and other capacity enhancement activities
    - -Engagement of community people in socio-economic activities

- Initiation of MH Implementation
    - -Construction of waterway
    - -Placement of order for E/M equipment including installation
    - -Construction or other civil works
    - -Transportation of equipment and installation works
    - -Testing and Commissioning
- Post-Implementation Works
    - -Conduction of safety classes, tariff fixation, fixation of rules and regulations
    - -Bio-engineering, catchment area development and other environmental works
    - -Business plan development and end-use promotion
    - -Institutionalization of the systems

(Please refer to Annex 3- Sequential activities for implementation of MH activities for more details.)

6. Description of Pilot Testing Site

Mainly two villages were visited with the objective of exploring the possibilities of developing the pilot micro hydropower demonstration scheme. The first site visited was in Darkanath area to assess the possibility of development of micro/mini hydropower plant for electrifying the Darkanath village and Jalernxai village. The Darkanath village is a clustered village with some 74 households and the Jalernxai village has some 91 households. The distance between the two villages is about 2 km.

6.1 The Darkanath and Jalernxai Village

The **Darkanath** is a village in Xanxai district which has 74 households built densely on the lap of hill slope. The GPS positioning of the village is 15^{o} 08' 09" North and 107^{o} 05' 21.7" East with altitude of 793 m amsl. The male population is 198 and the female population is 249. It was reported that 5 more households are added every year. With regard to village level institutions, there are three primary schools and four health-related institutions. Agriculture is the main occupation and upland rice is the main crop. Animal husbandry is the second business in the village. Coffee farming as cash crop has good prospects, which could be noticed with growing plantations. Fishing is extensively done in rivers and streams around the villages. The village could be reached by a fair weather road from Jalernxai, which lies along the main district road currently under improvement. The main river in the area is the So and the Sou that later form Nam Sou when converged just downstream of the Darkanath village.

The **Jalernxai** village falls within Xanxai district with 91 households. About five households are added every year. The village is located in a small valley and is seen as an emerging market place. The GPS locates the village with 15^{o} 08' 10" North, 107o 05" 22" East and 801 meters above mean sea level. The male population is 264 and the female population is 287. With regard to institutions, it has one dispensary, two midwifes, five primary and three lower secondary schools. Like in Darkanath village, agriculture, mainly upland rice cultivation, animal husbandry and fishing are the main occupation of the people. Coffee plantation as cash crop is getting increasingly practiced. The road that leads to Jalernxai from Attapeu is about 68 km long out of which 28 km is black-topped and 40 km remains fair weather.

6.2 Site Planning / Investigation for MH Development

As the two villages-Darkanath and Jalernxai- are located about 2 km apart having cultural, geographic, socio-economic similarities, the planning for MH development was carried out with the objective of electrifying the two villages with a single MH plant. The source of water for the proposed scheme is the Nam Sou discharge of which was assessed to be around 7 m^3 / second (September 12, 2010) through observation. Through the interaction with the community people, it was concluded that there exists at least about 25 % of this flow even during the driest month of the year (April), thus about 2 m^3/second of flow has been considered as the minimum dry flow. The river was not gauged and the measurement was not possible due to high flow in the river (monsoon season). Just downstream of the Darkanath village, there are three water falls in the Nam Sou river located within a distance of some 300 meters. The first fall is about 1.5 m high, the second fall is about 5 meters high and the third fall downstream is about 6 to 7 meters high. The intake has been identified just upstream of the 1st water fall of the Nam Sou river on the right bank of the river.

The GPS location of intake is 15^o 08' 33" North, 107^o 05' 33" East and elevation of 782 meters amsl. The type of intake proposed is masonry made side intake with orifice having the provision of course trash racks and regulating gates. As the natural rock bed is available working as a weir, no constructional weir to raise the water level has been proposed, as this would simplify the design and reduce the cost considerably leading to decrease in construction time at the same time. A de-silting basing has been proposed just downstream of the intake at chainage 0+ 025 meters from intake. The conveyance system proposed is open canal, cement masonry lined, to convey a minimum discharge of 1 m^3 / second. The length of the conveyance system (open lined channel) would come to around 400 meters. The power house location has been proposed on the right bank side of the Nam Sou, found relatively flat and sufficient for construction and safe from land-slides and flash-floods through preliminary

Picture: MH site planning in Nam Sou River

assessments. The GPS location of the proposed power house site is 15^{o} 08' 30" North, 107^{o} 05' 14.5" East and elevation of 764 m amsl. Roughly taking into account the head losses during conveyance and others, a 'head' of 16 meters could be easily obtained for the scheme. At the end of the channel and just above of the power house location, an open forebay basin would be constructed to facilitate the pressure flow of the water through steel penstock pipes. The penstock alignment seems good with ideal slope with length of about 36 meters (about 2:1, H:V). During the discussion with the beneficiary community people, district and provincial government officials and RLIP staff and others as well as in consideration of present and future energy demand, the scheme is preliminarily proposed to generate some **100 kW** of electric power to electrify some 165 households in Darkanath and Jalernxai as well as provide assured electric power for running various agro and other commercial businesses in the locality, especially in Jalernxai village. With the 16 meters of 'head' (net) and considering the overall system efficiency of about 60%, the required discharge for power generation would be around 1,000 litre per second (1 m^3 /second), just about half the assessed dry stream flow.

The proposed transmission/distribution line is low voltage (400 volts) overhead lines using ACSR conductors tensioned in steel/pre-stressed RCC poles, which seem to be readily available in Attapeu province. The length of transmission/distribution line from proposed power house location to Darkanath would come around 1 km where as the length of transmission line from proposed power house to Jalernxai is estimated to be around 2 km, thus no transformers need to be proposed to reduce cost, optimize design and facilitate ease in construction and maintenance.

Each household and enterprise would install energy meters and the billing would be done based on the actual energy used. However, the tariff would be fixed by the beneficiary communities taking into consideration the management structure, future system expansion, repair and maintenance and future replenishment cost.

The load governing system proposed is the electronic load controller with the provision of ballast heaters (immersed in water) to dump the un-used load. Necessary protection systems (MCCB, earthing system, cut-outs, switches, lightning arrestors etc) would be provisioned for the system safety.

The proposed electricity use in households besides lighting would be as follows:

Household use: Electric fan, micro wave, kitchen grinders, mixers, TVs, computers etc

There seems huge prospects for the promotion of end-uses, the key to livelihoods promotion, drudgery reduction, value addition to local produce and local employment generation that

ultimately leads to MH sustainability. Besides the running of agro-businesses and furniture industry, some semi-large businesses could be run in the community like the stone crushing industry, brick making and lift irrigation systems. Both off-farm and on-farm employment could also be generated with the establishment of these enterprises, end-uses. There are already agro-processing mill and rural carpentry running with diesel powered generators in Jalernxai.

Further, the telecommunication tower in Jalernxai is also being powered by diesel generator. There might be prospect to run stone crushing industry in the locality in view of abundance of power, need for growing construction business (houses, roads, irrigation canals etc). Further the up-lands could be irrigated with the use of water lifting pumps as there is sufficient water and power for the purpose.

Probable End-use, Enterprise: Agro processing (rice huller, grinder), coffee processing, drying, saw mill, metal fabrication, vehicle repair and maintenance, high vision hall (Jalernxai), telecommunication tower, schools and health post (computer, refrigeration), poultry farming, stone crushing, rural distillery, ice-cream making, lift irrigation etc.

Salient Features of the Nam Sou Micro/ Mini Hydropower Demonstration Scheme

Water Source	:Nam Sou
Discharge Considered	:~1 M^3 /sec
Head Available	:~ 16 meters
Power Output	:~ 100 kW (overall system efficiency ~60 %)
Beneficiary Households	: 164 (Darkanath-74 and Jalernxai-91)
Accessibility	:Fair-weather district road
Intake type	:Natural side intake with orifice
Length of Power Canal & type	: 400 meters, stone masonry lines, open channel
Penstock	: Mild steel, ~ 36 meter in length, rested on support piers and anchor blocks
Load Centers	:Darkanath and Jalernxai in Xanxai district
Transmission Line	: Low voltage (400 volts) overhead lines, power house to Jalernxai- 2 km

End-uses	:Lighting, agro-processing, rural bakery, saw mills & furniture, mechanical workshop, stone crushing, lift irrigation, information and communication center, poultry, coffee drying and processing, local distillery etc

6.3 Discussion with the Community People

Discussions and interaction were held with the community people together with District Director and personnel and professionals from RLIP, GTZ and some others on September 14, 2010. The discussion was focused on elucidation about the possibility of development of MH in the area, the power requirement and the utilization of the power to maximize the benefits. People queried about the power sufficiency for lighting, running other household appliances like TVs, computers, electric grinders, micro ovens, fans and refrigerators. Further, the community people's queries about the establishment of other productive end-uses were answered by explaining in detail about the prospects and the power requirements. The productive end-uses and enterprises are advised to run during off-peak hours (day and night time) when there is no need of power for lighting and running kitchen appliances. The community people also asked about the modality and schedule of project implementation and the responsibilities to be fulfilled by the communities. The community was briefed about the possibility for conduct of the detailed feasibility study after the monsoon season and the community people's participation/ engagement could be made in carrying out local level works such as earth excavation, mobilization of local construction materials, local transportation and the like during the course of project implementation. In the discussion program, people from both communities- Darkanath and Jalernxai participated quite actively. The District Director actively participated not only in the site exploration and investigation exercise, but also helped elaborate the program and district support to the community people. The RLIP Programme Manager Mr. Soulichanh Phonekeo and other programme personnel also participated actively and the Programme Manager encouragingly took the ownership for the way forward of the initiative.

6.4 General Observation and Comments about the Nam Sou Micro/Mini Hydropower Project

With the preliminary survey and study, the MH scheme seems one of the very attractive projects in view of the need for energy and potentiality for development of some 100 kW of power for 164 households, flow sufficiency, existence of natural weir and intake, short canal length (~ 400 meters, alignment in stable mild hill slope), low voltage overhead transmission line within 2 km

distance, ideal penstock alignment, safe and stable location for power house, availability of local construction materials namely stone aggregate, sand, stone, timber etc and road access. These features would lead to considerable reduction in cost provided detailed feasibility study is carried out within the aforementioned spirit and in addition; technical supervision and monitoring are effective. The power, especially during day time could be utilized for various multifarious end-use promotions, with some special end-uses like stone crushing (making stone aggregates), lift irrigation, coffee drying/processing, saw mill and running entertainment and communication centers. Promotion of more end-uses could be expected in the forthcoming years with the increase in awareness in people, growing market prospects and improvement in road condition.

6.5 The Nam Ngong Village Community and Development of MH

The Nam Ngong is a newly developed village in Nam Ngong valley which is fed by the Nam Ngong river. The whole Nam Ngong cluster has some 406 households with population of 2,359 persons. From within the entire cluster, some five villages lying in different hill slopes and river basins are being shifted to Nam Ngong village at present. The five villages (Nam Ngong cluster) and the households in the villages are as follows.

Darker	22 Households
Darknong	33 Households
Done Chan	49 Households
Dark Leum	36 Households
Dark Bang	55 Households
Total	**195 Households**

The Government of Lao PDR has plans to shift the families located in the above cluster in the Nam Ngong valley where it aims to develop the area in a planned way with all required infrastructures and institutions. Thus far, some 170 families (households) have already been shifted to the valley. The GPS locates the Nam Ngong village with 15^{o} 12' 05" North, 107^{o} 08' 23" East and elevation of 870 meter above mean sea level.

The Nam Ngong village lies in a very strategic location from where the connectivity to Vietnam is very important. Besides, the GoL is giving high priority for the development of this valley and is forging actions to develop it as a local hub with all the required supports and services with a view of settling all the households of the whole cluster in the valley. ***So the provision of electricity in the area is of very high importance***. The Nam Ngong stream passes through the middle of the valley and is the source for irrigation and other household use.

6.6 Site Investigation /Exploration for MH Development

It was highly desirable to have a feasible MH site right in the Nam Ngong valley, where the settlement is located. But unfortunately, the river gradient within its course in the valley is quite mild thereby necessitating for the construction of long canal even to have few meters of 'head'. Thus, the team headed by District Director along with RLIP and GTZ staff and community members made a trek upstream to locate a suitable site for MH. A relatively attractive site in consideration of the river gradient was identified beside the local bamboo-wooden bridge where the Nam Ngong flows with rapids and falls. However, the shortcoming of this site is that the flow remains quite low during dry season as per the participatory discussions held with the local community people. One of the reasons for low flow is that the other tributaries of Nam Ngong converge with the main river downstream from this point in the valley. The GPS location of the identified intake area is 15^{o} 13' 44" North, 107o 09' 08" East with elevation of 949 meters amsl.

The stream flow of the Nam Ngong river was measured with the Area-Velocity method on September 14, 2010 that gives the river flow of about 2.5 M^3/second. However, the local knowledge and experience suggest that only 25% of this flow is retained during dry season. Thus, the exact site planning for MH (location of MH components like intake, canal alignment, forebay, power house etc) could not be located along the Nam Ngong river. However, it is highly suggested / recommended to once again explore the possibility of MH site identification during dry season within the stretch between the identified intake and the mid of the Nam Ngong valley when a technical team might come to conduct detailed survey in Nam Sou river for Darkanath and Jalernxai.

As it was found quite necessary to provide electricity services in the Nam Ngong valley in view of the planned settlement development by the GoL, exercise to investigate other possible sites was done, especially by utilizing the water from Nam Ang river. The Nam Ang river lies about 5 km away from the Nam Ngong valley, however, the flow in the river is found more than that in Nam Ngong river, about 5 M3/second (about double than in Nam Ngong river). Thus, taking into consideration the community's views and experiences, the dry flow in Nam Ang river could have more than 1 M^3/second during dry season. A suitable river stretch was tried to be located by having reconnaissance survey along the Nam Ang river banks to assess the river gradient, permanency in course and bank stability. Through the preliminary assessment, the intake should be identified around the area with the bamboo bridge having GPS of 15^{o} 12' 10" North, 107^{o} 07' 10" East and elevation of 882 meters amsl. Like in the Nam Ngong river, the Nam Ang river also has gentle gradient, only the advantage in having twice the discharge than in Nam Ngong river and disadvantage of being too far from the load center-the Nam Ngong valley. In the aforementioned backdrop, it is highly suggested and recommended to explore the site for MH development with very good site planning in Nam Ngong valley using the Nam Ngong river source and

Nam Ang river source by well experienced technical personnel and to carry out comparative analysis between the two most feasible sites in the two river basins to choose the best one. Only after the exploration and analysis of that, it is recommended to proceed further to conduct the detailed feasibility study for providing electricity in Nam Ngong valley. As the exact site planning could not be carried out for the Nam Ngong valley, the participatory discussion in length could not be organized, however, the community members fully and actively participated during flow measurement, site exploration and provision of relevant information and views.

The micro hydro electricity is quite required in Nam Ngong valley and any one of the rivers need to be exploited for power generation irrespective of relatively higher costs as the extension of national grid is too remote a possibility. The site along the Nam Ngong river might necessitate the construction of relatively long power canal but it could be integrated with irrigation system. It was learnt from Irrigation Officer in Attapeu that the office is also taking initiatives for the construction of irrigation canal in the Nam Ngong valley. Development of MH by harnessing the water from Nam Ang river leads to high cost for transmission/distribution line. However, looking positively, pursuing the light at the end of the tunnel, a good micro hydro site could definitely be identified for Nam Ngong valley electrification.

The prospects for end-use development in Nam Ngong valley are tremendous as it is being developed to a market center. Electricity is required for all industrial, commercial, academic and health related activities besides household activities.

6.7 Discussions of Pilot Testing Findings with Provincial Government Personnel

A discussion and sharing of pilot testing findings programme was organized on September 15, 2010 by RLIP and Provincial Government of Attapeu which was presided by Provincial Vice Governor Mr. Khenethong. The participants were programme personnel from RLIP, GTZ and line Ministry officials (please see list of participants in Annex). The discussion programme proceeded with the welcome and background note by RLIP Programme Manager Mr. Soulichanh Phonekeo followed by Study Team Leader and Executive Director of AEPC, Nepal, Dr. Narayan Prasad Chaulagain, who made elaborate power point presentations on the objective and findings of the study and the suggested the way forward. During the participatory discussion program, the Team Leader highlighted about various aspects of MH development in Attapeu and the technicalities about the surveyed site. The Vice Governor queried about the actual implementation schedule, tentative cost for the project(s) and the procedures to be followed, which was responded by the Team Leader. The study Technical Officer made a picture presentation on power point about the MH implementation cycle to make the process easily understood with reference to MH development by AEPC in Nepal. The Vice Governor thanked

the study team and all the participants for their active participation in the discussion program and expressed his sincere commitment to support by whatever means for forging the actual implementation of the schemes.

6.8 Visit to Ministry of Energy and Mines, Vientiane, Lao PDR

A visit was made to the Ministry of Energy and Mines, Department of Electricity in Vientiane on September 16, 2010. Mr. Khamso Kouphokham, Director of Executive Planning Division was contacted. Discussion was mainly focused on the plans of the GoL on rural electrification, particularly in rural areas including Attapeu uplands. It was informed that the GoL has been giving priority to the development of decentralized micro hydro systems to electrify remote rural areas and has been developing suitable plans and policies for the same. Mr. Kouphokham was very much encouraged to know about the pilot testing programme in Attapeu highlands and has expressed to provide the necessary support required from his side.

7. Pilot Testing Proceedings

The pilot testing activities included the preparatory works in Kathmandu, Nepal that included the preparation of necessary guidelines, formats and conceptual frame for the testing activities. The field testing lasted from September 11 to September 14, 2010 that mainly involved in site investigation/exploration for MH development, interaction with community people, district governments, programme officials, information collection from all concerned that were directly linked to the future installation of the MH systems in Attapeu.

The site planning, which is some sort of pre-feasibility study was completed in Nam Sou MH Demonstration Project for Darkanath and Jalernxai villages, paving way for the conduct of detailed feasibility study immediately after the end of monsoon season, possibly in November/ December, 2010. However, in Nam Ngong village, the exact site identification work is still to be done. However, it could be concluded that a suitable MH site could be located, albeit with thorough exercise, along the banks of either the Nam Ngong river or the Nam Ang river, following comparative analysis of suitability for MH installations. Discussions were held with RLIP officials including the Program Manager on various aspects of program implementations- ranging from site identification to constructions, installations and commissioning including prospects for mobilizing necessary resources. It would be wise and pragmatic to implement two MH schemes at the same time to have implementation efficiency if the required resources are not a problem (Darkanath and Jalernxai area and Nam Ngong valley).

It is highly suggested to develop a simple 'community mobilization package' and its implementation to organize the local people and sensitize them as well as promote local governance. With the conduction of the detailed feasibility study which would include site survey, system design with working drawings, preparation of bill of quantities and cost estimation, financial analysis and operation and management modality, the actual field level implementation could be initiated provided the mobilization of necessary resources are properly dealt with. The implementation works follow the immediate start of construction of waterway by qualified contractors as construction by local people is not assessed that feasible in view of low economic condition of the people, low skills for construction etc. However, the local people's participation should be sought in mobilizing local construction materials, which actually instills sense of ownership amongst the beneficiary community people and also empowers them gradually. The works of electro-hydro-mechanical works including erection of transmission/distribution lines could be entrusted to qualified contractors/builders through competitive bidding to a single party or a number of parties depending upon the situation. All these actions and activities are mentioned here with the positive assumption that the MH projects would proceed further for their materialization.

8. The Rural Livelihood Improvement Project (RLIP) and its Role for Pilot Installation of MH

IFAD began its operations in Lao PDR in 1980 to support the Lao Government in implementing the National Growth and Poverty Eradication Strategy (NGPES) and achieving the Millennium Development Goals. It has the objectives of promoting economic growth, sustainable livelihoods and food security among poor people particularly among vulnerable and marginalized groups in upland areas. It applies the community-based development approach to strengthen the capacities of the poor communities and their organizations to manage resources and services.

Its priorities are:

i) introducing sustainable agricultural alternatives to shifting cultivation in the uplands and resolving associated land allocation issues ii) providing access to productive resources, improved technology and financial services iii) promoting market access and agricultural development led by the private sector and iv) building the capacity of institutions and contributing to policies to support rural development through the process of decentralization and promotion of gender sensitive initiatives.

The IFAD-supported Rural Livelihoods Improvement Programme in Attapeu is being implemented in three districts viz. Phuvong, Saysettha and Xansai. The districts are amongst the poorest in the country, and the programme is working with 93 of the 113 villages in the three districts. Poor infrastructure is one of the causes of extreme poverty, and the programme is helping communities and the government build community infrastructure in order to improve people's livelihoods and living standards. The RLIP works towards the sustained improvement of livelihoods among poor households and communities. It focuses on the poor and marginalized groups in poor villages in the uplands and resettled or merged villages in the low lands. Its main objectives are to help ensure food security, basic education, health services and road access. The main activities include amongst others the strengthening village institutions, introducing new farming technologies and crop diversification and improving livestock, supporting the development of off-farm income generation, small enterprises and market linkages, setting up village-based savings and credit institutions and introducing measures for natural resource management (including renewable energy promotion).

The programme was launched in June 2006 and has already made significant progress developing a variety of local infrastructures.

Education
The programme helped build five primary schools and repaired six old schools. A total of 450 students got enrolled in the new schools and about 300 continue to attend the rehabilitated schools. Total enrolment increased by almost 20 per cent. The schools targeted by the programme are being managed by the parent association in the villages

Health
Before the programme was launched, people had to travel a long distance to access primary health care. The programme supported the construction of three dispensaries during its first year of implementation. As a result, 1,082 families (5,702 people) now have access to health services. The government provided the dispensaries with a drug revolving fund to purchase medicines. The programme plans to construct three more dispensaries – one in each district.

Potable water
Before IFAD's intervention, people in Attapeu used to drink water from the streams and shallow wells, which often resulted in health problems such as diarrhoea. Women also had to travel long distances to fetch water. The programme constructed 66 hand pumps in 22 villages. As a result, women have saved one to three hours per day by having hand pumps in their vicinity.

Hygiene
The programme helped construct 513 family toilets in ten villages of Phouvong and Saysettha districts. It provided families with toilet sheets, pipes and iron angles. The families receiving the toilets provided local material, such as sand and concrete, and labour for their construction. The Department of Health provided technical support and supervised the installation. The new toilets were built for individual households.

Roads

Before 2006, the only form of transportation for people living in many of the villages was on foot or by bicycle. The program has supported the construction of almost 70 kilometres of roads (four roads to date) that link villages within a district. The government financed the construction of a 4-kilometre road in order to connect two districts. In addition, IFAD has been collaborating with the World Food Programme (WFP) that provides food-for-work assistance to the people involved in constructing roads. Through the assistance, villagers constructed 4 kilometres of road and another 29 kilometers are under construction.

Community markets

The programme helped build four community markets in Hadsan, Makkheua, Tadseng and Viengxay villages and an urban market in Phouvong District. Programme participants provided 60 per cent of the total cost of the construction in the form of wood, sand, stones and labour.

The development of micro hydro systems could play catalytic role in transforming the socio-economic condition of the rural people, especially in the upland areas of the Province and contribute to meeting the Millennium Development Goals. The micro hydropower energy could be utilized to enhance crop productivity by means of implementing lift-irrigation systems in the uplands which are often deemed unfeasible through gravity flow systems. The energy could be utilized for value addition in various agricultural products. In the context, it is of high importance for RLIP to support for the infrastructural works in rural energy systems development, particularly the micro hydro systems.

9. Immediate Actions Suggested for IFAD, RLIP

The proposed pilot testing of the MH scheme is in the working area of RLIP, in the uplands of Xanxai district. The living condition of the people is quite pathetic despite the prevalence of rich natural resources-land, water and forests. The pilot testing study has found the huge prospects for the development of micro hydro systems that would not only bring electricity in the locality, which has no possibility for the national grid extension in the near foreseeable future but it could play a catalytic role in the overall socio-economic development of the community. The micro hydropower could also be instrumental in contributing towards meeting at least five MDGs related health, education, child mortality, environment, women and human poverty. The study conducted by Winrock International on the 'Contribution of Rural Energy in Meeting Millennium Development Goals, the REDP Practice' has revealed this fact. Further, the advent of electricity could support and boost agricultural production through raised awareness about new technologies, provision of irrigation (power canal and lift irrigation) and rural mechanization of farm activities. The RLIP is required to take the lead role and move towards supporting the community people in the up-lands for harnessing the precious natural resources- the water resource, to develop reliable renewable energy systems with the

auspicious aim of providing access to modern form of energy –the electricity to bring rapid and real change in the lives of the people in the locality.

In the backdrop, the RLIP, with support from IFAD and other donor communities as well as through the mobilization of internal programme resources, needs to take proactive steps to conduct detailed feasibility study for Nam Sou MH Demonstration Project and site planning in one of the river basins of Nam Ang or Nam Ngong leading to detail feasibility for Nam Ngong valley.

Further, it is also required for the programme and the District and the Provincial Governments to work for the mobilization of the required resources for the execution of the project soonest.

As it is going to be a pilot scheme in Attapeu uplands, it is highly recommended for IFAD, which has been supporting the implementation of the RLIP, to allot some resources for the new but encouraging initiative that would really bring huge changes in the lives of the extremely poor people. The IFAD and RLIP could also work on mobilizing resources from other donor agencies which are working in the promotion of renewable energy in Lao PDR for the purpose. Although the exact cost of the MH could be ascertained only after the conduct of the detailed feasibility study, however, in view of the river systems near to the villages, clustered settlement pattern, availability of local construction materials and road accessibility, the per kW cost does not seem to exceed US$ 5,000, which seems quite promising. It would be quite pragmatic to take the services of the same consultant team as far as possible to conduct the detailed feasibility study, at least of the two sites. To show the commitments, the present team is required to carry out the site planning for the Nam Ngon valley without any added cost. Activities and initiatives to organize and aware the beneficiary communities need to be started right after the conduct of the detailed feasibility studies.

10. Conclusions and Recommendations

The visit on the pilot testing of MH schemes in selected localities of Attapeu province is quite successful and effective in the sense that the initial assessment shows the Attapeu province to have possessed huge and bright prospects for the development of decentralized micro hydropower systems to boost the agriculture, support livelihood related activities, generate local employment and preserve local environment to ultimately lead to enhanced rural livelihoods.

The visited sites for piloting the micro hydropower demonstration scheme are deemed technically feasible and economically attractive in that the socio-economic situations in the high

uplands could be tremendously improved through the installations of the plants. As the proposed MH schemes are supposed to be implemented as pilot projects, due attention need to be paid in all cycles of project development such that the future projects will have strong messages for promotion and success as well as clarity and confidence for way forward. The support and enthusiasm of all the stakeholders for the development of the systems was found very high although the capacity of the concerned agencies and beneficiaries need to be enhanced.

It is recommended to facilitate the conduct of the detailed feasibility study immediately by well experienced consultants in the two communities. The support to the community for this endeavour by APRACA-FinPower, IFAD and RLIP seem quite crucial besides various other anticipated supports from district /provincial bodies. The successful completion of the detailed feasibility would bring a clearer picture about the projects viz. the size and design of schemes, implementation aspects, resource needs, capacity assessment and operation and management module besides planning of actions after the advent of electricity.

Side by side, it is highly recommended to take proactive actions in providing the financial resources for the implementation of the project(s) as there is no doubt about the viability of the project in the identified areas. The IFAD support through its existing project- the Rural Livelihood Improvement Project - would be extremely effective and instrumental to forge ahead the activities as the implementation of the MH schemes seem to meet the IFAD, RLIP programme objectives. Implementation of some sort of social mobilization package is also highly recommended in the programme communities. Being the pilot schemes in the province, the implementation activities, especially the technical ones are recommended to be monitored and supervised by experienced technical personnel, as the success of the schemes would pave the clear and fast ways for the rapid dissemination of the technology in other parts in the latter days.

Annex 1

Schedule of Pilot Testing

Date /Duration	Activities
September 09, 2010	Travel to Vientiane
September 10, 2010	Travel to Attapeu, Discussion with IFAD-RLIP officials
September 11 to September 15, 2010	Pilot Testing
September 15, 2010	Travel to Vientiane (in the evening)
September 16, 2010	Discussion in Ministry of Energy & Mines, Travel to Bangkok
September 17, 2010	Travel to Kathmandu
September 18- October 5, 2010	Preparation of pilot testing report
October 5, 2010	Submission of first draft of completion report to FinPower
October 5-20, 2010	Review and comments by FinPower
October 31, 2010	Submission of final output

Annex 2

List of Persons Contacted

Name	Position	Organization	Address	Tel. / Email
1. Mr. Soulichanh Phonekeo	Programme Director	RLIP	Xaisy village, Saysettha district, Attapeu	T: +856 36211884 M: +856 20 55521416 E: soulichanhp@yahoo.com
2. Mr. Vilaphonh Soutthalavong	Deputy Director	RLIP	Do	M:+856202901193 E: vilaphon@gmail.com
3. Mr Khenethong Sisouvong	Vice Governor	Attapeu Province		
4. Mr. Bounhieng	District Governor,		Xanxai district	
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9. Mr. Viengsamone Chittarath	Liiason Officer	Vientiane Liason Office, RLIP	Vientiane	M: +856 20 55517930
10. Mr. Vongphet Insina	Civil Engineer	RLIP	Xaisy village, Saysettha district, Attapeu	M: 856 20 2292228 E: pyinsina@yahoo.com
11. Mr. Soutuchai Sinlapa	Director of Agriculture	Attapeu Province		
12. Mr. Vandsady	Head of Office of Province	Attapeu Province		
13. Mr. Wauewalat	Director of water resources			
14. Mr. Nalai	Head of Electricity			
15. Mr. Saksavant	Head of section, planning & invest			
16. Mr.Thanousac	Director of Department of Planning & investment			
17. Mr. Somwang	Director of RLIP			
18. Mr. Somvang	Head of Energy & Mines			
19. Mr. Khankham	Head of Cluster	Nam Ngon		
20. Mr. Phouxay Kaisonsgna	Head of Irrigation Department			M: +856 20 2932994
21. Mr. Wan Xai	Deputy head of Cluster	Nam Ngon		
22. Mr. Eak	Village Head	Nam Ngon		
23. Mr. Inkham	Village Head	Jalernxai Village		
24. Mr. Thoard	Elder Union	Jalernxai Village		
25. Mr. Yeb	Head of group 1	Jalernxai Village		
26. Mr. Hikeo	Head of Youth Union	Jalernxai Village		
27. Mr. Bounkham	Village Secretary	Darkanard Village		
28. Mr. Bounyang	Deputy Village Secretary	Darkanard Village		
29. Mr.Bounkhent	Deputy Head of Village	Darkanard Village		
30. Mr. Bounsone	Deputy Cluster Secretary	Darkanard Village		
31. Mrs. Khuan	Head of Lao Women,s Union	Darkanard Village		

Annex 3

Rural Livelihood Improvement Project
Attapeu Province, Lao PDR
Sequential Activities for Implementation of Micro Hydro Systems

I. Pre-implementation Stage (Completion of Ground-works)

1.1 Social Mobilization

The first step towards the installation of the MH system is the initiation of some sort of social mobilization process. The social mobilization process aims at building up the capability of the community people to plan, implement, manage and operate the MH systems. Further, it also helps organize the community people to get organized and empowered towards meeting the common objectives. It is reminded that the ***MHUG, the Developer of the MH Scheme, conducts the Detailed Feasibility Study*** of the proposed MH scheme with the support and facilitation from the programme. The Micro Hydro User Group (MHUG) is formed upon the maturity of the individual Community Organizations (COs) under the Community Mobilization Process. A CO is considered to have matured, if it is capable to smoothly conduct meetings, make decisions in consensus and implement the decisions made, carry out periodic savings and credit scheme with least facilitation from the Community Mobilizer and upon the fulfillment of the conditions **(xx nos)** set forth in the Terms of Partnership (ToP).

1.2 Scheme Appraisal / Approval

Approval of the Project Proposal including subsidy, grants, loans (Detailed Project Reports that include Technical Report, Environment Assessment Report and Vulnerable Community Development Study Report) from the concerned agencies.

1.3 Land Acquisition

Voluntary acquisition of land in the prescribed format following prescribed procedures (See VCDP Study Guidelines, REDP-Nepal) from the land owners. Registration of the donated land in the name of the MHUG in Land Revenue /Registration Office. In case of public land, certification/ permission from the respective Village Committees /related government agency to be used for the installation of the proposed MH scheme.

1.4 Water Use Right

Registration in the Water Resource Committee or related body for obtaining water use right for the development of the proposed Micro Hydro Scheme.

1.5 Provincial /District Resource Mobilization

Mobilization (collection) of the committed fund from the respective agencies /bodies to the Community Energy (Micro Hydro) Fund.

1.6 Mobilisation of Community Equity

1.6.1 Equity in the Form of Local Cost

Written commitment and decisions of the MHUG's Mass Meeting for providing all kinds of voluntary labour required for the development of the MICRO HYDRO SCHEME.

1.6.2 Non-local Equity

Approval of loan from the financial institution or mobilization (collection) of cash from the MHUG members (or both in very few cases) to meet the deficit fund. To take loan from FIs, it is normally required to get the MH schemes registered.

1.7 Establishment of Grievance Redressal

Establishment of Grievance Redressal mechanism in every MHUG as per VCDP Guidelines.

Appointment of VC Focal Point

Selection of a VC Focal Point in each MHUG in order to sensitize and resolve VC issues.

2. Implementation Stage of Micro Hydro Scheme

The field level implementation of the Micro Hydro Scheme starts with the Handover of the Cheque, i.e, mobilization of subsidy/ grant to CEF upon completion of the aforementioned ground-works. The concerned MHUG is the developer of the MH; hence, responsible institutions to carry out the implementation of the proposed Micro Hydro Scheme through the resources from CEF. The RLIP programme supports the MHUG in the latter's endeavour through provision/facilitation of technical & financial supports besides other relevant inputs. The local

NGO selected by the programme to work as support organization (SO) is responsible for carrying out the community mobilization (CM) process & also supports the MHUG in their initiatives of all kinds.

2.1 Action Plans Preparation

Thorough discussion in the MHUG about the project implementation and preparation of Action Plans and Work Schedules, through the facilitation of SO and programme.

2.2 Quotation Collection

Collection of quotations (at least 3 quotations but desirably 1 dozen (min.) from the different suppliers/installers, desirably pre-qualified. For this, the MHUG might seek the support from RLIP programme and local institutions. Quotations could be sought by MHUG from prospective and pre-qualified suppliers in consideration of past work records, skilled manpower, practicality, timely delivery of equipment, commitment etc.

2.3 Analysis of Quotations

Analysis of the quotations received by the MHUG (in view of cost, timeframe for supply and installation etc.) with the support and facilitation by RLIP programme and SO.

2.4 Supplier's Selection

Selection of the competitive supplier/installer for the supply and installation of E/M equipment based upon the analysis of the quotations from the Mass Meeting.

2.5 Agreement between Supplier & MHUG

Agreement between the supplier and the MHUG regarding the supply and installation of the electro-mechanical equipment as well as testing and commissioning of MH plant. The Agreement should be made not contradicting the government’s policy and the RLIP programme’s implementation modalities/ practices.

2.6 Selection of MH Plant Operators and MH Plant Manager

Selection of MH Plant Operators and MH Plant Manager following the prescribed/ recommended selection procedures by MHUG / Mass Meeting with facilitation by SO and upon requirement by technical personnel. Verification of selected candidates in consideration of the

compliance of criteria and process followed. Two MH Plant Operators per MH scheme are desirable. Training (on-the-job) is to be provided by the programme. MHUG is needed to take commitment fee and commitment statement from selected candidates prior to participation in the training.

The training is provided by programme prior to the installation of the MH plant. Refresher training is provided by the programme to MH plant Operators and Managers normally after one year's of work experience.

2.7 Mobilization of Other Resources (Construction Materials & Laborers)

Collection and transportation of local construction materials, especially for carrying out the civil works, such as: sand, stone, aggregate, timber, slates, bamboo etc. and mobilization of local labourers for aforementioned works.

Purchasing and transportation of non-local construction materials required especially for civil works, such as: cement, steel bars, CGI sheets, steel structures & arrangement of skilled labourers as masons, carpenters etc. The amount in the CEF could be utilized for the purpose through the decision of the MHUG Working Committee, which should be endorsed by the MHUG's monthly Mass Meeting. (MHUG's Mass Meeting should be held at least once in a month as mentioned in program's CM process.) The DEES releases the requested amount by MHUG only with the verification of the work and allocated / required amount for the proposed works.

2.8 Construction of Civil works

Construction of civil structures, mainly the waterway, such as: intake and diversion works, desilting basin, spillways, forebay and overflow, headrace canal, etc. by the concerned MHUGs as per the design and specification mentioned in DPR and approved by programme. The programme would provide technical backstopping and other advisory supports/ facilitation to the MHUG. The program personnel closely monitor the implementation process and provide all the necessary supports /facilitation.

2.9 Transportation of E/M Equipment

Transportation of E/M equipment to the nearest road-head from the supplier's premise is done by MHUG using trucks/tractors. From road-head to the site, transportation is to be made through the mobilization of voluntary labour. Prior to the transportation of equipment,

verification of equipment is made by concerned MHUG members and technical personnel could assist the MHUG in verifying / testing (physical) of equipments.

2.10 Installation of E/M Equipment Erection of T/D Lines

Installation of E/M equipment and erection of T/D lines as per specification and drawings. Supervision and monitoring by programme personnel (technical) together with MHUG. Completion of house wiring and fixation of MCBs / meters by individual households & connection to lines. Completion of remaining civil works, mainly the construction of power house, forebay basin, overflow / spillway, support piers & anchor blocks and tailrace are done during the time of installation.

2.11 Test Operation & Commissioning

Test operation of the scheme, examination of the performance of each and every equipment/ component and immediate correction if any malfunctioning. Commissioning of the scheme following the prescribed procedures in the presence of all the stakeholders: investors/ partners/ facilitators & installer.

2.12 Public Audit and Formal Audit

Public audit should be carried out in the presence of the entire beneficiary community (Mass Meeting). The MHUG Working Committee members should present all the works carried out for the development of the systems in a systematic way as documented in the Measurement Book as against the proposed works mentioned in the Detailed Project Report. All the costs incurred for the mentioned works should be presented which needs to be approved and endorsed by the Mass Meeting. Formal audit of the Community Energy (MH) Fund should be carried out by a Government Certified Auditor at least once a year. All the audit reports should be submitted to all the stakeholders and development partners of the MH scheme.

2.13 Implementation of Environmental Activities

Approval of the environmental plans and their implementation by the MHUG (nursery establishment, plantation (community and private), bio-engineering and slope stabilization works, community forest management etc.) in line with the EA study of the scheme. Necessary input and facilitation by RLIP /Village /Provincial Committees.

2.14 Implementation of Vulnerable Community Development Plans (VCDP)

Implementation of activities pertaining to vulnerable community as suggested in the VCDS report. Support and facilitation by the programme and SO to the community.

Note: The activities related to environment and VC are carried out prior to, along with and after the completion of the MH scheme.

3. Post-Implementation Stage

3.1 Tariff Fixation and End-use Promotion

Assessment of the probable and possible end-uses that could be promoted in the foreseeable future, their locations, energy consumption and expected revenue by the MHUG. Assessment of the annual recurring costs and replenishment costs. Determination and fixation of appropriate tariff following standard *Tariff Fixation Guidelines* and introduction of necessary rules and regulations on the use of electricity by the MHUG. Conduct of safety classes to the community members. Facilitation and input from the programme and SO.

3.2 Power Output Verification and Household Confirmation

Verification of the output of the power of the scheme following the prescribed procedures. Final payment to CEF and subsequent payment from MHUG to the concerned supplier as per the signed agreement. Verification of beneficiary households. To be carried out within one year from the date of testing and commissioning of MH scheme by independent certified Power Output Test (POT) Inspector/ Technician.

3.3 Institutionalization and Strengthening of CEF (MH Fund)

Investment of end-use seed grant to prospective entrepreneurs from MHUG and agreement regarding the sale of energy, especially during the day time and night time enterprises also (rural bakery). Exploration of possibilities to diversify various end-use and maximize income. Collection of tariff (household lighting and enterprises) and income from other sources (provision of information to researchers, donations received, water use for irrigation, sale of aquatic products etc.). Allocation of fund for future replenishment and repayment of bank loan as well as system expansion.

3.4 Conduct of Skill Enhancement and Institutional Development Activities

Identification of need-based and resource-efficient training. Training on skill enhancement to carry out income-generating activities and institutional development training. Facilitation and support from program and SO. (These activities are carried out during all the stages of project implementation). It should be strategized to include maximum participants from community in training programs organized by other local level line agencies and programs.

3.5 Operation and Management

Introduction of rules and regulations for the operation of the systems. Provision of repair and maintenance fund and spare parts. Management and refresher training to the concerned persons (MHUG members, operators, managers). Fixation of salary and other benefits to MH staff. Conduct of regular meeting of MHUG Working/Management Committee and reporting to Mass Meeting. Evaluation of performance of systems, progresses, constraints and future course of actions.

3.6 Internalization of CM Process and Legal Entity

Registration of the MHUG/MicroHydro Scheme in a suitable/appropriate institution to have legal entity (MH cooperative, cottage industry, NGO, private company, etc.). Internalization of CM process by the community (The MH plant Manager desirably should take up the role of Community Mobilizer).

Annex 4

Rural Livelihood Improvement Project

Attapeu Province, Lao PDR

Pilot Testing of Micro Hydro Project, Attapeu, Lao PDR

Household Level Data Collection Format for Baseline Survey

Name of Interviewee : Name of Interviewer :

Province / District : Date :

Village Committee :

Ward # and Village :

General Household Information:

1. Name of Household Head :
2. Gender of Household Head :
3. Ethnic Group of Household Head :
4. Occupation :
   - Primary :
   - Secondary :
   - Tertiary :
5. Physical Features of House (Mark √ in appropriate type)

Storey	Roof Type	Walls	House Condition	Space	No. of Sheds	Other Features
One	Straw/ Khar	In mud floor	Newly built	Very spacious		
Two	Slate/Tile	In cement mortar	Old but renovated	Adequate		
Three	CGI Sheet	Timber	Old and in poor state	Congested		
Four	RCC	Plastered	moderate			

6. Education Profile of Family:

Education: Illiterate: 1 Literate: 2 (indicate level of education); School Education: 3 (indicate grade 1-12);University Education: 4 (indicate level completed)

S.N.	Name	Sex	Relation to Household Head	Age	Education

7. Drinking Water

Source	**Distance to Source**	**Total Time Taken (to fetch)**	**Remarks**
Well			
Spring			
Pipe Supply			
Stream/ River			
Others			

8. Sanitation

Particulars	Yes	No	Remarks
Toilet			
i) Permanent			
ii) Temporary			
Garbage Management			
Provision of Waste Bins/Pits			
Use in Compost Making			
Free Disposal			

9. Health Facility

Common Diseases/ Disorders	***Mode of Treatment***					**Remarks**
	Homeopathic	**Faith Healers**	**Doctors/ Health Workers**	**Self Intake of Local Herbs**	**Others**	
Common Cold						
Diarrhoea						
Temperature						
Allergy/ Asthma						
Gastroenteritis						
Snakebite						
Others						

10.Energy-Related

10.1 Energy Use by Fuel Type

Particulars	***Use***		Price Per Unit (local market)	Monthly Consumption (average)	Remarks
	Lighting	Cooking/ Heating			
Fuel-wood*					
Biogas					
Electricity					
Kerosene					
Batteries (Dry cell)					
LPG					

Note: Explain in detail, how many kilograms (bundles) are collected by the household members and how many 'bundles' are purchased from outside out of the total use of fuel-wood.

10.2 Fuelwood

Fuelwood			**Collection Schedule (Mark 'v')**	**Fuelwood Collection (Mark 'v')**	**Timber for Construction**			**Remarks**
Source	%	Distance			Source	%	Dis-tance	
Com. Forest			Everyday	Male	Com. Forest			

Local Market			Once in a week	Female	Local Market			
Govt. Forest			Once in a month	Children	Govt. Forest			
Own Farmland			Once in a year	Hired Labour	Own Farmland			
Private Forest			As and when required	All above	Private Forest			
Others					Others			

10.3 Fuel-wood, Fodder, Fruits and NTFP in Own Land

Fuelwood		Fodder		Fruit		NTFP		Remarks
Type	No	Type	No	Type	No	Species	No	

10.4 Biogas

Size (Cu.m)	Installations			Use		Feeding of Plant ('√')	Use of Slurry ('√')	Remarks
	Com-pany	Year	Cost	Lighting	Cooking			
						Men Women Children All	Fertilizer Compost making Dung cakes Others	

10.5 Solar Energy

Technology		Use					Remarks
Type	**Size/ Capacity**	**Lighting**		**Cooking/ Heating/ Drying**	**Water Lifting**	**Operating HH Appliances**	
		Watt	Nos				
Solar Photo voltaic							*Mention about the quality of light, and energy sufficiency etc and other qualitative information.*
Solar Cooker							
Solar Dryer							
Solar Pump							

11. Night Hours Routine

S.N.	Particulars	Time (Hours)		Remarks
		In Summer	In Winter	
1	Bed time in the evening			
2	Rising time in the morning			
3	Study time of children			
4	Time for IG activities (if any)			

12 Miscellaneous

1. If agro-processing is done in the mills, how far is the mill? What is the rate of processing the grains? What kinds of mills are they? (grinder, rice-huller, expeller, etc)
2. Is there any loan taken for household expenses? If yes, specify them?
3. Is there any saving from household income? If yes, specify the rate of savings?

Annex 5

RURAL LIVELIHOOD IMPROVEMENT PROGRAMME

PRE-FEASIBILITY STUDY OF MICRO/MINI HYDRO SYSTEMS

(Guidelines for acquiring all necessary information for the proposed MHS)

General

1. Name of Scheme:……..

2. Location:

   a) Village: b) District: c) Province:

3. Roadhead:

   a) Name: b) Type: Fair-weather/ All-round c) Distance to Site: km

   d) Walking Hours to Site: ……hrs (normal) …….hrs (with load)

4. Name of Local Market (Bazaar):

Technical Information

1. Source:

2. Intake:

   a) Location b) Intake Type: c) Elevation:

3. Discharge:

   a) Measured Flow: lps b) Date:
   c) Methodology Applied: d) Minimum (Dry) Flow: lps (assessment through interaction with people)

4. Headrace Canal:

   a) Type: New/ Existing b) Length: c) Alignment:

d) No of crossings e) Lined Section: m f) Unlined Section: m

5. Location of Power House: Land Ownership: Private/ Government

6. Available Head (Gross): m

7. Penstock Length (approx): m Penstock Alignment:

8. Estimated Power Output: kW (55% overall system efficiency)

Remarks: (Comments on land use right, water use right, canal construction, location of natural spillways etc)

Electricity Use (Proposed)

1. Household Use (Lighting):

S.N.	Ward #	House holds	Average Subscribed Power Watt / HH	Total Subscribed Power in Ward kW	Remarks
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
Total:					

2. Productive End-uses/ Enterprizes:

S.N.	Possible End-use / Enterprises	Loca-tion	Required Power kW	Average Hours of Operation / day	Average Days of Operation / Month	Operational Months / Year	Total Power Used / Year	Remarks
1.								
2.								
3.								
4.								

5.								
6.								
7.								
	Total:							

National Grid Extension Possibility

1. Location of Nearest Grid Point:

2. Distance from Site to Grid Point: km

3. Plans of Grid Extension towards Site: Yes/ No

4. If Yes, Name of Village Committee / Province/ Location:

5. Remarks:

Availability of Local Construction Materials and Haulage

Local Materials	Place of Availability (PA)	Average distance from PA to Site	Average Time of Transportation (two way)	Man Load Capacity kg (Cu.m)	Remarks
Sand					
Stone					
Aggregate					
Wood					

Availability of Manpower / Foreign Materials / Others

Description	Unit	Rate	Remarks
Unskilled Labour	MD		
Mason	MD		
Carpenter	MD		
Technician	MD		
Mule Transportation	km.kg		cement transportation
Plane / Helicopter	kg		
Kerosene	liter		

Diesel	liter		
Dry Cell	pair		
Others			

Socio- Economic Information

1. Public Facilities Institutions:

Public Facilities	Exist within Community Yes/ No	Distance from the Village Centre to the Facility, if Located Outside Community km	Remarks
Schools			
Health Posts			
Village Committee Office			
Post Office			
Banks			
Agriculture Office			
Provincial Forest Office			
Others			

Note: Explain about the physical condition, quality of services and relevant information in 'remarks'.

2. NGOs/ INGOs Involved in Socio-economic Development:

NGOs/INGOs	Area of Support	Working Since	Remarks

3. Source of Income:

S.N.	Source of Income	Total HH	Remarks
1.	Agriculture		
2.	Business		
3.	Remittance		
4.	Employment		
5.	Wages		
6.	Others		

4. Poverty Ranking:

S.N.	Description	Households (Nos)	Remarks
1.	Households with less than six months of food sufficiency		
2.	Households having principle source of income from wages		
3.	Female Headed HH		
4.	HH without youths		
5.	HH with handicapped and without any income		
6.	Other identical		
7.			

5. Agricultural Production

S.N.	Particulars	Annual Production		Remarks
		Unit	Amount	
1.	Rice			
2.	Maize			
3.	Wheet			
4.	Millet			
5.	Oilseed			

6.	Potatoes			
7.	Others			

6. Environmental Considerations

S.N.	Environmental Treats	Yes/ No	If Yes, Possible Recommended Measures	Remarks
1.				
2.				
3.				
4.				

7. Resource Mobilization Possibility

Source	Amount	%	Resource Type	Remarks
Programme				
Community			Equity	cash/ labour
Banks			Loan	
Others				
Total:				

8. Appendices & Attachments

Particulars	**Type of Attachment**	**Remarks**
Project Location	Photograph/ Sketch	Birds eye view
Intake Site	Photograph	
Canal Route	Photograph/ Sketch map	
Forebay and Power House	Photograph	
Crossings in Headrace	Photograph	
T/ D Lines	Schematic Diagram	

9. List of People During Study

	Name of Persons	Designation
1.		
2.		
3.		
4.		
5.		
6.		

7. Study Team Members

Name Designation

1.
2.
3.

Date:

Annex 6

Definition of Technical Terms Used

Micro Hydropower: It is the system that converts the energy of falling water from some height to produce electricity. Mostly, these are run of the river type and categorized with power output up to 100 kW (could vary country to country with power output).

Penstock: A closed pipe that transports the water under pressure from the forebay to the turbine. The two most widely used materials for penstocks are mild steel and un-plasticized polyvinylchloride.

Turbine: A turbine converts the kinetic energy of falling water to mechanical energy of a rotating shaft. The water pushes the blades of the turbines to make the axes of the turbine rotate.

Generator: The generator converts the mechanical energy into electric energy. The generator is connected to the rotating shaft of the turbine and electricity is created when magnetic field and an electric wire move in relation to each other. The shaft of the generator has a magnet that is enclosed in an electric coil. The turbine makes the magnet rotate inside the electric coil and a voltage is induced in the wire (Benson 1996, Fraenkel et al. 1991).

Head: Normally it is the difference in 'height' between the water level in forebay and the center of turbine shaft /rotor.

Design discharge (flow): It is the required amount of flowing water expressed as liter per second or cubic meter per second (1 M^3/sec =1000 liters per second)

Controller: It is the devise designed to regulate the energy output of a micro hydropower system. The speed of the turbine varies depending on the load that is applied. This speed variation affects the frequency and voltage output from the generator and could damage it by overspeeding under low or no load condition or by overloading it under high demand periods. The controller automatically compensates for this variation by varying a resistive load (dump load), in order to keep a constant load for the generator and turbine (Fraenkel et al. 1991).

Transmission lines: Required to transport the electricity from the powerhouse where the electricity is generated, to the consumers of the electricity. Transmission lines are often quite expensive to build so it is an advantage if the site for the micro hydropower plant is situated near village to be electrified.

Power: Power, with unit Watt, is the amount of energy per time a system can produce. The potential a river has for producing power depends on the water flow rate and the head for where the water can be made to fall. The water flow rate is the amount of water passing a point at a certain time and is often given in litres or cubic metres per second.

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About the Experts

Dr. Narayan Chaulagain is the present Executive Director of Alternative Energy Promotion Center (AEPC), Nepal and holds a Ph.D from University of Flensburg in Energy Economics, Germany and M Sc in Civil Hydropower Engineering from Ukraine. He has Masters in Sustainable Energy Systems Management from University of Flensburg too. Previously, he worked with the Rural Energy Development Program as District Energy Advisor (1998-2001) and Executive Director in People, Energy & Environment Development Association (PEEDA). He has substantive experiences on hydropower development including formulation of plans and policies. He has also worked in issues related to climate change and its vulnerability. He has participated in numerous national and international workshops and seminars on renewable energy, climate change and livelihood related topics.

Mr. Thakur Devkota has a M.Sc. in Civil Structural Engineering from L'vov Polytechnic Institute, Ukraine (USSR) and has been working in rural and renewable energy sector in the country since the beginning of 1990. Till 1996, he worked in the Agricultural Development Bank, Nepal, especially in disseminating and promoting the rural energy technologies like the biogas, micro hydro, ICS as well as supporting the communities to implement projects like micro irrigation, slope stabilization, land development, rural water supply, mainly under the Small Farmers Development Program, supported by IFAD. He has been working in the Rural Energy Development Program (REDP) since the very beginning of 1997 in different capacities and presently as Sr. Rural Energy Development Advisor. The REDP mainly focuses to the implementation of community managed micro hydropower systems and associated livelihood related activities. Currently, he is deputed at the Alternative Energy Promotion Center to work as Advisor to Executive Director, especially in policy and program- related matters.