Policy Brief on Pico Hydropower

A short description of pico hydropower and its potential role for off-grid electricity in the Lao PDR

LIRE (Lao Institute for Renewable Energy) and ETC (Pico Hydropower Innovation and Capacity Building Program Phase 2)
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I. INTRODUCTION

The objective of this policy brief is to present an overview of the current pico hydropower situation in Lao PDR and offer some recommendations on how government, both international and national organizations, as well as the public could expand the access to energy through the use of pico hydropower technology. This policy brief document is divided into several parts. The next part, Section II, provides information forming a general background of Lao PDR. This is, followed by a short explanation of pico hydropower technology and how it is installed in Section III. The next section gives a brief overview of the current pico hydropower situation in Lao PDR, how the supply chain works, and how people use the pico unit, either individually or in shared communal systems. This section also describes the factors that influence end users decision making on usage and selection of turbine capacity, and also the safety, reliability and efficiency of pico hydro systems. Section V addresses issues related to electricity access expansion through off-grid electrification by pico hydropower. This section describes how the situation could be strengthened by improving current market driven systems, by increasing community electricity sharing systems and by providing sound policy frameworks that facilitate off-grid electrification or pico hydropower investments. Finally, Section VI is a summary of this paper

II. COUNTRY BACKGROUND

The Lao People's Democratic Republic (Lao PDR) is a landlocked country with a socialist political system situated in the centre of Southeast Asia. The country has abundant natural resources and a mountainous landscape that can bring about significant benefits from natural energy resources, in particular the huge potential for hydropower. Currently the Lao PDR is experiencing rapid economic growth that is bringing widespread change throughout much of the country. It is predicted that the Lao PDR will have the highest economic growth rate in 2009 in South East Asia at 7.5%[1].

Central to the national agenda, the National Growth and Poverty Eradication Strategy (NGPES) aims to raise the Lao PDR out of the UN list of Least Developed Countries by 2020[2]. Within this timeframe, the government is dedicated to achieving 90% electrification coverage and to promote Laos as a battery for the region. Therefore, the development of large hydropower facilities receives special attention from the Government of Laos (GoL), since the export of electricity to neighbouring countries generates significant national income, while also providing energy security (at low tariffs) for its population.

There is a great deal of foreign interest in large hydropower projects, with investment from numerous countries including China, Thailand, Vietnam, Korea, Italy, France, and Japan.

However small scale hydropower and especially pico hydropower, has received less attention, largely due to the lack of commercial opportunities making it less attractive to both public and private investment.

III. PICO HYDROPOWER TECHNOLOGY

Definition of pico hydropower

Pico hydropower is commonly defined as hydroelectric power generation with a maximum electrical output of five kilowatts. Hydropower systems of this size benefit in terms of cost and simplicity, originating from different approaches in the design, planning and installation to those which are applied to larger hydropower. Recent innovations in pico hydro technology have made it an economic source of power even in some of the worlds' poorest and most inaccessible places. It is also a versatile power source. AC electricity can be produced directly, enabling standard electrical appliances to be used and the electricity can be distributed to a whole village. Common examples of devices, which can be powered by pico hydro are light bulbs, radio's, televisions, refrigerators and food processors. Mechanical power can also be utilised with some designs. This is useful for direct drive of machinery such as workshop tools, grain hullers or mills, and other agro-processing equipment.

Types of Installation

The most common methods for low head pico hydropower installation are 1) free standing installation and 2) standing (vertical) installation. The installation of higher head turbines (i.e. turgo type) is rarely found in Lao PDR.

Free standing

A free standing or tilted installation is a type of pico turbine installation where an extended propellor shaft is locally fitted and the turbine is mounted above rapid and slightly descending water flows. This is the most common installation type for local people who install their pico turbine along rivers and streams throughout the country.

Standing (Vertical) Installation

[1] www.vientianetimes.org.la
[2] www.undplao.org

A standing (vertical) installation is equipped with an intake channel and a draft tube. This type of installation is usually installed in an irrigation weir or in a stream with a specially raised or diverted channel, which must create an elevation drop (head) of at least 1.5 m. This type of installation is usually found in the northern part of Laos where the landscape is hillier, which provides high head. Standing installations also provide more stable electricity due to more effective control of water flow to the pico turbine via the intake channel.

IV. CURRENT SITUATION PICO HYDROPOWER

Pico hydropower is very common in the remote rural areas of the northern provinces. It is completely market-driven and provides many people in off-grid regions with a source of electricity. An estimated 60,000 low-head pico hydropower units provide electricity for about 90,000 households, making it the most important renewable energy technology in the country. Yet there are challenges in using this technology, such as coping with low quality hardware, risks of electrocution and damage to electrical and electronic devices (e.g. light bulbs, televisions, etc). Many problems have been overcome by the innovation of local actors in the pico hydropower supply chain: end-users, village technicians, shopkeepers, traders and producers.

Supply chain

Product variety and availability: The pico market in Laos is completely informal. It constitutes free interactions between traders, shop keepers and end users without external internvention or help. However, pico turbines and their related products are mainly imported from Vietnam and China through brokers and/or traders. Low head pico and turgo units and their spare parts are available in several local markets in Lao PDR. . Product prices are still considered affordable to many villagers.

Ordering and delivery:

Between shopkeepers and traders: There are two main methods for shopkeepers to order pico hydro turbines and related products. The first method is a product order from traders who subsequently buy from retailing agents in producer countries. These traders will drop by shops to deliver and pick up an order from shop owners. The second method is for direct purchases to be made at border markets, where products are then transported back to the provincial markets by either private or public transport.

Between shopkeepers and end-users: there is no home delivery services provided by shops. All customers are required to buy at shops and bring the equipment back to their own village by private or public transport.

Quality of service:

Product warranty: there is sometimes a verbal warranty on products for a short period of time. However, feedback on after sales service and product quality from customers are generally not positive. Equipment is occasionally known to fail faster than expected and when brought back to the shop, the warranty is rejected on the grounds that the end-user was responsible for the damage. As a result, it is common for the products to be tested at the shops prior to being taken home for installation.

Manual or catalogue: these types of documents are not provided by shop owners as they either don't exist or are written in a foreign language which cannot be understood by customers. Furthermore, there is a lack of explanation from shopkeepers to customers concerning what information customers really require. This leads to a general lack of technical understanding in the proper installation of products and could also expose people to the risk of electrocution.

Sharing of pico hydro units

Individual: in many cases, pico hydro systems are used by a single family due to the limitation of output produced from the pico turbine and the location of the installation.

Familial sharing system: Those households that share their electricity generated from a pico hydro unit share it with their relative households, and are willing to share more with other households if there is sufficient electricity generated from the unit. Usually, one person buys the unit and parts while the sharing members just contribute their labour in the installation, maintenance and repair of the unit when it is broken. However, this is an unsustainable and unfair way to share the power as the owner of the pico turbine has the privilege to dominate and terminate the sharing arrangement whenever they see fit.

Community sharing system: this is a rare case where people in the same village share and manage their own system. An example of this is a community system in Huaphanh province, where people share the use of power generated by a pico turbine, while taking turns to maintain the system. Money is collected from all the users to buy spare parts and external technical services for any repairs that are required.

Use factors

Use patterns: The capacity of most pico hydro units range from 200 to 1,000 watts. They are installed to generate electricity for lighting, entertainment, education and small business applications.

Use period: Use of the system and electricity yield is highly seasonal. Most end users do not place their pico hydro units during the rainy season from July to September, because of the risks that the unit will be washed away. During the rest of the year, they leave their units in the water without any fears of the unit being stolen.

Selection of pico hydro units: In many cases, users buy high capacity pico hydro units in order to obtain higher final output. For example, users may buy a 1 kilowatt turbine because they think that the unit will provide a final output of at least 300 W in their house. This shows that, even after taking transmission losses into account, the nameplate ratings of most units are overstated. Even so, some end-users do not know the capacity of the turbine they buy and

make their purchasing decisions based on what they have seen from their friends or relatives.

For end-users that employ a standing (vertical) installation, some will have access to welding shops who can make a draft tube and intake channel for them, while others construct these components by themselves. Villagers rarely budget for electricity expenses but rather pay for what they need as parts wear out, especially bearings which are damaged more frequently than any other part.

Safety

Accidents: The safety risks associated with pico hydropower (PHP) systems, and in particular that of the cables, is one of the most important issues, because they are potentially life threatening. The voltage is as high (and sometimes higher) than that of main electricity, and there is anecdotal evidence of people and livestock being killed. Yet, how many people this concerns and how these casualties relate to the number of people getting injured or killed by electricity from the central grid is unknown. The most dangerous part of the PHP system is probably the cables running from the turbine to the house, as they can stretch for long distances and can break because of wear, adverse weather conditions and animals. However, the awareness of cable safety appears to have led to improvements in the type of cables being used. Whereas in the past, mainly uninsulated cables were installed, nowadays more people use insulated ones. However, the quality of the cables still remains a problem, mainly because of the high costs of good quality cables (in particular when the turbine is situated far from the household) and a lack of understanding in the importance of correctly sizing cables.

Safety information and awareness: Electrical safety, whether it is from PHP or from other sources, is of the upmost importance. In areas which will eventually be connected to the central grid, it is a great opportunity to inform people how to safely use electricity before they start dealing with dangerously high voltages (e.g. 22kV distribution lines). The example of the cables shows that people are already adopting safer practices, despite the associated increase in cost. However, the spread of these best practices could be more effective and faster by increasing the sharing of information and safety awareness between households and villages. Safe installation practices, setting up lightning protection, safe in-house wiring, and the use of distribution boards are just a few examples of issues that could be tackled using this approach.

Reliability and efficiency

Site selection: End-users find it difficult to identify the "best" location to place their pico hydro unit since the best places are often already taken by "early birds". Finding suitable locations is very challenging for users. Users may change installation locations a few times until they can find the best one. Despite limited financial capacity, a few users have even had to stop using their pico hydro units because they lacked the right location and have thus reverted to using diesel generators or kerosene (although the costs are higher). Others who encounter challenges finding an appropriate location for their pico hydro unit opt for alternative locations which may be far away from their home and may also have to resort to installing their pico hydro units in a non-vertical position.

Product quality and efficiency: This is another concern voiced by end-users. Many people complain about product quality, which is generally reported as low. In most cases, a pico hydro turbine can only be used for about three years. The wiring of the turbine is reported to be one of the most common problems. Another common problem is the early wearing out of bearings. End-users also point out that turbine efficiency is often very low. They complain that they are limited to the use of a few light bulbs despite the fact that the nameplate rating on the turbine is much higher.

Cost related to location: Difficulties in finding a location results in higher expenses, which are incurred from the purchase of longer lengths of cable and the extension of the shaft (for a free-standing installation). In order to save money, end-users may decide to buy lower quality uninsulated cables, which are less safe and durable.

Operation and maintenance: End-users tend to install their own pico hydro systems by themselves, and will only occasionally ask for assistance from more experienced end-users and technicians. Meanwhile, they have to check their PHP system at least once per day to clear any debris. Whenever the PHP system breaks down or parts wear out, end-users generally manage to fix it by themselves. End-users do not keep spare parts for their pico hydro unit at home, although some do maintain a stock of extra light bulbs in case light bulbs break due to fluctuating voltages. Whenever pico hydro parts wear out, especially bearings, end-users go to the nearest market to buy the spare part needed and return home to fix the unit themselves. Usually, a pico hydro unit would not be left inoperable for more than two days.

V. INCREASE ACCESS TO ELECTRICITY THROUGH IMPROVED PICO HYDROPOWER IN LAO PDR

Pico hydropower is essential for peoples' basic electricity needs, especially those that live in rural and remote areas without access to the central grid. Pico hydropower is therefore an important source of energy which can improve villagers' living standards. Nonetheless, this technology has

not really received serious attention by local authorities in spite of its importance as an affordable source of energy that poor people have access to. The current pico hydropower situation outlined above is in need of further improvement and expansion. Indeed, there are various ways to increase electricity access:

Market intervention: The pico hydropower market in Lao PDR is driven freely and informally by a network of manufacturers, traders, shopkeepers and end–users, without any influence or assistance external to the supply chain. This supply chain can be further improved by external invention through direct capacity building of the key actors:

Facilitation of supply and service chains:

Product supply chain: A supply chain for alternative importers and / or suppliers can be established to improve the quality of products in the existing market. The supply chain can link local Lao distributors or companies with neighboring country factories or producers where high technology products are manufactured. Meanwhile, the linkage between local producers and local markets can also be further developed through hardware development such as pre-fabricated intake channels, draft tubes and electronic load controllers (ELC). This is concluded by relevant national institutions in close cooperation with some regional institutions from neighboring countries (i.e. Vietnam and China). Locally made products should be encouraged in order to produce and make available "cheaper" and "better quality" products. This will also contribute to the national economy.

Village technicians and advisory service network:

Technicians and technical experts can be trained to be proficient in such skills as PHP system design, best practices in installation, proper maintenance of PHP systems and PHP troubleshooting and repair. While conducting such training, the details of these actors can be recorded. An advisory service network can then be established, whereby these trained technicians can be offered up as local capacity for relevant projects or companies working in rural electrification and renewable energy. The network will help these trained people to have access to jobs and of course income generation.

Dissemination of technical and safety knowledge: The pico hydropower capacity of shopkeepers, end-users, local government officials and other relevant parties can be further built through the dissemination of technical and safety knowledge. This can be achieved through the distribution of user manuals and other technical guides, training workshops and presentations, and distribution of technical training videos.

Increase awareness of pico hydropower:

Public awareness on benefits of pico hydropower: This is an important element. Pico hydropower is viewed as a familial energy source that many non-users do no consider as an option for widespread off-grid electrification. Awareness raising through an informed choice campaign will enable the public to understand the importance of this type of energy and to make the right choice for their energy needs. This awareness raising can be applied to community shared systems where people share all the costs and reponsibilities. A tool to drive people and policymakers, to increase their understanding, is a demonstration project which can be initiated as a proof of concept for community based shared pico hydropower. The result of this research could be published to inform policymakers and other interested parties on the usefulness of pico-based sharing projects, as well as the technical and management aspects of such a system. Furthur government and international and national organisation awareness raising is also important to transform this informal electricification to the formal off-grid systems.

Commercialization of pico hydropower: It is necessary to promote commercialization of pico hydropower in order to increase and improve accessfor people living in rural and remote areas. The current situtation of pico hydropower indicates that PHP systems are privately used in personal and communal applications, but there is almost no interest in a more commercial model for selling electricity with PHP, through models such as hire-purchase agreements, ESCOs, etc. This is a market niche where the private sector could invest in off-grid rural electrification.

Government policies to facilitate investment

Financial incentives by the government to increase access to electricity through pico off-grid electrification: The government can play a very important role in facilitating private sector investment in pico off-grid electrification system in various ways. Firstly, it can provide subsidies to private companies at the initial stage (the first ten years) of their investment. It can also support investors with more convenient and faster procedures and better access to bank loans so that they can develop pico hydro energy projects on their own or for implementing tenders issued by either government or other international organisations / companies. Finally, for local private companies involved in Public-Private Partnerships (PPPs), the public partner should facilitate access to financial resources for investment.

Government strategy: Policies for renewable energy and rural electrification should include support for pico hydropower investment and should encourage the involvement of foreign and domestic private companies in the rural energy sector, and especially in pico hydropower.

Electricity tariffs for off-grid pico hydro projects: Mandated tariffs for pico hydro projects should be the

same as or lower than for grid electricity. At the moment, the tariffs for grid electricity are considerably lower, which creates dependency on this source of energy while also discouraging competition in the power market. Adjusting main grid tariffs to not be lower than off-grid tariffs will principally ease the acceptability of off-grid projects by the users. Meanwhile, it will stimulate interest in private investors to invest more in the off-grid sectors as it will become more financial attractive.

VI. CONCLUSIONS

Lao PDR has high hydropower potential due to its mountainous topography and high precipitation. Pico hydropower is a very important energy source for the rural poor and it is a technology that people can purchase, install and maintain by themselves. Still, the situation of pico hydropower in Lao PDR requires further improvement in terms of reliability, efficiency and safety. The increase in access of this technology can be made through: (1) the expansion in investment for off-grid electrification projects provided by government, donors and the private sector, (2) the improvement of existing market outcomes to improve its reliability, efficiency and safety, (3) the raising of awareness for pico hydropower and its importance in lifting rural living standards, in order to increase acceptance and demand for the technology, (4) the increase in community-based sharing of PHP systems, and (5) the formulation of appropriate government policies, as well as a sound financial framework, to stimulate domestic and foreign investment in pico hydropower.

VII. ABOUT LIRE

LIRE (the Lao Institute for Renewable Energy) was founded in October of 2006 by Lao companies, organizations, and agencies with the common vision to establish a platform for renewable energy research in Lao PDR. LIRE is a government-authorised Non Profit Association (NPA) operating under the Lao Union of Science and Engineering Associations (LUSEA), the umbrella organisation set up by the Lao National Science Council (NSC) in 2001.

The principal founding member of LIRE was Sunlabob Renewable Energy Ltd., a successful Lao company specialised in providing off-grid rural electricity solutions. Other founding members include the National University of Laos (Faculty of Engineering and Architecture); XAO BAN Group; Lao Association of Organic Products Promotion (LAOPP); Geo - Systems International Ltd; Technology Research Institute (TRI); and the Lao Renewable Energy Services Development Association (RESDA Lao). The institute offers agronomical, technological and socio-economic research services, and works to provide free public resources. LIRE strives to support the development of the country by exploring commercially viable means to establish long term alternatives to conventional practices.

LIRE recognise that, in order for renewable energy technologies to offer a long-term solution for Lao PDR, it is essential to establish local expertise for the operation and maintenance of systems. The institute develops training and resources for the end user, and promotes renewable energy technologies as alternatives to traditional practices through educational initiatives.

Much of the research undertaken at LIRE is performed by Lao nationals, with the support of visiting researchers from overseas. In addition to facilitating the transfer of expertise to permanent staff, projects also benefit from first-hand insight into the Lao context, which is especially advantageous for field research.