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Profitable and affordable energy services for remote areas in Lao PDR: Private – Public Partnership as mutual leverage for Hybrid Village Grids in areas off the national grid

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Abstract: The need to enhance electricity access in rural areas of developing countries is universally recognized. However, tremendous challenges remain to finance electrification initiatives, to ensure the long term sustainability of rural electricity systems, to reach poor households and to transform electricity into higher income and better living conditions. In Lao PDR, the government has the objective to exit the status of least developed country by 2020. One of the targets set to achieve this goal is the provision of electricity to 90% of the households by 2020. Considering the topography of the country and the low density of population, this ambitious objective can be reached only if innovative financing and operating mechanisms are developed and if private and public investors work closely together. Indeed, a strategy based purely on government funded grid extension will not lead to the achievement of the objective. Sunlabob Renewable Energy Ltd. and Helvetas Swiss Association for International Cooperation are collaborating with the Lao Government on an innovative private-public partnership aiming at producing clean, reliable and affordable electricity in remote areas, empowering local communities, and promoting the use of electricity for productive and social purposes. The innovative features of this partnership include, mutual leverage of public and private funds for infrastructure development, community ownership and management of the fixed structures of the mini-grid (small dam, power house, transmission poles and lines), a combination of different efficient and reliable modern renewable energy technologies privately installed and owned which provide electricity 24/7 at low cost, training of local technicians who become energy entrepreneurs, empowerment of local communities for management and decision making as well as participatory work with local communities to identify productive and social uses of electricity. Both private and public partners have clearly defined roles and responsibilities. Linking reliable and affordable electricity generation on the one hand and development of productive and social activities on the other hand is a new approach which is needed to ensure the viability of the mini-grid and to maximize the positive impact on the socio-economic development of target villages.

Key words: hybrid mini-grids, private-public partnership, productive uses

I. Introduction

It is acknowledged that access to modern forms of energy, electricity in particular, is one of the prerequisites for socio-economic development of developing countries and the achievement of the Millennium Development Goals (DFID, 2002), (Modi et al., 2005) and (UNDP, 2005). On the other hand, the challenges of rural electrification are well known. The remoteness of some areas combined with low population density make grid based electrification an unviable option. On the other hand, decentralized systems are often financially out of reach of private entrepreneurs and the intrinsic low load-factor (sold energy compared to produced energy) of mini-grids makes the prospects for profit low. The high investment cost will have to be bourn by consumers (poor rural households) through high and unaffordable tariffs. On the other hand, governments in developing countries do not have the financial resources and technical expertise to reach remote areas. Similarly, maintenance of energy systems in rural areas is often a major issue and one of the main sources of failure of government/donor based rural electrification programmes in developing countries[1]. Finally, it is

[1] See for example the case of solar home systems in Thailand detailed in Lynch et al. (2006)

widely recognized that rural electrification per se does not guaranty the socio-economic development of rural villages. Electricity must be transformed into higher income and better social services for rural communities and this usually does not happen without external support (WB, 2008).

The Lao People's Democratic Republic (Lao PDR) is a landlocked country in South-East Asia with a population of about 5.6 million people. With a GDP per capita of 485$ and the 130th rank in the Human Development Index, Laos is considered as a least-developed country (UNDP, 2007). In its National Growth and Poverty Eradication Strategy, the Government of Lao PDR expresses its objective to exit the status of least developed country by 2020. One of the strategic priorities to achieve this objective is to "facilitate access to electricity for people in all areas and regions of the country in order to foster integrated economic development" (GoL, 2004). In terms of electrification, the 2004 Power System Development Plan defines a target of 90% of electrified households by 2020. To achieve this objective, 150,000 households will have to be electrified by off-grid systems (Maunsell, 2004). As of January 2008, 58.3% of the total number of households and 49.4% of the total number of villages had access to grid electricity (MEM, 2008). The households remaining without electricity access are getting increasingly more difficult to reach because of their remoteness.

II. Hybrid mini-grids to address the technical challenge

Mini-grids are the only option to provide off-grid areas with reliable DC electricity needed for agro-processing activities and other productive uses. Indeed, individual generators are expensive to buy and costly to operate. On the other hand, solar home systems do not provide enough power and energy to run productive appliances. In addition, if good quality standards are applied, mini-grids can be connected to the national grid the day it comes to the area. This reduces cost of grid extension, and can become an incentive that "pulls" the national grid to these far out villages. The mini-grids themselves may also act as "systems fringe boosters", with their generators remaining operational ensuring stable voltage at the outer reaches of the grid. This, combined with the reduced cost of grid extension may allow for increased efficiency of electrical coverage.

However an appropriate source of energy needs to be found to produce electricity locally and feed it into the mini-grid. The ever-increasing price of imported Diesel makes this source of energy unfeasible in Laos[2]. Locally available resources (water, sun and biomass) have therefore to be harnessed in order to produce the needed electricity. Micro-hydro is a reliable and cost effective source of energy used for off-grid electrification. In Laos at least 38 sites below 250 kW have been built. However, 20 of them were reported as broken in 2005 (DGS, 2005) and some of the remaining running systems do not provide adequate services (electricity available only a few hours per day, fluctuating voltage, etc.). One of the reasons for these operational failures is that in Laos, streams have strong seasonal fluctuations, sometimes drying out completely during the dry season. The best way to address this issue in a cost effective manner is to build hybrid mini-grids producing electricity with a combination of different sources of energy.

III. Public-private partnership to address the financing challenge

Optimizing the use of local resources through a combination of technologies improves efficiency of mini-grids and reduces investment costs but financing these systems remains a major challenge. In many countries including Laos, mini-grids are built mainly through government efforts, often with financial support and technical assistance from donors. However, the financing needs for these systems can become a major burden in the budget of a developing country or divert aid money that could be better used. In addition, centrally managed rural electrification is a slow process, expensive to operate and monitor. Finally and most importantly, publicly funded rural electrification systems are

[2] In 2005, only 8 out of 47 installed diesel based off-grid systems were running (DGS, 2005). GVEP (2005) further elaborates "It is found that villagers in Laos are very unwilling to use diesel for [electrification] purpose because of uncertainty as the price rises and experience of currency devaluation in 1997-8 which put almost all the existing diesel generators operating at that time, out of business."

often not effectively operated and maintained. This is due to the lack of competence and incentive to ensure regular service after installation. It is illustrated by the large number of defunct micro-hydro systems in Lao PDR.

On the other hand, for private investors the prospect of profit from rural electrification is usually too low and risky to be attractive. Subsidies programmes to make rural electrification investments less risky and more profitable for private investors are often ill-targeted and much money is wasted through the different level intermediaries. Furthermore when a private company builds and owns a mini-grid it relies on the willingness to pay of the villagers. When those stop paying their bills regularly, the private investor cannot earn money from its investment and cannot move the grid to where the willingness to pay is (i.e., "the market"). Finally local communities have limited access to financing and require substantial assistance to plan, design, operate and maintain a rural electricity system.

To address this investment challenge Sunlabob – Renewable Energy Ltd, a Lao private company specialized in providing renewable energy systems in rural areas has developed a concept for combining public and private sources of financing for the construction of village hybrid grids in rural areas. The main feature of this concept is a mutual leverage of public and private investments. This results in a split of ownership over the rural energy system: the private sector invests in the electricity generating equipment (mobile assets), which include micro-hydro turbine, penstock pipe, (bio)-diesel generator, solar panels, biomass gasifier, control units, etc. depending on the selected technologies. On the other hand, the village (public sector) invests in the fixed assets comprising transmission poles and lines, powerhouse, dam, intake canal, forebay, solar panel stand, etc. These assets belong to village. Finally, individual households and private businesses invest in their own connection to the village grid, including a meter to measure electricity consumption. Each partner is responsible to operate and maintain its own investment.

The split of ownership means the there is a mutual leverage of public and private investment. The private operator sells the electricity it generates to the village (through the village owned grid) and the village sells electricity to the households through the household owned connection lines. The movable assets become a feasible investment for private investors, as they no longer have to worry about investing in infrastructures over which they will have little control. The movable assets are easier for banks to accept as collateral. On the other hand, the fixed assets become a village infrastructure.

The split of ownership means that both sides are accountable to the other to make the system work. Both sides have the incentive to operate and maintain their assets properly as the partnership can be broken if one side does not fulfil its obligation: the village can look for another private energy provider of energy if for example the reliability of electricity deteriorates. Similarly, a private energy provider can shift its generating equipment to another site in case a village does not manage its public assets effectively and does not pay for the services. This creates an energy market at the village level. The fact that the private sector invests only in the moveable assets means that it can sell electricity at an affordable price to the villagers while still having a profitable investment. All partners have an incentive to work together to ensure that the mini-grid keeps producing electricity on the long term. Public and private organisations partnering together can overcome the financing challenge of making rural electrification sustainable.

IV. Trust Fund for transparent disbursement of public funding

In Lao PDR like in other developing countries, villages cannot raise the amount required for the public investment. Ideally, the government at national, provincial or district level should provide the funds. However, currently in Laos, the mechanisms and skills for transparent disbursement of public funds from national or local governments are not in place. Therefore, for the time being, external donors have to provide the capital needed for the public investment, whereas the villagers can contribute in terms of labour and material.

In order to ensure transparent and effective financial transactions between the donor investing in the public grid and the contractor building the public grid, a Trust Fund has been established. This instrument is meant to become part of the mechanisms developed under a future Lao policy for the development of hybrid mini-grids and the promotion of renewable energy. The operating mechanisms of the Fund are as follows: for each activity funded by public sources (e.g. feasibility study of the mini-grid, construction of the fixed assets, training of community members on mini-grid management etc.), the village requests the Trust Fund for financial support. The Trust Fund hires a neutral 3rd party expert to check if both the private company and the village fulfil eligibility criteria and if the budget for the activity is acceptable. Upon the expert's approval, the village signs an agreement with the private company for a specific activity. The Trust Fund establishes a letter of credit, guarantying the payment up to a certain amount upon satisfactory completion of the work. Once the village is satisfied with the quality of the work done by the private company, it sends a letter of accomplishment to the Trust Fund. The expert is then sent by the Trust Fund to check the quality of the work on site and to approve the total expenses incurred by the contractor. Upon reception of the letter of accomplishment and approval by the expert, the Trust Fund transfers the due amount to the private company.

This way of doing ensures that the money is directly spent for work carried out in the field and not wasted by intermediaries between the donor and the field. The Trust Fund also ensures that the private company is held accountable for its work in the field, disbursing money only after approval of a neutral third party expert.

V. Villagers' empowerment

For all issues related to energy, the village is represented by a Village Energy Committee (VEC). The members of the VEC, comprising both men and women, are elected by villagers. The main task of the VEC is to buy electricity from the private energy provider, to sell it to individual households, to maintain the village fixed assets and to manage the revenue from electricity in a transparent way. The VEC is therefore responsible to set up a village energy policy (defining the electricity tariff, the obligations of electricity customers, etc.) and to enforce it. Therefore, besides the increased sustainability of the whole systems, the management of the public assets by villagers empowers rural communities.

During construction of an hybrid-grid in a village, at least three Village Technicians (VT) are trained by both the private and the public sector. These VTs will become independent small entrepreneurs. These entrepreneurs will be the representatives of the private investor in the village and be responsible for the operation and maintenance of the moveable assets. VTs can also be contracted by the VEC for maintaining the grid and infrastructures owned by the village. VT will also be hired by individual users for installing/servicing their own installations. These energy entrepreneurs can also build the capacity of other villagers on technical issues and thereby contribute to diffuse new skills and open new opportunities for income generation at the village level.

VI. Implementation in the field

Sunlabob and Helvetas Swiss Association for International Cooperation have started a collaboration aiming at put these theoretical concepts into practice and demonstrating their viability for both private and public investors. A first small pilot project in the province of Xieng Khuang in Northern Laos was implemented by both partners in 2006-2007. The objective was to rehabilitate an ill functioning micro-hydro based mini-grid. An hybrid mini-grid comprising a 12.5kW hydro turbine, a 15kW diesel engine and a 1.84 kW solar array, was built, and the village infrastructure was renovated and upgraded to higher security standards. The first hybrid mini-grid in Lao PDR, funded by both private and public capital, was commissioned in April 2007.

As of December 2007, 56 households were connected to the hybrid-grid. The village has witnessed an increase of the number of households since the commissioning of the hybrid-grid. Villagers living in isolated hamlets decided to move to the main village in order to benefit from the newly available electricity.

After the first pilot project, the two partners decided to extend their collaboration to build electricity grids in 3 clusters of villages in 2 provinces of Northern Laos, Xieng Khuang and Huaphanh. 25 villages and 1,900 households are targeted by this project. A Memorandum of Understanding was signed between Helvetas, Sunlabob and the province of Xieng Khuang. The work has started in the field in the remote district of Paxay in Xieng Khuang province. This 40kW micro-hydro plant will be connected to the existing hybrid-mini grid of Nam Ka 1 and extended to four more villages.

In the current set up Helvetas is the main representative of the public sector, while Sunlabob is the main private partner. Helvetas has established a Trust Fund and is currently managing it. It is however foreseen that, in the future, other donors will invest in the Trust Fund and be involved in its management. In a longer term, it is expected that villages will be able to raise money locally and make their own investments. Sunlabob on the other hand is the private investor owning the moveable assets and selling electricity to the VEC. Sunlabob is also the contractor contracted by the VEC and paid by the Trust Fund to design and build fixed assets and train VTs and VEC members on technical issues. Other private companies might be hired to provide other services such as training of VEC members on management issues. It is foreseen that in the future other private investors will enter the Lao decentralized energy market and compete to invest in the moveable assets of mini-grids.

VII. Productive and social uses to close the electricity-development circle

A wealth of literature exists on the positive impact of electricity on rural development. However, all the authors, among which Modi et al., (2005), GNESD (2006), Martin et al. (2007), UNESCAP (2003) and many others, agree that electricity per se is not enough and that it needs to be used to power productive or social activities in order to increase income and improve living conditions. However, as noted in WB (2008), Martin et al. (2007), Dorji (2007), UNESCAP (2005) and many others, productive and social uses of electricity do not happen by themselves and an external catalyst (government policy, development programme, etc.) need support the process and bring relevant stakeholders together. In the case of Laos, Sunlabob (2007), quoting studies on the impact of gird extension commissioned by the World Bank and the Department of Electricity, observes that in villages “electrification increases the income disparities between households over time”. In addition, it says that “alleviation of poverty due to electrification was not observed”. Such conclusions are due to the fact that the objective of most rural electrification policies/programmes in Laos and in other countries is to provide electricity to a certain number of households. Uses of electricity and long term sustainability issues are often not considered.

To change the paradigm of rural electrification from connecting a number of households to an electricity network towards ensuring long term sustainability and contributing to socio-economic development, the project implemented by Sunlabob and Helvetas has a provision to develop productive and social uses of electricity. Linking reliable and affordable electricity generation on the one hand and development of productive and social activities on the other hand is a new approach. The objective of the project is not solely defined in terms of number of household connected to the grid but in terms of impacts on the socio-economic development of the village and achievement of the Millennium Development Goals.

Numerous barriers have to be overcome to develop successful businesses in rural areas. They include among others a) access to the markets: local markets are limited due to people lack of cash and distant markets are costly to access (transportation costs); b) access to capital: number of financing institutions are limited in Lao PDR and are not accessible to poor rural people. Furthermore, commercial interest rates are around 18%; and c) limited skills of local farmers to engage in new activities.

To help villagers address these barriers, Helvetas will work closely with public and private actors. The first step will be to carry out a participatory baseline survey in each village, in order to determine the access to and availability of natural resources, evaluate local people technical skills, assess the

main problems faced by villagers in terms of access to markets, development of new activities, etc. Participatory rural appraisal tools will be used in that effect. Local, provincial and national markets will then be surveyed in order to identify potential products which could be produced in target villages and find a (niche) market. Technical assistance to develop business plans will then be provided to interested villagers in order to assess the viability of potential businesses. If needed, project staff will link villagers with (micro-)credit organizations, service providers, development organizations, etc. to assist them to acquire required capital and skills to de develop new businesses. A value chain approach will be developed in order to benefit all actors on the market chain including small scale producers at the beginning of the chain. This will require implementation of activities such as identification of value chain actors and organisation of meetings with all concerned parties. Villagers will lead this process, irrespectively of their income, sex, ethnicity, etc. While doing that, it is expected that a maximum of villagers will benefit from electricity, not only the richest and most influential people.

Productive activities will depend on villagers' skills, interests, access to resources and market needs. However, some businesses are likely to become profitable very quickly with access to reliable electricity. They include local shops and handicraft producers who will be able to work after dark. In Laos PDR, village extension workers are often not able to keep livestock vaccines in their village because of lack of cold storing places. This is a very important issue hampering the development of livestock production in remote areas in Laos. Electricity would make vaccine storage in refrigerators possible, and extension workers would be able to provide vaccination services against a small fee. Running a refrigerator would cost less than 10$ a month and the refrigerator could be used for other productive (storing meat and selling it) or residential uses. Estimates show that running costs of a small village rice mill will be up to 45% lower with electricity than with diesel, whereas selling a diesel engine to buy an electric motor to run an existing rice mill would reduce the running costs by more than 55%. Provision of affordable vaccination and rice milling services are examples of businesses that would have a direct impact on the entire village. Another potential activity benefiting a large number of villagers is the production of biodiesel at the village level. Farmers would grow jatropha and would press the fruit to make oil (in an electric oil expeller) and sell their biodiesel to the private energy provider. This way, villagers would not only be energy consumers but become energy producers. Benefits would include new cash crop for farmers, production of oil cake for animal feed as by-product and reduction of cost of electricity produced in the village. However, a technical breakthrough to make this technology viable and feasible in remote villages as well as an institutional set up at the village level for the management of biofuel production would be needed before such an activity could be developed in remote areas.

In the village of Nam Ka 1, electrified since April 2007, a woman has started an ice-cream business, freezing sugar coloured water in her freezer. This shows that people in remote areas have potential entrepreneurial ideas but these could be improved with some advice. In this particular case, the refrigerator could be used for other purposes than jut for storing ice-creams.

To extend the impact of the project beyond the households able to connect to the mini-grid, the use of electricity for social activities will also be encouraged depending on the needs of each village. Two light bulbs will be given to each village and these will be used in schools, community buildings, health centres, etc. In addition, participatory tools described above will also be used to identify potential uses of electricity to address socio-economic issues. Financial solutions for the connection of social facilities to the mini-grid will have to be found in collaboration with villagers and other stakeholders. Public lighting for example, would make villages more secure at night and allow for the development of evening village markets.

The development of productive and social uses of electricity is not only needed to maximize the socio-economic benefit of electricity at the village level, it also improves the sustainability of hybrid mini-grids and the replication of the model in other sites. Indeed, the increased demand of electricity created by productive and social uses augments the revenue from electricity for both the private and

public sector. This increased revenue provides funding for proper operation and maintenance of both moveable and fixed assets. In addition, the village can decide to use some of the electricity revenue for a village development fund. Higher development in the village is likely to lead to increased demand of electricity thereby contributing to close the circle: electricity contributes to development which contributes to increase of electricity demand which ensures the financial viability of the system. Indeed, for the private sector a minimum demand is needed in order to make the investment profitable. This minimum demand can usually not be reached with residential consumption only. The lack of demand is responsible for the lack of financial sustainability of many micro-hydro mini-grids, as described in Dorji (2007) and Poudel (2004) for the cases of Bhutan and Nepal for example.

VIII. Future prospects

It is envisaged that the mechanisms developed within the private public partnership between Sunlabob and Helvetas could provide the basis for the development of a sustainable rural electrification policy in Lao PDR. The Trust Fund could in the future be managed by the Lao government and receive contribution from various donor agencies and from the government itself. A transparent legal framework could be built on the existing basis and private energy providers could compete to invest in moveable assets and build the mini-grids.

The objective of the government of Laos to electrify 90% of the households by 2020 will require at least 150,000 households to be electrified with off-grid systems (Maunsell, 2004). This represents more than 1,500 villages. Not all these villages would be feasible candidates for hybrid mini-grids but according to a Sunlabob survey, they are at present about 55 known locations in Lao PDR where micro-hydro based hybrid mini-grids could be built. Mini-grids combining renewable sources other than hydro could increase this number to about 200 sites. In addition at least 20 micro-hydro mini-grids are currently broken and 18 others could be in need of rehabilitation.

Furthermore, agreement on technical standards between mini-grid developers and the national electricity utility could extend the viability of mini-grids to places with low demand for electricity (the surplus could be sold to the grid). Innovative policies such as feed-in tariffs could increase the viability of mini-grids in areas already connected to the grid. Such a policy is already implemented in Laos' neighbour Thailand. It could result in the increase of private investments in clean technologies and the decrease need of public investment for large scale power generation, thereby freeing funds for other public activities.

Furthermore, the approach linking reliable and affordable electricity generation on the one hand and development of productive and social activities on the other hand could be adapted to other rural electrification projects, on or off-grid. This would ensure that electricity truly benefits villagers and improve the quality of life of the majority.

Finally, the ideas presented in this paper and being currently implemented in Northern Laos could be replicated in other developing countries where similar conditions are found: low population density and hilly topography making grid extension costly and ineffective, availability of natural resources such as water, sun, biomass, etc., interest of private companies to invest in decentralized power generation, availability of public funding for rural electricity and, more importantly, villagers willing to participate actively to their own development.

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