EIE-06-256 REEPRO

Promotion of the Efficient Use of Renewable Energies in Developing Countries

Appropriate Technology Scan Lao PDR

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June 2007

The REEPRO project receives funding from the European Commission. The contents of this document are the sole responsibility of the DGS and can under no circumstances be regarded as reflection of the position of the Europe Union.

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List of Acronyms

AC	Alternative Current
ADB	Asia Development Bank
Ah	Amp Hours
BCS	Battery Charging Station
CDEA	Community Development and Environment Association
CORE	Council on Renewable Energy in the Mekong Region
CTTE	Canada Thailand Trilateral Environment Project
DC	Direct Current
EDL	Electricité Du Lao PDR
ESCO	Energy Service Company
JICA	Japan International Cooperation Agency
MIH	Ministry of Industry and Handicap
NEDO	New Energy Technology Industry Development Organization of Japan
NGO	Non-Government Organization
NPO	Non-Profit Organization
NUOL	National University of Lao PDR
ODA	Official Development Assistance
PADETS	Participatory Development and Training Centre
RES	Renewable Energy Source
SHS	Solar Home System
STEA	Science, Technology and Environment Agency
TRI	Technology Research Institute
Wp	Watt peak (PV power in testing standard condition)

1 Introduction

The Promotion of the Efficient Use of Renewable Energies in Developing countries project (REEPRO) is motivated by the fact that poor households in Developing Countries often lack access to basic energy services. Currently the situation for many rural communities of developing countries is characterised by energy poverty and stagnation. The proposed project shall lead to the provision of energy services to those currently un-served or underserved by higher quality energy services on the basis of an introduction of renewable energies and energy efficiency. To achieve the overall objective, the development of a RES training kit in 3 levels is pursued, which targets country RES stakeholders with different educational background from RES experts (1) over technician (2) to community stakeholders (3).

The development of the training kit is divided in 4 parts: the data collection, the training kit development, the training performance and the implementation of RES projects in pilot and project communities. Based on the a local data collection and the updated guidebooks the consortium and trained 20 RES experts, 10 each from Laos and Cambodia will develop the training kit's level 1 including new policy planning and entrepreneurial modules to train further RES experts, Politicians, civil servants, etc.

The local data collection is needed for two integrated purposes. a) The collection of real live data by the partner organizations which will form the knowledge base for the content shaping of the training documents. b) to challenge the future trainers and to give them exposure to project work as well as to jointly generate thresholds of information necessary before decisions on pilot or real project implementation can safely be taken. This data coactions will also serve the purpose to present an up to date situation on the financial and technical developments applicable to this project.

The data to be collected consists of: Socioeconomic, educational competences (finance and economic and technological understanding), financing tool and appropriate technology. Scope of appropriate technology scan is scan of appropriate technical solutions for renewable energy conversion on the national and international level within technical associations, donor agencies and project experiences as well as among corporate offers. The scan will be completed in all participating nations on the local level as well as on the international level among aid agencies and project carriers as well as the respective industries. The appropriate technology report will include a technology catalogue with ranking and summary of technology, operational environment restriction, costs, economics as well as project experience.

Literature review, field assessment and individual interviews are used as the tool in this scan with following target groups: Ministry of energy and mines, Ministry of Agriculture and forestry, Technology Research Institute, Rural energy service provider: Electricité du Lao PDR (EDL), Sunlabob Co., Sengsavang Co.,

2 Overview of Renewable energy applications in Lao PDR

Lao People's Democratic Republic (Lao PDR) is a landlocked country in the heart of South-east Asia, around 70% of its terrain is mountainous. Lao PDR had a population of around 5.8 million (census 2004) with an estimated annual growth rate of 2.7% . Population density is 23 persons per square kilometre (km^2) and roughly 85% of the population lives in rural areas. It is largely rural and mountainous, only 48.3% of 1,000,350 households are electrified (2005).

Lao PDR has some exploitable energy sources available like abundant hydropower and biomass as well as some coal deposit with all the coal being exported at the moment. The energy consumption for 2005 in Lao PDR can be characterized as being heavy biomass based as in the total energy consumption of is shown in Table 1.

Table 1: Energy consumption by Type 2005

	Electricity	Oil	Gas	Charcoal	Fuel wood	Sawdust
Tera Joules	4.633	11.430	88	7.283	40.176	318
% of Total	7,25	17,88	0,14	11,39	62,85	0,5.

Source: EdL Annual report 2005 and DoE statistics.

Renewable sources of energy do play an important role in Lao PDR's economy , as is evident from table 1 which shows that about 81% of all energy is based upon a renewable source (74.74% of energy use consist of biomass and 7,25% is electricity which is predominantly hydro-power). The traditional sources of energy like fuel wood and charcoal and no doubt also other biomass residues like saw dust, rice-husks, etc. are still by far the most important. The following provides a brief overview of the various types of RE sources used in Lao PDR:

2.1 Solar energy

Lao PDR is situated in the tropical zone, the country has about 300 days of sunshine per year and the annual mean daily global solar radiation in the country is in the range of 4.5 – 5.0 kWh/m^2/day, which makes it a potentially good location for solar energy utilization.

Solar energy for electricity:

Solar PV systems were first introduced in Lao PDR during the early 1980s by Telecommunication Company and then the international development programs, mainly to supply electricity for telecommunication system and vaccine storage in remote area. Since then PV technology has applied for domestic electrification particular in remote area through many programs.

During 1997 to 2004, TRI with financial support from international development agencies: CTTE, Sida, NEDO and Solarlab (Vietnam) has installed PV systems with various types of application such as Solar home system, battery charging station and water pumping, combine SHS and BCS, these systems are mainly for apply research, demonstration and dissemination of PV application for rural electrification. Total installed capacity is 7.5 Kwp.

From early 1998 to 2000, The Japan International Cooperation Agency (JICA) provided a grant aid to the Lao Government to conduct a “Study on Rural Electrification Project by Renewable Energy in Lao PDR”. This electrification project was piloted in Vientiane and Borikhamxay Provinces through Solar Home Systems (SHS) and Battery Charging Stations (BCS). It was demonstrated in 12 villages with 440 households connected by SHS and 2 villages by BCS providing a total capacity of about 37 kW.

At the same time, the Southern Province Rural Electrification Project (SPRE I) provided an Off-Grid component to develop management systems for Off-Grid supply for isolated areas or villages where the on-grid was not feasible within a 5 to 10 years time span

This pilot hire-purchase system has now also been introduced to national level through the World Bank funded rural electrification program. The program is based on a fee for service type model - “hire-purchase” – that is end-users repays the capital of their system over 10 years to the Energy Service Company (ESCO) who in the mean time is responsible for ensuring the provision of a service, the full operation of the system and collection of payments through their network of village electricity managers. The system ownership is shifted to the end-user after 10 years if there are no defaults on payment. To date 5300 households participate in this “hire-purchase” system. Five provincial ESCOs are now registered and in operation, and these have a network of village electricity managers – there are about 130 of such managers throughout Laos.

Active PV commercial activities are also operational in Laos. Sunlabob, selling about 900 systems on an annual basis since 2000, has established a network of 21 provincial franchises throughout Laos offering a range of products (including a maintenance service) and modalities for payment: cash, credit or rental. This is an example of a company who is evolving in response to its market – it should be noted that this is a purely commercial activity that has no access to subsidies or exemptions on the high import duties on PV systems and components.

Solar Energy is considered to be a viable and suitable option to supply electricity in the larger portions of off-grid to support rural development. It is very important to rural people as it can improve their living conditions serving light for children, more working hours to promote income generation for women and men during the night, health care, access to information, etc.

Solar energy for thermal application

Solar thermal energy has not yet been widely used in Lao PDR for exception of open air drying and simple solar water heating systems. Mostly domestic solar water heaters are imported from neighbouring China to Northern provinces of Lao PDR.

2.2 Biomass

Biomass is one of the most important sources of energy in Lao PDR and in particular in rural areas. There is a potential for various biomass technologies, but there is a shortage of data on local resources and feasibility in different areas of the country. According to an estimate of the Food and Agricultural Organization (FAO), wood fuel consumption in 1993-94 was more than 2.3 million tons and accounted for nearly 90% of total energy consumption of the country. The 1995 census indicated that 92.7% of the people used fuel wood, 4.3% of the people used charcoal and 0.7%of the people used sawdust as their main cooking fuel. However, there was a marked difference between urban and rural area with 85.6% of the people depending on wood fuels (fuel wood, charcoal and sawdust with charcoal being used by 17% of the people) while in rural areas 99.4% of the people used wood fuels with fuel wood being by far the most important (97.7%). The recently completed "National Biodiversity Strategy to 2020 and Action Plan to 2010" estimates the amount of wood used for energy (fuel wood, charcoal, etc.) at 5.6 million tons per year which is more than double the FAO estimate[1].

With regard to industrial applications of biomass energy technologies like for brick making, tobacco curing, etc. very little work has been carried out in Lao PDR. For the domestic sector the picture is more promising as an improved charcoal stove program, initiated by CORE in close cooperation with PADECT has resulted in commercializing the stoves with sales reported to be in the tens of thousand and with exports to Thailand and Cambodia. STEA/TRI has continued the work with the same stove type in other areas of Lao PDR, again with success. However, the charcoal stove is mainly used in urban areas, where charcoal is the fuel of choice, while in rural areas fuel wood is the pre-dominant fuel. Further work, in close cooperation with the end-users could result in the development of an improved wood stove which would help not only in reducing fuel wood consumption but also (and probably more important) lead to a reduction in indoor air pollution and improved living (health) conditions of the users.

Biogas technology was introduced to Lao PDR in 1983 through the assistance of FAO. Initially there family-size biogas units ware set up by the Ministry of Agriculture and Forestry with the cooperation of FAO. Since 1993, the Science Technology and Environment Agency (STEA) has been involved in the development of pilot biogas plants, under the TRI\STEA Canada-Thailand Trilateral Environment (CTTE) sub-project. TRI has constructed 10 biogas plants of various sizes (8,12,16 m^3) in several provinces of the country. There were various categories of demonstration site such as institutional premises, hospital, school and private households. There are two types of feeding material can be used for those plants such as waste water/manure from toilet and animal dung. Beside that project TRI also installed some similar biogas under the Lao-Chinese cooperation program and ADB rural development project.

The Lao-Chinese cooperation program has disseminated family size biogas plants (6-8 m^3). Under framework of this program, 30 biogas plants have been installed at out skirt of Vientiane capital, Ban Nogphouvieng Village, Pakngum district, Vientiane Municipality.

Sunlabob rural energy system Co. has started piloting family size biogas plant on the commercial basis. In cooperation with the Netherlands Development Organization in Laos, Sunlabob turned to promote family size biogas plants on the commercial basis. The pilot plant was installed at Ban Sorg village, Sangthong district, Vientiane municipality.

SNV is providing technical assistance to Lao PDR to promote biogas as a viable alternative as a source of energy mainly for cooking but potentially also for other heating as well as power generation after gas conditioning (removal of sulfur). The Government of the Netherlands, through the Asia Biogas Project, will be providing funds to promote the use of biogas with funds to be used to provide subsidy (about 33% of the cost of a biogas digester system) to farmers who decide to install a biogas system. The bio gas digester use in this programme is Nepal biogas technology, sizing of 6-8m^3 which the material used for construction is mixing of cement-brick for and concrete. The pilot programme was stated in 2007 in 4 districts: Hatxaifong, Pak-Ngum, Xaithani and Naxaithong, the number is expected to be no more than 100 digester units in these areas.

2.3 Policy, constraints and limitation

In order to leave status of a Least Developed Country (LDC) by 2020, government of Lao PDR (GoL) has committed to poverty eradication, especially in remote areas, by promoting integrated rural development. Industrial development is based on integrated agro-forestry development. To support the government policy, energy plays an important role and, considering rising fossil fuel prices, indigenous sources of energy like hydropower and other local sources of energy should be promoted. Beside, power policy of GoL is aimed to: i) increased the household electrification ratio from the current level of approximately 48% to 90% by 2020, with intermediate targets of 70% in 2010 and 79% in 2015 and ii) Reduce the use of imported fuels for electricity generation and other uses by substitute indigenous energy resources principally hydropower but also solar, coal and biomass energy.

The power policy states that “much of the country lies beyond the economic reach of the main-grid and the government therefore, promotes commercially prudent and sustainable electrification in off-grid areas to improve socio-economic conditions and reduce poverty within isolated rural communities” in response the government is currently seeking methods by which to reduce costs, ensures reliability and while rapidly increasing the number of connections. An initial program of Off-grid household’s electrification employing state, donor and private resources is targeting 150.000 households by the year 2020 under the wider national poverty alleviation goals.

The constraints and limitations of developing a national Main-grid are considerable. In conjunction with the government’s strong social development agenda Off-grid development presents a number of benefits. In order to achieve the goal of power policy in 2020 a range of renewable energy alternatives must be rapidly developed. The objective and guidelines set out in the Electricity Law provide a strong lead for further development of the renewable energy sector. However further clarification is needed on the specific needs of small-scale renewable energy outside of hydropower. PV system and biomass for example, are well positioned to address these needs and further legislative reform should focus on these and similar technologies.

Even though many of these RE systems and applications are available and are being used to some extent, there are several constraints and barriers to a more widespread use. Based on the Country and Policy Report for Lao PDR by the ADB's PREGA Program, the following are some of the identified barriers to RE development and utilization in the country:

- Lack of an integrated national energy policy and no clear or existing vision for all energy sub-sectors
- Lack of energy policies and strategies including appropriate legislation, guidelines and regulations
- Lack of data and information of all sub-sectors of energy
- Government has financial constraints in what it can do. Most of funding sources for energy sector comes from the loans and grants of multilateral financial organizations and international donors, and that local participants into this sector are still limited.
- Local bank/financial institutions lack the necessary capacity to evaluate RE projects – they are hesitant to lend to RE projects due to perceived high risks and the long time needed to recover the investment cost.
- High transaction costs due to the smallness of potential RE projects
- Limited manpower with the knowledge of know-how, experience and skills in strategic planning and those of implementing the plans
- Lack of institutional arrangements and responsibility for energy - not clearly defined and coordinated responsibilities among agencies, which are in charge of the energy sector.
- No incentives from the government that would facilitate the acceleration of the development and wider scale application of sustainable biomass energy resources.
- Cost of renewable energy devices is still high while income of rural households is low
- Lack of large enterprises that supply biomass energy system equipment and services
- Project developers hesitate to invest in biomass energy projects due to high risks and difficulties in recovery of the investment cost
- Poor knowledge of opportunities and obstacles to the application RE technologies, in general, and biomass energy technologies, in particular, for productive and social uses
- Limited knowledge of renewable energy resources, in general, and of biomass energy resources, in particular
- Low level of public awareness regarding improved and efficient biomass energy applications.

3 Appropriate technologies

There are some applications of Renewable energy technology considerable appropriate in some area condition in Lao PDR such as PV for various applications in rural areas and bio-gas technology that use animal dung/manure for produce gas to use as cooking fuel and lighting as well as control pollution from animal waste. Those technologies are described below.

3.1 Technology description

3.1.1 Solar Photovoltaic application

3.1.1.1 Solar home system

There are various sizes of solar home system which depend on propuse of using and afford of user, it can be designed to meet the demand of each users, the size of system can be from small like 20 Wp for lighting to over 100 Wp for more appliances. However, the most popular size of solar home system is range of 20-50 Wp that can use for lighting and some hours of Black and White TV. In general, the solar home system is consists of PV panel, charge controller, battery and direct current (DC) load. For using with alternative current (AC) load it needs inverter to invert DC to AC.

Example1: solar home system under MIH-WB off-grid pilot program(1999-2004) the system consists of 20 Wp PV panel, 3 A stecca charge controller , 40 Ah car battery and 2 of 7 W energy saving lamps can serve for 3 hours per day of lighting.

Example 2: solar home system installed under MIH-JICA pilot project (1997-2002). The system consists of 55 Wp PV panel, 15 A charge controller; 110 Ah car battery, a 8 W energy saving fluorescent lamps and a DC 12 V wall outlet. The system serves electricity for lighting and small entertainment appliances (Black and White TV, Radio cassette player). The power is still available 3 days without sun in case it is used 3 hours per day.

Example 3: Sunlabob Co installed rental solar home systems in Ban Sorg village, Sangthong district, Vientiane capital. Users pay for used energy while hardware remains the company property. Smaller size rental solar home systems are used mainly for lighting only. Larger systems are used either for lighting or for income generation, e.g., by providing evening movie show. The system consists of 110 Wp PV panel, 15 Stecca charge controller, 120 Ah sealed deep cycle battery, 150 watt AC output inverter and 2 of 7 W energy saving lamps. The power is still available 3 days without sun in case it is used 3 hours per day.

3.1.1.2 Solar Battery Charging Station

About 28.7% of the Lao population is still living under national poverty line. This figure is much higher in rural areas. Solar home systems for renting, even subsidized are not affordable for these people, who can pay less than 1.05 US$ per month for energy usage only. For comparison, rental fee for Sunlabob’s smallest 20Wp-SHS is around 3.66US$.

To meet a demand of these people with affordable costs, Sunlabob has offered new approach of rural energy service: **solar battery charging station for poor rural people**. The idea is to rent small movable electric torch, which consists of 7.5 Ah rechargeable battery and saving lamp (1 or 4 W), directly mounted on battery container. The set also includes timer for controlling energy usage time. Currently Sunlabob offers 15 hours unit. This movable unit is convenient for rural people, who often stay for long period (several days) in their work spot. User pay month fee of 0.63 US for one full charge (for 15 hours use). Timer will automatically cut the system off when reserved time finished and thus helps protecting the device from over discharging and longer battery lifetime.

These torches are recharged by a PV system, which is installed in the village and operated by Sunlabob franchisees. The charging system component consist of PV module 1x240 W, Charge controller which can charge from 18 to 36 of 7.5 Ah battery daily and also can manage to charge 6 V battery. From the pilot system high demand is observed among port portion of rural population due to affordable prices and convenience (movable, easily manageable, long lifetime) and flexibility in charging (6-12 V battery).

3.1.1.3 Solar pumping system for community

The system was installed in Ban Sor Village, Sanghthong district. Vientiane capital the system capacity is 16.000 m^3 of water per day, storage tank 14.000 m^3. The system is powered by solar panel array of 400 Wp(4x100Wp), connected in 48 V scheme. Lorentz Pump is used in this system. Water is pumped from a Sang river, with pumping head of 35 m to a tank, which is located 3.5 high above ground of highest hill within the village. Water Distribution network connects water tank with 12 local distribution points (tapes) within the village. In average each distributing point consists of 9 households. In general, water systems is serving day round, for exception in cloudy period, system maybe operated with several beak times so that the system can be able accumulating enough water. Users pay monthly fee of 5.000 LAK (around 0.52 US$) for water use.

3.1.1.4 Solar PV system for rural health clinic

This system was installed in Ban Kuai Village Sangthong district to supplies electricity for lighting, ventilating and vaccine storage at the clinic. the system consist of PV panel 4x75 W, 1X 20 Stecca Charge Controller, 2x150 AH Deep cycle sealed maintenance free batteries, 5x7 W Energy saving lamps and 1X50 L STECA vaccine storage. The system is 3-4 ours of power available per day for lighting and 24 hours for vaccine fridge, within 3 days with out continuously sunshine.

3.1.1.5 Hybrid system (Hydro, PV, diesel generation)

This system is installed under the Public-Private Partnership project in Namka village, Phaxay district, Xiengkhouang province between Sunlabob Co. and Namka villge in April 2007., It is the first Public-Private partnership for Hydro-PV-biodiesel or diesel genset with mini-grid. Such approach is more suitable for productive use of electricity, and hence, it provides more opportunities for income generating activities and makes energy service more reliable and sustainable.

Village (Public) assets: dams, intake, channel, machine housing, village grid, etc (depending on each concrete situation)

Company (private) assets: Equipment, machines, PV systems, penstock, turbine, generator, solar generators chargers, inverters batteries, etc (depending on installed system's components)

Energy service provider manages the system through village electricity committee and village technicians, and sells 220V AC electricity.

The system consist of Hydropower 15 KWe, PV: 1.84 KWp and Gen-set : 15 kWe (currently works on diesel, but planned for Bio-diesel, which will be produced locally)

3.1.2 Biogas

Anaerobic digestion is a biochemical process in which particular kinds of bacteria digest biomass in an oxygen-free environment. Several different types of bacteria work together to break down complex organic wastes in stages, resulting in the production of "biogas". The biogas produced in a digester is actually a mixture of gases, with methane and carbon making up more than 90 percent of the total. Biogas typically contains smaller amount hydrogen and hydrogen sulfide, nitrogen, methylmercaptans and oxygen. The biogas can be used for cooking, lighting and running engine. The anaerobic digested residue (biogas slurry) is a potent organic fertilizer

The biogas model constructed in Lao PDR is adapted from German and Chinese fixed dome type technology. The biogas plant has a fixed spherical dome with a flat digester floor. An inlet pipe connects the digester with the feeding tank and a spherical brick outlet. The manhole is situated on top of the dome. The manhole is gas tight sealed with clay and water. Animal dung/manure is for feeding material in digester.

There are three types of digester in Laos, sizing range of 6-16 m^3 depend on the demand of consumption and availability of feeding material. There are various of construction material such as for Thai/German model is construct of brick and cement, Chinese model is construct of concrete by using mould and Nepalese model is construct of mixing of brick cement and concrete.

The biogas plant sized of 8 m^3 requires a daily minimum-loading rate of 30 kg and sixty days of hydraulic retention time (HRT). The recommended minimum number of livestock is six cows or buffalo. With an average gas production of 40L/kg of dung, the 8 cum can produce 1200 liter of biogas daily, which is enough for the average daily requirement. The 16 m3 biogas plant requires a minimum loading rate of 60 kg dung per day. By a recommended daily loading rate for 60 kg of dung daily, approximately 2400 liter of biogas can be generated daily, equivalent to at least five stove hours.

3.2 Operational environment restrictions

Solar energy applications as the use of PV panels to convert sunlight into electricity usually are easy manageable Those applications need for their operation an automatic control mode and some small maintenance work like cleaning of PV panel, checking the connection and wire and fill distilled water for lead acid battery. The good system design will provide reliable performance. However, the performance often is not so good due to the fact that the systems are almost installed in rural and remote area where the users lack of skills in operation, lack of the after sale service and spare parts are also roughly available in there. Furthermore, the power produced by PV panel depends on weather conditions, so it needs more care in system design, installation and use to ensure reliable and sustainable operation of PV systems**.**

The experiences of the existing renewable energy technology projects in Lao PDR have shown that failures of such projects usually caused by the following conditions:

- Lack of participation from the local community and neglect of local needs in the planning stage of renewable energy projects
- Lack of tariff collection from villagers for proper maintenance of equipment
- Lack of income generating activities using electricity produced by renewable energy, which, in turn, means lack of ability to pay for energy service or systems repayment;
- Lack of training for local users
- Lack of maintenance services by suppliers, including spare parts supply and replacement.

3.3 Cost structure and economic

3.3.1 Solar home system

Solar home system of example 1 (MIH-WB off-grid pilot program): the investment cost for system is 15 US$ for initial payment (installation fees) then monthly payment of 2 US$ and 1 US$ for 5 and 10 years repayment period respectively. The saving from energy service is around 30 US$ per year saved cost of battery charging (compare to carried battery to charge in electrified village, roundtrip takes about 3 hours) or saved kerosene and candles.

Solar home system of example 2 (MIH-JICA pilot project): the total of system cost is 525 US$ not include Black and White TV, by using this system user can save 24 US$ per year as saved home energy expenses kerosene, battery charging in electrified areas~2 US$/month.

Solar home system of example3 (Sunlabob's rental system): investment cost is 10 US$ one-time connection fees and 15 US$ for monthly rent. The system is belonging of company, when the system component fault (100 US$ for battery and 60 US$ for Charge controller) company replaces it without any charge from users. The income from energy service is 40 US$ per moth from evening TV and VCD movies shows, and around 230 US$ pre year of saving from energy service compare to Diesel generation for 3 hours per day (1litter per day @0.65 US$/L in 365 days).

3.3.2 Solar battery charging station in Ban Sor village

The total investment cost by the energy service provider on PV charging system is 1,600 US$ and income from charging service is estimated around 600 $ annually (about 30% is a compensation for village electricians, covering their customers service and system maintenance). Each user has to invest initially 23 US$ for electrical torch purchase and recharging fee of 0,63US$ per full charge (15 usage hours) (6 charges per month account to 3.78 US$/month). As the electrical torch has a timer for control discharging (15 usage hours), the charging cycle is not uniform among the users it is depend on the using time per day of each, however supposed they use 3 hours per day , each full charge will use for 5 days. Therefore one month they will charge the electrical torch for 6 times, at the cost 0.63 US$ per one full charge they will pay for charging about 3.78 US$/month. If they use less than 3 hours pre day the number of charging will be reduced and also reduced the expense for charging per month. Income of the users have not yet been estimated, but at least, each of them can save 3 to 4 litters of kerosene for lighting per month (local price of kerosene is 1 US$/L), or save (2-4 times/month @ 0,8 $/per charge~2-3 $/month) for charging their automotive battery in 15-km-far-away nearest electrified village, but in case of solar charging station- better light and more conveniences.

3.3.3 Solar pumping system for community

The investment costs of this system cost is 11.000 US$, while the maintenance cost is around 60-80 US$/year. The average income from water sales is 400 US$ per year.

3.3.4 Solar system for rural health clinic

This system is full scale rental PV system from Sunlabob Co. The total investment cost is 2,890 US$ (including solar system and 50 L vaccine fridge) the maintenance cost for this system is around 40 US$ per year. Saving from energy service is about 20 US$ per month saved expenses on recharging battery bank in electrified village (16 Km far away), kerosene or candles.

3.3.5 Biogas

The cost of construction of TRI-CTTE plants was found to be beyond the capacity or affordability of small and medium farmers in Lao. The existing TRI-CTTE biogas digesters cost around 800 - 1200 USD for 8-16 cubic meter plant. The functioning of the TRI's biogas plant at the Renewable Energy Technology Centre (RETC a toilet pipe is attached directly to feeding tube of the plant. Biogas from this plant is enough for cooking for Mr. Souk's family – a staff of the centre, who is responsible for the plant. Due to the use of biogas he can save a one bag (20 kg) of charcoal per month (1,500 LAK/kg of charcoalx20~3 US$/month).

The Lao-Chinese Cooperation biogas plants with 6 cubic meters digesters awoke the interest of villagers due to its fordable costs (350-450 US$), response to their energy needs, daily available loading materials (3-6 pigs) and benefits of using slurry for vegetable growing. Biogas is used for cooking and lighting. Each month the owner can save up to 1,5-2 bags of charcoal or about 3.7-5 US$. The biogas plants' owners also use slurry for growing vegetable for own needs and for sale to merchant from capital city to get additional income besides of selling pigs. Used slurry was not counted.

4 Technology data sheet

4.1 Technology data sheet 1 - Operation of Hybrid Village Grid

<table>
<tr><td>Project name:</td><td>Operation of Hybrid Village Grid by Private Energy Provider (PEP) as a solution for LDC countries</td></tr>
<tr><td>Type of project:
(tick off the type)</td><td><table><tr><td>PV</td><td>Solar Thermal</td><td>Biomass to Energy</td></tr><tr><td>✓</td><td></td><td></td></tr></table></td></tr>
<tr><td>Location of the plant:</td><td>Lao PDR
Namka village, Phaxay district, Xiengkhouang province, Lao PDR</td></tr>
<tr><td>Year of Implementation:</td><td>April 2007</td></tr>
<tr><td>Operator:
(Name and address)</td><td>Village committee and technicians, Namka village, Phaxay district, Xiengkhouang province, Lao PDR</td></tr>
<tr><td>Planner:
(Name and address)</td><td>Sunlabob Co.
Watnak. Lao-Thai friendship road. Vientiane Lao PDR
Tel.: +856-21 313874</td></tr>
<tr><td>Detailed description of the installation:
(technology, function, benefit for users, etc. max 150 words)</td><td>Public-Private partnership for Hydro-PV-biodiesel or diesel genset with mini-grid. Such approach is more suitable for productive use of electricity, and hence, it provides better for income generating activities and makes energy service more reliable and sustainable.
Village (Public) assets: dams, intake, channel, machine housing, village grid, etc (depending on each concrete situation) (see diagram attached below)
Company (private) assets: Equipment, machines, PV systems, penstock, turbine, generator, solar generators chargers, inverters batteries, etc (depending on installed system's components)
Energy service provider manages the system through village electricity committee and village technicians, and sells 220V AC electricity.</td></tr>
<tr><td>Generated Energy service:
(tick off the energy type)</td><td><table><tr><td>Electricity</td><td>heat</td><td>gas</td><td>Light</td><td></td></tr><tr><td>✓ (220V AC)</td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Power output of installation: (kWel, m³ biogas, kW th, etc.)</td><td>• Hydropower: 15 kWe
• PV: 1.84 kWp
• Gen-set: 15 kWe (currently works on diesel, but planned for bio-diesel, which will be produced locally)

currently about 40 households already connected to the village grid with ~1,3 kWh/ household/day), totally domestic use ~ 1500 kWh/month; for productive use ~ 3700 kWh/year (load profile estimation</td></tr>
<tr><td>Financing
(tick off the financing type)</td><td><table><tr><td>Private investment</td><td>loan</td><td>donation</td><td>Grant</td></tr><tr><td>✓ (public-private)</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Investment costs in US$</td><td>• Public asset costs: 30,000 US$
• "Soft" investments in the form of trainings and coaching for company engineers, local technician and entrepreneurs, plus the demonstration and media efforts: 30,000 US$
• Movable private assets: 90,000 US$</td></tr>
</table>

Project name:	**Operation of Hybrid Village Grid by Private Energy Provider (PEP) as a solution for LDC countries**
	• Total investment: 150,000 US$ **[www.sunlabob.com]**
Maintenance costs in US$	800 US$]year **[www.sunlabob.com]**
Savings:	Expected savings • Battery charges. Two ways to charge the battery: **(1)** in nearby electrified areas, via daily commuted shuttle pick-up (the nearest is about 35 km far away from the village); **(2)** from small gen-set –charger right in the village, but limited capacity and more expensive due to expensive fuel). About 50% of villagers owning batteries • Diesel fuel for engine gen-set to run rice huller, batteries charger, lighting, entertainment devices (several houses own such systems) • Kerosene, candle, dry-cells torch batteries for lighting • in the future: Saving wood fuel for water heating and cooking, at least rice cooking (from survey, many households have expressed their willingness to purchase electric rice cooker if there was suitable electricity) • Automotive battery charging costs: ~0,8$/charge (including travel 0,3$ and charging fee 0,5$) • Local Kerosene price~9500LAK/L or ~1 $/L • Wood fuels from surrounding village forest are free of charges
Energy sale income in US$:	Estimated 8,000 US$ annual income (to be verified by this pilot phase) [**www.sunlabob.com**], ~0,2 UScent/kWh x (domestic 42000kWh+public 6650kWh+productive 44400kWh) x 40% the first year connection ~ 7831,58 US$
Comments:	This is a pilot system and it has just been commissioned recently. Many management and operational processes are being set up.
Pictures and grafics	


Micro Hydro unit


Forbay Reconstruction


PV system unit


Control box

4.2 Technology data sheet 2 - Rental village solar Battery Charging station

Project name:	**Operation of rental village solar Battery Charging station**				
Type of project: (tick off the type)	PV ✓	Solar Thermal	Biomass to Energy		
Location of the plant	**Lao PDR** Ban Sor Village, Sangthong district. Vientiane capital. Lao PDR				
Year of Implementation:	2007				
Operator (Name and Address)	Sunlabob's franchisees: Mr. Khamsao Khamphavongsa and Mr. Boualay Keomangkone, under supervision of village committee of Ban Sor Village, Sangthong district. Vientiane capital. Lao PDR				
Planner: (Name and address)	Sunlabob Co. Watnak. Lao-Thai friendship road. Vientiane Lao PDR Tel.: +856-21 313874				
Detailed description of the installation: (technology, function, benefit for users, etc. max 150 words)	About 28.7% Lao population is still living under national poverty line[2]. This figure is much higher in rural areas. Solar home systems for renting, even subsidized are not affordable for these people, who can pay less than 1.05 US$ per month for energy usage only. For comparison, rental fee for Sunlabob's smallest 20Wp-SHS is around 3.66US$. To meet a the demand of these people with affordable costs, Sunlabob has offered new approach of rural energy service: **solar battery charging station for poor rural people**. The idea is to rent small movable electric torch, which consists of 7.5 Ah rechargeable battery and saving lamp (1 or 4 W), directly mounted on battery container (see picture). The set also includes timer for controlling energy usage time. Currently Sunlabob offers 15 hours unit. This movable unit is convenient for rural people, who often stay for long period (several days) in their work spot. Each User has to purchase an electrical torch of 23$ (expected lifetime of 2-3 years) and pays charging fee of 0.63 US for one full charge (for 15 hours use). Timer will automatically cut the system off when reserved time finished and thus helps protecting the device from over discharging and longer battery lifetime. These torches are recharged by a PV system, which is installed in the village and operated by Sunlabob franchisees.				
Generated Energy service: (tick off the energy type)	Electricity ✓ (12 V DC)	Heat	Gas	Light	
Power output of installation: (kWel, m³ biogas, kW th, etc.)	• PV: 240 Wp with controller, which can charge from 18 to 36 of 7.5 Ah battery daily depending on sunshine intensity • The controller can also manage charging 6-V battery				
Financing (tick off the financing type)	Private investment ✓	loan	donation	Grant	
Investment costs in US$	Total investment: 1600 US$ for PV system 23 US$ for electric torch				
Maintenance costs in US$	Data Not available yet				
Savings:	• Expenditures on Kerosene (3-4L/monthx1US$/L) or/and car				

[2] owning less than 1.5$ per day. *Source*: World Bank, *World Development Indicators.* www.worldbank.org/ida

Project name:	**Operation of rental village solar Battery Charging station**
	battery charging (2-3 times/monthx0,8$/charge), which usually available in nearest electrified village (18 km far away) • Households get more conveniences: movable and brighter light with affordable and easily manageable costs
Energy sale income in US$:	Average income 600 US$ per year from battery charging (source: sunlabob co.). Torch owner pays in cash 6000 LAK/charge~0,63$ 40 torch x 2 times/month x 0,63$/charge x 12 months~ 600 US$/year
Comments:	From the pilot system, high demand is observed among poor portion of rural population due to affordable prices and conveniences (movable, easily manageable, long lifetime) and flexibility in charging (6-12 V battery)
Pictures and grafics	

240 Wp PV array of battery charging station
(Courtesy by Sunlabob Co.)

Mr Khamsao, village technician and Sunlabob’s franchisee at his work
(Courtesy by Sunlabob Co.)

4.3 Technology data sheet 3 - Community rental solar PV systems

Project name:	**Operation of community rental solar PV systems (rural health clinic)**				
Type of project: (tick off the type)	PV		Solar Thermal	Biomass to Energy	
	✓ (Community solar PV system)				
Location of the plant	**Lao PDR** Ban Kuai village, Sangthong district. Vientiane capital. Lao PDR				
Year of Implementation:	2005				
Operator (Name and Address)	Sunlabob's franchisees: Mr. Khamsao Khamphavongsa and Mr. Boualay Keomangkone, Health post chief: Mr. Sonxay Phonexaysak Supervision: village committee of Ban Kuai Village, Sangthong district. Vientiane capital. Lao PDR				
Planner: (Name and address)	Sunlabob Co. Watnak. Lao-Thai friendship road. Vientiane Lao PDR Tel.: +856-21 313874				
Detailed description of the installation: (technology, function, benefit for users, etc. max 150 words)	Sunlabob has piloted another scheme of renting solar PV systems: rental community solar PV system, for powering rural clinic, which serves several villages (Ban Sor, Ban Kuai, Napo and Vangma) in the cluster. The system is owned by Sunlabob. Users charge is around 500 LAK or 0,05 US$//household/month. The system Income is estimated as following: 500 households/4villages x 0,05US$/household/month x 12 months ~300 US$/year. This figure is slightly increased due to changing number of moved in households. The system supplies electricity for lighting, ventilating and vaccine storage at the clinic. The monthly rent of the system is around $ 0.05 per household per month, which is quite affordable for them. This fee has declined due to rapidly increasing number of households in the cluster. The renting system consist of PV panel 4x75 W, 1X 20 Stecca Charge Controller, 2x150 AH Deep cycle sealed maintenance free batteries, 5x7 W Energy saving lamps and 1X50 L STECA vaccine storage. The system is 3-4 ours of power available per day for lighting and 24 hours for vaccine fridge. The power is still available 3 days without sun in case it is used 3 hours per day.				
Generated Energy service: (tick off the energy type)	Electricity	Heat	Gas	Light	
	✓				
Power output of installation: (kWel, m³ biogas, kW th, etc.)	PV: 300 Wp (4x75Wp),				
Financing (tick off the financing type)	Private investment	loan	donation	Grant	
	✓				
Investment costs in US$	Total investment: 5000 US$ (Sunlabob investment)				
Maintanance costs in US$	Around 40 US$ per year				
Savings:	• Expenditures on Kerosene or/and car battery charging, which usually available in nearest electrified village (16 km far away) • More conveniences in the clinic: light available, vaccine storage, electric ventilation				

Project name:	**Operation of community rental solar PV systems (rural health clinic)**
Energy sale income in US$:	Average income 300 US$ per year from provided energy service (source: Sunlabob co.)
Comments:	If administration is well set up at the clinic, such system would perfectly be functioning, supplying electricity by affordable prices
Pictures and grafics	



Ban Kuai health clinic and its PV system
(Courtesy by Sunlabob Co.)

Solar PV powered Vaccine storage
(Courtesy by Sunlabob Co.)

4.4 Technology data sheet 4 - Rental village solar pumping systems

<table>
<tr><td>Project name:</td><td colspan="5">Operation of rental village solar pumping systems</td></tr>
<tr><td rowspan="2">Type of project:
(tick off the type)</td><td colspan="2">PV</td><td colspan="2">Solar Thermal</td><td>Biomass to Energy</td></tr>
<tr><td colspan="2">✓ (solar pumping system)</td><td colspan="2"></td><td></td></tr>
<tr><td>Location of the plant</td><td colspan="5">Lao PDR
Ban Sor Village, Sangthong district. Vientiane capital. Lao PDR</td></tr>
<tr><td>Year of Implementation:</td><td colspan="5">April 2005</td></tr>
<tr><td>Operator
(Name and Address)</td><td colspan="5">Sunlabob's franchisees: Khamsao and Mr. Boualay Keo-mangkone, under supervision of village committee of Ban Sor Village, Sangthong district. Vientiane capital. Lao PDR</td></tr>
<tr><td>Planner:
(Name and address)</td><td colspan="5">Sunlabob Co.
Watnak. Lao-Thai friendship road. Vientiane Lao PDR
Tel.: +856-21 313874</td></tr>
<tr><td>Detailed description of the in-stallation:
(technology, function, benefit for users, etc. max 150 words)</td><td colspan="5">Sunlabob has provided community solar pumping systems for rent to it's franchisees. System pumping capacity: 16,000 m^3 of water per day, storage tank-14,000 m^3. The system is powered by solar panel array of 400 Wp (4x100Wp), connected in 48 V scheme. Lorentz Pump is used in this system. Water is pumped from a river Sang, with pumping head of 35 m to a tank, which is located 3.5 m high above ground of highest hill within the village. Water Distribution network connects water tank with 12 local distributing points (tapes) within the village. In average, each distributing point consists of 9 households
In general, water systems is serving day round, for exception in cloudy period, system maybe operated with several beak times so that the system can be able accumulate enough water.
Users pay monthly fee of 5,000 LAK (around 0.52 US$) for water use.</td></tr>
<tr><td rowspan="2">Generated Energy service:
(tick off the energy type)</td><td>Electricity</td><td>heat</td><td>gas</td><td>Light</td><td></td></tr>
<tr><td>✓ (48 V DC)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Power output of installation: (kWel, m³ biogas, kW th, etc.)</td><td colspan="5">• PV: 4x100Wp=400 Wp for water pump (48V DC)</td></tr>
<tr><td rowspan="2">Financing
(tick off the financing type)</td><td colspan="2">Private investment</td><td>loan</td><td>donation</td><td>grant</td></tr>
<tr><td colspan="2">✓</td><td></td><td></td><td></td></tr>
<tr><td>Investment costs in US$</td><td colspan="5">Total investment: 11,000 US$</td></tr>
<tr><td>Maintanance costs in US$</td><td colspan="5">60-80 US$]year</td></tr>
<tr><td>Savings:</td><td colspan="5">• Times and labour of women in carrying water from the deep river. They would have more times for doing household cares, like: children care; a rest after hard field work; vegetable growing; or handicraft making, etc.
• Households are more comfortable and have more times to do other income generating activities, such as handicraft, weav-ing, etc.</td></tr>
<tr><td>Energy sale income in US$:</td><td colspan="5">Average income 400 US$ per year from water sales (source: sunlabob co.)
As Sunlabob staff informed, right now only 1/3 of households use this service. Now people have understood its benefits and more and more people willing to use the community water supply. If all households have been used the community water, income would be tripled. Besides, water charge is subject to change after pilot</td></tr>
</table>

Project name:	**Operation of rental village solar pumping systems**
	phase verification. Another point, if demand will be significantly increased, the company would install another system. The company also looks forward to using water for vegetable and animal livestock production, which would have another tariff. Franchisees compensation is about 20% of total income. The franchisees (two of them) are responsible for several rented systems in this cluster of villages: solar home system, water supply system, biogas production (now piloting), rural clinic systems, battery charging station, and they get commissions from all these services
Comments:	Demand now has raised due to both reasons, as growing number of households (110 households in moment of installation and 200 households now) and willingness of people (not all villagers used to use water from the beginning). Sunlabob has planned to install new two units more
Pictures and grafics	

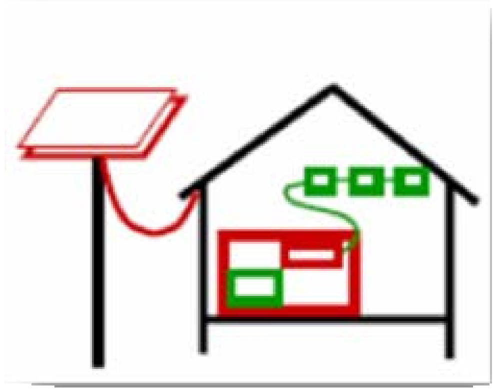
Panel array and water tank
(Courtesy by Sunlabob Co.)

Project name:	**Operation of rental village solar pumping systems**

At distributing point
(Courtesy by Sunlabob Co.)

4.5 Technology a data sheet 5 - MIH-WB off-grid pilot program

Project name:	**MIH-WB off-grid pilot program (rent to buy solar home system)**			
Type of project: (tick off the type)	PV	Solar Thermal	Biomass to Energy	
	✓			
Location of the plant	**Lao PDR** Ban None Savang village, Keooudom district, Vientiane province			
Year of Implementation:	2003			
Operator (Name and Address)	Mr. Bounthan, Sengsavang ESCO, Thalad town, Keooudom district, Vientiane			
Planner: (Name and address)	Off-grid promotion office, Rural Electrification Division(DoE/MIH) Ban Phai, Vientiane capital, Lao PDR			
Detailed description of the installation: (technology, function, benefit for users, etc. max 150 words)	Since 1999, Ministry of Industry and Handicraft (MIH) has managed the soft-loan from the World Bank to finance solar home systems, village hydro and small gen-set by applying Rent-to-Buy mechanism. Villager buys system by monthly prepayment with repayment period from 5 to 10 years. The system is install and maintenance done by trained village technicians, newly formed or existing Local Electricity Service Company. The village electricity Advisory Committee is formed in each target village and to play advisory role to village electrification strategy and implementation. Small Solar home systems are designed for lighting. system The system consists of 20 Wp PV panel with mounting pole, 3 A Charge controllers, 40 Ah Car Battery and two 7 w energy saving lamps. PV panel inverts sunlight into electricity in daytime, and then produced power is stored in Battery to use with 2 lamps at nigh time.			
Generated Energy service: (tick off the energy type)	Electricity	heat	gas	Light
	✓ (12V DC)			
Power output of installation: (kWel, m³ biogas, kW th, etc.)	• 20 W			
Financing (tick off the financing type)	Private investment	loan	donation	grant
	✓ down payment			
Investment costs in US$	15 US$ for initial payment (installation fees) and monthly payment: 2 US$ for 5 year repayment period or 1 US$ for 10 years			
Maintanance costs in US$	Around 0.4 US$ per month for distilled water for batter this cost is not include replacement of lamps and other damaged components			
Savings:	Around 30 US$ per year saved cost of battery charging (the battery carried by small boat to charge in electrified village, roundtrip takes about 3 hours) or saved kerosene and candles.			

Project name:	**MIH-WB off-grid pilot program (rent to buy solar home system)**
Energy sale income in US$:	no
Comments:	The system provides light and more convenience for doing activity in night time compare to kerosene or candles. It is easy to operate and not much time taking for maintenance just clean panel in some time, refill distiller water to battery.
Pictures and graphics	
 Solar Home System diagram	 PV panel with support pole  Battery and charge controller installed in safty box

4.6 Technology a data sheet 6 - MIH-JICA pilot program

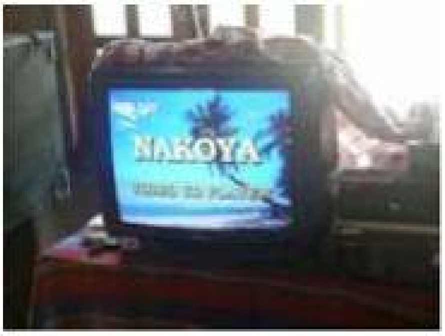
<table>
<tr><td>Project name:</td><td colspan="4">MIH-JICA pilot program (monthly charge)</td></tr>
<tr><td rowspan="2">Type of project:
(tick off the type)</td><td>PV</td><td colspan="2">Solar Thermal</td><td>Biomass to Energy</td></tr>
<tr><td>✓</td><td colspan="2"></td><td></td></tr>
<tr><td>Location of the plant</td><td colspan="4">Lao PDR
Don Xayoudom island, Keooudom district Vientane province</td></tr>
<tr><td>Year of Implementation:</td><td colspan="4">1999-2003</td></tr>
<tr><td>Operator
(Name and Address)</td><td colspan="4">Village electricity committee Don Xayoudom, Keo-oudom district, Vientiane province</td></tr>
<tr><td>Planner:
(Name and address)</td><td colspan="4">Rural Electrification Division and Japan International Cooperation Agency (RED-JICA)</td></tr>
<tr><td>Detailed description of the installation:
(technology, function, benefit for users, etc. max 150 words)</td><td colspan="4">In 1999, the Japan International Cooperation Agency (JICA) supported the Ministry of Industry and Handicrafts in piloting solar home systems and small battery charging station at two provinces: Vientiane and Bolikhamxay. The objectives of the projects were to gain experiences of village electricity management scheme, to demonstrate it acceptability of Lao people and also to draft the master plan for National Rural Electrification with favouring renewable energy resources.
Formed village electricity committee (VEC) was entrusted to manage the installed systems.
The MIH-JICA pilot projects installed solar home system of two sizes (55 Wp and 110 Wp) and BCS of several sizes, between 1-3 kWp.
The Small Solar home system are designed for lighting. The system consists of 55 Wp PV panel with mounting pole, 15 A Charge controller, 110 Ah Car Battery and one 8 W energy saving fluorescent lamp and one 12 V DC wall outlet
All system components were granted by the project and belong to the project. The users will pay for monthly charge. For Solar home system, the users will play 10 US$ for installation fees and 1 US$ for monthly charge. For battery charging station, VEC will manage, operate the system and collecting money from user for charging fee at cost of 0.4 US$ per month of one battery (7 times charging cycle per month). Each month VEC will send Depart of Electricity, MIH the collected money of 30 US$ for station capacity of 3 Kwp and 20 US$ for station capacity of 2 Kwp</td></tr>
<tr><td rowspan="2">Generated Energy service:
(tick off the energy type)</td><td>Electricity</td><td>heat</td><td>gas</td><td>Light</td></tr>
<tr><td>✓ (12V DC)</td><td></td><td></td><td></td></tr>
<tr><td>Power output of installation: (kWel, m³ biogas, kW th, etc.)</td><td colspan="4">55 W</td></tr>
<tr><td rowspan="2">Financing
(tick off the financing type)</td><td>Private investment</td><td>loan</td><td>donation</td><td>grant</td></tr>
<tr><td></td><td></td><td></td><td>✓</td></tr>
<tr><td>Investment costs in US$</td><td colspan="4">The cost of SHS 55Wp of install capacity is around</td></tr>
</table>

Project name:	**MIH-JICA pilot program (monthly charge)**
	550 US$,
Maintenance costs in US$	Around 0.4 US$ per month for distilled water for battery this cost is not include replacement of lamps and other damaged components
Savings:	Around 30 US$ per year saved cost of battery charging (the battery carried by small boat to charge in electrified village, roundtrip takes about 3 hours) or saved kerosene and candles.
Energy sale income in US$:	no
Comments:	The system provides bester light and more convenience for doing activity in night time compare to kerosene or candles. It is easy to operate and not much time taking for maintenance just clean panel in some time, refill distiller water to battery.
Pictures and graphics	
 Solar Home System diagram	 PV panel with support pole

Project name:	**MIH-JICA pilot program (monthly charge)**
	 Battery connected to breaker and Loads.

4.7 Technology a data sheet 7 - Pilot rental solar home system

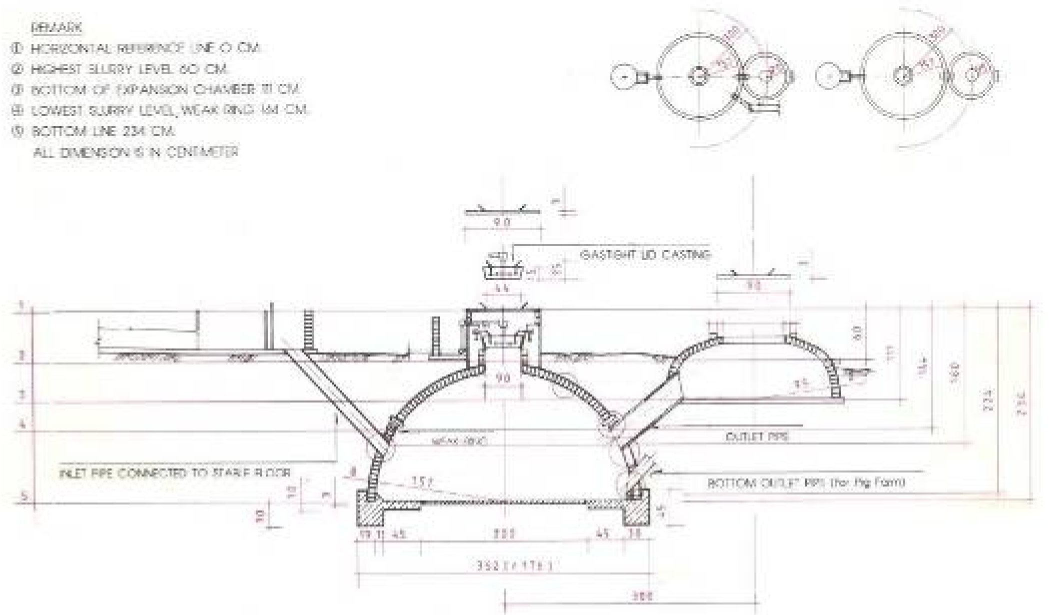
Project name:	**Pilot rental solar home system for income generation**			
Type of project: (tick off the type)	PV	Solar Thermal	Biomass to Energy	
	✓			
Location of the plant	**Lao PDR** Bansorg, Sangthong district, Vientiane capital			
Year of Implementation:	2003			
Operator (Name and Address)	Mr. Bualay and Khamsao Bansorg, Sangthong district, Vientiane capital			
Planner: (Name and address)	Sunlabob rural energy system Co. LTD P.O.Box 9077, Watnak. Vientiane, Lao PDR			
Detailed description of the installation: (technology, function, benefit for users, etc. max 150 words)	Sunlabob has pilot scheme of renting solar PV system to its franchisees to provide installation and maintenance service to render. The system components like PV panel, charge controller and battery is belong to company, user just pay for rental fees that depend on the size of system, as the solar home system sizing of 110 Wp which consists of 110 Wp PV panel, 8 A Stecca Charge Controller, 120 Ah Sealed deep cycle battery and two of 7 W Energy saving lamps. This system are also designed to use AC appliance there 150 Watt AC output was added to for powering to 21” Colour TV, VCD and 20 W of AC lamps. Power from system availability 3 days without sun, 3 hours of power available per day. The user will pay 10 US$ one-time for connection and 15 US$ monthly rent.			
Generated Energy service: (tick off the energy type)	Electricity	heat	gas	Light
	✓ (12V DC)			
Power output of installation: (kWel, m³ biogas, kW th, etc.)	110 w			
Financing (tick off the financing type)	Private investment	loan	donation	grant
	✓			
Investment costs in US$	The cost of the system is 1000 US$ invested by Sunlabob co. The renter will pay 10 US$ for one-time connection, and 15 US$ for monthly rent.			
Maintenance costs in US$	100 US$(Battery), and 60 US$ (Charge controller) if fault, company replaces it without any charges from user. The user is responsible to replaces the lamps.			
Savings:	Around 292 US$ per year saved cost for Diesel for 3 hours daily gen-set running (1litter per day x 0.8 US$/ litter x 365 days).			
Energy sale income in US$:	SHS-user provide entertaining an generate income: 40 US$ per month from evening TV and VCD movies show. Some clever users rent bigger SHS and then provide movie shows at night for fees. Village technicians (Sunalbob franchisees) get			

Project name:	**Pilot rental solar home system for income generation**
	commissions from Sunlabob, e.g., 20% of 15$ monthly fee and 10$ of an one-time connection fees for this system
Comments:	The user is only benefit from using solar home system in household but also using it to generate income.
Pictures and graphics	
 Solar Home System components for 110 Wp system size, designed to use with AC colour TV and VCD player.	 VCD playing with colour TV powered by Solar PV

4.8 Technology Data Sheet 8 - Lao-Chinese Cooperation program's biogas plants

Project name:	**Lao-Chinese Cooperation program's biogas plants**				
Type of project: (tick off the type)	PV	Solar Thermal	Biomass to Energy		
			x		
Location of the plant:	**Lao PDR** Nongphouvieng village, MaiPakngum district, Vientiane municipality				
Year of Implementation:	2004				
Operator: (Name and address)	Local Farmers, with support from village technician				
Planner: (Name and address)	Chinese Technicians, (address is not available)				
Detailed description of the installation: (technology, function, benefit for users, etc. max 150 words)	The Lao-Chinese Cooperation program's has disseminated 30 family size biogas plants including the installations and equipment for biogas use for lighting and cooking in the Nongphouvieng village. This village is characterizes by small-scale pig farming. The biogas plants are fed with the manure of 3-6 pigs. The produced Biogas is used for cooking and lighting. The biogas plants' owners also use slurry as organic fertilizer for growing vegetables for own needs and for sale to merchant from capital city, therefore get additional income besides of selling pigs. The installed fixed dome type biogas plants (see graphic below) are characterized by relatively easy installation because of using ready mold and concrete, where no needs of highly skilled workmanship.				
Generated Energy service: (tick off the energy type)	electricity	heat	gas	light	
		x	x	x	
Power output of installation: (kWel, m³ biogas, kW th, etc.)	Biogas production:797,7 m³/year				
Financing (tick off the financing type)	private investment	loan	donation	grant	
			x		
Investment costs in US$	450 US$				
Maintanance costs in US$	.. US$				
Savings:	4 US$/month By saving the purchase of charcoal for cooking. Monthly demand without biogas: 2 bags á 20.000 kip/bag				
Energy sale income in US$:	no				
Comments:	Plants are in a perfect condition. Other farmers in the village are interested in getting a biogas plant too. The farmers miss access to spare parts, e.g. the incandescent mantles for the gas lamps. Therefore, they do not use the gas lams frequently. They use ordinary neon lamps in stead. (see picture)				
Pictures and grafics					

Project name:	**Lao-Chinese Cooperation program's biogas plants**



Scheme of the fixed dome biogas plant

Biogas cooker with gas pipeline and pressure measurement divice

Gas lamp

Digester

Pig stable

4.9 Technology data sheet 9- Improved cook stove

<table>
<tr><td>Project name:</td><td colspan="3">PAEK IMPROVED STOVE PROJECT</td></tr>
<tr><td rowspan="2">Type of project:
(tick off the type)</td><td>PV</td><td>Solar Thermal</td><td>Biomass to Energy</td></tr>
<tr><td></td><td></td><td>X</td></tr>
<tr><td>Location of the plant:</td><td colspan="3">PAEK, Xiengkhuang Province</td></tr>
<tr><td>Year of Implementation:</td><td colspan="3">2007</td></tr>
<tr><td>Operator:
(Name and address)</td><td colspan="3">Lao Women's Union and Science of Paek District, Technology and Environment Office, Xiengkhuang Province</td></tr>
<tr><td>Planner:
(Name and address)</td><td colspan="3">Technology Research Institute, Vientiane, Lao PDR</td></tr>
<tr><td>Detailed description of the installation:
(technology, function, benefit for users, etc. max 150 words)</td><td colspan="3">An improved version of the traditional wood fuel stoves was developed in the eighties in Thailand and the technology was subsequently transferred to Cambodia as well as Laos (Vientiante only). Technically, the stoves, although looks to a certain extent similar, have distinct differences to common ones such as:
• The Improved Stove has a fixed number (many more than the traditional stove) of air holes in the grate which improves combustion
• The improved version has standard sized pot rests, measuring from 1 cm to 2 cm based on the stove size.
• The improved version has a higher fuel efficiency compared to the traditional stove
• The improved version saves time compared to traditional stove
• The improved version burns better and faster, and has lower emissions
• The improved version has a much thicker refractory liner in the combustion chamber
• The improved version has much lower pot rests for maximum heat transfer to the cooking pot
• The improved version has a thicker insulation layer out of rice husk ash between the ceramic part and the metal bucket
• The improved version has a metal bucket which covers completely the ceramic par and has a robust handle which facilitates moving the stove around and consequently the lifetime of the improved stove is longer (1-2 years versus 6 months in average for the traditional version)
In the first step of the project, 60 improved cook stoves were bough in Vientiane and brought selected users who were interested in participating in the demonstration programme. They had to provide information on their experience using the improved stove in comparison with the traditional stove to the project and people around their home. The total cost of improved stove reached to Xiengkhuang province is 3 $US per stove.
The second step the local stove producers were trained by the project, Now improved stove is produced locally and commercially by market assistance form Peak Women Union, at cost</td></tr>
</table>

<table>
<tr><td>Project name:</td><td colspan="5">PAEK IMPROVED STOVE PROJECT</td></tr>
<tr><td></td><td colspan="5">around 2.2-2.8 $US.</td></tr>
<tr><td rowspan="2">Generated Energy service:
(tick off the energy type)</td><td>electricity</td><td>heat</td><td>gas</td><td>light</td><td></td></tr>
<tr><td></td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Power output of installation: (kWel, m³ biogas, kW th, etc.)</td><td colspan="5">2-3 kW_{th} per stove</td></tr>
<tr><td rowspan="2">Financing
(tick off the financing type)</td><td>private investment</td><td>loan</td><td>donation</td><td colspan="2">grant</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">X</td></tr>
<tr><td>Investment costs in US$</td><td colspan="5">Total project costs are 17,880 Euro for the introduction of 3,000 improved stoves</td></tr>
<tr><td>Maintanance costs in US$</td><td colspan="5"></td></tr>
<tr><td>Savings:</td><td colspan="5">Fuel wood savings of about 35-50%</td></tr>
<tr><td>Energy sale income in US$:</td><td colspan="5"></td></tr>
<tr><td>Comments:</td><td colspan="5">The project is in the initial stages of implementation but the enthusiasm of the users (housewives) is high as they see the benefits of the improved stoves in terms of reduced fuel wood use which in turn reduces the time needed to collect fuel wood or reduces the costs in cases where fuel wood is bought.</td></tr>
<tr><td>Pictures and grafics</td><td colspan="5"></td></tr>
</table>

Traditional stove

Improved stove

Traditional stoves in the kitchen

Used stove with contaminations