Final Report

Solar PV plants in Lao PDR

prepared by

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1 Background

Solar energy is among the huge renewable energy resources in Lao PDR, with annual sunshine about 2.000 – 2.600 hours and annual solar radiation is estimated at 1600-1700 kWh/ m^2 (NASA SSE data).

2 History of solar PV application in Lao PDR

The first PV systems have been introduced in Lao PDR since early 1980s by telecommunication companies and then international development programs, mainly to supply electricity for telecommunication systems, vaccine storage and lighting in remote or off-grid areas. Since then PV technology has become more and more popular in remote rural areas. In general, two main categories of PV systems users in Lao PDR are Telecommunication systems and off-grid electrification programs.

2.1 Telecommunication systems

Since middle of 1980s, telecom companies have started to use PV systems for power supply to telecommunication devises, such as telecom substation or microwave repeaters. Usually, telecom systems voltage is 48 V or higher, with bank of deep cycle maintenance-free batteries and inverter. In some cases, inverter-combiner is used when PV systems are installed as stand-by power source for diesel gen-set. The panels usually are imported from China, while inverters/combiners are made in Europe.

2.2 Off-grid rural electrification programs

In order to leave status of a Least Developed Country (LDC) by 2020, Government of Lao PDR (GoL) has to achieve electrification rate of 90% of population by 2020. Rural electrification is the one of the highest priorities in menu of rural development in Lao PDR.

Currently, rural electrification has been promoted mainly by grid extension with hydropower as a main energy resource. But when electrification moves to remote areas, where very low power demand, under developed infrastructure and difficult geographical conditions, grid extension becomes less economically viable.

In response, GoL turned to promote off-grid electrification with favouring renewable energy resources in remote rural areas. According to estimation made by the Rural Electrification Division (Department of Electricity-DOE, Ministry of Industry & Handicraft, MIH), the number of households to be served by off-grid electricity is about 150.000 (RED/MIH, 2004). That means, not less then 10.000 households are to be electrified by off-grid option annually.

3 Some remarkable achievements in promotion of PV technology in Lao PDR

3.1 Solar PV for telecommunication systems

Up to year 2003, communication companies have installed more than 122.000 Wp of solar systems (MIH, 2003), to supply electricity to telecom substations or repeaters in remote or off-grid areas.

3.2 TRI/STEA demonstration projects (1997-2000)

Since 1997, Technology research Institute under the Science, Technology and Environment Agency (TRI/STEA) has started several solar PV projects (TRI report, 2004). The objectives of the projects were to demonstrate viability and feasibility of PV technology application in Lao PDR.

3.2.1 Solar Battery Charging Station (BCS).

The project was to show viability of solar PV systems in Lao conditions; as well as to find out management scheme for village energy system and raise public awareness on renewable energy technologies. Two BCS - 1775Wp funded by the Lao-Canadian-Thai Trilateral Environment program (CTTE) and 1875 Wp funded by the Swedish International Development Agency (SIDA) were installed by TRI. Both systems are designed for 45 households. Each household (user) is equipped with house kit, including battery (80 Ah for the first BCS and 85 Ah for the second one), one or two Direct Current (DC) saving lamp and assigned a certain day for charging the battery. User pays monthly fee (about 1,5 US$ per household) for covering system's administration.

The equipment was installed by TRI technicians and then handed over to village authority. Village committee hereby was formed thereby to handle system's management and tariff collecting. Village technician was briefly trained on systems maintenance and troubleshooting.

3.2.2 Combined Solar Home-Battery Charging Station systems (SH-BC system).

This system was intermediate between solar home system and village battery charging station. Each SH-BC system consists of 240 Wp Solar panels and is designed for a group of 7 households, closely located:

- The house which attached panels and charge-controller is called **a Key House**.
- The other 6 houses called **a Satellite House**. Each satellite house is equipped with discharge controller, DC socket and some saving DC lamps.

The charge controller was specially designed so that it can charge 3 batteries at one time: one battery for use in the key house, the two others – are standby for satellite houses. To charge a battery, each satellite house needs to do only one trip: in a day assigned to him, he

carries his battery to the key house and takes back home a standby one, which is already fully charged during previous days.

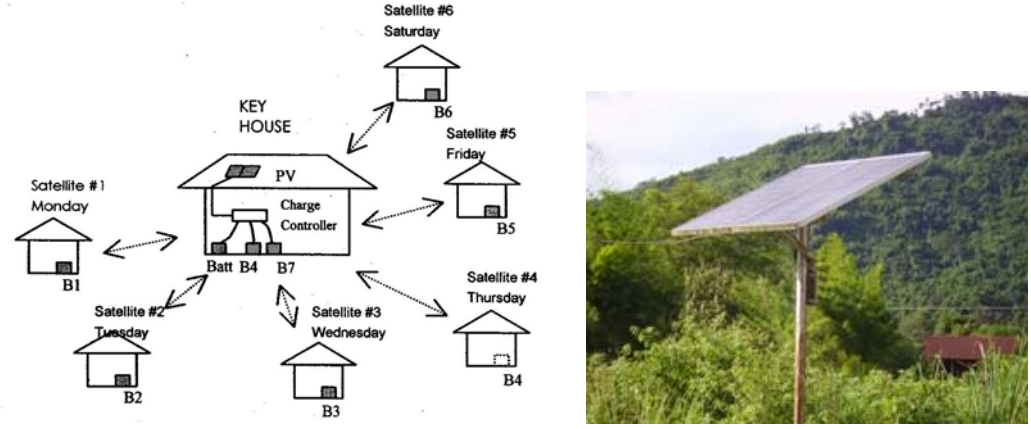

Figure 3-1 Principle of Solar Home – Battery Charging system

Per household capital cost of SH-BCS is lower than cost of SHS, but is higher than that of village BCS.

The main advantage of SH-BCS is users' convenience: closer to user house, flexible charging process, lower capital cost. But the main disadvantage of this system is probably its more complex management scheme: to have to deal with many key-house managers (15 in this pilot project) instead of one manager as in case of village BCS. So, it is difficultly to keep service standard as the same high as for all systems.

These SH-BC were in service only for less then two years and have been evacuated due to grid connection of the target area.

3.3 MIH-JICA pilot project (1997-2002)

In 1999, the Japan International Cooperation Agency (JICA) supported the Ministry of Industry and Handicrafts (MIH) in piloting solar home systems and small battery charging stations at two provinces: Vientiane (more prosperous) and Bolikhamxay (less prosperous). 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. Briefly trained village electrician(s) assists VEC with daily maintenance and troubleshooting of solar systems.

Figure 3-2 Electric lamp gives better lighting and helps extending times for income generating activities

The MIH-JICA projects found relatively high acceptability and willingness of people to obtain PV systems by rural people, however, high initial costs of PV systems and low income of major rural people may hinder quick spread of PV systems use in rural areas.

Therefore, for successful promotion of PV systems in rural areas, as suggested in the Drafted Master plan for Rural Electrification of Lao PDR, there should workout an appropriate financial support mechanism and technology options that suit reality of Lao rural areas.

The MIH-JICA pilot projects installed solar home systems of two sizes (55 Wp and 110 Wp) and BCS of several sizes, between 1-3 kWp.

3.4 MIH-WB off-grid pilot program (1999-2004)

Since 1999, Ministry of Industry and Handicraft (MIH) has managed the soft-loan from the World Bank (WB) to finance solar home systems, village hydro and small gen-set by applying **rent-to-buy** mechanism. In case of solar home systems (SHS) the villagers are prospective owners of the systems. Villagers buy systems by monthly repayment with repayment period from 5 to 10 years. Systems installation and maintenance service are performed by trained village technicians. Newly formed or existing Local Electricity Service Company (ESCO) has responsibility to support village technician with their installation and maintenance service. The Village Electricity Advisory Committee (VEAM) is formed in each target village and to play advisory role to village electrification strategy and implementation.

Figure 3-3 Rent-to-buy solar home systems consist of solar kit (solar panels, outdoor wiring, mounting pole and charge controller) and house kits (indoor wiring, saving lamps, car battery and battery box)

Figure 3-4 Application of SHS can be: Lighting for handicraft production, education and entertainment

The strong points of the rent-to-buy scheme:

- Smart hardware subsidy (up to about 50%), soft loan support with long repayment term make repayment affordable for majority of rural population.
- Well-designed financial mechanism, applying financial incentives as management tools

The weak point of this approach, perhaps included in the following:

- Systems installation and maintenance are performed by village technicians, whose skills and capacity may not yet be mastered during short training and practice. Quality of their service may not as high as required for PV system and, therefore, long-term sustainability and reliability of the systems are still doubtful.
- Incentives are not strong enough to involve private sector investment into this business, where, for example, long term investment versus low profitability.

the largest state electricity utility-Electricity du Laos was involved into project for the beginning stage (1999-2001), then since 2001, the project was transferred to the Off-grid Promotion and Support Office (OPS) under authority of Department of Electricity (MIH).

To date, over 5200 solar home systems have been installed or being purchasing by this scheme.

3.5 Sunlabob Solar PV systems (2002-present)

Sunlabob rural electrification systems Co. LTD is the only registered company in Laos, which is specialized on rural electrification by using renewable energy resources. Installation and sale of community solar PV systems, solar fridge for vaccine storage, solar home systems, etc, are among business service of Sunlabob.

Two typical systems offered by Sunlabob are **Community system** and **Rented Solar home systems**.

Figure 3-5 Community solar system: Ban Kuay health post

Figure 3-6 Possible appliance of community PV system

To date, Sunlabob has sold / installed around 948 community systems, with total installed capacity about 60kWp and sized from 10 Wp up to several kWp (these information are courtesy by Sunlabob Co.). Usually, these systems are installed as a component of various rural development projects, funded by in Lao PDR accredited international organizations.

Sunlabob installed Community systems for such purposes as health post vaccine storage and lighting, community water pumping systems, telecommunication, etc

Figure 3-7 Rented Community solar water pumping system

Since 2003, Sunlabob has started piloting rented PV systems. The objective of the project was to pilot another approach of off-grid rural electrification, by renting power systems. Rural people do not have to make any significant initial investment, but just pay for used electricity on regular basis, while systems remain property of the electricity service company. The service company also do installation and after installation (maintenance & repair) service.

The strong point of this approach: all works, such as installation, regular maintenance service are performed by electricity Service Company through its network of well-trained skilled franchisees, so that high satisfaction of service is always guaranteed. Also, in order to achieve long-term sustainability and reliability, usually high-quality equipment is installed, and that more reliable service provides.

The weak point of rental systems is that relatively high monthly rent may limit its market within wealthy portion (approximately 10%) of rural people only.

Figure 3-8 Rental Solar Home systems

Figure 3-9 Possible Applications of larger scale of solar home system (with entertainment)

Figure 3-10 Larger rented solar PV system helps directly generating income by TV and Movies shows

Figure 3-11 Installation and maintenance service are performed by well trained technicians, operating systems as franchisees of Sunlabob Co.

So far about 925 solar home systems with total capacity of 24,610 Wp have been already rented in different parts of the country. Prospective targets for grid extension and more prosperous rural areas are among favourable areas for renting power systems.

4 PV applications in Laos

Type of project,	Location of the plant	Planner-Backer	Year of Implementation:	energy type to be generated	Type of system	total installed capacity, (Watts)
Telecommunication system						
Solar PV for Communication (microwave repeaters and substations)	All provinces of Lao PDR	LTC/MCTPC	Since 1980s	electricity for communication systems	stand alone or hybrid systems	122.000 Wp (MIH, 2003)
TRI's demonstration systems						
Demonstration Solar BCS	Savannakhet province	TRI-SIDA TRI-CTTE	1997	Electricity	Community Battery charging station	1.875+1.775= 3.650 W (2 BCS)
Demonstration Solar Home – BC System	Vientiane municipality	TRI-NEDO	2001	Electricity	Solar home-Battery charging station	15 SHBC x 240 Wp = 3.600 Wp
MIH-JICA's pilot systems						
Pilot BCS	Bolikhamxay province	MIH-JICA	1999	Electricity	Battery Charging station	254 SHS
Pilot 55 WpSHS & 110 WpSHS	Vientiane province	MIH-JICA	1998	Electricity	55 Wp SHS 110 WpSHS 1-3 kWp BCS	152x55WpSHS 102x110WpSHS 3 BCS(3165Wp)
Pilot BCS	Bolikhamxay province	MIH-JICA	1998	Electricity	BCS	1x3kWp BCS 1x2kWpBCS
MIH-WB's pilot systems						
Rent-to-buy solar home systems	Vientiane province	EDL- MIH-WB	1999-2001	Electricity for lighting and entertainment	stand alone SHS	11 villages (~ 40 SHS)
Rent-to-buy solar home systems	Luang Namtha province	MIH-WB	2000	electricity for lighting and entertainment	stand alone SHS	901 households in 32 villages

Type of project,	Location of the plant	Planner-Backer	Year of Implementation:	energy type to be generated	Type of system	total installed capacity, (Watts)
Rent-to-buy solar home systems	Oudomxay province	MIH-WB	2001-2004	electricity for lighting and entertainment	stand alone SHS	1.133 SHS in 44 villages
Rent-to-buy solar home systems	Xayaboury province	MIH-WB	2001-2004	electricity for lighting and entertainment	stand alone SHS	346 SHS in 6 villages
Rent-to-buy solar home systems	Xiengkhouang province	MIH-WB	2001-2004	electricity for lighting and entertainment	stand alone SHS	192 SHS in 2 villages
Rent-to-buy solar home systems	Vientiane province	MIH-WB	2001-2004	electricity for lighting and entertainment	stand alone SHS	867 SHS in 22 villages
Sunlabob's systems						
Community system	Remote areas of Lao PDR	Sunlabob Co.	since 2001	electricity for health post, school, private home, etc	Stand alone solar community systems	948 systems, capacity of 59.941 Wp
Pilot, Rented solar (PV) home system	Vientiane mun., Xiengkhouang, Vientiane, Bolikhamxay, Khammuane, Champasak & Sekong provinces	Sunlabob Co.	2003-present	electricity for lighting and entertainment	Stand alone solar home system	925 systems with total installed capacity of 24,610 Wp

BCS: Battery Charging Station
SHS: Solar Home System
TRI: Technology research institute
STEA: Science, Technology and Environment Agency
RETC: Renewable Energy Technology Centre
CTTE: Canadian-Thai Trilateral Environment project
NEDO: New Energy & Industrial Development organization
JICA: Japan International Cooperation Agency
SIDA: Swedish International Development Agency
MCTPC: Ministry of Communication, Transport, Post and Construction
LTC: Lao Telecom
MIH: Ministry of Industry & Handicraft
EDL: Electricite du Laos
SHBC: Solar home - Battery charging systems
InWent: Internationale Weiterbildung und Entwicklung gGmbH

5 Data Sheets of selected PV plants

5.1 TRI/STEA demonstration projects (1997-2000)

Type of project:	Pilot
Location of the plant:	Dong Phosy, Naxaithong district, Vientiane municipality
Years of Implementation:	
Operator: (Name and address)	Key house owner
Planner: (Name and address)	TRI-NEDO cooperation project
Description of the technology: (name, function, supplier)	Solar home – Battery charging system includes two components: **Key House:** 2 x 120 Wp Solar Panel 1 x 20 A Charge Controller, which is to charge 3 batteries at one time 1 x mounting pole 3 x 70 Ah Car battery 1 FL x 10 W DC socket (for 25 W B/W TV) **Satellite House:** 1 x discharge controller 1 x 70 Ah battery 1 FL x 10 W DC socket (for 10 W Radio)
Energy service to be generated: (like electricity, light, heat, etc.)	Electricity for lighting and small entertainment appliances (B/W TV, Radio-cassette player) for 7 houses
Plant type: (grid connected, stand alone, solar home system, hybrid)	Stand alone solar home – battery charging system
Producer of modules	Sharp corporation
Amount of modules	2
Total module area	1,4 m²
Power output of installation: (kW or others like light generation)	240 Watt
Nominal voltage:	12 V
Number of inverter:	0

Income from enery service:	no
Saving from energy service:	24 US$/year Saved costs of battery charging at far away electrified area, Kerosene or Candles
Uptime of installation: (meaning availability of service in the day, e.g. solar lamp at night)	Usually power availability within 3 days without sun, 3 hours of power available per day
Investment costs:	(granted)
Yearly service costs of operation: (e.g. lubrication oils, battery fluid)	10 US$/year Battery fluid
Labour intensity per power unit or year: (amount of work per kWh or year)	Not labour intense automatic charge control
Labor costs: (costs of a correctly skilled operator per day, month or year)	none
Technically critical part: (most likely to fail part, like engine in gen-set or battery in solar home system)	Battery and charge-discharge controller
Costs of technically critical part: (costs of that part)	120 US$ 3 Batteries

5.2 MIH-JICA pilot project (1997-2002)

Type of project:	Pilot
Location of the plant:	Don Xayoudom island, Vientiane province
Years of Implementation:	1999-2003
Operator: (Name and address)	village electricity committee, Don Xayoudom island, Keooudom district, Vientiane province
Planner: (Name and address)	RED-JICA
Description of the technology: (name, function, supplier)	Solar home system including: 1 x 55 Wp Solar Panel 1 x 15 A Charge Controller 1 x mounting pole 1 x 110 Ah Car battery 1 x 8 W Energy saving fluorescent lamps 1 x DC 12 V wall outlet
Energy service to be generated: (like electricity, light, heat, etc.)	Electricity for lighting and small entertainment appliances (B/W TV, Radio-cassette player)
Plant type: (grid connected, stand alone, solar home system, hybrid)	Stand alone solar home system

Producer of modules	Sharp Corp.,
Amount of modules	1
Total module area	0,78 m²
Power output of installation: (kW or others like light generation)	55 Watt
Nominal voltage:	12 V
Number of inverter:	0
Income from enery service:	no
Saving from energy service:	24 US$/year Saved home energy expenses – Kerosene, battery charging in electrified areas ~ 2 US$/month
Uptime of installation: (meaning availability of service in the day, e.g. solar lamp at night)	Usually power availability within 3 days without sun, 3 hours of power available per day
Investment costs:	525 US$
Yearly service costs of operation: (e.g. lubrication oils, battery fluid)	5 US$/year Battery fluid
Labour intensity per power unit or year: (amount of work per kWh or year)	Not labour intense automatic charge control
Labor costs: (costs of a correctly skilled operator per day, month or year)	none
Technically critical part: (most likely to fail part, like engine in gen-set or battery in solar home system)	Battery and charge controller
Costs of technically critical part: (costs of that part)	40 US$ Battery

5.3 MIN-WB off-grid pilot program (1999-2004): Rent-to-buy Solar Home System

Type of project:	Pilot
Location of the plant:	516 None Savang, Keooudom disrict; Vientiane province
Year of Implementation:	2003
Operator: (Name and address)	Mr Bounthan, Sengsavng ESCO, Thalad town, Keooudom district, Vientiane province
Planner: (Name and address)	Off-grid Promotion Office, Rural Electrification Division (DOE/MIH) Ban Phai, Vientiane, Lao PDR
Description of the technology: (name, function, supplier)	Solar home system including: 1 x 20 Wp Solar Panel 1 x 3 A Stecca Charge Controller 1 x mounting pole 1 x 40 Ah Car battery 2 x 7 W Energy saving lamps
Energy service to be generated: (like electricity, light, heat, etc.)	Electricity for lighting and small radio
Plant type: (grid connected, stand alone, solar home system, hybrid)	Stand alone, solar home system
Producer of modules	Chinese company
Amount of modules	1
Total module area	0,25 m²
Power output of installation: (kW or others like light generation)	20 Watt
Nominal voltage:	12 V
Number of inverter:	no
Income from enery service:	no
Saving from energy service:	30 US$/year Saved cost of Battery charging (the batteries are carried by small boat to charge in electrified village, roundtrip takes about 3 hours); or saved Kerosene and Candles
Uptime of installation: (meaning availability of service in the day, e.g. solar lamp at night)	3 hours of power available per day
Investment costs:	15 $ initial payment (installation fees) Monthly payment: 2 $ and 1 $ for 5- and 10-

	year repayment period respectively
Yearly service costs of operation: (e.g. lubrication oils, battery fluid)	0 US$/year User refills battery fluid by himself
Labour intensity per power unit or year: (amount of work per kWh or year)	Not labour intense automatic charge control
Labor costs: (costs of a correctly skilled operator per day, month or year)	not applied, (Users operate systems them selves)
Technically critical part: (most likely to fail part, like engine in genset or battery in solar home system)	Battery and charge controller
Costs of technically critical part: (costs of that part)	from 6-14 US$ per year depending on how carefully the system is used Battery

5.4 Sunlabob rental systems (2002-present)

5.4.1 Community Solar PV system

Type of project:	Full scale rental PV system
Location of the plant:	Ban Kuay village, Sangthong district, Vientiane municipality
Year of Implementation:	2004
Operator: (Name and address)	Mr Khamsao and Mr. Bualay, technicians from near by Bansorg village, Sangthong distirct, Vientiane municipality
Planner: (Name and address)	Sunlabob rural energy system Co. LTD P.O.Box 9077. Watnak. Vientiane, Lao PDR
Description of the technology: (name, function, supplier)	2 x 110 Solar Panels, 1 x 20/20 Stecca Charge Controller Mounting pole and panels frame 2 x 150 Deep cycle sealed maintenance free batteries 5 x 7 W Energy saving lamps 1 x 50 L STECA vaccine storage
Energy service to be generated: (like electricity, light, heat, etc.)	Electricity for village clinic lighting and vaccine fridge
Plant type: (grid connected, stand alone, solar home system, hybrid)	Stand alone
Producer of modules	Suntech-power Co., Ltd
Amount of modules	2 x 110 Wp

Total module area	2 x (0,8x1,4) =2,24 m²
Power output of installation: (kW or others like light generation)	220 Watt
Nominal voltage:	12 V
Number of inverter:	0
Income from enery service:	no
Saving from energy service:	About 20 US$/month or 240 US$/year Saved expenses on recharging Battery bank in electrified village (16 km far away); Kerosene or Candles
Uptime of installation: (meaning availability of service in the day, e.g. solar lamp at night)	3-4 hours of power available per day for lighting and 24 hours for vaccine fridge, within 3 days without continuously sunshine,
Investment costs:	2,890 US$ (including solar system and 50 L vaccine fridge)
Yearly service costs of operation: (e.g. lubrication oils, battery fluid)	no (sealed maintenance-free batteries are used)
Labour intensity per power unit or year: (amount of work per kWh or year)	Not labour intense automatic charge control
Labor costs: (costs of a correctly skilled operator per day, month or year)	none
Technically critical part: (most likely to fail part, like engine in genset or battery in solar home system)	Battery (to be replace in 5 years) and charge controller (between 8-10 years)
Costs of technically critical part: (costs of that part)	80 US$ for Battery 120 US$ for charge controller

5.4.2 Rented Solar Home System

Type of project:	Pilot
Location of the plant:	Bansorg, Sangthong district, Vientiane municipality
Year of Implementation:	2003
Operator: (Name and address)	Mr. Bualay and Mr Khamsao Bansorg, Sangthong district, Vientiane municipality
Planner: (Name and address)	Sunlabob rural energy system Co. LTD P.O.Box 9077. Watnak. Vientiane, Lao PDR
Description of the technology:	Solar home system including:

(name, function, supplier)	1 x 110 Wp Solar Panel 1 x 5 A Stecca Charge Controller 1 x mounting pole 1 x 120 Ah Sealed deep cycle battery 2 x 7 W Energy saving lamps
Energy service to be generated: (like electricity, light, heat, etc.)	Electricity for lighting and radio
Plant type: (grid connected, stand alone, solar home system, hybrid)	Stand alone, solar home system
Producer of modules	Suntech-power Co., Ltd
Amount of modules	1
Total module area	0,25 m²
Power output of installation: (kW or others like light generation)	150 Watt AC output (21" colour TV, VCD) 20 W DC lamps
Nominal voltage:	12 V
Number of inverter:	1
Income from enery service:	40 US$ per month from evening TV and VCD movies shows
Saving from energy service:	~ 230 US$/year Diesel for 3 hrs daily gen. set running (1 litters per day x 0,65 $/L x 365 days)
Uptime of installation: (meaning availability of service in the day, e.g. solar lamp at night)	Availability 3 days without sun, 3 hours of power available per day
Investment costs:	10 US$ one-time connection fees, and 15$ monthly rent
Yearly service costs of operation: (e.g. lubrication oils, battery fluid)	15 $/month x12 months = 180 US$/year monthly rent
Labour intensity per power unit or year: (amount of work per kWh or year)	Not labour intense automatic charge control
Labor costs: (costs of a correctly skilled operator per day, month or year)	village technicians get their margins from total monthly rents
Technically critical part: (most likely to fail part, like engine in genset or battery in solar home system)	Battery and charge controller
Costs of technically critical part: (costs of that part)	100 US$ (battery) and 60 $ (Charge controller) If fault, company replaces it without any charges from users

5.4.3 Solar PV water Pumping system for rural community

Type of project: (R&D, pilot scale or full scale)	Pilot scale
Location of the plant:	Bansorg, Sangthong district, Vientiane municipality
Year of Implementation:	2005
Operator: (Name and address)	Mr. Bualay and Khamsao Bansorg, Sangthong district, Vientiane municipality
Planner: (Name and address)	Sunlabob Rural energy system Co.LTD P.O.Box 9077. Vientiane, Lao PDR www.Sunlabob.com
Description of the technology: (name, function, supplier)	Community Solar PV water pumping system 4 x Solar panels 1 x Water Pump set (ETAPUMP & Controller, Lorentz) Water tank V = 16.000 L Water pipes + taps Delivery water pipes
Energy service to be generated: (like electricity, light, heat, etc.)	Electricity to drive water pump from a river (35 m delivery head)
Plant type: (grid connected, stand alone, solar home system, hybrid)	Stand alone water pumping system
Producer of modules	Suntech – power Co., Ltd (China)
Amount of modules	4
Total module area	3.8 m²
Power output of installation: (kW or others like light generation)	4 x 110 = 440 Watt
Nominal voltage:	24 V
Number of inverter:	0
Income from enery service:	Pumped water is to be distributed among villagers, who have to pay monthly fees (about 10.000 kips)[1] for used water
Saving from energy service:	saved times and labour of women and children for carrying water from the river
Uptime of installation: (meaning availability of service in the day, e.g. solar lamp at night)	Water pumping for about 6 hours daily and serves villagers during the day through distribution pipe-network and faucets

[1] These monthly fees are under negotiation between Sunlabob and village authority.

Investment costs:	5.200 US$ (PV+Pump set, here not included costs of water tank construction materials, and water distribution components)
Yearly service costs of operation: (e.g. lubrication oils, battery fluid)	~ 10 US$ / year (lubrication oil)
Labour intensity per power unit or year: (amount of work per kWh or year)	none
Labor costs: (costs of a correctly skilled operator per day, month or year)	**5** US$/month (labour charges for two village technicians)
Technically critical part: (most likely to fail part, like engine in genset or battery in solar home system)	Water pump (imported from Europe)
Costs of technically critical part: (costs of that part)	1.800 US$ /year