Empowered lives.
Resilient nations.

RENTING LIGHTING SERVICES: PAYING FOR THE SERVICE AND NOT THE HARDWARE

Towards an 'Energy Plus' approach for the poor: A review of good practices and lessons learned from Asia and the Pacific

Case Study 14

ENVIRONMENT AND ENERGY

We would like to take this opportunity to recognize Sunlabob Renewable Energy Ltd, the enterprise behind the energy sector project described in this report. In addition, the project would not have been possible without the co-operation of the Government of Lao People's Democratic Republic.

"UNDP partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. On the ground in 177 countries and territories, we offer global perspective and local insight to help empower lives and build resilient nations."

Cover photo courtesy of UNDP/Energy Access for Poverty Reduction

Contents

Acronyms iii

Synopsis v

Acknowledgements vi

Preface viii

1. Background 1

1.1 Geographic and economic context 1

1.2 Energy access in Lao PDR 1

1.3 Barriers to energy access in Lao PDR 2

1.4 Energy sector in Lao PDR: policies, programmes and the institutional framework 2

2. Project overview 3

2.1 Background on the company 3

2.2 Project concept 3

2.3 Institutional arrangements, project partners and funding 4

3. Implementation strategy for the SLRS scheme 5

3.1 Main actors and responsibilities 5

3.2 Implementation process 5

3.3 Product and delivery details 6

3.4 Financing mechanisms 7

3.5 Socially and environmentally responsible supply chain 8

3.6 Local participation 8

3.7 Capacity development 9

3.8 Project costs 9

4. Impacts 10

4.1 Implementation to date and future targets 10

4.2 Case studies 10

4.3 Income and livelihood impacts (MDG 1) 11

4.4 Improving gender equality (MDG 3) 12

4.5 Ensuring environmental sustainability (MDG 7) 12

4.6 Developing a global partnership for development (MDG 8) 13

4.7 Improving access to telecommunication systems and information 13

5. Sustainability of the SLRS model and potential for replication **14**
5.1 Challenges to the SLRS uptake 14
5.2 SLRS replication in Uganda and Afghanistan 15
5.3 Prerequisites to sustainability and successful replication 15
6. Lessons learned and good practices in expanding energy services for the poor **16**
6.1 Providing a high quality, robust product 16
6.2 Matching service with consumer demand and behaviour 16
6.3 Ensuring a profitable and sustainable business for all stakeholders 17
6.4 Ensuring local ownership 17
6.5 Proactive information dissemination at the highest levels 17
7. Conclusions **18**
References **19**

September 2011

ISBN: 978-974-680-303-8

Acronyms

AFESIP	Agir pour les Femmes en Situation Précaire
APRC	Asia-Pacific Regional Centre
COPE	Cooperative Orthotic and Prosthetic Enterprise
CO_2	Carbon dioxide
CDM	Clean Development Mechanism
CFL	compact fluorescent lamp
DAI	Development Alternatives, Inc.
EdL	Electricité du Lao PDR
GoL	Government of Lao People's Democratic Republic
ICT	information and communication technology
km^2	square kilometre
kW	kilowatt
kWh	kilowatt hour
LAK	Lao kip (currency)
Lao PDR	Lao People's Democratic Republic
LED	light-emitting diode
LIRE	Lao Institute for Renewable Energy
lm	lumen
LPRYU	Lao People's Revolutionary Youth Union
LWU	Lao Women's Union
MDG	Millennium Development Goal
NAST	National Authority for Science and Technology
NGPES	National Growth and Poverty Eradication Strategy
PPP	public-private partnership
RE	renewable energy
REP	Rural Electrification Program (World Bank)
SCU	system control unit
SHS	solar home system

SLRS	Solar Lantern Rental System
SPV	solar photovoltaic
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USD	United States dollar (currency)
UXO	Unexploded ordnance
VEC	village energy committee
VT	village technician
W	watt
WREA	Water Resources and Environment Administration

Synopsis

Project title: Solar Lantern Rental System (SLRS) scheme

Country and region of implementation: Lao People's Democratic Republic (South-East Asia)

Focus area (technology/energy service): Solar photovoltaic lantern (fee-for-service model)

Contact details:
Andy Schroeter
PO Box 9077
Vientiane
Lao PDR
andy.schroeter@sunlabob.com
Tel. +856 21 313 874 / +856 20 551 8016

Duration: 2006-present

Cost: USD 541,695[1]

Project brief: Sunlabob Renewable Energy Ltd., a private company operating in Lao PDR, has been providing rechargeable solar lanterns in rural areas using a fee-for-service rental model. First piloted in 2007, the scheme has sparked substantial interest in other developing countries. As of April 2009, pilot schemes were underway in the Republic of Uganda (East Africa) and the Islamic Republic of Afghanistan (South Central Asia).

The Sunlabob delivery model distributes electricity via rechargeable lanterns which are charged at solar charging stations. A unique feature of the delivery model is that end-users do not pay for the hardware (i.e. the lanterns), but rather for the service (i.e. the charging). This feature enables poor households in off-grid areas to buy hours of solar lighting, offering a cheaper, cleaner and safer alternative to kerosene lamps.[2]

Sunlabob firmly believes in the involvement of local actors as an essential ingredient for the success and sustainability of rural schemes. Members of off-grid communities are key partners in this scheme: the village energy committees provide local governance while village technicians operate charging stations as small businesses.

[1] This figure represents the SLRS cost for Sunlabob Renewable Energy Ltd between 1 January 2008 and 31 December 2009.

[2] The term 'kerosene lamps' is used throughout the report since it is widely understood. However, rural populations in Lao PDR typically use diesel for their lamps.

Acknowledgements

Renting lighting services: Paying for the service and not the hardware is one of 17 case studies which, together with a report titled 'Towards an 'Energy Plus' approach for the poor: A review of good practices and lessons learned from Asia and the Pacific' and an Action Agenda Note, comprise a review of good practices and lessons learned in energy service delivery to the poor. Commissioned and facilitated by the United Nations Development Programme Asia-Pacific Regional Centre (UNDP APRC), this case study identifies key characteristics that have helped poor households and communities gain access to modern energy services, and to derive valuable lessons for future energy access activities. This case study is the product of an intensive collaborative process and we wish to acknowledge the many contributors, without whose generous support this work would have been impossible.

We express special gratitude to the main researcher and writer of the case study, Geraldine Huet, whose expertise and knowledge established the basis of this report. UNDP is also grateful for the informative discussions with Sunlabob members regarding technical, financial and operational components of the project. The Lao Institute for Renewable Energy kindly provided information and advice regarding the Lao rural energy sector, and made valuable contributions to the internal review of the report. UNDP wishes to thank the Lao rural communities that participated in the pilot trials and data collection.

Special thanks to Thiyagarajan Velumail, supported by Soma Dutta, Lara Born and Butchaiah Gadde, for his technical leadership and guidance in the conduct of the 17 case studies.

Felicity Chard, David Galipeau (Chair), Daniela Gasparikova, Arun Kashyap, Faris Khader, Maya Nyagolova and Ashley Palmer of the UNDP-APRC Knowledge Products Review Committee (KRC) kindly provided a final review and endorsement of this publication.

The case study also benefited from the rich and fruitful interactions of the 9-12 November 2009 writeshop participants, including Praveen Arakkal, Expedito Belo, Lara Born, Ivo Besselink, Mamta Chander, Karma Chogyal, Beau Damen, Soma Dutta, Butchaiah Gadde, Geraldine Huet, Thomas Lynge Jensen, Xin Liu, William Mohns, Wattanee Niyomyath, Sunjita Pradhan, Kamal Rijal, Bhupendra Shakya, Bala Ram Shrestha, Kiran Man Singh, Dean Still, Yusuke Taishi, Pia Treichel, Kapila Subasinghe, Vernon Ray Vinluan, Veronica Villavicencio, Julien Wallet-Houget and Sirintharat Wannawong. Special thanks to the writeshop moderators Kamal Rijal and Thiyagarajan Velumail. In addition, the case study benefited greatly from an intensive peer review. Special thanks are due to Sivanappan Kumar of the Technical Advisory Committee for providing a detailed review that guided the finalization of the case study. We would also like to acknowledge Soma Dutta's support to the case writer in preparing the final case study.

UNDP APRC in Bangkok was responsible for the facilitation and conceptualization of the 17 case studies and the associated report. We thank the core team, comprising Saana Ahonen, Aalok Awalikar, Lara Born, Soma Dutta, Butchaiah Gadde, Thomas Lynge Jensen, Pratima Mathews, Wattanee Niyomyath, Thiyagarajan Velumail and Julien Wallet-Houget. Thanks to Sirintharat Wannawong, who has been instrumental in supporting the entire process administratively.

Finally, UNDP would like to thank Nikolai Beresnev and Collin Piprell for their excellent editorial support, and KEEN Publishing Co. Ltd. (Thailand) for logistical support and graphic design.

Martin Krause
Team Leader
Environment & Energy
UNDP Asia-Pacific

Preface

Asia-Pacific has achieved remarkable economic growth and socio-political progress in the past two decades, with almost every country in the region experiencing a concomitant decline in poverty.

Despite this progress, 800 million people in the region remain without access to electricity and almost 2 billion rely on the traditional use of biomass for cooking. While some countries are almost completely electrified, others, including Lao PDR, face economic, geographic and demographic obstacles to electrification. Seventy percent of Lao PDR is mountainous and thickly forested. Currently, 58 percent of households have access to electricity. In urban regions, the electrification rate is 96 percent, compared to 33.3 percent in rural areas without road access.

The poor often live in subsistence economies that do not generate cash surpluses, limiting their purchasing power and opportunities to shift to modern energy services. As a result, they have to invest relatively more of their income and time in obtaining energy, and tend to use traditional energy services and fuels. Women and children are particularly affected, spending many hours a day collecting fuelwood and preparing meals in the kitchen. Smoke from inefficient stoves in poorly ventilated homes kills 1.6 million people worldwide every year; the majority of victims are women and children younger than five years. Indoor air pollution is the fourth-biggest killer in the developing world.

Asia-Pacific countries have applied many cutting-edge practices in providing energy access to the poor, including innovative financing mechanisms. Apart from satisfying basic needs, energy services can act as an instrument to empower women and disadvantaged communities; as an entry point to mobilize communities to take charge of their own development; and, most importantly, as a means to livelihood enhancement and poverty reduction. However, the scale of expansion of energy access projects has been far from sufficient.

UNDP has been working with its country partners to address these energy poverty issues, aiming to meet user needs, broaden energy supply options and link these efforts in achieving the Millennium Development Goals. Between 2009 and 2011, the UNDP APRC reviewed 17 energy access programmes and projects implemented by various development agencies and the private sector in the region. These projects were documented as 17 case studies (including this report), a report titled 'Towards an 'Energy Plus' approach for the poor: A review of good practices and lessons learned from Asia and the Pacific' and an Action Agenda Note. Together, these documents provide practical guidance for policymakers and development practitioners in designing and implementing future programmes and projects that ensure the delivery of low emission, affordable and reliable energy services for poverty reduction.

This case study documents the experience of a private company disseminating rechargeable solar lanterns to off-grid households in rural Lao PDR as an alternative to the use of diesel. By constructing solar charging stations and distributing rechargeable lanterns, Sunlabob uses an innovative method of service delivery: end-users only pay for the charging, rather than for the lanterns themselves. This fee-for-service model effectively enables poor households in off-grid areas to buy hours of solar lighting, offering a cheaper, cleaner and safer alternative to kerosene lamps.

Nicholas Rosellini

Deputy Assistant Administrator & Deputy Regional Director
Regional Bureau for Asia and the Pacific

1. Background

1.1 Geographic and economic context

The Lao People's Democratic Republic (Lao PDR) is a landlocked nation in South-East Asia, bordered by the Kingdom of Cambodia, the Union of Myanmar, the Kingdom of Thailand, the People's Republic of China and the Socialist Republic of Viet Nam. The country proclaimed its sovereignty in 1975, after many years of political instability. Lao PDR is a single-party state ruled by the Lao People's Revolutionary Party. Since 1986, the Government of Lao PDR (GoL) has progressively introduced measures to liberalize the economy. Despite these efforts, Lao PDR remains a least developed country, with a UNDP global Human Development Index rank of 122 out of 169 countries.[3]

Development challenges. Development initiatives in Lao PDR are impeded by geographic and demographic conditions. Seventy percent of the country is mountainous and forested,[4] with a highly dispersed population living largely in remote areas.[5] These areas lack basic social infrastructure, communication, transport links and professional opportunities, and experience higher levels of poverty.[6] Consequently, Lao PDR is currently experiencing the onset of a rural-to-urban shift, with a young population (50 percent under the age of 20) looking for better educational opportunities in urbanized areas.[7] The country also has a relatively low literacy rate, particularly in rural regions without road access (41.1 percent for women and 67.6 percent for men). Lao PDR is also ethnically diverse, with 49 ethnic groups and some 160 subgroups.[8]

Other issues have further slowed national development:

- in 1998, Lao PDR was the third-largest opium producer in the world. By 2005, the GoL managed to reduce opium cultivation by 93 percent and opium addiction by 68 percent. These achievements, however, have necessitated sustainable economic alternatives for former highland opium farmers;[9]
- Lao PDR suffers from a legacy of military conflict, being the most heavily bombed country per capita in the history of warfare.[10] Tonnes of unexploded ordnance (UXO) still contaminate 25 percent of the country, mostly in eastern regions. Cultivation of this land is highly hazardous, and an estimated 300 people are injured or killed every year;[11] and
- the GoL needs to overcome a poor record of transparency, consistency and corruption when dealing with investment and aid.[12]

1.2 Energy access in Lao PDR

Fuelwood is the primary energy source in Lao PDR, supplemented by fossil fuels, charcoal and electricity. Lao PDR imports all its petroleum products.[13]

Currently, 58 percent of households have access to electricity: 50 percent are connected to the regional grids, while 8 percent depend on off-grid mini-hydropower plants, solar photovoltaic (SPV) systems, diesel generators and car batteries.[14] In urban regions, the electrification rate is 96 percent, compared to 33.3 percent in rural areas without road access.[15] The un-electrified

3 UNDP, 2011.

4 Asian Productivity Organization, 2006; Mongabay, 2009.

5 82.9 percent of Lao PDR's population (5.6 million people) live in remote areas, according to the 2005 census. Of the inhabited land area, 75 percent has a population density of fewer than 20 people per km^2 (Messerli et al., 2008).

6 GoL/United Nations Country Team, 2006.

7 WHO, 2008; Messerli et al., 2008.

8 Messerli et al., 2008; Ministry of Planning and Investment, Lao PDR, 2008.

9 WHO, 2008.

10 UXO LAO, 2009.

11 SODI, 2009.

12 Transparency International, 2011.

13 Asian Productivity Organization, 2006.

14 Messerli et al., 2008.

15 WHO, 2008.

households rely on other energy sources, including petroleum products, fuelwood and dung. These households are predominantly situated in the remote areas of the north or along the border with Viet Nam. Over 50 percent of the electricity is used for lighting and appliances such as televisions and radio sets, with very few households using electricity for cooking.

Hydropower accounts for 99.8 percent of the generated electricity, utilizing a small fraction of the national hydropower potential. Most of the generated electricity is exported; however, since Lao PDR does not have a single integrated national grid, some regions simultaneously import electricity from neighbouring countries such as China, Thailand and Viet Nam.[16]

1.3 Barriers to energy access in Lao PDR

Accessibility is a crucial parameter for social, economic and cultural development of rural areas. Beyond the main towns on the Mekong Plain, the country's transport infrastructure is poorly developed. This makes access to remote areas difficult, particularly during the rainy season when many dirt tracks become impassable.[17]

UNDP/Energy Access for Poverty Reduction

Laos villagers with a Sunlabob lantern.

Poverty, being particularly acute in remote areas, presents a major barrier to grid connection and decentralized solutions. Nationwide, 25 districts have been identified as 'poor' and 47 as 'very poor' by the GoL's National Growth and Poverty Eradication Strategy (NGPES).[18]

Renewable energy (RE) infrastructure in the country remains embryonic. The RE private sector is small, comprising few local companies with limited human capacity. Similarly, institutional infrastructure is insufficient, with no single entity responsible for RE at the GoL level. The absence of financial incentives, such as subsidies provided to grid electricity and diesel, results in unfavourable conditions for investment in decentralized RE solutions.

1.4 Energy sector in Lao PDR: policies, programmes and the institutional framework

The GoL has committed to electrifying 70 percent of households by 2010, 80 percent by 2015 and 90 percent by 2020.[19] The GoL recognizes that electrifying the widely dispersed population requires decentralized solutions, as some communities are so isolated that the cost of grid connection is prohibitively expensive.

In 1997, solar energy projects for rural electrification were initiated by the GoL in five districts. Since then, diverse electrification efforts have been undertaken in areas where the grid would not be extended within five to 10 years. The Ministry of Agriculture is running a programme to provide domestic biogas digesters for smallholder livestock farmers. The Technology Research Institute, a GoL organization, is implementing demonstration projects on biogas and biomass technologies and improved cookstoves. Small hydropower is also seen as an appropriate electricity source for domestic use in small villages in remote areas, and a study is currently underway in northern Lao PDR.[20] A national RE policy is currently being drafted, although some energy sub-sectors already have their own RE policies.

[16] Messerli et al., 2008.

[17] MRC, 2008.

[18] Poverty in Lao PDR is measured using both quantitative and qualitative measures. Two quantitative poverty measures are used. The first one is the food poverty line, equivalent to a lack of food security; in Lao PDR, the threshold is 2,100 calories per day per person. The second measure is the overall poverty line, equivalent to a lack of combination of food and non-food necessities (e.g. shelter and clothing). The qualitative measures used rely on the perceptions and views of Lao people about what constitutes poverty (GoL, 2003).

[19] Department of Electricity, 2008.

[20] Asian Productivity Organization, 2006.

The following GoL agencies are involved in the energy sector:[21]

- Ministry of Energy and Mines (Department of Electricity and Department of Energy Promotion and Development);
- Ministry of Industry and Handicrafts;
- Ministry of Agriculture and Forestry;
- Ministry of Commerce;
- Ministry of Communication Transport, Post and Construction;
- Lao National Committee for Energy;
- National Authority for Science and Technology (NAST); and
- Water Resources and Environment Administration (WREA).[22]

Other stakeholders include Electricité du Lao PDR (EdL) – the state-owned utility responsible for the national grid – and international independent power producers such as Electricité de France and Mitsui & Co. In regards to RE, the Lao Institute for Renewable Energy (LIRE) conducts research and development projects and promotes the use of RE sources. Several donor organizations and international non-governmental organizations play a critical role in the design and implementation of energy access programmes.

2. Project overview

2.1 Background on the company

Established in 2000 in Lao PDR, Sunlabob Renewable Energy Ltd. is a private RE company, selling hardware and providing energy services. Sunlabob's team of 42 full-time staff offers a full range of RE solutions, including solar water pumps and heaters, water purification systems, street lighting solutions, cooling units for health posts and solar lanterns.

2.2 Project concept

Sunlabob's SLRS model promotes the use of rechargeable solar lanterns in off-grid areas using a fee-for-service rental model. The SLRS model aims to offer a safe, clean, reliable and affordable alternative to the use of diesel for lighting in the poorest households in isolated off-grid communities.

The model contains two strategies:

- launching and sustaining village enterprises to take charge of system operations; and
- facilitating the uptake of the system by replicating the current habits of villagers for purchasing diesel so they do not have to invest in hardware, but instead only pay a small but regular charging fee.

The SLRS model allows for the sale of light hours rather than the sale of equipment. Users do not need to buy expensive equipment or be responsible for maintaining it. This fosters a relationship to such services similar to that enjoyed in developed economies and urban areas.

[21] Asian Productivity Organization, 2006.

[22] NAST and WREA recently replaced the Science Technology and Environment Agency.

Box 1: Building on experience – lessons learned from disseminating SHSs in Lao PDR

Sunlabob's first rural electrification initiative was renting solar home systems (SHSs) to rural households. An extensive network of franchisees trained in SPV system installation and maintenance was developed.

It soon became clear, however, that even on a rental basis only one third of village households could afford the systems. In addition, SHSs and services needed to be adapted to existing consumer behaviour: collecting rent from end-users on a monthly basis was difficult, since most rural households had irregular, agriculture-based incomes and were not used to putting money aside on a monthly basis. These factors led to Sunlabob winding up its SHS initiative and paved the way for the development of its Solar Lantern Rental System (SLRS) model – the subject of this case study.

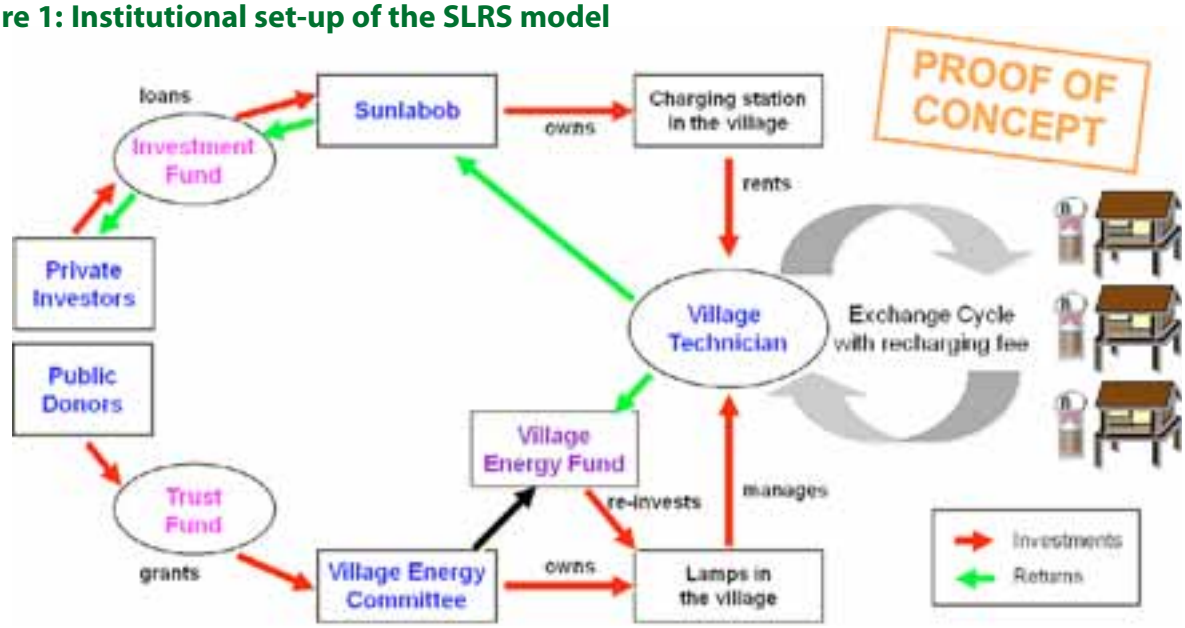
The SHS project gave Sunlabob its first experience with establishing and training village energy committees (crucial for the sustainability of the project at the village level) which were subsequently used in the SLRS model. The SHS experience also taught Sunlabob the importance of involving local individuals ('champions') within local distribution networks in developing new businesses, undertaking collections and maintaining a presence at the provincial level.

The SLRS model was created in 2006 and the first pilot tests in Lao PDR ran through 2007 and 2008. The scheme has now reached Phase 1 of implementation, which comprises the installation, operation and close monitoring of 10 to 12 solar charging stations. These serve as demonstration projects for introducing SLRSs to the larger market in Lao PDR.

2.3 Institutional arrangements, project partners and funding

As a licensed Lao company, Sunlabob has permission to initiate rural electrification projects in the country. However, each individual project initiative must be approved by the authorities of the province and district concerned. Generally, any electrification project in Lao PDR of less than 100 kW comes under the supervision of district authorities; 100-200 kW projects are managed by the province; and projects of more than 200 kW must be coordinated at the national level. Arrangements with other partners are illustrated in Figure 1 and described in detail in Section 3.

Figure 1: Institutional set-up of the SLRS model



3. Implementation strategy for the SLRS scheme

3.1 Main actors and responsibilities

Sunlabob is responsible for installing a solar charging station in each selected village and selling rechargeable SPV lanterns to the village energy committee (VEC, described below). It undertakes selection and training of a village technician (VT, described below) in operation and maintenance of the charging station and the lanterns. It also provides training to the VEC on energy service management, basic book-keeping, maintaining transparency and community communications. Sunlabob collects a monthly fee from the VT for renting the charging station. It also provides ongoing advice and assistance in marketing through demonstrations and campaigns, and provides assistance to VECs on accessing soft public loans for lantern purchase.

A **village energy committee (VEC)** is established at every SLRS village. The VEC consists of four or five village representatives, usually including a village chief, a representative of the Lao Women's Union (LWU)[23], a representative of the Lao People's Revolutionary Youth Union (LPRYU)[24] and one or two other well-respected individuals elected by the villagers. The VEC is responsible for purchasing lanterns from Sunlabob (with the help of soft public loans, if necessary); the lanterns are then rented to interested households. The VEC oversees operations of the VT (see below) and manages the lantern maintenance fund (described in detail in Section 3.4).

A **village technician (VT)** is usually a village entrepreneur identified by Sunlabob as someone who is interested in the SLRS and who can be trained as a village technician. The VT is hired by the VEC and is responsible for operating and servicing the charging station and the lanterns. The VT receives training from Sunlabob in business and operational features, servicing and maintenance of the charging station, stocking spare parts and keeping records of usage prior to commencing operations. The VT operates the SLRS as a business, paying a monthly fee to Sunlabob for renting the charging components – SPV panels, charging station and the system control unit (SCU, described in detail below) – and collecting a fee from households for recharging each lantern.

3.2 Implementation process

The implementation process for the SLRS is outlined below.

1) Sunlabob selects a village on the basis of two criteria: it must be situated in one of the country's 72 'poor' or 'very poor' districts as identified by the NGPES; and it should have no foreseen imminent access to the grid, according to EdL's grid extension plans.
2) Sunlabob identifies a potential VT in the selected village.
3) Sunlabob installs a solar charging station at a central location in the village and assumes responsibility for regular maintenance and servicing of the station.
4) Sunlabob provides the VT and the VEC with required training.
5) The VEC purchases portable lanterns from Sunlabob (with the help of public funds, if necessary) and rents them out to interested village households.
6) The VT operates the solar charging station as a business (on a franchise arrangement with Sunlabob), collecting fees from village households for recharging lanterns and paying a monthly fee to Sunlabob for renting the solar charging station.

A Ugandan company representative learning about Sunlabob's products and practices.

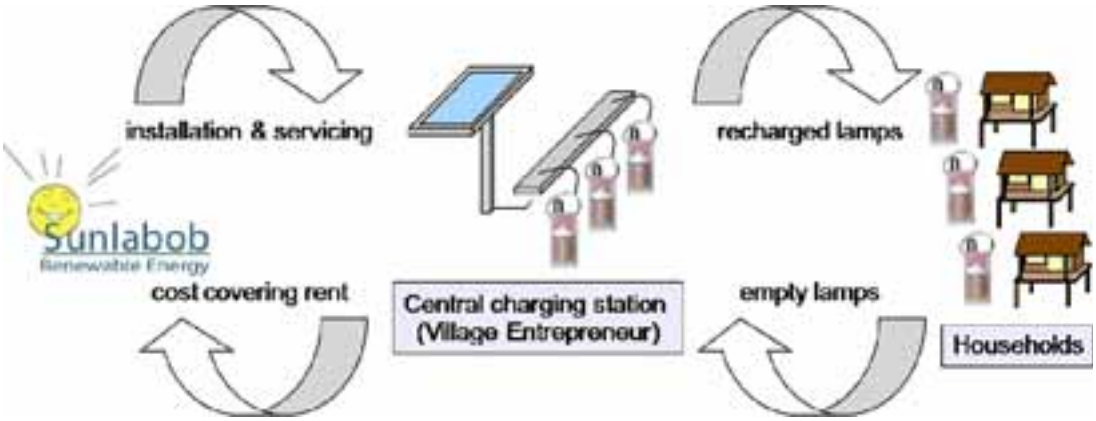
UNDP/Energy Access for Poverty Reduction

[23] Founded in 1955, the LWU provides the national machinery for the advancement of Lao women. A mass organization for women with a network extending from the GoL to the grassroots level, the LWU promotes the implementation of GoL policies, the Constitution and laws that relate to the benefits of women and children (LWU, 2009).

[24] The LPRYU is a mass organization tasked with guiding the country's youth under Party leadership, helping to educate and train young pioneers as the driving force for the nation's future. Founded in 1955, it comprises 311,000 active members aged 15-30 years plus a further 882,000 non-active members. It is dedicated to mobilizing youth to contribute to national development, with particular focus on the fields of information, media, entertainment, art and music (Visiting Arts Cultural Profiles, 2009).

Figure 2 provides a visual representation of the SLRS model.

Figure 2: Operational flow of the SLRS model



3.3 Product and delivery details

Rental model. The SLRS model is designed to suit the established behaviours of rural households. Specifically, the lantern recharge fee is a small regular expense, comparable to typical household purchases of diesel. The routine household cycle of expenditure therefore remains unchanged. Even the act of visiting the solar charging station to 'buy light' resembles the act of buying diesel from a village outlet. The sale of hours of light – as opposed to the sale of equipment – also emulates the service provided by grid connection.

Lantern unit. The lantern comprises a 4 W compact fluorescent light (CFL), a battery and control electronics. Besides providing lighting, the lantern can be used as an unregulated 12 volt power supply for small electronic devices; possible uses include charging mobile phones and powering portable radios or mini-televisions.

UNDP/Energy Access for Poverty Reduction

Assembling lanterns in Sunlabob's head office in Vientiane.

The following features make the lantern appropriate for rural consumers:

- it is portable and can be hung from a fixture, stood on a surface or carried while illuminated;
- a robust, tamper-proof casing protects the internal components;
- controlled use is ensured by an integral microprocessor that records the total number of hours the lantern has been active since charging. Lanterns automatically switch off after 10 hours of use;
- if a low-voltage condition is detected while a lantern is being used as a power supply (e.g. to charge a cell phone), the integrated low-voltage protection feature disconnects the power outlet, and the lamp is deactivated; and
- in the period between charges, the lantern's power output receptacle cannot be used to charge its battery, ensuring no unauthorized charging.

To prepare for charging, the lantern must first be connected to the SCU so that it may be unlocked. The SCU reads the number of hours the lantern has been used since the previous recharge; this data is then recorded on the charging log, along with the lantern's unique ID, date and time. The lantern is then connected to the charging station until fully charged. While in charging mode, the internal controller prevents switching on the lamp or any attempt to extract power through the receptacle exceeding a set period of time; this ensures that only fully charged lanterns are handed out. Once the battery is fully charged, the lantern is reconnected to the SCU to activate it for lighting operation, at which time the lantern's ID is recorded in the activation log, along with the date and time. The lantern can then be handed out to the next customer, usually in exchange for a spent one.

When the lantern is used as a power supply, any draw on the power outlet is measured, converted into an equivalent number of lighting hours, and the operating time of the lantern reduced accordingly. This ensures that the users get the exact amount of energy they pay for, regardless of whether they use the lantern for lighting, as a power supply, or both.

The lantern design keeps construction as simple as possible, while still providing versatility, robustness and ease of use. The number of technical components is reduced to a bare minimum, placing most of the system's 'intelligence' in the SCU. The system is entirely modular and additional charging stations can be operated if required.

The SCU. The SCU is located at the charging station and is used to activate the lanterns for either charging mode or lighting mode, and to collect any data acquired after the last recharge. The SCU uses an integrated secure digital storage module to store log files, SCU configuration data and firmware updates for SCU and the lanterns. The size of the storage module can be increased to accommodate the needs of system set-ups with large numbers of lanterns per SCU.

Management software. To manage data collected by many SCUs in several villages, the SLRS comes with management software featuring a graphical user interface. Collected data can be analysed in terms of number of charges, fluctuations in time, lamp distribution, intensity of usage in various areas, frequency of switching on and off, and average time of switched-on light. The management software also enables firmware updates and is used to modify SCU configuration settings.

Design modifications. In response to changing demands over the years, Sunlabob has introduced several design modifications and technical product improvements.

Modifications to the lanterns include:

- additional CFL protection in the form of a polypropylene cover;
- repositioning all electronic components to the top of the lantern box to avoid water damage;
- larger reflective surface behind the CFL; and
- an additional light-emitting diode (LED) lamp to indicate the number of remaining hours of light available. This lamp flashes a number of times corresponding to the number of hours remaining when the user presses and holds the 'on' button, and indicates 60 and 30 minutes remaining by continuous flashing.

Additional lantern microprocessor functions include:

- precise determination of each lantern's usage in terms of hours (essential for carbon-trading opportunities);
- socio-economic analysis of lantern use (e.g. gender or age monitoring) upon request by the donor organization; and
- firmware updates sent by email and uploaded via the SCU, which is essential as Sunlabob now has systems in three countries separated by thousands of kilometres.

The SCU casing has also been improved to make it waterproof and dustproof.

3.4 Financing mechanisms

Start-up investment. Sunlabob had developed a collaborative financing mechanism with public donors, thereby creating a public-private partnership (PPP). Specifically, private investment is used to pay for the construction of charging stations, whereas donor-launched revolving funds provide loans to VECs for the purchase of the first batch of lanterns. Following the initial public investment, the VTs are expected to sustain their businesses with the recharging revenue alone, without further outside investment.

Managing revenue from recharging. In order to be adopted by the poorest rural households, the lantern must be competitive with the price of diesel. In Lao PDR, households typically spend USD 3-6 per month on diesel for lighting. The recharging fee for the solar lanterns has been set at LAK 4,500 (USD 0.59) for a full charge (10 hours of lighting).[25]

The revenue from each recharge is collected by the VT and then divided as follows:

- LAK 1,900 (42 percent of the recharge fee) is set aside in a maintenance fund, managed by the VEC. The fund is used for lantern maintenance, and purchase of replacement components and additional lanterns;
- LAK 1,100 (25 percent) is retained by the VT as salary;
- LAK 1,000 (22 percent) goes to Sunlabob as rent for the charging station; and
- LAK 500 (11 percent) is shared among the members of the VEC as remuneration for administering the service.

3.5 Socially and environmentally responsible supply chain

Supporting local suppliers. The economy of Lao PDR is largely agricultural, with few industries. Consequently, the more sophisticated SLRS components have to be imported.[26] To maximize its contribution to the national development, however, Sunlabob purchases as much material as possible from local suppliers, including all SLRS accessories such as cables, outer boxes and straps.

Recycling. Out of environmental considerations, the lanterns are built from scrap material wherever possible. The front covers for the lanterns (used to protect the CFL) are made from locally sourced waste polypropylene. The Cooperative Orthotic and Prosthetic Enterprise (COPE) is a Vientiane-based organization that manufactures artificial limbs mainly for victims of UXO.[27] Sunlabob purchases the waste polypropylene from the moulding of artificial limbs to produce lantern front covers. The revenue enables COPE to supply more prosthetics and mobility devices.

Sunlabob also buys scrap rubber from a local rubber flip-flop factory. Once cut to size, the scrap rubber is used for padding inside the lantern (to protect electronic components) and for the 'feet' of the lantern (to provide stability when the lantern is stood on a flat surface).

3.6 Local participation

Public consultations. Prior to any SLRS intervention, Sunlabob holds a consultation with the villagers and village authorities (usually village chiefs). At the consultation, the villagers learn about and inspect the lanterns, allowing Sunlabob to ascertain the volume of demand. If villagers favour the SLRS, a one month trial is initiated with around 20 lanterns (all equipment being provided for free), giving villagers an opportunity to test the system prior to committing to the scheme. This consultation also provides the opportunity to raise awareness about energy sources and energy use. Due to a relatively low literacy rate, visual media (demonstrations, posters and videos) are preferred for Sunlabob's target communities.

Suggestions for product improvement. During the first SLRS pilot tests, observations by participants regarding the quality of the lantern resulted in improvements to the initial design, including changes to the leather straps and improved connectivity of a CFL.

UNDP/Energy Access for Poverty Reduction

A village technician (VT) issuing lanterns.

[25] LAK 1 = USD 0.00013, as of 9 September 2011 (www.xe.com).

[26] SPV panels and batteries are imported from China, CFLs from the Republic of Singapore, and microprocessors and charging units from the Federal Republic of Germany.

[27] COPE, 2009.

Box 2: Integrating SLRS management into existing governance structures

The VEC replicates existing governance infrastructure in Lao PDR. The country is administratively divided into provinces, districts and villages, and the GoL is represented at each level. At the village level, there are three representatives of the GoL: a village chief, a representative of the LWU and a representative of the LPRYU. All three representatives are elected by their community and their authority is recognized. Hence, by including these three people in the VEC, the SLRS model ensures good governance of village services. In addition, communal matters in rural Lao PDR are generally decided by a committee, which lends itself to the creation of the VEC.

In regards to the VT, it is common to find one competent individual in a village who is identified by villagers as a focal point for technical issues, with an inclination towards commercial activities and providing access to material and hardware.

Local involvement in operation of the SLRS. Once the scheme is accepted by the community and required infrastructure (the charging station and the lanterns) is acquired, VECs and VTs play vital roles in its operation. The SLRS model makes full use of existing institutional structures found in rural Lao PDR, as described in Box 2.

3.7 Capacity development

Sunlabob's experience with VT selection is that while technical skills are desirable, they can be taught and are hence not essential. Indeed, business skills appear more important.

For each village, the cost of capacity building is about USD 500. This comprises the initial training sessions and three coaching visits over a period of 18 months. Capacity building costs in Lao PDR are high as existing skills are relatively low due to an underdeveloped education system.[28] In addition, the SLRS technology is new to rural communities. To reduce training costs, Sunlabob trains VECs and VTs from neighbouring areas in groups of five to eight people.

3.8 Project costs

Sunlabob's SLRS costs in Lao PDR for January 2008 - December 2009 are provided in Figure 3.

Figure 3: Sunlabob's SLRS cost report

Sunlabob Renewable Energy Ltd.

Battery Lantern Cost Report

For the Period From Jan 1, 2008 to Dec 31, 2009

Filter Criteria includes: 1) IDs: LADM. Report order is by ID. Report is printed including Balance Forward.

Activity Line Items	Year Ended Dec 31, 2008 ($)	Year to date as at Oct 31, 2009 ($)	Total Costs to Date ($)
Product development (Lamps & Charge Stations)	92, 528	74,732	**167,260**
Transport & Import Taxes	2,332	6,353	**8,686**
Training & Dissemination	40,000	40,000	**80,000**
Direct Staff Costs	3,500	17,500	**21,000**
Other Direct Costs	6,854	6,927	**13,781**
Apportioned overheads (20% of total)	139,203	111,765	**250,968**
	284,418	**257,278**	**541,695**

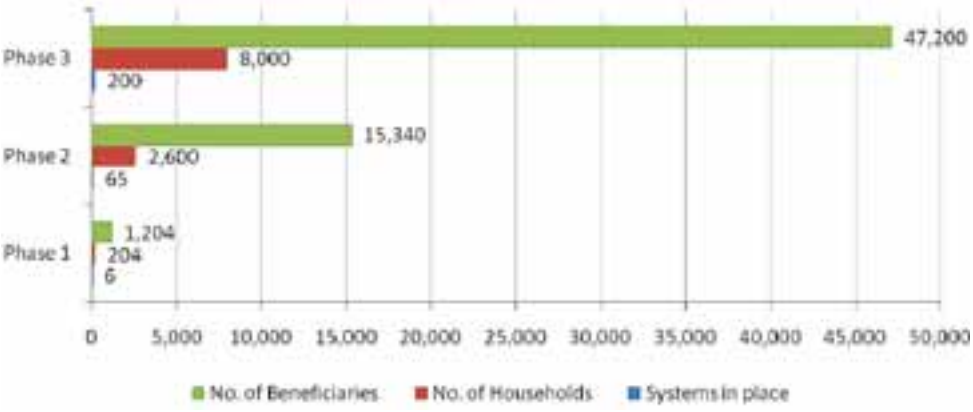
[28] Nationwide, 15.5 percent of the population aged six years and older has completed primary education; 6.1 percent has completed lower secondary education; and 5.1 percent has completed upper secondary education (Messerli et al., 2008).

4. Impacts

4.1 Implementation to date and future targets

As mentioned above, the SLRS scheme in Lao PDR is currently in Phase 1 of implementation. To date, six SLRSs have been established, benefitting 204 households and approximately 1,200 people. Targets for Phases 1, 2 and 3 are provided in Figure 4. Phase 2 (scheduled to begin in 2011) will also include developing milestones and quantifiable results (e.g. turnover of lantern rental and minimal product breakdown), which will then be implemented during Phase 3.

Figure 4: SLRS phases and targets in Lao PDR



In April 2009, SLRS pilot schemes were launched in Afghanistan and Uganda. To date, 12 charging stations (600 lanterns) have been established in Uganda and 11 charging stations (550 lanterns) in Afghanistan. These schemes are discussed in greater detail in Section 5.2.

4.2 Case studies

Detailed evaluation of SLRS impacts would require several years of operation, which it is yet to achieve. Nevertheless, it is useful to examine information from two typical villages chosen for the pilot schemes, Ban Thaheua and Ban Phonlek.[29]

Ban Thaheua is situated in Bolikhan District, Bolikhamxay Province. It lies about 200 kilometres from Vientiane, the national capital, and 35 kilometres from Paksan, the provincial capital. Bolikhan District has been identified as 'very poor' by the NGPES. With the last leg of the journey from Vientiane during the rainy season a one- to two-hour boat trip, Ban Thaheua provides a good example of geographical inaccessibility. Ban Thaheua has 49 households and a population of 240. Lao-Tai and Mon-Khmer are the two main ethnic groups inhabiting the area.[30]

Before the introduction of the SLRS, a few households in Ban Thaheua had electric lighting drawn from car batteries charged by a tractor, while one household had an SHS provided by Sunlabob. 15 households are taking part in the pilot scheme. On average, the participants use about three hours of light per night. Women use light for weaving baskets or textiles, while men tend to gather outside by one of the houses to socialize.

Ban Phonlek is situated in Mahaxai District, Khammuane Province. The district has been identified as 'poor' by the NGPES, with 77.5 percent of villages and 31.3 percent of district households lacking rice and shelter.[31] The village is surrounded by mountains, with rivers running near the southern and western areas of the village. The road connecting the village to regional infrastructure is passable only from September to June.

[29] Ban means 'village' in Lao.

[30] Messerli et al., 2008.

[31] GoL, 2003.

The village population is 665, of which 327 are women. The main agricultural product is rice, followed by animal husbandry. The conventional energy sources for lighting are kerosene lamps and bamboo torches, although 22 households are using SHSs provided by a GoL rural electrification project. The 22 kilovolt national electricity grid is currently 34 kilometres away from the village, though the GoL plans to extend the grid to Ban Phonlek within the next five to seven years.

Forty households are taking part in the Ban Phonlek SLRS, with 35 percent of the registered users being women. On average, users charge the lantern nine times per month, each spending an average of LAK 42,000. Half of the users use their lanterns for income-generating activities such as production of handicrafts, each earning an additional average of LAK 100,000 per month. Once the cost of the lantern rental is accounted for, these households make an average monthly profit of LAK 56,000.

The contributions of the SLRS to the attainment of Millennium Development Goals (MDGs) in Lao PDR are outlined below.

4.3 Income and livelihood impacts (MDG 1)

Reducing expenditure on and improving the quality of lighting. Electricity provided by the SLRS is cheaper than diesel per lumen (lm), meaning that end-users spend less on lighting. The quality of light of SLRS lanterns is considerably better than that of traditional kerosene lamps. One solar lantern can replace several kerosene counterparts; the light of a single lantern is sufficient for household chores and income-generating activities in the evening.

Improving energy security. Prices of fossil fuels such as diesel fluctuate dramatically, as shown in Figure 5. In contrast, the price of electricity provided by the SLRS is controlled, increasing energy security for poor households and making household finances much easier to plan.[32] On a national level, locally produced RE sources reduce reliance on imported fossil fuels.[33]

Figure 5: Average market price of diesel in eight provinces, Lao PDR, 2004-2007 (LAK)

Source: GoL, 2011.

Generating jobs and creating income opportunities. The SLRS scheme creates employment for 17 workers assembling lanterns in Sunlabob's head office in Vientiane and for those installing charging stations in rural areas. At the village level, jobs are created for VECs, VTs and VTs' families (described below).

By increasing the number of productive hours in a day, the SLRS indirectly creates income-generating opportunities. Sunlabob's studies (e.g. in Ban Phonlek) show that households use the light for productive activities such as weaving textiles and baskets.

Encouraging local enterprises. Operating a charging station as a microenterprise provides business opportunities for VTs. A single charging station of 50 lanterns provides the VT with a net income of around USD 400 in the first year of operation. This is a decent income when compared to an average Gross National Income of about USD 600 per capita (which includes the higher-income urbanized communities).

[32] Periodic price updates are planned with reference to the country's Consumer Price Index.

[33] ASPI, 2007.

In addition, the VTs – and rural households – are linked to Sunlabob's franchise network, through which they gain exposure to other products and services they may want to develop. These include coolers, telephones, laptops with internet connections, UV-sterilized bottled drinking water, televisions and screen projectors.

The SLRS also introduces a fee-for-service concept into rural communities, which may be adopted by other local enterprises as a model for their own operations.

4.4 Improving gender equality (MDG 3)

Employment through VTs. All VTs and VEC members in Lao PDR are men.[34] However, VTs often run their micro-enterprise as a family business, which generally involves engaging female family members. Men typically perform technical tasks such as cleaning solar panels, while wives or daughters perform administrative duties such as accounting or sales. This conforms with the traditional role of Lao women, who typically take charge of household finances.

Technical employment at Sunla bob. Since 2008, Sunlabob has been cooperating with Agir pour les Femmes en Situation Précaire (AFESIP) Lao PDR, an organization that tackles the causes and effects of human trafficking and sexual exploitation.[35] Sunlabob participates in rehabilitating affected women by offering employment opportunities in lantern assembly at its head office in Vientiane. Three women have been employed in this technical capacity to date.

UNDP/Energy Access for Poverty Reduction

A villager using a lantern to weave.

Women tend to benefit more from improved energy. Given that women constitute the majority of the workforce in two thirds of Lao villages, the extension of productive hours benefits mostly women.[36] Many of these women are involved in the production of handicrafts.[37] Additional production enables women to earn more and improve their economic situation.

4.5 Ensuring environmental sustainability (MDG 7)

Reducing fossil fuel consumption. The SLRS seeks to provide a competitive alternative to the conventional use of diesel for domestic lighting in off-grid households, thereby reducing fossil fuel consumption among the rural poor. Fuel-based lighting, such as kerosene lamps, consumes an estimated 77 billion litres of fuel annually worldwide, equivalent to 1.3 million barrels of oil per day.[38]

The average daily burn time of one kerosene lamp is three to four hours, which equates to around 40 litres of diesel per year. Furthermore, the light provided by a single kerosene lamp is of poor quality, making it inadequate for many activities. Consequently, more than one kerosene lamp may be used to ensure sufficient lighting per household, which further increases diesel consumption.

The SLRS also reduces the amount of fossil fuels consumed for transport of lighting fuel.

Reducing greenhouse gas (GHG) emissions. According to Lawrence Berkeley National Laboratories, the replacement of fuel-based lighting with electric lighting could contribute significantly to reducing GHG emissions from developing countries.[39]

[34] In the Uganda pilot scheme, one VT is a woman.

[35] AFESIP, 2011.

[36] Messerli et al., 2008.

[37] Handicrafts produced vary in type from village to village. In Ban Thaheua, women were observed using the lantern light for weaving baskets or textiles.

[38] LBL, 2005.

[39] LBL, 2005.

Typically, a kerosene lamp consumes around 40 litres of diesel per year. The associated emissions of nearly 100 kg of carbon dioxide (CO_2) are saved when households switch to solar lanterns. One SLRS charging station serves 50 lanterns; these can substitute for at least 50 kerosene lamps – probably more, given their superior brightness – allowing a minimum estimated savings of 5 tonnes CO_2 per year per SLRS. Technically, 36 systems can be assembled and installed in a 12-month period, resulting in 180 tonnes of CO_2 saved per year of operation.

The usage of each SLRS lantern is recorded in detail by the internal microprocessor. This data is collected and aggregated at charging stations. Basing its calculation directly on the diesel off-set, Sunlabob can accurately quantify reduced emissions. Sunlabob is consequently currently working on strategies to enter the carbon trading market using the Clean Development Mechanism (CDM).

Reducing indoor air pollution and health risks. Many homes have poor ventilation, with kerosene lamps causing indoor air pollution. This leads to illnesses such as eye and respiratory problems. Furthermore, the quality of light is so poor that the users can only work or read if they are almost directly over or beside the flame, thereby inhaling fumes.

Kerosene lamps containing flammable liquids can also cause burns and fires. Each year, many homes and even entire communities worldwide burn down as a result of fires starting from toppled kerosene lamps.[40]

In contrast, the solar lantern does not produce harmful emissions and does not pose risks to the user, providing a healthy and safe alternative to kerosene lamps. In addition, children are more inclined to do homework and read with the improved light quality.

Increasing energy efficiency. The SLRS improves energy efficiency by providing high-quality light compared to kerosene lamps. The light output of a typical kerosene lamp is 45 lm compared to the 120 lm provided by a SLRS lantern's 4 W CFL.[41] In addition, an LED lamp which indicates the remaining hours of light available enables villagers to plan their energy usage.

4.6 Developing a global partnership for development (MDG 8)

SLRS model is a PPP. The SLRS model brings private and public actors together. In its mediating role, Sunlabob connects both local and international actors, including the GoL and local authorities, development organizations, research institutions such as LIRE, and a spectrum of local and international organizations ranging from conventional manufacturers to social enterprises such as COPE.

South-South cooperation. By extending the SLRS scheme beyond the boundaries of Lao PDR, Sunlabob promotes South-South cooperation. In 2008, for example, three representatives of African enterprises visited Lao PDR to learn about Sunlabob's products and practices. The delegation was guided around SLRS pilot villages, where VTs explained their roles and the benefits to households and the community.

4.7 Improving access to telecommunication systems and information

In Lao PDR, the information and communication technology (ICT) sector is emerging.[42] As in many developing nations, the lack of fixed telephony infrastructure has led to the rapid progress of mobile phone technology, with 638,202 mobile phone subscribers in 2005 compared to only 55,160 in 2002. Mobile phone technology has tremendous potential for development and poverty reduction in rural areas.[43]

[40] Pode, 2008.

[41] The brightness of an average kerosene lamp is 45 lm; the lamp consumes 0.03 litres of diesel per hour. This represents a power consumption of 292 W. A 4 W CFL in a solar lantern provides 120 lm. Therefore, the luminous efficacy (lm/W) of the CFL is almost 200 times greater than that of the kerosene lamp. Converting lm into W allows for the calculation of the energy efficiency of both lamps (0.023 percent for the kerosene lamp compared with 4.5 percent for the CFL). Even if we extend the system boundary to include the conversion efficiency of the SPV panels (15 percent) that are delivering energy to the CFL, then a battery lantern system is still more than 29 times as efficient as a kerosene lamp.

[42] UNCTAD, 2007.

[43] In Uganda, for example, a programme is in place to distribute the latest market information on a weekly basis via SMS technology to help farmers organize production and distribution (UNCTAD, 2007).

However, operating ICT systems (including mobile phones) is difficult without adequate access to electricity. The SLRS can bridge this gap with battery lanterns equipped with a power outlet that can serve as portable power supplies, used for charging mobile phones and powering small electrical appliances such as radios or mini-televisions. The SLRS therefore enables rural households to use solar power to operate equipment that gives them access to the outside world, reducing both isolation and poverty.

5. Sustainability of the SLRS model and potential for replication

The following sections describe the challenges to the uptake of the SLRS model in Lao PDR and the expansion of the model in Uganda and Afghanistan. The prerequisites for the sustainability of the SLRS model are consequently identified.

5.1 Challenges to the SLRS uptake

Traditional ownership concepts at the local level. Since lanterns are distributed and charged on a rotational basis, there is no individual ownership. This principle has not always been understood in some of the Lao PDR and Uganda pilot schemes. For example, one user attached a sticker on 'his' lantern so that he could keep track of it. Similarly, others preferred to go without a lantern for a few days until 'their' lantern was charged. Raising awareness of the concept of communal ownership should be conducted prior to the implementation of schemes such as the SLRS.

Sub-standard precedent solar technology. Projects that subsidize solar lighting or provide it for free pose a major threat to the SLRS model. Low-cost equipment is often used, and early equipment failure leads to villagers losing confidence in solar technology in general. This complicates Sunlabob's consultation phase and discussions with local authorities. A particular challenge for earlier Sunlabob endeavours has been the need to convince such villagers to try RE solutions again.

National grid expansion. Another clear risk to the scheme is the ongoing expansion of the national grid in Lao PDR. Local electricity tariffs are very low (USD 0.03 per kWh); as a result, if an SLRS village becomes connected to the national grid, many households may decide to abandon the SLRS. This risk is mitigated by the fact that the installation fee for a household grid connection is often too high for the poorest households (about USD 100), who are the main targets of the SLRS model.

Regardless, should an entire village decide to abandon the system, the SLRS equipment can be dismantled and moved to another community. Indeed, this security is provided by the PPP model. Most importantly, Sunlabob has good relations with the EdL and has been granted access to its grid extension plans. This ensures that the SLRS scheme does not target the same villages as the EdL.

Retaliation from diesel vendors. Another threat to the scheme is the loss of livelihoods for diesel vendors. This danger is mitigated by the fact that the diesel vendors often become VTs themselves.

Insufficient public sector support. The SLRS scheme has high initial investment costs and is hindered by the lack of financial support from the public sector. The lack of commitment might be linked to the fact that the scheme does not yet feature in the GoL's rural electrification plans, which are largely influenced by the World Bank's Rural Electrification Program (REP). Running from April 2006 to 31 March 2010, 85 percent of REP Phase 1 activities were assigned to grid extension, while the remaining 15 percent focused on decentralized RE (mostly SHSs). To date, solar lanterns have not been included in the REP. Phase 2 of the REP is currently in preparation, however, and solar lanterns are being considered, which could open the way for their widespread dissemination in Lao PDR.

5.2 SLRS replication in Uganda and Afghanistan

Financing and implementation arrangements. In Uganda, the SLRS pilot scheme is financed with money received from the Lighting Africa Award (USD 200,000) and by Sunlabob's local partner, Technical and Specialist Services for Development Ltd. In Afghanistan, the charging stations and lanterns have been purchased by United States Agency for International Development (USAID) and are managed by Development Alternatives, Inc. (DAI), a global consulting firm.

Adapting to local conditions. In Uganda, although a VEC has been set up, it is responsible only for communication with end-users and does not oversee a maintenance fund. Instead, maintenance and replacement costs are borne by VTs, who receive greater remuneration for their work than their Lao counterparts. The recharge fee is much higher, reflecting higher local diesel prices. In Afghanistan, local enterprises are not involved in implementing the scheme.

Drivers of expansion. The main facilitators of the SLRS expansion in Uganda and Afghanistan have been the personal contacts of Sunlabob's director and publicity from the numerous awards received by Sunlabob for the SLRS concept.[44]

UNDP/Energy Access for Poverty Reduction

Installation of a charging station, Uganda.

UNDP/Energy Access for Poverty Reduction

Training in operation and maintenance of the charging station and the lanterns, Afghanistan.

5.3 Prerequisites to sustainability and successful replication

Overall, the SLRS experience in Lao PDR, Uganda and Afghanistan shows that the model is sustainable and can be replicated worldwide, provided the following prerequisites are satisfied:

- there is adequate sunlight in the targetted geographical area;
- target users are organized into villages or, if more dispersed, regularly gather at locations such as schools or markets;
- diesel is expensive at the household level (i.e. at least USD 1.5 per litre);
- the lantern is robust and reliable, and the service is aligned with existing consumer behaviour;
- the model is profitable for all players. The financial risks for the most vulnerable partners in the scheme should be minimized (e.g. minimizing the risk for the VT by means of a franchisee agreement); and
- local institutions offer energy service delivery. In Lao PDR, provincial and district authorities are involved in SLRS activities with local communities, and the village authorities are part of the SLRS operation (through the VEC). Without this, local governance cannot work. Involving local institutions often requires capacity development.

[44] These include the Ashden Award in 2007, the Lighting Africa Award in 2008, the Tech Award in 2008 and the UNEP Sasakawa Prize in 2008.

6. Lessons learned and good practices in expanding energy services for the poor

6.1 Providing a high quality, robust product

Various solar lanterns have been propagated as a lighting solution in off-grid villages. Standard solar lanterns, however, have been shown to fail earlier than expected because a) low-quality components are often used in an attempt to make the lanterns more affordable; b) batteries are often charged irregularly; or c) households engage in 'hot-wiring' lanterns to use batteries for operating other appliances. The net outcome has been that solar lanterns have not been widely adopted, with diesel still dominating the off-grid lighting market.

In light of this, the challenge for Sunlabob was to find an operational scheme for solar lanterns that could:

- use advanced charging equipment and tamper-proof lanterns to deliver the full life expectancy of components; and
- strictly control the use and charge status of the lanterns, and monitor the life cycle of their components, thereby improving their performance.

To this end, for critical SLRS components (CFLs, batteries and SCUs) Sunlabob uses only certified material from renowned international suppliers. All charging stations and solar panels are certified by the International Electrotechnical Commission and are of the highest quality. Less critical parts (e.g. casing and padding) are purchased from local suppliers. In addition, Sunlabob sets high training standards for its staff and enforces a strict 'safety first' policy.

6.2 Matching service with consumer demand and behaviour

In the course of Sunlabob's earlier SHS scheme, villagers in areas visited by Sunlabob teams often asked for a cheaper alternative to the SHS. The SLRS hence fills a gap in the market by providing reliable lighting and low-power charging for low-income households.

The following elements of the SLRS model were also introduced to fit consumer demand and behaviour:

- moving away from a monthly rental fee to fee-for-service;
- introducing monitoring features to indicate the state of charge in a lantern;
- aligning the model with a household's conventional behaviour of purchasing diesel for lighting;
- using CFLs instead of LEDs; and
- introducing straps to enable the lanterns to be carried and hung.

Since the SLRS is operated and maintained locally by the VT and the VEC, consumers are in direct contact with their service providers. Consumer satisfaction is clearly visible and has an immediate effect upon those responsible for the systems.

6.3 Ensuring a profitable and sustainable business for all stakeholders

The SLRS model benefits all stakeholders, as described below.

UNDP/Energy Access for Poverty Reduction

Lantern used during a village meeting, Lao PDR

End-users (households) receive safer and brighter lighting at affordable prices. They are able to use the lighting for productive uses such as weaving textiles or baskets, or keeping small retail outlets open after sunset.

VTs operate SLRSs as small businesses. This means they have a strong interest in 'selling' as many recharges as possible and in ensuring that the charging process and lanterns function properly. They also gain employment, additional skills and access to new business ventures.

The profitability of the SLRS is ensured for all stakeholders by setting a minimum number of 50 lanterns per charging station; with additional charging stations, the VT earnings increase dramatically. Sunlabob provides technical and operational support to the VT through a franchise arrangement, providing the security of its competence and experience. These are essential elements of the SLRS model: if too much risk is carried by the VT, it is difficult to draw potential entrepreneurs to the scheme.

VECs safeguard the sustainability of SLRSs and actively contribute to the development of their communities, thereby reasserting their role as village-governing entities.

The village community is able to operate the SLRS with minimal technical support from Sunlabob beyond the initial investment. Over 75 percent of the generated revenue stays within the community and funds the maintenance of the system. Income generated for the community supports the sustainability of the SLRS by generating a favourable perception among villagers that the SLRS is promoting social and economic development. To prevent corruption, the fee structure should be transparent and clearly understood in the villages.

6.4 Ensuring local ownership

Local ownership is an important contributor to the sustainability of the SLRS. At the end-user level, it is crucial that the community demonstrates a real buy-in for the system and voices ideas on how it can effectively use the new technology.

Payment of nominal lantern-charging fees is also essential. Sunlabob's experience has shown that when technology is provided for free, few incentives exist for end-users to take care of the equipment.

The VT maintains the SLRS and replaces components when they wear out, using the money set aside for that purpose (the maintenance fund). This ensures that the SLRS continues to function independently of Sunlabob's technicians. Simultaneously, the VEC ensures that the revenue is collected and allocated properly so that high-quality services can continue to be delivered to end-users.

In short, the SLRS model seeks to ensure that all community members have an interest in the system's longevity.

6.5 Proactive information dissemination at the highest levels

The GoL recognizes that decentralized off-grid solutions are essential to achieving its electrification targets. Currently, however, no single GoL department is overseeing the RE sector in Lao PDR.

Sunlabob devotes considerable resources to advocating rural electrification efforts and promoting the understanding of its projects (including the SLRS) by government authorities at the national, provincial and district levels. This involves participation in workshops and seminars with local actors, and marketing the SLRS worldwide through conferences, award competitions and publications. Sunlabob also works with development organizations on energy access strategies and programming.

7. Conclusions

The SLRS model combines a number of strengths, including:

- state-of-the-art technology;
- a delivery method based on fee-for-service;
- an innovative financing mechanism (a PPP); and
- strong involvement from local communities (local governance).

The SLRS experience has shown that technical expertise to maintain and service the technology is essential. However, it has also demonstrated that rural electrification programmes need to incorporate a robust operational and financial model offering economic sustainability. It is also a showcase scheme for including community empowerment as an integral part of an energy service delivery.

The SLRS model is the product of several years of experience in rural electrification efforts in Lao PDR. The SLRS approach should prove replicable on a wide scale in communities where a village member can be entrusted to ensure the system's day-to-day operations, and where a committee can be appointed to provide good local governance.

References

AFESIP (Agir pour les Femmes en Situation Précaire). 2009. Home page available at www.afesiplaos.org.

Asian Productivity Organization. 2006. Country Paper. 'Utilization of biomass for renewable energy'. Homepage available at www.apo-tokyo.org.

ASPI (Australian Strategic Policy Institute). 2007. Power plays: *Energy and Australia's security*. ASPI, Australian Capital Territory. Available at www.aspi.org.au/publications/publication_details.aspx?ContentID=142&pubtype=5.

COPE (Cooperative Orthotic and Prosthetic Enterprise). 2009. Homepage available at www.copelaos.org.

Department of Electricity. 2008. *Hydro power in Lao PDR & power development plan*. Ministry of Energy and Mines, Lao PDR. Available at www.edl-LaoPDR.com/download/Presentation%20to%20EDL%20executive%20seminar%20(21-Nov%202008)-Sanhya.ppt.

GoL (Government of Lao PDR). 2003. *National growth and poverty eradication strategy* (NGPES). GoL, Vientiane. Available at www.undplao.org/newsroom/ngpes.php.

—. 2011. 'Lao Statistics Bureau'. Homepage available at www.nsc.gov.la.

GoL/United Nations Country Team. 2006. *United Nations Common Country Assessment (CCA), Lao PDR*. UNDP Lao PDR, Vientiane. Available at www.undp.org/asia/country_programme/CCA/CCA-LaoPDR2006.pdf.

Visiting Arts Cultural Profiles. 2009. 'Lao PDR Cultural Profile'. In partnership with the Ministry of Information and Culture of Lao PDR. Available at www.culturalprofiles.net/laos/Directories/Laos_Cultural_Profile/-20.html.

LWU (Lao Women's Union). 2009. 'About LWU'. Available at www.grid-lwu.org.la/english/about_lwu.html.

LBL (Lawrence Berkeley National Laboratory). 2005. 'Berkeley lab scientist proposes solution to reduce developing world's expensive, polluting fuel-based lighting'. Available at www.lbl.gov/Science-Articles/Archive/EETD-diode-lighting.html.

Messerli, P; Heinimann, A; Epprecht, M; Phonesaly, S; Thiraka, C; Minot, N. (eds). 2008. *Socio-economic atlas of the Lao PDR – An analysis based on the 2005 Population and Housing Census*. Swiss National Centre of Competence in Research (NCCR) North-South, University of Bern, Bern and Vientiane: Geographica Bernensia.

MRC (Mekong River Commission). 2008. *Annual report 2008*. MRC, Vientiane. Available at www.mrcmekong.org/annual_report/2008/2008-tab-content.htm.

Ministry of Planning and Investment, Lao PDR. 2008. *Sustainable development in Asian countries: "A case of Lao PDR"*. Available at www.ide.go.jp/Japanese/Ideas/pdf/followup_14/07.pdf.

Mongabay. 2009. 'Lao PDR: Environmental Profile'. Available at http://rainforests.mongabay.com/20laos.htm.

Pode, R. 2008. *LED lighting technology – Clean lighting for the poor*. Available at www.koreatimes.co.kr/www/news/community/timeforum_view.asp?categoryCode=184&field=&keyword=&page=8&idx=128300.

SODI. 2011. *Humanitäre Kampfmittelräumung und Entwicklung in Laos*. Available at www.sodi.de/projekte/laos/humanitaere_kampfmittelraeumung_und_entwicklung_in_laos/.

Transparency International. (2010). '2010 Corruption Perceptions Index'. Available at http://www.transparency.org/policy_research/surveys_indices/cpi/2010.

UNCTAD (United Nations Conference on Trade and Development). 2007. *Information economy report 2007-2008 – Science and technology for development: The new paradigm of ICT*. United Nations, New York/Geneva. Available at www.unctad.org/en/docs/sdteecb20071_en.pdf.

UNDP. 2011. 'Regional and National Trends in the Human Development Index 1980-2010'. Available at http://hdr.undp.org/en/data/trends/1980-2010/.

UXO Lao (Lao National Unexploded Ordnance Programme). 2009. Available at www.uxolao.org/uxo%20problem.html.

WHO (World Health Organization). 2008. *Lao People's Democratic Republic*. Country Health Information Profile. Available at www.wpro.who.int/NR/rdonlyres/36A805A1-0774-4352-801C-7C97ECE95470/0/17LaoPDR08.pdf.

For more information: http://asia-pacific.undp.org
UNDP Asia-Pacific Regional Centre | United Nations Service Building, 3rd Floor, Rajdamnern Nok Avenue, Bangkok 10200
Tel: +66 (0) 2304 9100 | Fax: +66 (0) 2280 2700 | E-mail: aprc@undp.org | http://asia-pacific.undp.org

Empowered lives.
Resilient nations.

United Nations Development Programme
Asia-Pacific Regional Centre
United Nations Service Building
3rd Floor, Rajdamnern Nok Avenue
Bangkok 10200 Thailand
E-mail: aprc@undp.org
http://asia-pacific.undp.org