IEA INTERNATIONAL ENERGY AGENCY

Summary of Models for the Implementation of Photovoltaic Solar Home Systems in Developing Countries
Part 2: Practical Experience

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Report IEA-PVPS T9-02:2003

IEA PVPS
International Energy Agency
Implementing Agreement on Photovoltaic Power Systems

Task 9
Deployment of Photovoltaic Technologies: Co-operation with Developing Countries

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Summary of Models for the Implementation of Solar Home Systems in Developing Countries

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Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD),which carries out a comprehensive programme of energy co-operation among its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme is one of the collaborative R&D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic (PV) conversion of solar energy into electricity.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (Tasks) is the responsibility of Operating Agents. Currently activities are underway in five Tasks.

The 21 members of IEA PVPS are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), European Commission, Finland (FIN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), the United Kingdom (GBR), and the United States (USA).

The objective of Task 9, which started in late 1999, is to increase the overall rate of successful deployment of PV systems in developing countries, through increased co-operation and information exchange with developing countries and the bilateral and multilateral donors.

Twelve countries[1] participate in the work of Task 9, which is an international collaboration of experts appointed by national governments and also includes representatives of the World Bank and United Nations Development Programme. Developing country representatives are invited to participate.

The main report is based on a study prepared for Novem by
B. Schulte, BH van Hermert, and Q Sluijsc of Ecofys.

Part 2: Practical Experience is based on work prepared for the RESUM[2] project. The examination and preparation of the studies with regard to this guide was financed by GTZ. The practical experience examples were elaborated with the support of the German Federal Ministry for the Environment.
D. Reinmuller of ISES and D. Adib of the Fraunhofer Institute.

The study was edited and updated, incorporating comments of Task 9 experts, by
R. Gunning and K Syngellakis.

The statements in this report have been discussed and agreed upon by Task 9.

[1] Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, the United States of America.
[2] Renewable Energy Supply Models, www.resum.ises.org

Abbreviations and Acronyms

A	Amp
ADB	Asian Development Bank
Ah	Amp hours
BEP	Break even point
BOS	Balance of system
BPPT	Indonesian Agency for the Assessment and Application of Technology
CFL	Compact Fluorescent Lamps
Charge Controller	Charge Regulator
Dealer credit	Credit between dealer and end-user
Dealer re-finance	Credit between a financing source and a dealer
Deposit	Down payment
End-user finance	Credit between a credit provider and an end-user
EC	Electric Cooperatives (Philippines)
ESC	Energy Supply Committee
ESCO	Energy Service Company
ESD	Environmental Sciences Division
ESDP	Energy Services Delivery Project
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GOC	Government of China
GoI	Government of Indonesia
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IRP	Indonesian Rupiah
Km	kilometres
kWh	kilowatt hour
LCC	Life Cycle Cost
MW	Megawatt
MWp	Peak Megawatt
NEA	National Energy Administration (Philippines)
NGO	Non-Governmental Organisation
O&M	Operation and maintenance
ONE	Moroccan state utility
PERG	Rural Electrification General Programme, Morocco
PV	Photovoltaic
PVMTI	Photovoltaic Market Transformation Initiative
S&SC	Sales & Service Centres
SA	Sales Agents
SCs	Service centres
SEEDS	Sarvodaya Economic Enterprise Development Services
SELCO	Solar Electric Light Company
SETC	State Economic and Trade Commission, China
SHS	Solar Home System
SLBDC	Sri Lanka Business Development Centre
Souk	Market
SP	Service Points
SPC	State Planning Commission, China
SPM	SunLight Power Maroc, S.A.
SSL	SELCO Solar Lanka Ltd
SSTC	State Science and Technology Commission, China
UNDP	United Nations Development Programme
W	Watt
WB	World Bank
Wp	Peak Watt

1 Introduction

The implementation models described in Part 1 are being used in many countries worldwide. The following examples describe the operations of a number of companies supplying solar home systems in developing countries. The practical experience examples are a description of the businesses, highlighting the success and failure factors of the organisations. They are only a sample of the many PV companies operating internationally. They are not a critical evaluation of the implementation models, but seek to give the reader an idea of the realities of using the models in practice.

In most cases the information for these practical experience examples was supplied by the PV companies. In all but one of the cases the PV companies described follow more than one of the implementation models. The following examples are detailed:

Case Study	**Implementation models**
SELCO Solar Lanka Limited, Sri Lanka	Cash sales and end-user credit
Solar Energy Supplies in Zimbabwe	Cash sales and dealer credit
PT Sudimara, Indonesia	Case sales and hire purchase
PT Mambruk Energy International, Indonesia	Cash sales and hire purchase
Solar Home Systems in Swaziland	Cash sales and leasing
Soluz Honduras, SA de CV	Fee-for-service, cash and credit
Sunlight Power Maroc, Morocco	Cash sales, hire purchase and fee-for-service
Gansu PV, China	Cash sales

2 SELCO Solar Lanka Limited, Sri Lanka – cash sales and dealer credit[1]

2.1 General Background Information on Rural Electrification in Sri Lanka

In Sri Lanka, over 50 % of the 18 million population lack access to the electricity grid. The Government of Sri Lanka places high priority on rural electrification. It envisions rapid expansion of electricity access to enhance rural economic and social development. While good progress has been made in connecting villages by conventional grid extension, the success of the ongoing World Bank / GEF financed Energy Services Delivery (ESD) Project has demonstrated that off-grid systems - such as solar home systems and community-level independent grids - are frequently better suited to provide electricity services to remote, rural communities in a timely and economic manner. Thus, the likelihood of attaining Sri Lanka's vision of 75 % electrification by 2007 will be increased by a rural electrification strategy that uses both main grid and off-grid systems. Sri Lanka is in a position to add significant generation capacity in a least-cost manner through grid-connected hydro, wind, and biomass projects developed and financed by the private sector.

In order to be in a position to attract needed investment in generation, transmission and distribution over the next five years and facilitate the proliferation of rural energy systems to meet electrification goals, Sri Lanka's new Government has articulated two strategic approaches. First, the creation of investor confidence by restructuring the electricity industry along commercial lines and establishing appropriate regulation critical to secure the scale of investments required. Second, the establishment of a coherent and credible rural electrification and renewable energy policy to promote sustainable market-based provision of rural energy services and reduce the need for larger grid investments.

Despite its strengths, the sector currently faces acute power shortages and a serious financial crisis. There is an overall unfavourable view of the sector's management, given that there are significant power cuts, and electricity prices are perceived to be high in relation to the poor service.

Under the changed political circumstances in Sri Lanka, the Government is moving ahead to address the short term crises, as well as the long term issue of reforms. An Energy Supply Committee (ESC) has been established. Actions to speed up institutional and regulatory reform are underway. The World Bank, Asian Development Bank (ADB) and other donors are supporting the Government in this effort.[23]

2.2 Project Description

SELCO Solar Lanka Limited (SSL) is a subsidiary of Solar Electric Light Company (SELCO), USA. SSL sells, installs, services and helps to finance solar photovoltaic lighting and power systems in rural areas of Sri Lanka that lack access to grid-based power.

SSL works closely with the World Bank-funded Energy Services Delivery Project (ESDP) in Sri Lanka. This programme aims to facilitate the development of a commercially viable model for off-grid power supply and delivery in rural Sri Lanka.

SSL sells SHS on cash as well as on credit, in partnership with its main micro-financing partner - SEEDS (Sarvodaya Economic Enterprise Development Services). SEEDS is one of Sri Lanka's best established rural micro-financing agencies.

It is estimated that around 50 % of rural households can afford a solar home system (SHS) on cash or through credit. Of these, about 10 % can afford to pay cash, 90 % need credit. SELCO Solar Lanka Limited (SSL) assumes that the other 50% might be reached through partial grant, donor, or subsidy programmes.

SSL has sister companies in India and Vietnam, both of which have their own unique sales, marketing and consumer financing approaches. All SELCO companies operate on the same model of a permanent presence in rural areas through wholly owned branch offices, and guarantee a high quality of product and a personalised, efficient service.

SSL offers its customer not just lights or electricity, but guarantees that it always works. The SSL motto is: "Service within 24 hours, no matter how remote the customer." The customers are given warranty cards on which it is clearly stated that they can expect service within 24 hours, if a system does not work.

2.3 Company Procedures

Promotion for the systems is mostly done through word of mouth and door to door business through a network of sales personnel, but also through village demonstration events. SSL also has a van fitted with a demonstration system, which they take around the villages and markets. There are further World Bank-funded awareness raising programmes carried out by the Sri Lanka Business Development Centre (SLBDC) in which SSL can participate. It was found that demonstrations are good in creating awareness about the product and company, but to really convince a customer it takes a much more personalised approach.

The contract negotiation takes place in the customer's home. For a credit sale, a contract is signed between SSL, the customer and the financing agency (SEEDS – Sarvodaya Economic Enterprise Development Services). The SSL sales agent and the financing agency field officer visit the house, where the latter performs a credit check (assessment of assets, e.g. land, and customer's ability to pay). The customer has to bring two guarantors who sign on the form, along with the customer and the SSL agent. This loan application is taken back to the financing agency's office, and a loan committee has to approve the loan. Once the system is installed, the

customer also has to sign a World Bank grant form, which states the technical specifications of the system (panel size and manufacturer, battery capacity and manufacturer, etc.). Only once the customer signs this form is the grant made available.

The credit contract states that SSL installs and undertakes to maintain and service the system. Ownership of the system is passed to the customer on payment of the down payment.

SSL will provide the following service to the customer (i.e. attending to routine maintenance and complaint calls):

1. In the first year – four free service calls
2. In the second year – three free service calls
3. Subsequently, the customer pays a nominal charge for service. He / she also pays for any component that has to be replaced, unless it is within the warranty.

The financing agency undertakes to provide credit and makes all loan collections.

In case of a cash purchase, SSL also does the installation and provides after-sales service.

There are no regulations regarding maintenance intervals, however, in the agreement between the financing agency and the company, it is clearly stated that the company has to provide adequate servicing to the customer. This is very important to the financing agency because if a customer is dissatisfied with the service he stops paying his loan, which directly affects the financing agency. A network of rural SSL branch offices with technicians on call is available, additionally there are regular preventive technical inspections.

During the installation the customers are trained in how to use their system. The customer is also given a user manual, and it is clearly explained what he can expect of the system. Technicians, who are SSL employees, carry out the installation. They are qualified by SSL in-house training programmes, on the job training, and some may get sent on World Bank sponsored external training programmes. A new technician is always sent out on a job with an older, more experienced technician.

The financing agency's solar officer collects payment at the customer's house. The repayment rate is very high for SSL customers, on average over 90 %. SEEDS train the collection staff on credit assessment and collection. They also train SSL's own marketing officers on how to select credit-worthy customers. SEEDS is one of Sri Lanka's best established rural micro-credit agencies. For solar loans, no special lending method is used as such, but once a SHS user gets on the SEEDS credit programme, he is encouraged to become a Sarvodaya Society member (if he is not already one). Sarvodaya is Sri Lanka's largest rural development NGO, and works on the principle of self-help groups. Sarvodaya societies cover one third of the villages in Sri Lanka, and when it comes to loan collections, they use the principles of social pressure. Therefore the collections have not been a real problem. This is partly because once a person has a SHS, electricity in itself is enough incentive for the customer to make the payments. Also, the SEEDS system of collections (field officers going to the home, vs. customer coming to the bank) is very effective. In case of non-payment, the customer is given three months to make good his loan default. If he fails to make any payment after three months the solar company, on the advice of SEEDS, repossesses the system.

2.4 Technical Description

A SELCO Sri Lanka SHS includes PV panel(s), a battery, lights, a charge controller, a battery box, wiring and accessories (e.g. switches, plug points). They also offer models with other appliances such as fans, doorbells and DC televisions.

The system has a warranty for one year. Individual component warrantees reflect the suppliers' warranties (e.g. panel: ten years).

2.5 Financial Description

The approximate price of a typical 4-light system is USD 400-450. There is a World Bank grant available of USD 100, so customers pay approximately USD 300-350. If they access the financing, they pay 10 % as down-payment, and the remaining amount, plus interest, divided equally between the number of months of their loan period (one, two, three or five years). Commonly, they pay 10 -15 USD a month. Ownership is passed to the customer on payment of the down payment.

The system itself is used as collateral.

2.6 Infrastructure and Quality Assurance

Of the components used by SSL, the battery and accessories such as wires, switches, and plugs are locally produced, all the other components are imported. Quality assurance is self-maintained, i.e. SSL's own standards. It is also ensured through the World Bank programme. To claim the grant, the system and components have to conform to standards and specifications stated by the ESDP programme. The programme has specified which suppliers are approved, and there is a well-established system for approving new suppliers. Therefore the reliability of components is very high.

SSL has established a network of local SSL branches. Offices cover most of the country.

Batteries are recycled by the supplier.

2.7 Impact and Lessons Learnt

At first the main problem encountered was the lack of access to finance. This seriously limited the market. Initially SSL was self-financing systems (prior to the WB programme and SEEDS involvement). This proved extremely difficult, and affected SSL's cash flow badly since SSL did not have the infrastructure nor the know-how to function as a credit agency. This problem was resolved with the involvement of SEEDS.

There are, however, still problems related to financing. SEEDS has been finding it difficult to keep up with the large number of loans it now has to process. As a result, there are serious delays in credit assessment and in the release of funds by SEEDS to the solar companies, which affects the solar companies' operations and cash flow.

SSL maintain a high quality of service by keeping the installation and servicing in-house. The personalised approach and a high quality of product and service ensure that the customer feels a bond with the company and will not go elsewhere.

3 Solar Energy Supplies in Zimbabwe – cash sales and dealer credit[4]

3.1 General Background Information on Rural Electrification in Zimbabwe

While in Zimbabwe about 69% of the total population live in rural areas, only about 5% of the rural households have access to electricity, as well as access to clean water. The main goal of various donor-funded electrification projects has been to improve the status of the rural population.

Until 1992 private companies with a general interest in renewable energy were the major suppliers of PV systems. In 1992, the Global Environment Facility (GEF) started a Photovoltaic (PV) Pilot Project, which intended to reduce emissions from combustion of kerosene for lighting and also to deliver systems for lighting by providing financial support to rural households. It also supplied PV systems for income-generating projects such as small-scale irrigation. In 1998 the Japanese government supported a project to assess the ability to pay by rural households.[5]

3.2 Project Description

Solar Energy Supplies sells PV solar home systems to users in the unelectrified rural areas of Zimbabwe. Different size "standard" kits for 3, 4, 5 and 6 light systems are sold for cash or credit through a network of credit and other stores.

3.3 Project Procedures

The PV systems are available in credit stores, directly from the producer's shop and from other solar suppliers. Credit stores are located in major towns as well as in remote rural areas – basically anywhere where there are sufficient customers. For instance, one of the best customers is in Nyika, which is a very remote spot in Zimbabwe. The stores give orders for a set number of kits of each type. After manufacturing (3 to 6 weeks) the kits are delivered and invoiced. The stores then display and sell the kits to their customers. If the system does not work, the customer complains to the store and usually will not pay. The store then contacts the system provider, who needs to solve the problem as soon as possible. There are usually no written contractual obligations between the provider and the credit store, but if the kits fail, the store may sue the providers and not buy from them again, which has proved to be enough of an incentive to produce good-quality systems.

Demonstrations in villages have proven to be very effective advertising measures. Contract negotiations then take place in the credit store, or in the shops. The procedure includes a discussion of how many lights, whether on not the customer has a TV, and how many hours per day he expects lighting.

The customer is responsible for installation, operation and maintenance and there are no additional regulations on the use of the system. To this end, an illustrated installation manual is supplied with each kit. This details both installation and maintenance procedures. A cash sales system must be easy to install, even by non-skilled and semi-literate people. No knowledge can be assumed. Wiring standards and neatness are very unlikely to be of the same standard as the developed world, but it must be borne in mind that the sole criterion as far as the customer is concerned is that the system works reliably for years without attention. Luxuries such as conduit enclosed wiring and surface mounted "mains" type switches are inappropriate in this environment. A lot was learned by watching people install their systems, noting where difficulties or confusion occur, then trying to resolve these problems by appropriate design or modification of the installation booklet.

A good SHS does not require extensive maintenance other than to ensure the battery is correctly filled and the terminals are clean and greased. The user easily does occasional fluorescent tube or halogen capsule replacement. If the customer has a problem he will go to the credit store and if the department manager cannot resolve the problem, he will phone the supplier, who must solve the problem.

On commercial credit sales, the credit store collects the payment. The favoured method is deduction from salary. Otherwise, the customer has to come in monthly and pay in the store. The store never goes out collecting money unless repossession is imminent. The PV supplier will not be involved in credit sales to customers. In Zimbabwe, there are numerous credit stores who specialise in consumer credit and have effective methods of debt collection. It was found that it was unadvisable for the solar suppliers to provide credit themselves, as it is not their core business and recovering money can be a very costly business that eliminates all profit.

3.4 Technical Description

The systems consist of a pre-engineered package that includes the lights, complete with switches, wiring, a charge regulator, a battery and a solar module. A mix of halogen and fluorescent lights according to customer requirements is supplied, and the module size depends on whether or not the customer wishes to run a monochrome TV. However, these components are supplied in “standard” kits for 3-light, 4-light, 5-light and 6-light systems. This method ensures a correctly sized and engineered system, with all wires of adequate cross section and length. By using different high quality plug-in connectors for the plus and minus connections, mistakes regarding polarity are eliminated and all connections are reliable.

Warranties are given on the balance of system components (five years), on the module (usually 10 to 20 years) and on the battery (one year).

3.5 Financial Description / Project Financing Plan

The cost of a 4-light system is approximately USD 300 cash, but varies with the type of solar module supplied. In the commercial credit scheme, a 25 % down payment is required, followed by equal monthly payments. These payments can be made over a period of 6 to 24 months, depending on the customer’s income and credit rating. Interest is at the commercial bank rate, currently about 30% in Zimbabwe. Civil servants may purchase without a down payment because their payments are paid direct to the store by the government Salary Service Bureau. Ownership transfers to the customer on completion of payment.

It is estimated that about 70% of the systems are sold through credit, and only 30% on a cash basis.

3.6 Quality Assurance

All items included in the kit are locally produced with the exception of the solar module. In general, imported BOS components were found to be of poor quality, inappropriate and very costly. The locally produced components are engineered for at least 10 to 20 years life and are 100 % tested after manufacture.

The sales staff in the credit stores and other outlets are trained by the system supplier on system operation and use in order to advise their customers. It was found that the staff operate far more effectively if they understand how the system functions.

3.7 Infrastructure and Institutional Issues

By using credit stores, a distribution network of approximately 120 branches countrywide was established. It was not found to be cost effective to set up their own branches. The credit stores have their own infrastructure, each covers an estimated radius of about 100 km. The stores stock a limited quantity of consumables such as tubes and halogen capsules. It was not found necessary to stock light fittings and charge regulators. Should these fail, they are replaced by the supplier, if still under warranty, or the customer must purchase a replacement if not covered by warranty.

For communication, each customer is provided with a warranty card that they mail to the supplier after purchase. This must be stamped and signed by the supplying store. Other than that, there is no further communication, unless customers experience a problem that cannot be sorted out by the credit store staff. Sometimes customers also telephone the suppliers or visit their shop. These in turn write periodically to a random selection of customers who have returned their warranty cards, asking about their satisfaction with the product. Additionally the suppliers like to visit a small number of customers on a random basis just to see how their systems are performing.

For recycling, there is a market for old batteries as scrap lead input to the local battery manufacturers. Thus most old batteries are “traded in”.

3.8 Impact and Lessons Learnt

User behaviour is generally good and no problems have been encountered. This is attributed to the fact that the users have to pay for the system, so they look after it.

3.8.1 Problems encountered

During initial involvement in the conventional method of SHS sales and installation it was found that installations (by the technicians) were often of poor quality and unreliable, leading to costly revisits to site. Costs were high due to installation costs and transport costs.

When the cash sales method of supply was first started, lights and regulators provided by other suppliers were used. Initially standard plugs and sockets were used, wires from the charge controller to the battery, or the controller to the lights, were not pre-cut, and poor quality switches were used as they were the only ones available. This meant that the customer had to screw wires into terminals, and observe polarity. Initially no colour coded wires were used because they were not available in Zimbabwe. All this lead to a variety of problems, and reliability was totally unacceptable.

Therefore, new lights and charge controllers were developed by the suppliers themselves and even the wire that is used (0.7 mm^2 colour coded twin flex) is made by them. The components are now designed and manufactured to industrial standards, which means the components used are such that an average of 20 years life is expected. Since the system is now pre-engineered, all components match, e.g., wire size and length from controller to battery (this was seen as a large problem in most installations done by technicians and home owners).

However there are still some foreign kits of very poor quality on sale. These are perceived to be little more than toys with problems occurring with the following:

- Wire size totally inadequate.
- No charge regulator or inferior charge regulator.
- Very poor quality lights.

- Very poor quality solar module.
- Misleading packaging. A kit for a 8 Wp panel shown powering refrigerators, TV sets etc.

It is worth noting that Solar Energy Supplies disagrees with the prevalent perception that SHS and Solar PV are something unique and special, requiring foreign “experts”, pilot schemes, etc. They believe that the only relevant experts are those who make their daily living from providing solar PV and SHS in Africa on a purely commercial basis. A solar home system is a universally desired product in rural Africa. Initially customer awareness education is necessary but after that, all that counts is cost and performance, as with every other commercial product.

3.8.2 Advantages encountered

- The cost of the systems is greatly reduced because no installation and travel costs are involved.
- The system is correctly engineered as regards wire size, module size, wire length, number of lights, correct charge regulator and battery.
- The customers own their systems.
- The systems can be expanded at a later date.
- A real and effective warranty operates. Because credit customers will not pay instalments for a non-working system, the supplier is instantly aware of any problem. The supplier is not dealing with a possibly unsophisticated rural buyer but with the management of the credit store, so must rectify the problem or reimburse the store. Poor quality suppliers cannot remain in business for long.

4 PT. Sudimara, Indonesia – cash sales and hire-purchase[6]

4.1 General Background Information on Rural Electrification in Indonesia

The geography of Indonesia, with its 13,677 islands, makes it impossible to build up an interconnected electric grid. Even on electrified islands most rural households often do not have access to an electric grid. It is estimated that only 40% of all households are electrified. Solar Home Systems (SHS) present the best access to light and communication for many of the household in rural areas.

The Government of Indonesia (GoI) has undertaken PV programmes since 1989. A 50 MW_P-Programme to install one million SHS with international support was proposed in 1998. In Indonesia, as well as in most developing countries, the dissemination of SHS is impeded by financial problems. Most rural households are unable to purchase a SHS on a cash basis.

The economic crisis in East Asia in the 1990s had severe consequences for the Indonesian PV market: Between 1997 and 1998 the Indonesian Rupiah (IRP) lost 80% of its value. This affected the price of a SHS, which tripled, because the Indonesian PV market depends strongly on imports.[7]

4.2 Project Description

From 1993 to 1998, PT. Sudimara installed SHSs on a hire purchase and cash sale basis in the Indonesian provinces of Middle-Java, West Java, Lampung and Jambi. Prior to 1993, the company was owned by Shell Renewables under the name R&S.

Sudimara developed and produced different balance of system (BOS) components such as lights, batteries and charge controllers and integrated systems, with batteries and a charge controller in one box.

When the economic crisis hit Indonesia and the government pretended to electrify rural villages by putting up electrification poles (which they took back after the elections), the company's markets were destroyed, and it stopped operation.

4.3 Company Procedures

For promotion and awareness raising information handouts and demonstration systems were used. The latter turned out to be much more effective than the former. A sales brochure for direct selling was also used. It was found that this could be effective, though success strongly depended on the sales staff.

Hire purchase contracts were concluded in the branch office of Pt. Sudimara. The contract stated that Pt. Sudimara technicians were responsible for installation and maintenance during the contract period. It was also agreed that no direct connections to the batteries were allowed. Complete installation was then done by qualified and trained technicians. Maintenance was also available after the contract period had expired, for a fee.

During installation, extensive user training was offered. Instructions were given, for instance, on how to check the level of the battery fluid. However, when components failed, it was difficult to find out what caused the breakdown. For example, a faulty battery may be responsible or the battery may have been overused.

The branch offices were relatively close (not more that 40 km), so if any problems arose, the customers could seek help in these offices.

The Sudimara technicians also collected the monthly instalments, which was significant additional work as people tended not to come to the branch offices, so payments had to be collected at their homes. The repayment ratio, a few days after the due dates, was between 90

to 95 %. It was found that as long as the systems worked well, people were prepared to pay. In case of non-payment, first the PV panel was taken away, and later the rest of the system.

4.4 Technical and Financial Description

The product consisted of a 40 W PV module, an 8 A charge controller, a battery and switch box, a 70 to 100 Ah battery, several 6 W lights, cabling and a 45 W TV. All components except for the PV panel were locally produced.

A warranty of 10 years was given on the solar panel and one year for all other components.

Ownership was transferred after full payment. A system cost about USD 400. The down payment was 20 % of the system cost, and monthly instalments with an interest rate of 20 % could be spread over up to three years.

4.5 Infrastructure and Institutional Issues

Sudimara had 5 regional offices, and 65 branches that could cover 80 % of the total area where they were operational. Each branch had three to four employees. Regional offices were equipped with a car and two motorcycles and branch offices with one motorcycle. The total number of staff was 260, 50 % of whom were in sales, 20 % in technology development, 20 % in manufacturing, and 10% in administration. The number of systems looked after by one technician depended on the number of installations at that branch and other factors like how dispersed the installations were, but there was a maximum of about 250 systems per technician.

The rural branches operated in a radius of about 40 km. There were decentralised stocks of spare parts at the branches and regional offices. Stock lists were checked on a monthly basis when the collection of the instalments by the head office was done.

Communication with the customers was once a month during fee collection.

The sales manager at the branches carried out sales training courses every four to six months. Such a sales course took about 3 days before the sales persons went into the field.

4.6 Impact and Lessons Learnt

It was found that customers took care of their systems; however, this largely depended on what kind of product was sold to them (quality of installation, etc.) and how customer complaints were handled. Poor quality systems tended to be abused and failed within a short time. Complaints were dealt with in an ad hoc manner because technicians did not have the skills to perform a solid diagnosis (what is broken and why did it happen, system failure or abuse?). A better, more user-friendly design of the systems is seen as an option to prevent these problems and better technician training would help.

Batteries are often the weak part of the solar home system. Therefore the customers often saw the system performance declining with time.

Lights were included in the Sudimara SHS systems and so were covered under the system's one year warranty. High quality lights were required to avoid the technicians having to go out (driving for a few hours) to replace them every few months. Therefore their production demanded strict quality control procedures.

In the opinion of the former sales manager, the hire-purchase model could work. Selling SHSs through this model makes PV just another consumer product, and sales results can be excellent.

It was found that a growing business was difficult to contain. In the beginning the business was very successful. Later when the number of customers had increased, credit management became a major concern and took up a lot of time for the branch employees.

Cash flow problems became worse and worse as the company grew. Banks were unwilling to give loans, as there was no acceptable collateral (PV panels were unacceptable to the banks).

Finally, the overhead costs were higher than expected. This was especially the case when new branches were opened and did not perform as well as expected. Closing a branch down when there were already systems installed made “cutting losses” very costly.

5 PT. Mambruk Energy International, Indonesia – cash sales and hire-purchase[8]

5.1 Project Description

In 1998, Mambruk and Hollandia Kloos started to import complete SHSs from the Netherlands to see whether promotion of solar energy was feasible in Indonesia. Around 2000 systems were sold during that phase.

During the second phase 20,000 SHSs were be delivered within two years. A commercial network for the sales and service of SHS and other PV applications was set up for this purpose. This was to be part of the World Bank and BPPT, the Indonesian Agency for the Assessment and Application of Technology, Programme.

Sales & Service Centres (S&SC) were established through an agency/distribution system, under a franchising system. The centres are based in the small cities on a regional level. The goal is to have at least one S&SC per province. These S&SC receive stock from Mambruk on a consignment basis, as well as a sales target (100 units per month). The S&SC have an obligation to open Service Points (SP) or Sales Agents (SA) in the rural areas, who are selected in close cooperation with Mambruk,. In every case Mambruk provides warranties for the PV systems. Installation is carried out by the technician of the S&SC, or in some cases by the technician of the SP.

Customers can buy systems either by cash sale or on hire-purchase.

5.2 Project Procedures

Advertisements for the products are made in local newspapers and on the radio; furthermore, there are presentations and demonstrations in the villages and banners on main roads and flyers. There are plans to advertise on billboards and to start marketing through TV. The success of the advertising approach depends on the area; different ethnic groups have to be approached in different ways.

Projects are normally co-financed by organisations, governments or even companies. This means the contract will be signed with them. In cash sales, the agreement is signed in the houses of the end-user. The buyer fills in a special form (receiving report), which is then sent to Mambruk and co-signed by the installer and the manager of the S&SC. Standard contracts are used for cash as well as hire-purchase sales.

In some regions a government owned credit assurance organisation, PERUMPKK, takes over the decision of who will get financing. However, unfortunately this service is not available for every potential customer, since PERUMPKK works per province, and agreements have not been settled with all province offices yet. Further, the customer has to be a member of the cooperative. If this is not the case, credit evaluation starts in the house of the end-user, where a pre-selection of customers is done by the S&SC. They then fill in the credit request form and send it to Mambruk's credit manager in the head–office, who evaluates the available data and makes the final selection. This procedure is completed within one week.

Directly after or when paying the full amount or the down payment, the technician installs the system. The technicians are appointed installers, either directly from Mambruk or from the S&SCs, who have to pass a training course.

The owner of the system is responsible for operation and maintenance in co-operation with the S&SC technicians. Once every two months, Mambruk sales-technicians visit the installed systems for regular maintenance checks during the first three years. When there is a failure, the

S&SC go directly to solve the problem. After the three years, the service points take it over as part of their marketing approach.

During installation, training is offered to the customer. The customer is also provided with a clear manual, including lots of pictures and some writing. In addition, Mambruk puts an instruction sticker on the battery box. The customer can also turn to the local S&SCs and ask for help if anything is unclear.

End-users are asked to maintain the units properly as well as not connecting other batteries or loads to the system. However, no written regulations exist on this agreement.

There are different approaches to payment collection: either from house to house (through a debt-collector) or the customer deposits the monthly instalment with a trusted person. This person is appointed by the end-user and approved by Mambruk. In some cases this can be the S&SC, SP or SA, but also a trusted person or cooperative in the village. The collector receives a known collection fee for his services so the customers know the amount. The collector is not trained to do this special task. Experience shows that the repayment ratio is higher than 80%. Customers sometimes “forget” to pay for two months or so due to some family matters, but after that they pay correctly. Social pressure is high in rural areas, and people are “proud” to pay. Sometimes group lending is used, normally coordinated by cooperatives or factories. They usually take the instalments directly from the salary.

Regular payments in some regions are insured through PERUMPKK, which warranties the instalments for a percentage of the warranty. If the customer is approved by PERUMPKK and does not pay within a certain period, PERUMPKK will pay Mambruk the full amount, i.e. 75 % of the system price (there is a 25 % down-payment). PERUMPKK then takes over the unit. In the worst case after three months of non-payment, the panel and the controller are disconnected and taken away.

5.3 Technical and Financial Description

The systems sold consist of a 50 Wp PV module, a 10 A charge controller, a 70 Ah solar - battery, three 10 W lights, installation and power cable. Only the controller and the PV-module are imported; all the other components are produced locally. A workshop/assembly line was set up in Jakarta in October 1999.

For the solar module, there is a warranty of ten years; for all the other components (charge regulator, inverter, lamps and the battery) warranties of one year are given.

A system (in 2001) cost IDR 3,200,000 (around USD 320). The down payment is IDR 750,000 (75 USD), i.e. 25 %, and can be spread over three months. Instalments are IDR 122,000 per month (12.2 USD) over two and a half years.

For cash sales, ownership is transferred directly to the end-user. With hire-purchase-sales ownership is transferred after the last instalment.

5.4 Quality Assurance

Both local and imported products are used. There is an internal quality assurance in accordance with ISO 9001. Experience with the lifetime of components has generally been good. Batteries last four to five years, inverter lamps three to four years, and so far no problems have been encountered with controllers or PV panels.

To assure quality in other areas as well, every week there are internal staff training courses, as well as internal audits and audits to the suppliers.

5.5 Infrastructural Issues

The S&SC are fully equipped solar shops complete with spare parts, cables, lamps, panels etc. They are supplied with one car and several motorbikes. The staff usually comprise four

technical sales persons, one sales co-ordinator and one administration agent (of course this depends on the total of units they sell per month). The SPs have a staff of three people. One technician installs approximately 20 systems per month. Infrastructure costs amount to around IDR 50,000 (USD 5) per unit, i.e. 1.5 % of cost.

Contact with the customers is through the bi-monthly visits of the technicians. It was found that customers in general take care of the systems. Audits from head-office, as well as the sales calls, are made to ensure correct user behaviour.

To make sure that old batteries are recycled, an agreement is made with the battery manufacturer that if people give back a failed battery, they can get a new one with a large discount.

5.6 Impact and Lessons Learnt

It is estimated that about 50% of the Indonesian market will be reached through the Mambruk approach.

A big advantage encountered with the franchising system was that investment costs in infrastructure are much lower than with other approaches, so that Mambruk can spend more money on training and quality assurance as well as traceability and marketing. However, the project had a slow start due to network establishment activities. It was therefore necessary to try to find a balance between project sales, cash sales and sales though the network. This then created a positive cash-flow and volume in sales.

6 Solar Home Systems in Swaziland – cash sales and leasing[9]

6.1 General Background Information on Rural Electrification in Swaziland

An estimated 5% of the rural population of Swaziland have access to the national grid. Only a small number of the total population benefited from the grid extension programme, due to the high costs of the grid-based services. Off-grid systems, especially photovoltaic (PV) systems have been considered to be a realistic alternative and have been applied to public services remote from the grid, such as telecommunications and lighting for schools and clinics.[10]

In 1991 the Swaziland Ministry of Natural Resources and Energy was already undertaking various activities to stimulate the use of solar energy in the country. A PV demonstration project was implemented between 1992 and 1995 with the intention of creating awareness of solar energy among the rural population and in meeting basic electricity needs. In co-operation with UNESCO the Ministry established a “solar village” in Mphaphati, 80 km from the capital Mbabane, to create a sustainable demonstration project and to fulfil basic electricity requirements with the use of PV. A USD 100 000 loan from the World Bank was given to a private sector supplier supporting the availability of equipment installed and this stimulated the PV market in general.[11]

6.2 Project Description

In 1997, a leasing system for Solar Home Systems was established in Swaziland. The SHS can be bought through cash sales or leasing. Project management is carried out by the local private sector with management support from the Energy Research Foundation ECN (Netherlands), a loan from Triodos Bank (also of the Netherlands) for the set-up of customer credit, and a loan from the World Bank (for general market development support).

6.3 Project Procedures

Information on the systems is spread using a whole range of methods including those listed below:

- Road shows with drama group
- Video shows and demonstrations at rural schools and community meetings
- Demonstration stand at trade fair
- Demonstrations during gatherings of potential customer groups (teachers, nurses, police, etc.)
- Radio advertisements
- Education talks on radio
- Documentaries on television
- Editorials in newspapers
- Leaflet drop from aeroplanes
- Solar displays at rural hardware shops (including training of sales personnel)
- Workshops for rural NGOs with a view to spread the solar message
- House-to-house sales
- Brochures and leaflets at strategic places (television distributors, LPG distributors, rural grocery shops)

The indirect effect of all these measures is difficult to assess. Based on the direct responses of the people, radio and newspaper adverts combined with the information and advice of a professional salesperson seem to be the most effective method for generating sales. Moreover, having one system installed and working properly also has a good demonstration effect (word of mouth). Drama groups, demonstrations at communities, trade fairs etc. may have been useful for the creation of awareness, but not for generating sales.

The leasing contract is always signed in the company's office/shop. As Swaziland is small, informal networks have generally been used to check the creditworthiness of the customers. There have been no strict rules set down, the only condition is that customers should prove they are either employed, have a pension or earn sufficient money from their own business.

In case of a lease sale, the system is installed by a technician employed by the system provider. Every customer receives training during the installation process. But obviously training is limited to the people who are at home at the time of installation. In case of a cash purchase, customers can decide whether they would like to install the system themselves or whether they would like the system provider to do it. If customers prefer to do the installation themselves, the sales person gives detailed installation advice. In addition, some written installation leaflets are provided.

Users are responsible for the operation and maintenance of the SHS in both cash sales and leasing sales. There are no regulations laid down in the contract on how to use the system. When technicians are in the neighbourhood of a SHS installation and have time, they will pass by to check on the system.

For payment collection, an arrangement was initially made with a local bank with various branches throughout Swaziland. Customers could deposit their monthly instalment into the bank account of the solar company. This did not work well, because

a) the bank was not able to provide the company with customer payment details.

b) people did not like to go to the bank (because of long queues or just because of an aversion to formal institutions). Consequently, people preferred to come to the shop to make their monthly payments.

c) at the beginning (first two years after its launch) repayment discipline was very good. However, after many cases of failing batteries (expected lifetime of the batteries is about 2 years) and hence non-performing systems, the default rate has increased.

The initial credit injection has stopped (one-off loan from Triodos bank) and hence no more financing is provided. As a result people tend to buy smaller (cheaper) systems or just single panels. Moreover, the 'savings' option is very popular (people bring money to the shop until they have saved an amount equal to the purchase price of the system or components).

6.4 Technical Description

The SHS consists of a 40 to 50 Wp PV panel, a 5 to 10 A charge regulator, a 96 to 105 Ah battery and four 7 to 15 W lights. The whole package comes with installation, cabling, and mounting materials.

The complete system has a warranty for one year. Within this period, any faulty parts will be replaced by the supplier free of charge. After that the customer has to pay for maintenance and replacements. There are different warrantees for the individual components: e.g., light ballast two years, regulator three years and PV panel ten years.

6.5 Financial Description / Project Financing Plan

The cash price of a system is ZAR 4200 (USD 525). For the leasing option, customers have to pay a down payment of 25 to 30 % of the cash price and an interest of 2% above base interest rates paid back over a maximum repayment period of 36 months. Ownership of the system is only transferred after the full payment. The complete system is used as collateral, so if customers do not pay their debt, the system provider repossesses the complete system.

6.6 Infrastructure and Institutional Issues

Since Swaziland is so small (maximum 2 hours drive in all directions to reach border), the project started with one office/outlet in a central location. Later on, the network was spread out by using existing rural hardware chains. These shops received training, promotion and display material and could phone whenever assistance was needed. The shops got a commission on every sale made. This did not work well. The sale of SHS requires highly trained staff who can adequately inform and convince customers of the benefits and limitations of SHS.

It was considered very important to have decentralised technical support centres. For the purchase of a system people will be prepared to travel to the main centres, but to buy spare parts and for technical support, nearby centres are needed. Whether such centres are viable strongly depends on the number of customers. Ideally, such support centres are integrated with existing businesses (local repair shops, garages etc).

Today, if customers need help with anything, they either phone the shop, go into the office of a support centre, or meet the technicians when they are on duty in the field. The staff have been thoroughly trained on the job and have participated in sponsored PV training courses.

6.7 Impact and Lessons Learnt

It is estimated that 1-2% of all rural households (generally the more wealthy rural population) are reached through this mixed approach.

Follow up surveys have been made to assess system performance and user satisfaction. In general, people do take care of their systems and are generally very happy with them. The main problems encountered are related to the battery. People do not always have the money to replace the battery instantly and often have to wait for some time before they have saved enough to replace the battery. In the mean time, the system is not used. If this happens with a system sold on leasing terms, this may result in non-payment.

Experience with lifetimes of components so far only exists for batteries, which last about two years. People do get a small refund when they return the old battery, but nevertheless obsolete batteries are often used as roof supports; two batteries plus a shelf make a bench or table top, etc. Panel lifetime is difficult to assess at this stage. A few failed due to lightning. The same applies to charge regulators.

The general experiences suggest that SHSs are a useful product that meets basic electricity needs of households in rural areas. So far however, their use has been limited to higher income households. It is definitely not a product for the poor. The initial upfront cost is the biggest barrier. But even leasing schemes do not provide access to the majority. Smaller panels to charge an existing car battery, which are readily available, do well if financing services are not available or people do not qualify for a financing scheme.

Technical support is essential for the long-term satisfactory performance of the systems. Many people leave a defunct system idle for a long time because they do not have the money for repairs and replacements. Regular inspection visits by a qualified technician are very useful but are very expensive. In the case of dispersed installations, such visits can be uneconomic for a small entrepreneur.

It was found that financing for SHS works best if the repayment period is not too long. Financing for more than 2 years will result in a higher default rate (not only due to system breakdowns, but also because of socio-economic factors, e.g., sudden unemployment, illness or death of bread winner).

7 Soluz Honduras, S.A. de C.V. – cash, dealer credit and fee-for-service[12]

7.1 General Background Information on Rural Electrification in Honduras

Honduras has about 6.5 million inhabitants. It is one of the poorest countries in Central America. Although it is rich in natural resources, they are rapidly being depleted. The economic challenges facing the country include poverty, rapid population growth, unemployment, and inflation.

Fuelwood and biomass have traditionally met about 67 % of the country's total energy demand (petroleum 29 % and electricity 4 %). In 1987 Honduran households consumed approximately 60 % of total energy used, transportation and agriculture used about 26 %, and industry used about 14 %.[13]

7.2 Project Description

Soluz Honduras, a subsidiary of Soluz, Inc., was incorporated in December 1997 and operations began in July 1998. Soluz, Inc. is a stock corporation founded in 1993 which has built two rural energy delivery subsidiaries, Soluz Dominicana and Soluz Honduras. These two operations combined have supplied over 5,000 PV systems.

Soluz Honduras's revenues are from the sale of PV equipment and services to rural customers. The company is capitalised with equity and debt financing. The company sells SHS for cash or on credit and provides electricity services on a fee-for-service base. Soluz Honduras has supplied over 1,600 PV systems with about 1,100 of these on a fee for service basis.

Soluz Honduras' sister company in the Dominican Republic, Soluz Dominicana, operates in the same manner. In the Dominican Republic, Soluz is co-operating with an NGO on a rural credit programme that finances customers in their geographical area. They also use their own capital to extend credit. The fee-for-service offer is now the most common choice by customers.

7.3 Project procedures

Promotion of the business is done primarily through direct sales visits to potential customers.

Installation technicians are employees of the company. They are trained internally by lead technicians and PV suppliers. At installation the customers are provided with a verbal explanation and printed materials to help them use the system properly.

In credit sales, the customer can pay Soluz Honduras for maintenance, paying for labour and components if they are past the warranty period.

In the fee-for-service scheme, all maintenance is included in the monthly fee. The fee-for-service customers have a guaranteed service, and the company aims to remedy failed systems within a specified time. The systems are maintained by Soluz Honduras zone managers and their assistant technicians. The customer is responsible for simple maintenance tasks such as adding distilled water to the battery. Service calls occur in the event of failure, visits are not made for preventive maintenance. When the battery reaches the end of its life, the customer purchases a new one, typically from Soluz Honduras on a payment plan.

Soluz Honduras zone managers are responsible for a set geographical area and operate out of a service centre. Soluz Honduras identifies and rents a suitable building for such service centres.

Payments are made at rural collection points that are the responsibility of Soluz Honduras collection agents. There is monthly contact at these collection points. The agents are contracted by the company and are not employees. Soluz zone managers in turn collect the payments from the collection points.

For the fee-for-service scheme, the collection rates are essentially 100%. Non-payment results in the rapid removal of the system. Incentives are used to motivate collection agents and zone supervisors. Resolving payment problems with systems sold on credit is clearly a more complicated situation.

7.4 Technical Description

For cash or credit sales, the product consists of different sizes of PV modules (20 to 75 Wp), mounting hardware, a charge controller, a battery (60-100 Ah), and various CFLs (5 and 9 W). Under the fee-for-service provision, the service is defined by the size of the PV system (20 W to 100 Wp) and includes a certain number (one to six) of lighting fixtures.

In a cash or credit sale, the complete systems are provided with a 90-day warranty on all components (including switches and lamps). PV Modules carry the manufacturer warranty of 10 to 25 years, depending on the manufacturer. Batteries carry local warranties of 12 to 15 months.

7.5 Financial Description

Cash sale prices for complete systems range from about USD 600 to USD 1 500 (30 W-100 Wp) with complete wiring installed and warranty. Consumer credit is offered with typical commercial terms with at least 25 % down payment and up to 12 months to pay with interest rates at about 3 % per month in local currency.

By maintaining ownership of the PV system assets, Soluz is able to provide them at affordable monthly rents, ranging from USD 10 to USD 20 per month, prices equivalent to that now paid for kerosene, dry cell batteries, and the re-charging of car batteries for TV usage.

In cash as well as credit sales, ownership is transferred upon installation. In the latter case, however, sales are conditional, with the final title secured upon completion of pre-signed payment stubs for credit sales. Therefore, the complete system is used as collateral. For fee-for-service business, the ownership of PV systems is retained indefinitely by the company. However, the battery is the property of the customer.

7.6 Infrastructure and Institutional Issues

Both imported and local components are used. Soluz specifies system design and components and compliance is reviewed in on-site visits. Ongoing staff training is provided, and periodic quality reviews are made of installation quality and customer satisfaction using standardised quality check lists.

Local collection point agents are normally an existing “country store” infrastructure.

All buildings used by Soluz Honduras, the national office, the service centres and the collection points were existing facilities. There is a total current staff of 15 employees working for Soluz Honduras. Local branches are outfitted with trucks and motorcycles. Zone managers are responsible for 250 to 1000 customers. Spare parts are warehoused in Soluz Honduras facilities.

Batteries are recycled by the suppliers, who send them back to the factory for reuse of the materials.

7.7 Impact and Lessons Learnt

In some areas, up to 50 % of the population have been reached through PV fee-for-service. Cash and credit sales has had much less penetration.

Customers care for their systems because they want to continue Soluz Honduras' service. The main problems encountered with fee-for-service and the credit approach is the significant capital that needs to be raised.

Soluz has experience with cash, credit and fee-for-service and continues to offer SHSs under all three financial offers in Honduras. After experience was gained with cash and credit models, the fee-for-service option was offered to significantly expand the energy service impact of the company through commercial growth. The majority of customers prefer the fee-for-service option.

8 SunLight Power Maroc, Morocco – cash sales, hire purchase and fee-for-service[14]

8.1 General Background Information on Rural Electrification in Morocco

The overall electrification ratio in Morocco is low, even by regional standards. ONE (the Moroccan state utility), is responsible for the national electrification programme working in partnership with the municipalities. The slow progress of the original programme before 1994 led to a number of changes and new arrangements, known as the Rural Electrification General Programme (PERG), which was launched in 1996. The original objective of the new programme was to connect 1000 villages to the distribution network annually at an annual cost of a billion MAD. This has since been increased to 1500 villages per annum (at a cost of 1.5 billion MAD per year) with the target of completing the programme by 2006. In 1999, 1650 villages were electrified under the PERG programme.

PERG has three general aims:

Territorial: to complete the electrification of rural households as soon as possible;

Technical: to integrate all rural electrification techniques; and

Financial: to integrate all financial resources possible for the rural electrification of the Kingdom.

PERG is a co-operative programme, where three partners contribute to the financing: local councils, end-users and ONE.

The local councils contribute USD 200 per electrified end-user in cash or USD 50 per annum for 5 years.

The end-users contribute USD 250. This is paid either at the subscription or as USD 4 per month for 7 years. ONE's contribution will cover the remaining percentage of about 55 %. 35 % of this amount is met from a 2.25 % charge on electricity sales. [15]

8.2 Project Background/Context

In Morocco approximately 35 % of the 30 million people lack access to grid based electricity. It is estimated that approximately 60 % of this population can afford a SHS on a fee-for-service basis. Such market penetration will increase during the course of the Moroccan governmental electrification programme, in which approximately 90 % of the non-electrified households shall be connected to the electric grid and approximately 200,000 households will be electrified with SHSs. In this programme, ONE co-operates with the private sector, pursues the fee-for-service approach and subsidises the investment cost of the SHS.

8.3 Project Description

SunLight Power Maroc, S.A. (SPM) was founded in 1998 as a subsidiary of SunLight Power International Holdings, Inc. and became an independent company in 2000. SPM sells solar home systems to rural households in Morocco that lack access to grid-based power. The solar home systems are designed to supply energy for lighting and audio-visual equipment (TVs, Radio-cassettes). The distribution and maintenance network set-up by SPM also allows for the

diffusion of equipment such as colour televisions, cellular phone charging systems, solar hot water collectors and water pumping systems.

The SPM business is based on a permanent presence in the rural areas targeted through wholly owned branch offices in the medium-sized towns of Taza, Sefrou and Taounate, in the north-eastern part of Morocco, as well as regular presence at rural markets. On this basis, SPM offers continuous technical support and follow-up to the customer. They sell, install, operate and help to finance SHS.

SPM's core business is the sale of off-grid, solar-based electricity service on a fee-for-service scheme, which is chosen by approximately 80% of its clients. Additionally, SPM sells SHS on a on a cash sales or hire purchase base. To ensure the continuous functioning of the systems out of the service scheme, SPM offers these customers the possibility of entering a maintenance contract.

8.4 Project procedures

Promotion of the SPM system takes place weekly at the most important regional souks (local markets). To inform potential customers, the "marketing team" often carries a demonstration system with them. As most of the communication between SPM and (potential) customers is done at the souks, they are of central importance for the whole business. Additionally, promotion is done through word of mouth and sometimes village demonstration events.

Contract negotiation, too, is mainly done at the SPM market stand in the souk but also in the local SPM offices (SPM service centres). Customers targeted by SPM are regularly present at the souks. Thus information and contract negotiation is spread over a longer period, furthering the establishment of a good relationship between the customer and SPM staff. SPM staff also get to know the customer and "judge" whether he will be reliable with payments. Hence, no contracts are concluded in the first meeting between the customers and SPM. When a customer has decided, the contract form is filled in and signed by the customer and the SPM staff. The contract includes the system configuration and all mutual responsibilities. The customer has to certify his signature with the local authorities and pay the two first instalments before an appointment for installation is made.

Installation is done by an SPM technician on a pre-arranged date. The SPM technicians are qualified through SPM's in-house workshops and on-the-job training of approximately three months in the local offices. Generally, teams are of two people where a new technician is accompanied by a more experienced one. At installation the operation and maintenance is

handed over to the customer. Instruction and a manual is given to those family members present on the correct operation of the system.

In the fee-for-service scheme, the customer commits himself to respect the contract and allow SPM staff to undertake maintenance and control visits of the system, i.e. visit his house and check the equipment. The customer is responsible for keeping the system in good condition, in accordance with the directions included in the user manual.

After installation, SPM is responsible for the maintenance and repair of the system and the replacement of broken components, except for tubes and fuses, which have to be replaced by the customer. If the system breaks down, the customer must inform SPM and ask for repairs. They try to remedy the problem within 48 hours of notification. Additionally, an inspection of the system is carried out every six months. For each "technical" call on the SHS, the SPM technicians fill in a maintenance and repair form, which allows for a follow-up of installed systems and is signed by the technician and by the customer.

Basic maintenance like cleaning the module, refilling the battery with distilled water, and exchanging fuses and broken tubes is carried out by the user. Break-downs that are the customer's fault, such as demolition and system manipulation, theft and fire are exempted from this regulation. In these cases, the customer bears the costs for the damage.

Customers are asked to come to the souks or the local SPM offices for payment, as the customers generally attend the important souks. This offers an opportunity to decrease operation costs for fee collection. Generally, the repayment rate is very high as the customers are aware of their obligation. However, the recent years of drought have worsened the economic situation of rural households and affected the repayment ratio. If a customer fails to pay, SPM staff will try to meet the customer at the following souks or even visit him at home. Rules are that after one month of payment default the SHS should be repossessed and may be installed for another client. In practice, local staff try to make individual arrangements. SPM also uses the possibility of involving local authorities and NGOs to come to an agreement with the customer concerned.

No specific training of SPM staff is done for assessing the credit worthiness of potential customers, but a relationship prior to doing business allows for a certain customer screening. As SPM staff are integrated in the regional society, knowing the customers and their social environment offers a possibility to react to payment default on an individual basis.

8.5 Technical Description

For all schemes, SunLight Power Systems (SPS) include PV panel(s), battery, charge controller, fluorescent lamps, wiring and accessories (e.g. switches, plug points). All products are manufactured locally with the exception of the solar panel. To meet the different demands of rural customers, SPM offers the following different system sizes:

SPS	**Wp**	**Battery**	**10 W-Lamps**	**15 W-Lamps**	**TV & RK7 outlet**
SPS 200	25-30 Wp	60 Ah	1	1	1
SPS 300	35-45 Wp	60 Ah	2	1	1

SPS 400	50-60 Wp	80 Ah	2	2	1
SPS 500	50-60 Wp	80 Ah	3	2	1
SPS 700	70-80 Wp	100 Ah	4	3	1
SPS 1000	100-110 Wp	150 Ah	5	5	1

8.6 Financial Description

In fee-for-service, ownership stays with SPM. The customer pays a service fee for the use of the system – the electricity service. The monthly instalment depends on the system size and ranges from 9 USD to 24 USD. Before installation, the customer has to pay two monthly instalments, one part is used as warranty, the other part is an advance payment for the first month's service. For late payments, a penalty is charged calculated on the amount due.

The customer can cancel the contract with one month's notice. In such a case, the customer will be charged a removal fee of 25 USD. The warranty payment will be used to cover the service costs of the last month.

Contract regulations for the cash sales and hire purchase scheme offered by SPM differ with respect to operation, maintenance and payment:

In these cases, SPM commits itself to do the installation, repair and regular maintenance during the first year under the same conditions as in the fee-for-service scheme. After this first year, only the manufacturer's warranty for the solar panel is honoured (usually ten years). For maintenance, customers may agree to enter a maintenance agreement with SPM, for which they pay an annual fee of approximately 25 USD, or pay for each repair and cover replacement and service costs.

In the cash scheme, the customer pays between 450 and 1200 USD, depending on the system size, and the ownership title is transferred after the payment. Conditions for the hire purchase contract are as follows: a down payment of approximately 30 %, terms of 6 to 36 months, according to customer preference, with an interest rate of 20 to 30 % p.a. and monthly payments. The total price is approximately of 570 to 2100 USD. The ownership title is transferred to the customer after payment of the total amount due.

8.7 Infrastructure Issues

The SPM business is based around three local offices, service centres (SCs), in Taza, Sefrou and Taounate with 15 employees. Central management and coordination are carried out at the headquarters in Rabat. The SC staff are responsible for promotion, sales, installation, operation and maintenance, fee collection, customer follow-up, inventory management and reporting to headquarters. Generally, the staff consists of teams of two people with rotating activities to ensure a complete understanding of SPM work. In total, the service centres have got two vehicles and one motorcycle to undertake installation, maintenance visits and fee-collection in case of payment failure. To quickly meet customer demand for installation and repair, a local stock is maintained in the service centres.

8.8 Quality Assurance

An intensive reporting and controlling system is set up between the service centres and headquarters. Daily reports are sent via e-mail from the service centres including the names of new customers, installations carried out, maintenance activities and total fee collection of the

day. Additionally, the service centres send a monthly report of the total number of installations, money collected, new installations, new orders, etc. The main office in Rabat, which is responsible for accounting and overall management, sends a monthly report with an overview per customer to enable the local team to easily recognise late payments and 'problematic' customers, but also stating the objectives for the following month for each service centre, e.g. the number of new installations. Generally, this reporting and controlling system focuses on the service aspect, i.e. quickness of response, which can be considered quality assurance for customer satisfaction. In contrast, technical quality assurance, e.g. for components, systems and installation, is not centrally structured.

There is intensive communication between SPM staff and customers at the souks. As the customers normally pay on a monthly basis, regular communication is possible. The trust of the customers in the SPM staff shows that communication is working.

8.9 Impact and Lessons Learnt

Since the incorporation of the company, more than 2000 SHS have been installed.

Customer satisfaction is measured by demand: since the beginning, demand has been increasing and SPM has had to turn down many customers to stay in line with its present investment capabilities. Customer faithfulness is also a good indication of customer satisfaction.

Advantages in this approach include the adaptation to low-income rural households. It is also possible to build customer confidence, specifically during the initial penetration in a new area. And finally, the fee-for-service approach enables customers to benefit from a service with a warranty for a long time, as long as they choose to keep the system.[16]

The main problem is that this approach is highly capital-intensive: it is difficult to raise capital in the traditional financial sector. Even the International Finance Corporation's (IFC) sponsored project, Photovoltaic Market Transformation Initiative (PVMTI), has several similarities with the traditional financiers' criteria.

To overcome this problem, SPM is using private capital and has applied for money under ONE's electrification programme. Micro-credit organisations, with PVMTI support, are also to be involved in the future.

9 Gansu PV Co. Ltd., China – cash sales in Western China[17]

9.1 General Background Information on Rural Electrification in China

Development of renewable energy is regarded by the Government of China (GOC) as an important means to reducing the power sector's heavy reliance on coal, which is essential to reducing greenhouse gas (GHG) emissions. Energy is the largest source of GHG emissions worldwide and China accounts for 10 % of global GHG emissions from energy use. China's share will grow if rapid rates of economic growth continue, as predicted. However, macro-economic and energy modelling work show that an aggressive programme to promote energy conservation and renewable energy could limit the increase in GHG emissions between 1990 and 2020, under a high economic growth scenario, from a three-fold increase to less than two-fold. Reducing local environmental damage is also important, as annual health and agricultural losses associated with coal-related air pollution in China are estimated to be as high as 6 percent of GDP.

Renewable energy is a critical component of China's long-term energy strategy for rural development. China has strongly supported small hydropower (<25 MW), biogas, and small wind turbines over the past 35 years, to provide energy and electricity to isolated rural populations. In 1995, the GOC voiced a new commitment to renewable energy, as outlined in the New and Renewable Energy Development Programme, 1996-2010, developed by the State Economic and Trade Commission (SETC), the former State Planning Commission (SPC) and State Science and Technology Commission (SSTC). This programme aims at improving the efficiency of renewable energy technology applications, lowering production costs and enlarging the contribution of renewable energy to overall energy supply. The 1995 Electricity Law also extends GOC support to solar, wind, geothermal and biomass energy for power. [18]

Large-scale investment programmes such as the UNDP, World Bank, and Brightness[3] programmes are providing a framework to facilitate the widespread use of renewable energy. Pilot projects provide electricity to previously unelectrified homes, rural villages, and schools to meet basic and growing human needs. Depending on the resource and the needs, wind and solar hybrid systems can be used to electrify households or wind systems can be integrated with existing diesel plants to decrease the amount of diesel fuel used. Larger systems can be used to power computers, telecommunications equipment and refrigerators.[19]

At present there are still 70 million people[4] in China without access to electricity. Most of these people live in remote areas of the western provinces, such as Inner-Mongolia, Gansu, Qinghai, Xinjiang and Tibet. Villages without access to electricity are in remote and sparsely populated regions, where there is often limited access to roads, markets and other services. The people who live there are among the poorest in China.

[3] National PV Rural Electrification Programme

[4] Market Potential of PV Village Power in China, Li Junfeng et al, 2002, Conference Proceeding of PV in Eurupe: For PV Technology to Energy Solution.

9.2 Project Description

In 1994, the Gansu PV company started operating in the Gansu province of western China. They manufacture, install and service solar home systems and small portable solar lighting systems. About 1 000 systems are sold per year.

For project promotion, radio is the most important medium. Gansu PV used to have up to five adverts on the radio each day. However the number reduced to zero in 2000.

At least half the price of the system is paid in advance. The second payment is only paid after the customer has made sure that the system works and understands exactly how to carry out the operation and maintenance.

The company's salespeople carry out the installation of the system. These salespeople are trained once every three months. During the installation user training is provided.

The user is responsible for operation and maintenance. In addition to the training during the installation, a detailed printed booklet with pictures is provided to the customer to explain the function of the system as well as operation and maintenance.

9.3 Technical Description

The product includes PV modules between 6 Wp and 120 Wp, a module mount which can be adjusted each season by hand to track the sun, a charge controller, battery, lights and a small fan to help cooking and save coal. The very small systems (6 Wp module) are lighting systems, for one lamp and a radio only. All balance of system components, except for the battery, are manufactured by the company itself. The systems cost around 100 CNY / Wp (12 USD), including five years service fee and a transport fee from Lanzhou to the system installation site. Western China is a very remote area and so the transport fee is high.

9.4 Financial Description

The systems are sold on a cash sale basis. Therefore, the customers own the systems and have to pay at least half the price before installation. In an earlier attempt a credit model was applied. This, however, was found to be unsuccessful since customers did not understand the concept of credit and did not feel obliged to pay back. To increase affordability in spite of the lack of financing options, an exchange or trade-up mechanism was developed. Thus customers can start with a small system and exchange it for a bigger one when their energy demand increases and they have saved up more money.

Different warranties are given on the different components. These are passed on to the customers, however the customer still has to pay a proportion of the costs of the replaced components. They pay at a reduced rate during the warranty period (e.g. the warranty on the battery is five years - if the battery fails after three years, the customer only pays three fifths of the price to get a new battery).

9.5 Infrastructure Issues

Gansu PV company has a number of local branches. Each branch is equipped with motorbikes. One salesman with a motorbike can install a maximum of 30 systems per month. A salesman without a motorbike can only install about 3 systems per month.

About 100 salespeople are employed at Gansu PV. The top salesman installs about 100 systems per year. An average salesperson installs about ten systems per year. Communication with the customers occurs about once per month through the salespeople, who live very close to their customers. The ratio of infrastructure costs to system costs is estimated to be around 20 %.

9.6 Impact and Lessons Learned

It is estimated that about 1 % of the rural population can afford to buy the PV electricity systems described. Average system lifetimes are estimated to be only about seven years. After that time the replacement of components costs almost as much as a new system.

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