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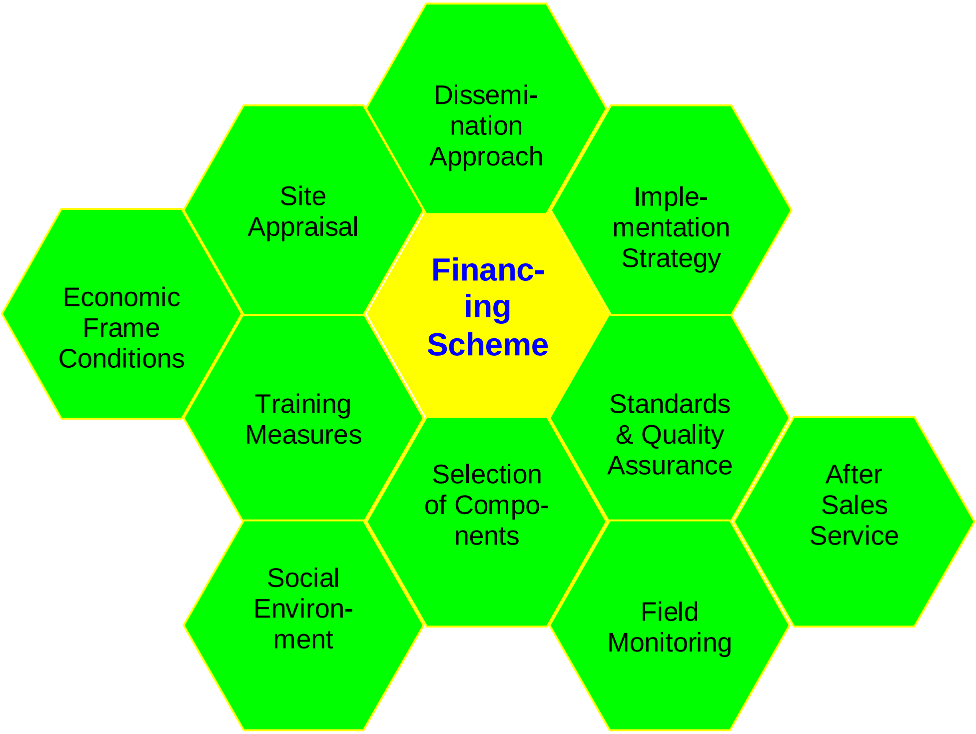

FINANCING OF SOLAR HOME SYSTEMS IN DEVELOPING COUNTRIES

THE ROLE OF FINANCING IN THE DISSEMINATION PROCESS

Volume I: Main Report

Updated edition 2001

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

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(Updated edition 2001)

Eschborn, March 2001

Published by:

Division 44
Environmental Management, Water, Energy, Transport
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Foreword

‘‘Lent and lost‘‘ – this was often the fate suffered in the past by loans provided to finance Solar Home Systems for rural households (SHS). At the same time, there were repeated claims that the commercial introduction of SHS on a wider scale was being impeded by insufficient financing for both the PV dealer and the customer. The problem itself seemed evident: insufficient financing, the low-incomes of the potential clients in remote rural areas, and the high initial investment costs for the Solar Home System are the factors responsible for holding back the breakthrough in rural areas. Learning from the experience of the past, and being able to offer more sustainable types of financing models for the dissemination of SHS, is the objective of the study "Financing of Solar Home Systems in Developing Countries" that has been carried out by the GTZ.

The study has made an evaluation of the experience gained with financing systems for SHS - both within GTZ supported projects as that of other international agencies. It looks at how, on the basis of this knowledge, can recommendations for future financing models be formulated. The investigations made into a large number of projects came up with results which, in some cases, differed widely from the commonly held views of the specialists.

Contrary to these views, not only access to financing but the quality of the SHS itself, and how well the users had been informed about it beforehand, are all prerequisite factors which need to be equally rated when introducing SHS on a wider scale. Technical unreliability and also unawareness of the SHS limitations are both factors which can contribute to an end-user’s disappointment about SHS performance, and ultimately create reluctance to pay back a credit. Nevertheless, if carefully designed and with responsive after-sales services, Solar Home Systems will have the potential to increasingly build up a good reputation as being an attractive means of installing basic or pre-electrification in rural areas. To achieve this, both the financial and the private sectors will have to play a key role. This study has been compiled as a contribution towards achieving this objective.

An issue for which the study does not come up with a final conclusion is the often and controversially discussed topic of subsidies. So far all SHS programmes have relied on subsidies of one sort or another. In doing so it is often argued that market imperfections (e.g. lack of private financial institutions in rural areas, lacking information on available SHS options) justify the subsidisation of SHS or related activities. The challenging task is then how to target and allocate those corrective subsidies. This is a difficult question because what is deemed a market imperfection may well be economic barriers or transaction costs correctly priced by the market. For instance, is it a market imperfection that small amounts of money are more costly to lend than large amounts, or that lending against a steady stream of income is less risky than a loan given to a household with irregular or no income? Probably not. One could still make a case for special support measures that redress social or economic imbalances, but the case would rest on other arguments than that of imperfect or distorted markets.

Hence, the core of the discussion on subsidies boils down to the question whether SHS serve economic development or other public policy objectives. If this question is answered in the affirmative, the alleged violations of free market principles often criticised by opponents of subsidisation appear in a different light. However, the claim of contributing to the achievement of general welfare objectives has important impacts on the design of projects: SHS projects should be designed as but one component of a larger programme aiming at a variety of development objectives like power sector reform, rural electrification, and rural development.

Brief Summary

Background and objective of the study

The lack of financial services for users of Solar Home Systems (SHS) is often regarded as the main barrier for their commercial dissemination and is often the justification for donor assisted programmes. The problem is well-known: the main target group for SHS is the rural population - usually that part of the population with low and/or irregular income, with limited saving potential and with low energy consumption, mainly for non-productive use. The acquisition and operation of a SHS, however, requires a high initial investment and moderate operating and maintenance cost. Financial services for SHS are usually not available or accessible for this target group. The latter is regarded as being the main barrier hampering the widespread introduction of SHS in rural areas.

The study wishes to shed some light on the question whether the commercial SHS dissemination in remote rural areas could be made easier if financial services were available. It is based on the thesis that carefully designed target-group-oriented financial services may speed up the widespread dissemination of SHS. This thesis assumes that any financial services have to fit into existing financial structures in order to be sustainable and to avoid distortions of local financial systems.

Findings of the study

1. The access to financing, the quality of the SHS itself, and how well the users were informed about it, are all prerequisite factors which need to be equally addressed when it comes to disseminating SHS. Technical unreliability, a less than assured durability of vital components (battery, electronic ballasts), and also the known limitations of the SHS, which the users themselves are often unaware of, can all contribute to a poor credit repayment performance.

2. There are direct and indirect subsidies to be found in all projects supported governmentally and internationally, and at all levels. Subsidies are quite often undisclosed, and therefore not transparent enough to be clearly recognised as such by those who would benefit, and those who have the political authority to decide in favour. This leads to SHS financing programmes that are not able to fulfil the standards of finance sector conformity and long-term sustainability. In the partly controversial discussion going on about subsidies, the view that SHS can be propagated with the help of subsidies, as long as they are transparent, serve public interest and do not distort the market, seems to be gaining ground.

3. Formal and informal financial intermediaries alike only offer SHS credits in exceptional cases. Even in the micro-finance sector there are relatively few known examples where SHS financing has been provided with any consistency. Although the SHS target group partly comprises the same microfinancing institution clientele, SHS are still not simply incorporated in the credit programmes offered.

4. Alternative types of dissemination and financing are operating in various countries. The promoters are PV dealers and suppliers, but also other potential distribution channels such as the retail trade (e.g. at so called 'furniture shops' in southern Africa). By refinancing the retail-dealer/ supplier, commercial banks are also participating in SHS activities, even though only indirectly and with a limited amount of risk.

5. The operating costs of a SHS (maintenance, repairs, replacements) are often underestimated, especially if it happens to be a system of lower quality. The end-user needs to be not only capable of coping with the repayment of credit, but also with considerable operating costs that follow the purchase of a SHS. This highlights the fact that for the poorest segments of the rural population the SHS is a technology that is often not affordable, even with subsidies and smaller systems.

6. In spite of their increasing ability to save, and thus bankability of rural target groups, acquisition of a SHS often enough does not rank as a priority. Only after other commodities that are considered more important have been acquired, does the SHS become of any focal interest to a potential user. This very basic observation needs to be taken into account under any market-driven dissemination programme that deserves that name. So far, there is little evidence that SHS have an impact on poverty alleviation.

7. Finally, the documentation of the evaluated SHS projects generally turned out to be weak in giving detailed information on financing models applied. With few exceptions like e.g. GEF (2000) and World Bank (2000), most reports concentrate more on technical and institutional rather than on the underlying financing schemes and associated data. In cases where corrective measures of SHS financing schemes become necessary during implementation, the results of these changes were often not, or not completely, documented. The duration of a SHS project is usually not long enough to monitor and evaluate the impact of these corrective measures. With repayment periods often longer than the project duration, the evaluation of financial sustainability of a SHS programme must, therefore, be subject of an evaluation after the SHS programme itself has come to an end.

Abbreviations and Acronyms

AC	Alternating Current
Ah	Ampere hour
ALCC	Annualised life-cycle-cost
AME	Agence pour la Maîtrise de l'Energie
BCU	Battery Control Unit
BOS	Balance of System
CEMIG	Companhia Energética de Minas Gerais
CDER	Centre de Development des Energies Renouvables (Morocco)
CGAP	Consultative Group to Assist the Poorest
CRE	Cooperativa Rural de Electrificación
CRF	Capital Recovery Factor
DC	Direct Current
DOE	Department of Energy (Philippines)
DSM	Demand Side Management
EC	European Commission
EIES	Environmental Improvement for Economic Sustainability
EU	European Union
ESCo	Energy Service Company
GDP	Gross Domestic Product
GNP	Gross National Product
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
kWh	kilowatt hour
LCC	Life Cycle Cost
LEC	Levelised energy cost
ONE	Office Nacional de l'Electricité (Morocco)
NEA	National Electrification Administration
NGO	Non Governmental Organisations
PVC	Present Value of Cost
PVE	Present Value of Energy
PV	Photovoltaic
PV-GAP	Photovoltaic Global Approval Program
PV-MTI	PV Market Transformation Initiative
RE	Rural Electrification
RPE	Rural Photovoltaic Electrification
ROSCA	Rotating Savings and Credit Associations
SAER	Schéma d'Approvisionnement Energétique Régional (de la Province Kenitra, Morocco
SDC	Solar Development Corporation
SELF	Solar Electric Light Fund
SEP	Special Energy Project
SHS	Solar Home Systems
SLI	Starting, Lighting, Ignition (SLI-batteries)
STEG	Societé Tunisienne d'electricité et Gaz
VA	Volt Ampere
W	Watt
WB	World Bank
Wp	Peak Watt

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1. Introduction

1.1 Prefatory notes

At present, more than 35% of the world's population has no access to electricity. This totals almost 2 billion people or 400 million households in rural areas.[1] For mainly economic reasons, there is no hope for the majority of the rural population to get connected to grid electricity in the short and medium term.

During the past decade a growing consensus of international donor organisations and national governments was reached that the increased utilisation of *Solar Home Systems (SHS)* may provide a basic level of electricity supply in remote and dispersed rural areas. In addition to its potential for social development, PV electricity may offer an attractive win-win-option in both economic and environmental aspects.

Solar Home Systems are commonly regarded as a relatively simple, technically mature and easy-to-handle technology with considerable market potential for rural electrification in developing countries. The major disadvantage, however, is the high initial investment cost. Subsequently, there is a growing consensus among the PV proponents that access of the rural population to appropriate credit services plays a key role in overcoming this often called *first cost barrier*.[2]

A significant and sustainable contribution to rural electrification can only be achieved with a large-scale dissemination of SHS, building on existing markets or creating responsive market structures for rural energy services supported by appropriate financial services.

Between 200,000 (WB 1995)[3] and 700,000 SHS[4] have already been installed world-wide during the past two decades. Success stories have been reported particularly from Zimbabwe, Morocco, Kenya, and Mexico. The above numbers need some qualification, however. Firstly, the majority of the systems were installed under donor funded, often highly subsidised programmes and secondly, reliable statistics on the number of systems in operation do not exist.

Nonetheless, the number of SHS installed world-wide is impressive and will significantly increase, if the large-scale donor assisted programmes currently under preparation with several tens of thousand units gain momentum and when they manage to create the market transformation they are intended to do.

1.2 Objective, methodology and structure of the study

In the past, market imperfections in rural areas represented by high market segmentation and the lack of private formal financial institutions broadly servicing the rural population have often led to financial instruments that combined direct targeting with considerable direct subsidies to SHS users.

There is generally no debate about the need to introduce and enforce measures against market imperfections by using subsidies and other interventions. However, the real question is how these measures, if justified by overall development objectives, can be properly targeted and

[1] World Bank (1996).
[2] See: World Bank (1996, (2))
[3] World Bank (1995).
[4] Posorski, Fahlenbock (1998).

focused without introducing new market distortions. They must also be self - terminating when no longer needed.

The study is based on the thesis that carefully designed, target-group-oriented financial services support the widespread dissemination of SHS. This thesis also assumes that any financial services have to fit into existing financial structures in order to be sustainable and to avoid distortions of local financial systems.

To meet its objective, the study analyses the experience and expectations of both financial intermediaries at the formal, semi-formal and informal levels on one side and decision-makers, planners and implementers of SHS programmes on the other one. In this regard, it is also an attempt to find a 'common language' between '*bankers and technicians'* enabling them to understand each other when it comes to creating models for financing of SHS.

Methodologically, the study is based on the evaluation of project reports, studies and other project documentation of implemented SHS projects as well as of planning documents of SHS programmes as far as they were available. To complete the overall picture, interviews were conducted with experts in selected countries.[5] This revised edition takes also account of lessons learnt by other organisations, such as GEF, World Bank, UNDP and others.

Some difficulties existed in gathering concrete data for the applied financial models that have been used in the identified projects. When it comes to specifying the financial conditions of these models like effective interest rates, down-payment rates, monthly repayment and service fees, most of the evaluated documents lack these figures, or existing data are not fully transparent[6].

In consequence, financial performance indicators such as loans in arrears, loan default rates and level of operational and financial self-sufficiency can be found only in exceptional cases. Unfortunately, even in those cases where financial data are available, it is often not clear which concepts were employed and how figures were calculated.

In Chapter 2 the system design in terms of technical and economic parameters of a typical SHS is presented. A brief description of *what a SHS can do and what it cannot* is given for those readers who are not familiar with these aspects of PV technology.

Chapter 3 analyses the need for financing of SHS from the viewpoint of the energy sector. Key criteria affecting the willingness- and ability-to-pay of interested customers as well as their income situation are briefly discussed.
Chapter 4 presents the requirements for sustainable finance and the two ruling principles *outreach and sustainability.* It further looks at the existing organisation and structure of the financial sector, and analyses the different levels of formality in the sector.

In Chapter 5 an analysis of financial mechanisms is given, which distinguishes between two approaches, sales models and service models. Several examples for existing micro-finance schemes under the sales model are presented and discussed in more detail.

Chapter 6 summarises the findings and lessons learned and gives recommendations for future SHS dissemination programmes.

Detailed case studies from selected countries and international programmes are presented in Volume II of the study.

5 Especially in the projects which are carried out by the authors themselves like Philippines, Morocco and Brazil.
6 E.g. monthly fees are not broken down into their parts like O&M-part and repayment of credit thus not being transparent neither for the client not for the financial intermediary.

2. SHS – the Technical and Economic Characteristics

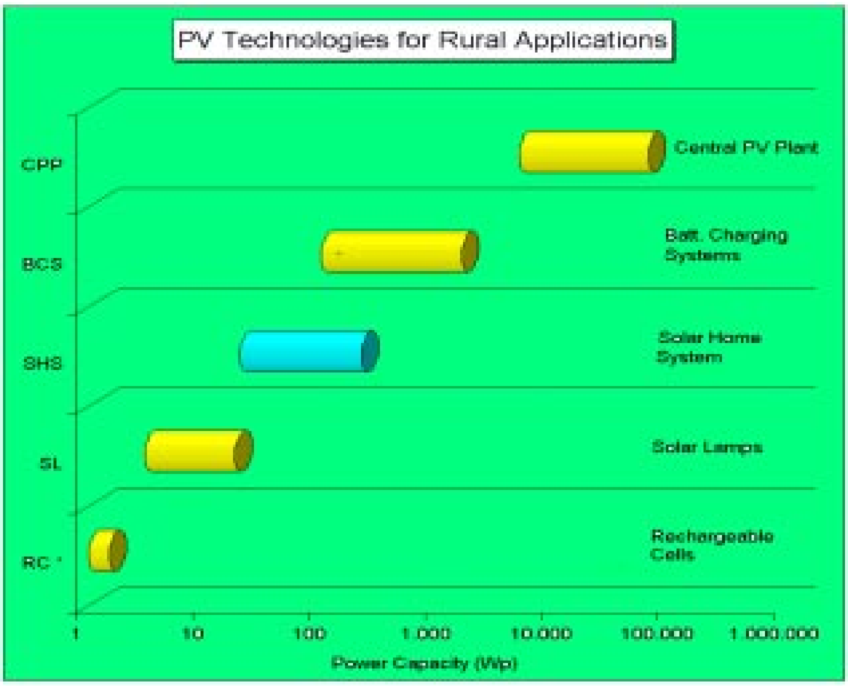
2.1 Potential contribution of SHS to rural electrification

A Solar Home System (SHS) is usually defined as a small scale, solar powered autonomous power supply to private households living in sparsely populated rural areas, far away from the electricity grid. The 12-V DC electricity generated by the SHS is capable of replacing not only traditional energy sources like kerosene lamps and candles but also dry cells for radios and cassette recorders, thus addressing both economic and environmental aspects. According to the energy consumption pattern of an average rural household, a minimum panel capacity of 50 Wp should be used capable of providing rural households with electricity for lights and, possibly, for a small TV-set, a radio and/or other small domestic appliances.

In many rural areas, common 12 V car batteries are used for these purposes. These batteries, however, usually have to be transported to the nearest location with grid electricity, recharged and transported back. Experience shows that in these cases people are already accustomed to this kind of electricity and, therefore, also familiar with its limitations making the introduction of SHS easier.

PV systems with only 10 or 20 Wp-panels (even SHS with 6 Wp only) are sometimes regarded as SHS as well. These very small PV-systems are (mainly) cash-sold in some countries like in China, Indonesia, Kenya and Morocco. There are reports, however, that due to technical problems with locally produced components, these systems may create a negative image of PV technology [7].

Graphic 1: Classification of PV systems



SHS vary over a wide range in size and technical design. The typical SHS being dealt with in this study has a generating capacity of approx. 50 to 100 Wp. The low voltage DC-electricity (nominal 12 V) generated by a SHS is limited to consumptive use only. A productive use of PV-electricity is generally not possible due to its limited capacity - a fact that in many cases is not known to potential SHS-customers.

Providing information about the SHS capabilities and limitations is of overall importance for the sustainability of any dissemination programme. Several surveys on the willingness-to-pay (WTP) for electricity service revealed that a significant portion of rural people give electricity a

[7] Kublank et.al., (1997)

high priority.[8] Keeping this and the high expectations of the rural population in mind with regard to electricity, awareness building and correct information are key factors for successful dissemination and commercialisation of SHS.

Although current designs are limited to consumptive use, the common view of rural electrification programmes being only for consumptive use with productive use seen as being a luxury seems to be changing. Experts at a specialists meeting organised by the World Bank raised the question that

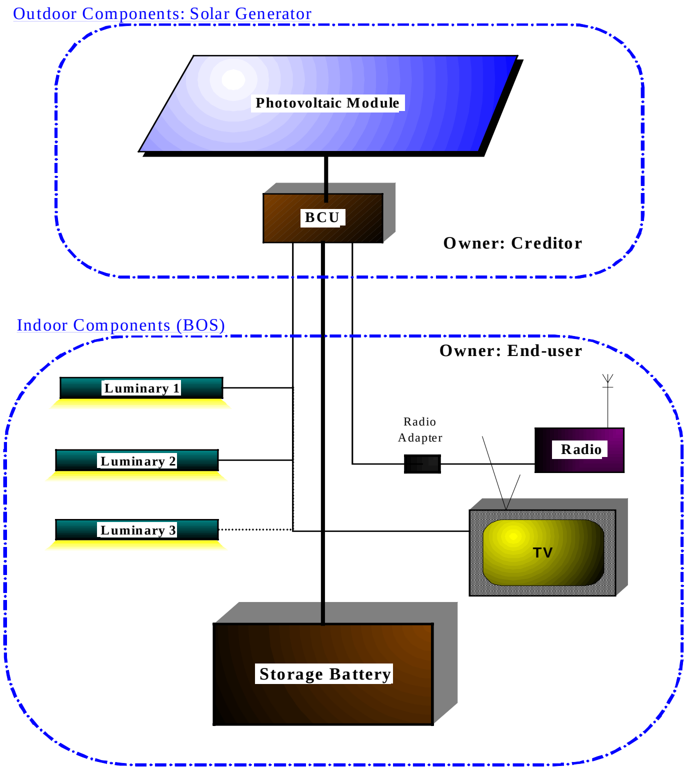
"If analysts do not worry about 'unproductive' electricity use (in cities) why do so in villages? Indeed, it was even suggested that doing away with spurious distinctions between the productive and the welfare benefits of rural electrification would not only greatly simplify rural electrification project appraisals; it would also avoid the time now wasted by project proposers trying to invent future productive use of electricity."[9]

2.2 Technical design of SHS

A SHS as defined above consists of the *Solar Generator* (SG) which is an array of one or two PV-panel(s) with the Battery Control Unit (BCU), and the *Balance of System* (BOS)[10] consisting of the storage battery, the domestic installations like cables, clips, fixtures, switches, sockets etc. and DC applications like fluorescent lamp, radio, TV and any other small DC appliances.

Larger PV-systems with capacities of several hundreds Wp can use an inverter converting DC to AC for domestic AC appliances. Although these types of PV systems are not dealt with in this study, the general findings and conclusions concerning quality assurance aspects are valid for these PV-systems as well.

Graphic 2: Components of a SHS



The critical components of a SHS in terms of technical reliability and lifetime are the electronic ballast, the fluorescent lamps and the 12 V DC battery. The latter is the most critical component because batteries with typical storage capacity of 60 to 100 Ah are costly and very sensitive to maltreatment by the user. While deep-cycle batteries are recommended, due to their higher costs end-users very often employ automotive batteries with storage capacities of some 60 to 100 Ah approx.

The lifetime of automotive batteries is often very limited, although, under special conditions (e.g. in the Altiplano of Bolivia and Peru with low environmental temperatures), automotive starter

8 However, there is little evidence that SHS ranks high in priority for the poorest of the poor part rural population.
9 World Bank (1997 (1))
10 From a financial perspective, this distinction between BOS and Solar Generator is of importance for those cases in which the SHS serves as collateral for a financial institution. In the case of the Philippines only the Solar Generator serves for this purpose, the BOS Parts are subject of the down-payment by the user.

batteries are reported to have reached a lifetime of approx. 4 years. Practical experience in many countries shows typical lifetimes ranging from 1 to maximum 3 years.

The reliability of SHS components and the technical life cycle are also critical to the design of appropriate financial services. Unreliable technical components will reduce the attractiveness of using SHS and, hence, lower the willingness to repay a loan on SHS.

In some countries so-called maintenance free or sealed batteries are used in SHS. Low budget ‘solar batteries" are also available sometimes. These types of batteries are modified versions of the standard SLI (Starting, Lighting, and Ignition) battery based on grid plates. Apart from their limited availability, experience shows no clear evidence that they have a significant better performance than standard SLI batteries. However, the life-cycle-cost of automobile batteries is high, and protective measures like BCUs are needed to prolong their lifetime as much as possible.

The difficulty of choice: standard automotive or solar battery?

Lead-acid batteries provide the standard energy storage for Solar Home Systems. Though not the best option, standard automotive batteries with grid plates (SLI - starting, lighting, ignition) are normally used in SHS because they are ideally available locally, and they are low priced (about US $60-80 per 100 Ah/12 V). This battery’s lifetime is limited from 1 to 3 years depending on the working requirements. Therefore, the life-cycle-cost of SLI batteries is high in comparison to industrial type lead-acid batteries with tubular plates (sometimes also called ”solar batteries”). As well as the higher initial costs (3-4 times more than SLI batteries), the main disadvantage of these is that they are not normally available on the open market, especially in the rural areas where SHS users need them most. Therefore, it is realistic to accept the automobile battery as the second best solution for the SHS.
In SHS in some countries so-called maintenance free or sealed batteries are used. Low-budget “solar batteries" are also sometimes available. These types of batteries are modified versions of the standard SLI battery based on grid plates. Apart from their limited availability experience shows no clear evidence that they have a significant better performance than standard SLI batteries.
However, the life-cycle-cost of automobile batteries is high, and protective measures like BCUs are needed to prolong their lifetime as much as possible. For SHS to be economically viable, it makes a big difference if the battery has to be changed every year, or every two or three years.

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2.3 Economics of solar home systems

The cash price for a basic DC SHS[11] is in the range of 500 US$ to 1,200 US$. Depending e.g. on size, origin of components and country-specific taxes and duties, the domestic system price for an installed SHS ranges from 7 US$/Wp (e.g. in Indonesia, 1994) to 26 US$/ Wp (in Kenya, 1993). The price of PV modules dropped from some 20 US$/Wp in 1980 to presently about 5 US$/Wp and is expected to decrease further due to economies of scale. The cost for the module, however, represents only approx. 50% of the cost of the complete system.

Although the PV technology is regarded as a nearly maintenance-free one, the operational costs[12] over the lifetime of the SHS have to be added to the purchase price of the SHS. While typical monthly payments of 5 to 10 US$ to be borne by the end-users mostly cover only the credit repayments and – if at all - a service/ administration fee, very often no provisions are made to meet the operational costs. This issue may become crucial in those cases where an end-user can just afford the monthly payments but cannot accumulate savings for the operational costs.

[11] 50 Wp panel, BCU, battery
[12] Operational costs cover maintenance, repair, replacement of battery, lamps and electronic ballast.

Comparing the economic competitiveness of SHS with conventional grid extension (which costs generally some 10.000 US$/km rural transmission line) and traditional energy sources like kerosene and candles, a SHS represents the least-cost option for a vast portion of the rural population. While rural grid extension electricity on a small scale would cost in the range of 2 to 10 US$/kWh, PV electricity might be in the range of 'only' 1 to 3 US$/kWh.[13]

There are mainly three reasons to assess the economics of a SHS. Firstly, to determine the cost effectiveness (the least cost option) of competing rural energy supply options like conventional grid extension, small isolated grids (micro grids) or hybrid systems. Secondly, to provide a potential financial institution with a basis for credit risk assessment, and, finally, to inform the user about the total monthly (or annual) cost of a SHS considering not only the credit repayment costs but also the operational cost over the lifetime of the SHS.

For the economic evaluation of a SHS project the ***Discounted Life-Cycle Costing (LCC)*** formula is widely used.[14] Herewith all initial and future costs the system will incur can be calculated over the operational lifetime of a system. The formula converts the **present value of costs** (PVC) into an annuity by multiplying PVC with the **capital recovery factor** (CRF).[15]

The application of the LCC-formula delivers two results:

Firstly**, annualised life-cycle-cost** (ALCC) (e.g. in $/year or $/month) allows one to determine the total cost of a SHS over its expected operational lifetime, with ***ALCC = PVC*CRF***.

Analysing the ALCC, the result is the annual expenditure for a SHS over the total lifetime including capital and operational costs. With regard to capital costs, the costs for the Solar Generator and the BOS (incl. any taxes and duties) have to be taken into account, but also transport, installation service and overhead costs for design and logistics etc. Spare parts have to be considered, too. At this point, it should be mentioned that the quality of the chosen SHS components is of utmost importance for the sustainability of any financial scheme. Low quality components lead directly to high replacement costs, and thus to higher operational costs.

Secondly, **levelised energy cost** (LEC) is the ratio of discounted costs (PVC) to discounted energy (PVE) and allows the comparison of the generation cost of different energy supply options and determination of the least cost option.[16] The analysis of the LEC (measured e.g. in $/kWh) provides mainly project planners and political decision makers with a projection tool to decide whether a SHS programme can be justified economically when compared with other supply options.

For the private user the re-sale value of the system is normally not of much interest. However, for financial intermediaries as well as for utilities it can be an important figure if either re-installed by a utility at another site or used as collateral by a financial service provider. The resale value of a SHS is determined by its market value, which may be estimated by the present value of the expected (net) cash flow generated during its remaining lifetime. Another issue is whether this value can be liquidated. If there are no functioning secondary markets for SHS, the resale value may be close to zero; i.e., the investment costs of SHS are sunk.

Limiting the term "financing" to the initial investment cost of a SHS only, may have serious consequences for the widespread introduction of SHS. Understating or even ignoring the

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13 Eckhart (1998).
The price of 1 US$ figure is very optimistic compared to another calculation resulting in 3 US$/kWh (Pertz, 1998). Extremely optimistic is the figure of only 0.20 to 0.30 US$/kWh given by IFC/World Bank (World Bank, 1998).

14 For a detailed description of this method applied for renewable energies see: Fink/Oehlert, 1985 and Gregory et. al. (1997)

15 where is: $CRF = i/(1-q^{-T})$, $q = 1+i$, i = discount rate, T = project lifetime.[15]

16 where is: LEC = PVC / PVE = PVC * CRF / PVE * CRE = ALCC / PVE * CRF

operational costs, especially the additional costs caused by unexpected replacement of faulty components, has often led to difficulties in the execution of SHS programmes, to the disappointment of users and, as the final consequence of their unwillingness- or inability-to-pay, to the collapse of financial schemes. [17]

2.4 SHS – an off-the-shelf-product?

In the past decades the PV technology has progressed significantly in terms of system efficiency and reliability. The availability of sophisticated PV components in the industrialised countries on one hand and the apparently high number of SHS installed in rural areas on the other one have led to the widespread belief that SHS is a reliable and a readily available 'off-the-shelf-technology'.

This view, coupled with the impression that it just needs appropriate financial services for the poor rural population in order to initiate the widespread and sustainable dissemination of SHS in the developing countries, is often shared by national Governments and international solar manufacturers.

The reliability of solar panels has advanced significantly due to the application of strict quality control systems. The technical lifetime of panels is currently estimated at 20 years, even up to 30 years[18]. This, however, does not always apply to the local production of PV components in developing countries lacking strict quality control. Quite often local production does not meet internationally recognised technical standards, resulting in poor quality of the produced components and thus potentially jeopardising SHS dissemination programmes. However, international suppliers sometimes deliver poorly designed components, too. At the international level, standardised quality control, certification of quality PV products etc. are just beginning. An important international initiative is the PV GAP (PV Global Approval Programme).

In the text box below an example is given for problems arising from poor quality components.

Consequences of poorly designed electronic components for SHS

In Tunisia the governmental agency for renewable energies AME was involved in several PV installation activities which included lighting applications. In co-operation with the GTZ project SEP it was possible to identify the technical criteria for specifying the electronic component requirements for ballasts, for fluorescent lamps and battery control units

In various field tests with components of different manufacture and price, various quality related problems could be identified. The AME became aware of the serious consequences for the operating conditions, maintenance costs, and last but not least, for the overall image of the technology and the executing agency.

The AME established the technical specifications for the fluorescent lamps (including lamps and electronic ballast) and BCUs in the bidding documents for new projects.

Although well prepared, some problems could not be avoided. The AME had to stop the work of the third project of the national PV program involving over 1,000 SHS due to technical problems experienced with the system's electronic components. "Thousands of cases" were reported in which BCUs and ballasts failed and became inoperable. The regional office of the AME, which is responsible for maintenance and spare parts, was overwhelmed by the sheer number of failures. Consequently, they had to deal with the supplier/manufacturer, as well as placate the end-users. Negotiating the costs for replacements not only had to include the material price, but also transportation and personnel costs for the visits to the sites involved, mostly in remote areas. In this case, since no service fees were requested by AME from the end-users, AME had to cover these additional costs themselves.

[17] Examples for such difficulties are the projects in Tunisia (see textbox in Chapter 2.4) Bolivia, Morocco and Lesotho (see Volume II: Case Studies)

[18] It should be noted, however, that the 'real' lifetime of modules of 20 or even 30 years could not be field-tested so far. There are reports (from Argentina) that faulty panels had to be replaced after a few years only. The manufacturer of these panels, however, does not exist anymore.

3. Financing Needs for SHS from the Perspective of the Energy-Sector

3.1 The need for financing SHS purchases

The target groups for basic rural electrification by means of Solar Home Systems are rural households living in remote villages with scattered housing, far from the grid and unattractive for grid extension by the national or regional electric utilities.

An important precondition of PV-electrification of interested rural customers is the need to mobilise enough money for the acquisition of the system. As already mentioned above, the current price of a standard SHS lies in the range between US $ 500.- to 1,200.- depending on the size of the market, duties and taxation, the share of locally produced components and on site related factors.

Unless system prices decline substantially in the near future, the cash sale of SHS will be limited to the higher income classes of developing countries. As is well known from marketing, rich buyers do not care much about prices of new products, which they think are fashionable, and typically pay cash. Less prosperous target groups, however, have more serious economic constraints and behave differently. Average rural households, although being unable to pay in cash, might nonetheless be willing to acquire a SHS with credit if there is access to suitable lending services.

At the first look, there seems to be no qualitative difference between the acquisition of a SHS and any other consumer good which can be financed e.g. through a hire purchase or any other form of consumer credit scheme, like for a refrigerator or other household appliances. SHS, however, have not yet been established on the market as mature commodities like standard appliances and are not commensurable with them in terms of technical maturity, reliability, after sale service etc. This is certainly one of the reasons for the hesitation of financial institutions to offer attractive financial services for SHS.

Since income generation from PV-installations - if any at all - is rather marginal, users have to finance a SHS from their current income. This refers not only to the initial investment for a SHS but also to the operational cost over the lifetime of the system. Without having access to an affordable credit scheme or other forms of financing mechanisms like hire purchase, leasing, etc the interested rural customer will hardly be in the position to acquire a SHS.

Do benchmarks of income exist which allow further narrowing down the target groups in terms of income level? This question has been circumvented in many studies on SHS-dissemination by asking what is the average monthly household expenditure for energy *before* installation of a SHS. Benchmarks for this are important not only for financial intermediaries but also for SHS suppliers in order to estimate the market potential for SHS. It has been estimated that rural households with monthly expenditure for traditional energy sources in the range of US-$ 10-12 should be considered as typical candidates for SHS-electrification.

However, this benchmark should only be taken as a rule of thumb, and must be seen in relative terms mainly for the following reasons: Firstly, regular monthly household income and, hence, monthly expenditure budgeting are found only in few households in most rural areas, such as teachers, health workers, government employees. Secondly, this figure for traditional energy expenditure is only an average one and does not necessarily reflect the regular monthly expenditure. In times of economic crisis, expenditure for traditional energy commodities can be stopped or adjusted to the availability of cash. However, the monthly repayment rate for a SHS cannot be stopped normally. Thirdly, experience has also shown that the installation of a SHS does not necessarily induce the user to stop the purchases of e.g. dry cell batteries and candles. This is particularly the case when a small SHS is used for TV reception but does not allow sufficient margin for additional lighting and/or operation of a radio. Fourthly, even for households with regular monthly income (e.g. teachers), the point of reference for assessing the maximum tolerable price of PV electricity service is the household's income constraint and not a hypothetical energy expenditure restriction: In what quantities PV-electricity (and maybe traditional energy commodities) are finally consumed depends of the relative *marginal utilities* of both consumption goods. If it turns out that PV electricity is ranked higher than traditional energy applications, and there is strong evidence for this, then households are prepared to pay more for a SHS than for the traditional energy sources to date. In other words, what rural households usually pay for traditional energy is relevant only in so far that it represents rather the lower limit of what these households are prepared to spend for a more convenient source of energy for lighting and TV.

From the viewpoint of a financial institution, the assessment of a loan application for SHS would usually have to be based on a cash-flow analysis including a sensitivity analysis that assesses the risk exposure of various income sources and expenses; how income/expenses will change with the acquisition of a SHS and what surplus is expected in the future. To consider, however, how much has been spent historically for other sources of energy over a longer period of time would provide loan officials with a reference for the minimum average expenditures for energy and therefore, provide additional information for the risk assessment.

Apart from this, the following insights based on practical experience are worth to be considered when assessing the willingness-and capability-to pay for a SHS:

- Households with regular income such as teachers, store owners and bakers have revealed the highest preference for SHS and have been the most reliable target group in terms of *capability-to-pay*. Also, households with a family member working abroad, a common phenomenon in a number of developing countries, have frequently acquired a SHS, although affordability cannot be taken for granted, since delays in the remittance of funds from the respective family member often occur.

- Due to the seasonality of agricultural income, farmers, who are typically involved in a complex web of credit relationships, might be a difficult target group for PV dissemination programmes. Typical farmers produce substantial cash once or twice a year with considerable risk exposure that cannot be easily assessed by many financial institutions. In addition, farmer households are even more scattered than are teachers, store owners, etc. who largely concentrate in the villages. Therefore, providing financial services to farmers involves considerable operating costs that must be either assumed by the financial institution (i.e. establishing mobile services or small outlets in a decentralised manner in order to get closer to their potential clients) or externalised to the client (i.e. making him/her travel to the financial institutions in the villages).

- Many rural households, particularly the poorer ones and those engaged in agricultural production, have recourse to a considerable number of sources of funds to manage their cash flow. It is evident that rural households will first serve those outstanding loans that are most needed to maintain a high level of economic activities. It would be naive to assume that income will be used for the acquisition of a SHS *before* settling the outstanding debt accumulated for working capital and living expenses over the year.

- Women are affected to a higher extent than men are, since SHS are installed in the house, which tends to be a woman's domain. SHS have created more flexibility for women to schedule their income earning and domestic activities due to the possibility of extending work in to the evening hours. However, a definite answer as to whether and to what extent

PV-electrification has enhanced women's productivity, or intensified their work load, or even increased gender inequality is not yet possible.

Improving access to suitable credit sources, however, is only one means to enhance SHS dissemination. As empirical evidence from many countries has shown, the rural population and even the poorest in remote areas have savings and lending capacity to certain extent. This can be learned from many informal savings mechanisms that do exist around the world, including Rotating Savings and Credit Associations (ROSCAs), informal savings clubs, the large number of informal credit transactions between family members and the widespread use of non-monetary, in-kind savings facilities such as savings in livestock, gold and jewellery. Poor people in rural areas prefer depositing money in formal financial institutions when appropriate savings services (easily accessible, safe and profitable) are available.

Examples from Bank Rakyat Indonesia, Bank for Agriculture and Agricultural Co-operatives (BAAC) in Thailand and the village banks in West Africa – to mention just a few - show that a large volume of deposits can be mobilised even among the poorest. Many of these financial institutions provide savings facilities that are specifically tailored to the needs of these clients. In many cases, savings plans with weekly or monthly deposits exist that allow accumulation of money over a longer period of time that will be spent, in most cases, to purchase durable consumer goods or comply with social obligations (e.g. dowries, wedding parties). From this perspective, SHS could also be financed through savings plans that build up capital over a certain period of time, provided a SHS ranks high in priority for the rural population.

3.2 Factors influencing the willingness-to-pay

The central problem in SHS dissemination projects with a credit scheme has often been the low rate of credit repayment by the end-users. One important reason for that is a *decreasing willingness-to-pay* caused by, firstly, operational problems (due to poor quality components) and, secondly, the growing awareness of the system's capacity limitations, none of which is directly related to financing but to technical reliability and lack of information of the user. A third reason is related to political influence factors.

Operational problems abound simply because customers learn after relatively short time that the systems are not maintenance free: BOS components, i.e. battery and fluorescent lamps (with electronic ballast) but also the BCU, represent major bottlenecks. For the battery, the risk of early failure could partly be reduced by better information about the average lifetime depending on type, brand and, quality as well as on the required maintenance. In the case of (especially if locally produced) BCU and fluorescent lamps, it is not so much the missing attention of the user but poor quality caused by the lack of technical standards which have not been systematically introduced or enforced. Improving the quality of fluorescent lamps and BCU as well as extending the lifetime of batteries is probably the biggest challenge in the future to increase acceptance of SHS by customers. Since quality improvements result in higher durability at the expense of higher prices, the customers have to decide whether to buy a low quality but cheap product or a durable but expensive one. With private rates of time preference much higher than in industrialised countries, this decision may possibly be in favour of cheap, low quality fluorescent lamps as long as end users remain responsible for their purchase.

The second factor refers to the user's experience with the limited generation capacity of the SHS he/ she owns. This limited electricity supply of the installed SHS may lead to the impression of solar energy as being 'second class power'.[19] The often-cited process of adjusting user expectations to the performance limitations of SHS is easier to manage in theory than in practice. Product design and marketing typically run the other way round. Electric appliances

[19] Therefore, utilities like CEMIG in Brazil deliberately call the SHS based electrification "pre-electrification".

are usually designed in a way that they fit consumers' expectations and preferences and not *vice versa*. With a determined generating capacity the SHS requires from the user a more or less *static consumption behaviour*, not allowing connection of additional load to the system whenever required. Technically, additional panels can extend the SHS, which however, means further investment and operational costs. Electricity consumption in newly electrified areas during the first month after grid connection have typically been in the range of 0.5 - 1.0 kWh per day per household. With a standard SHS installed this level of consumption cannot be satisfied. Note also that there is often a subjective preference by households for diesel generators, which, due to their relative low investment costs are usually oversized and, therefore, provide higher flexibility adjustable to increasing load factors.

The third important reason for low credit recovery rate is related to *political disincentives*, closely connected to the question of how credit services are designed and managed. In SHS dissemination programmes, government has often been an important stakeholder that determines to a large extent how credit services are set up. On one hand, state interventions in this area refer to directly targeting the programmes in regional terms. On the other hand, a large part of the funds stem from government sources and come with special conditions, often with direct subsidies to utilities or other intermediaries or even directly subsidising the SHS end-user. As soon as the user becomes aware of politically motivated donations (e.g. by congressmen or governors), who offer to finance SHS installations at virtually no (monetary) cost for the user, any project is ruined which, for the sake of sustainability, adheres to the principle of cost coverage. Similar conclusions can be drawn for the widespread introduction of special incentives to increase potential users' acceptance of SHS (such as to allow reduced payments of principal for those users who have acquired the systems first). Most villagers are led by *rational expectations*: if the borrowers' outstanding loan obligations are reduced once, why then pay at all, since the credit conditions will possibly be changed to the borrowers' advantage and costs will be socialised for a second time.

The issue of subsidies has always caused controversial discussions. In the recent discussions[20] the distinction is made between 'good and bad subsidies' trying to justify subsidies which are designed to fade out after barriers have been removed, like anticipated risks due to lack of knowledge of SHS technology and/or awareness of capabilities and limitations of PV systems. This is part of the concept of GEF subsidising barrier removal activities and the justification for the incremental costs policy.

Subsidies are often regarded as 'good' for banks/dealers/private sector manufacturers who are said to be travelling on the PV-learning curve. There are more benefits for which the 'good subsidies' can be justified: employment effects, education of banks and political decision makers, training of technicians of dealers, utilities etc. The direct global environmental benefits from SHS projects in terms of avoided CO_2 are small, however, relative to other sources of CO_2 emissions in developing countries.

According to this discussion, 'bad' are targeted subsidies for the end user, because an end user will probably buy a SHS one time in life only and therefore not produce significant barrier removal effects apart from a possible demonstration effect encouraging other users to buy a SHS.

Whether subsidies are good or bad, could easily become an endless discussion. The fact of the matter is that dealers, credit collectors etc. face a myriad of problems due to long distances, poor transport infrastructure, impassable roads during the rainy season, low literacy rates, cash and barter transactions, lack of technical skill etc. The related high transaction costs, if not balanced by significant system cost reductions, will make some sort of subsidies a permanent feature of SHS delivery. If backed by domestic development policy, subsidies should be disbursed for incremental, non-recurring business and market development costs, rather than

[20] World Bank (1997 (1))

for equipment procurement. Such non-recurring costs may be related to business planning support, feasibility studies, consumer awareness measures, credit delivery pilot schemes, and initial marketing and market development efforts.[21]

4. Sustainable SHS Finance from the Perspective of the Financial Systems

4.1 Requirements for sustainable finance

Apart from the characteristics of SHS users who demand credit to purchase a solar generator (analysis of the demand side), the structures of the financial sector, particularly at the institutional level, are critical for SHS finance (analysis of the supply side). In order to better understand the basic features of sustainable finance a brief overview of the state-of-the art of financial systems development will be provided.

As experience from various countries and continents has shown, sustainable financial sectors must be free from government interference in financial markets.

Market-conformity of interventions plays a crucial role. Market conformity means that capital is allocated where the maximum return can be achieved. Depositors should be able to go to the financial intermediary that seems to be most attractive. The same refers to the financial intermediary that selects the most attractive, i.e. least risky, borrowers. Financial intermediaries must price their products according to the need to attract depositors and the need to cover the costs of financial intermediation.

What are the effects of subsidised credit? [22]

- Subsidised credit leads to low levels of operational efficiency as financial institutions have little or no incentive to become sustainable.
- Subsidised interest rates create excess demand that may result in a form of rationing.
- Subsidised credit leads to poor repayment habits.
- As subsidised funds are scarce and desirable, credits tend to be allocated to local elites who have influence.

In other words, first and as a necessary condition, government interference in terms of interest rate ceilings and credit quota systems must be cut back. Financial institutions must be allowed to determine their interest margins according to their operating costs and to engage in cautious, independent risk-management.

Second, and as an additional condition, however, financial market liberalisation must be complemented by efforts to establish and enforce a regulatory and supervisory framework that instils customer orientation and sound financial management in financial institutions. In fact, the requirements for sustainable finance are not fulfilled in those SHS finance schemes where targeted credits and direct and/or indirect subsidies to the end-users prevail. Such a situation definitely inhibits participation in the market by any private financial institutions that wish to provide financial services on a cost-covering long-term basis.

On the institutional level, since the nineties development finance has been based on two principles: outreach and financial sustainability. Outreach refers to the basic objective of development finance to provide large numbers of poor people with access to a broad range of customer-oriented financial services. Direct targeting was therefore substituted by an indirect approach of attracting clients through well-designed financial services. Financial sustainability aims at creating or strengthening financial institutions to become independent from continuous inputs from governments and donors so as to maintain themselves in the financial markets on a

[21] See GEF (2000).
[22] World Bank (1997 (3))

long-term basis. A key factor to help achieving financial self-sufficiency is cost covering interest rates. There is a widespread understanding that subsidised interest rates for end-borrowers are detrimental to financial institutions. While financial sustainability is a sine qua non for reaching a large number of people with financial services over a sustained period of time, scale and quality of outreach is a complementary condition to connect finance with a development objective. Table 1 below provides an overview of the basic indicators used to measure outreach and financial sustainability on the institutional level.[23]

As has already been partially discussed in Chapter 3, another important factor for sustainable finance is the repayment and savings capacity of the clients and their willingness to make use of formal savings instruments. As empirical evidence has shown, the financial behaviour of the clients will largely depend on the efficiency of financial institutions. Where institutions with sound lending techniques and attractive savings products exist, the clients will respond positively to this and, hence, show a high repayment performance as well as a large volume of deposits. In this context, it should be stressed that even few cases of unsound and highly subsidised lending practices or fraud in deposit-taking institutions can discredit the entire financial sector. When the repayment culture in a country is undermined through subsidised soft loan programmes or deceitful practices, confidence in the financial sector is lost and bank runs occur. In this situation, sustainable finance is a difficult job even for the most efficient financial institutions.

Table 1: Basic criteria of sustainability on institutional level

Outreach[24]		Financial sustainability	
Indicator	**Benchmark**	**Indicator**	**Benchmark**
1. Number of clients	at least 3,000 [25]	1. Portfolio at risk (outstanding credit balance in arrears > 30 days	Max. 10%
2. Growth of number of clients and volume	depends on the phase of the institutional life-cycle; rough figure 10%	2. Credit losses	Max. 4%
3. Average credit size	below GDP per capita	3. Operational self-sufficiency [operational income > (administrative costs + provisions for loan losses + inflation costs)]	After 3-7 years
4. Participation of women	between 1/3 and 2/3	4. Financial self-sufficiency [operational income > (administrative costs + provisions for loan losses + inflation costs + financial costs)]	After 5-10 years
		5. Operational efficiency [(administrative costs + provisions for loan losses)/average outstanding loans]	Tendency to decline over time; goal: < 20%

Therefore, SHS finance should adhere to the above-mentioned principles in order to make itself a sustainable business and also to avoid jeopardising other target-group-oriented financial programmes that try to operate on a sustainable basis. It is recognised that SHS finance will largely be required to take place in remote rural areas where there is a permanent lack of financial infrastructure due to incomplete markets. This problem, however, should not be solved

23 GTZ (1997 (1))
24 GTZ (1997 (1))
25 Standard defined by CGAP.

by directing subsidised credit through financial institutions that are isolated from the rest of the financial sector, creating "hot spots" or "island solutions". Subsidies might be necessary for development policy reasons but should not be addressed to the final borrowers but rather to institution-building measures, providing incentives for financial institutions to do profitable business in these regions. In fact, this is an arduous task, but has already produced interesting results in some cases (see Chapter 5).

4.2 The key elements of credit product design

Every financial institution that engages in credit product design must consider two basic factors:

- ***Risk mitigation.***
  The credit product must be designed in such a way that risks of credit loss are minimised.

- ***Operating costs***
  Every financial institution is interested in keeping its operating costs (administration plus provisions) as low as possible.

Any credit product incorporates the following key elements:

(i)	credit amount,
(ii)	guarantee,
(iii)	term structure,
(iv)	repayment schedule,
(v)	interest rate

While the elements (i) to (iv) should be adjusted to the needs of the customer, the interest rate (v) must be determined on a cost-covering basis and, hence, reflects the conditions of the financial institution rather than those of the borrower.

Table 2 gives an overview of these different elements and establishes qualitative benchmarks for PV finance. In addition, it summarises the effects on risk mitigation and administration costs, considering each element and the respective benchmarks.

Table 2: Elements of credit product design for SHS

Elements	Qualitative benchmarks	Effects on risk mitigation and operating costs
Amount	• credit amount should not fully finance the SHS (down payment with own funds) • considerable proportion of self-finance	• if borrower invests part of his/her own funds in purchasing a SHS he/she will probably feel more responsible for it and also take credit more seriously
Repayment schedule	• constant (optimal: monthly) interest payment • monthly, quarterly or biannual amortisation payments (without grace period)	• constant (monthly) interest payment permits better control over time -> similar to regular expenses for alternative electricity sources[26] • amortisation payments according to individual cash-flow • no grace period is recommended as SHS starts working immediately
Guarantee	• SHS in case that financial institution could make use of it -> probably feasible for companies that sell SHS and less for „classic" financial institutions	• as technical problems often contribute to customer dissatisfaction and unwillingness to repay, SHS guarantee will probably not be effective in enforcing repayment

[26] The collection cost must be considered; e.g. in remote areas or Outer Islands the mobilisation costs for the personnel may be higher than the amount to be collected.

	(this depends on market situation and technical reliability and may change in future) • Other collateral than SHS or „artificial“ guarantees	• Utilisation of SHS as collateral may result in high operating costs for those financial institutions that do not deal with SHS on a daily basis
Term structure	• Not longer than the shortest individual lifetime of a SHS-component unless reliable provision for replacements costs of Parts is made • Not longer than the time grid electrification is expected to reach the area	• Technical failures increase over time and will result in unwillingness to repay as long as effective quality management measures are not in place. • grid electrification can be more attractive than SHS and, hence, lead to unwillingness to pay
Interest rate	• on a cost-covering basis	

It is evident that every financial institution will incorporate sufficient safeguards to mitigate risks. From this perspective, it will require from the borrower that he/she contributes a considerable proportion of own resources to purchase the SHS. This demonstrates that the person is seriously interested in the SHS and is willing to invest and, hence, to “risk“ its own money. By the same token, the willingness to pay should be constantly tested by monthly interest instalments. On the one hand, this gives the financial institution a good monitoring device and it will notice quite early when a repayment problem emerges. On the other hand, the borrower will be disciplined through regular payments. In any case, the borrower would have had to spend money on a regular basis anyway for alternative sources of energy that the SHS partially or totally has replaced so that monthly interest payments should fit in with its overall household cash flow. The SHS should only be used to guarantee the credit when the financial institution can make effective use of this collateral. This would require a contract with the dealer to take back this already used SHS from the bank. In practise, however, the enforcement of this collateral turns out to be a difficult task since the legal basis for such action is often not clear, and additional costs apply for dismantling the SHS, etc. In cases, where the user stopped repayment due to operational problems of the SHS, he/ she will probably not feel threatened by losing the SHS that serves as collateral. Therefore, it could be advisable for a financial institution to require additional guarantees to enforce payment, such as private property items, blocked savings, joint liability, etc.

Finally, the term structure should consider the technical life cycle of the SHS and the possibility that more sophisticated energy sources may become available over time. As a consequence, financial institutions should consider short credit maturities.

5. Financial Mechanisms to Stimulate and Achieve Commerciali-sation of SHS

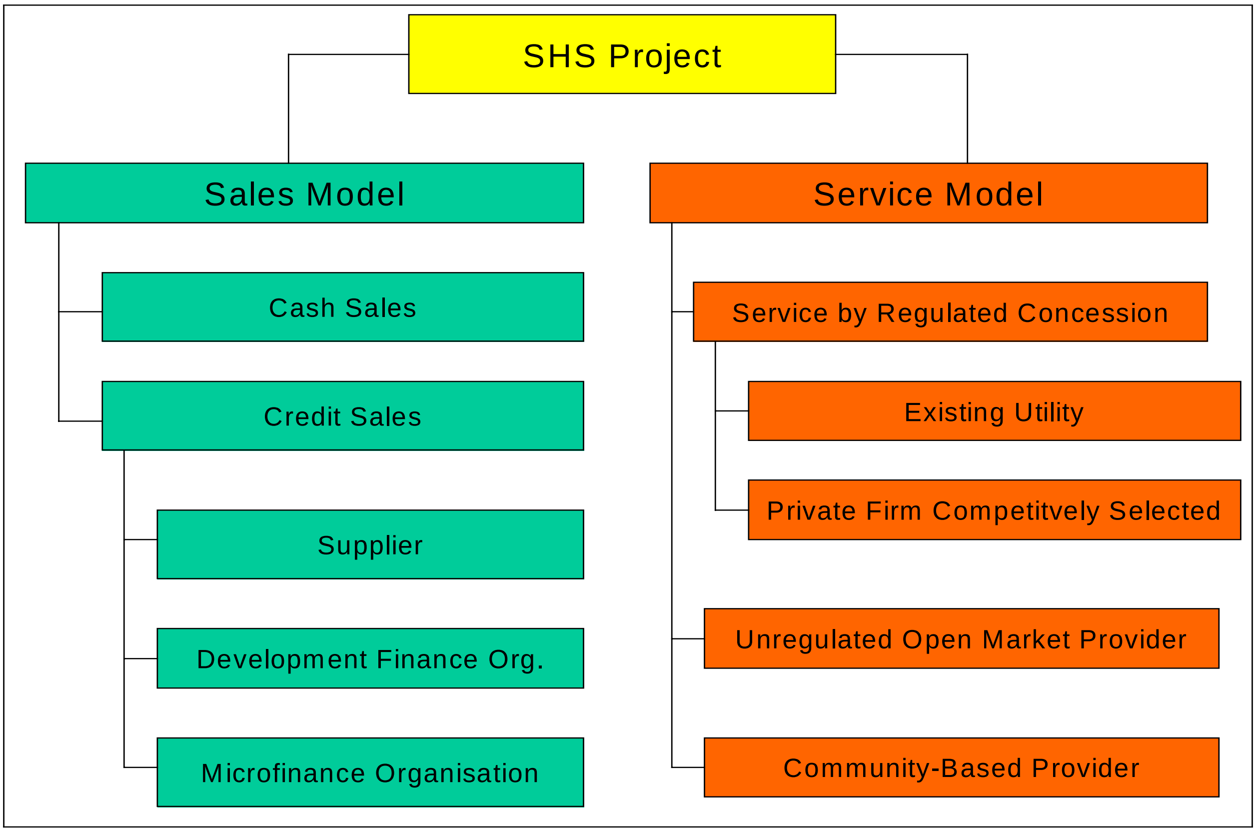
5.1 Primary approaches

Stimulating and achieving commercialisation is the common objective of practically all projects dealing with the dissemination of SHS. To achieve this objective, usually one of two basically different approaches is followed: The sales model or the service model.

With a *sales model*, private dealers sell SHS to rural households, who pay cash or receive credit. Rural households have to maintain the systems and are responsible for debt service in the case of a credit sale. Credit may be provided by the dealer, by a micro-finance organisation, or by a development bank.

Under a *service model*, an energy-service company (ESCo) supplies solar electricity for a monthly fee to rural households. The systems are owned and maintained by the ESco. From an organisational point of view, the service may be provided by a regulated concessionaire (existing utility or competitively selected private firm), an unregulated open market provider, or a community based provider. See the typology of delivery models in Graphic 3.[27]

Graphic 3: Primary approaches of delivering SHS



Source: GEF 2000

5.2 General experience with sales models

Recent reviews by GEF and World Bank of SHS dissemination projects, which employ the sales model, have drawn the following picture:

1. The effectiveness of the sales model depends much on the long-term credibility of the SHS technology, which is a question of assuring the quality of both hardware and service (see above).

2. Customer education on proper maintenance is particularly important.

3. Credit risk is a serious concern of both dealers and financiers and makes credit sales particularly challenging. Again, adequate after-sales service is a key to adequate credit repayment performance.

[27] UNDP (1999) in a recent survey on financial mechanisms provided a longer list of models, among which the sales model and the service model play the most prominent role, however.

4. Although there is not yet enough experience on the viability of dealer supplied credits under the sales model, dealer cash flow seems to be the major constraint in selling SHS on credit. In particular, many dealers have not yet learnt how to approach banks for business finance. As World Bank (2000) puts it: "SHS delivery firms face a myriad of difficulties operating in rural areas. These low-margin firms must develop good business models and need flexibility from projects in doing so."

5. To participate in a project dealers should be selected upon clear eligibility criteria, such as existing business competence, sales/ service infrastructure in rural markets, and a refinancing agreement with a participating bank.

6. In the case of funding from a development finance organisation, a long-term commitment is essential, which might go beyond the end of a project, since the dealer may depend on continued development institution assistance unless longer-term business financing becomes available.

7. Similarly, a strong and long-standing micro-finance organisation with high creditworthiness is needed, if this type of sales model is selected. For a more extensive treatment of, see sections 5.3 and 5.4.

5.3 General experience with service models

In spite of the fact that substantial implementation experience is still needed before the success of the service model can be judged, a trend is discernible in favour of this approach:

1. The trend towards service models is nothing but a reflection of the after-sales service issue, which implies enormous transaction costs to dealers who have not yet established a service infrastructure in rural areas.

2. Despite the seeming advantages of the service model, SHS market expansion may be impaired by unrealistic and often false promises by politicians about rural grid extensions. Such practices are counterproductive whether the service comes from a regulated concessionaire, unregulated open market provider or a community-based provider.

3. If governments attest rural electrification high priority even in areas where grid extension is not economical, regulated concessions (e.g. for specific franchise areas) are more likely to be favoured. For such regulated energy service concessions, a government agency at an appropriate level must learn to serve as an effective regulator (approval of tariffs, attracting capable bidders, ensuring service quality etc.).

5.4 Micro-finance programmes: examples

The objective of this section is to analyse some examples of existing target-group-oriented credit products in the informal, semiformal and formal financial sector to review their suitability for SHS finance. These target-group-oriented credit services are often classified as micro-finance due to their small loan size.

Money-lenders in Cochin, India [28]

The money-lenders in Cochin work with a well-known credit scheme of 10 weeks. For each 100 rupees lent, 3 rupees are kept as a fee. The credit of 100 rupees must be repaid over 10 weeks at 12.5 rupees a week. The effective interest rate for the 10 week period is 28.9%.

Though the informal financial sector is probably the main source of credit for low-income people, it also shows some serious shortcomings. First, the amount of funds available from each individual informal intermediary is insignificant. Second, the characteristics of the financial services provided by moneylenders and ROSCAs do not fit with those needed for long-term finance, such as SHS finance. The example of the professional money-lender in Cochin, India, shows that the term structures are short and rigid and the interest rates are very high. ROSCAs operate in a similar way over a short period, though the ROSCA members do normally face lower financial costs than borrowers of a moneylender. In the literature on money-lenders and ROSCAs, SHS finance has never been mentioned. This is probably due to the fact that SHS require a higher credit amount and a longer repayment period than these informal intermediaries normally provide. Despite these shortcomings, credit transactions with moneylenders and ROSCAs might serve as references to determine the repayment capability and credit worthiness of SHS purchasers.

FINACOOP – Honduras

FINACOOP is a credit union whose members are agricultural co-operatives and individuals. Their speciality is agricultural lending but they also provide credit for consumption and housing. In the past, FINACOOP delivered credit to agricultural co-operatives that on-lend these funds in their own credit programmes to their members. Due to little experience with financial intermediation, the credit programmes of the agricultural co-operatives showed high credit losses. Therefore, FINACOOP decided to establish a direct customer relationship with the members of these agricultural co-operatives. FINACOOP has opened branches in the agricultural co-operatives to get as close as possible to their clients. As agricultural production involves high risks, FINACOOP signs partnership agreements with the technical assistance units of agricultural co-operatives. Technical assistance of borrowers is compulsory and must be paid. Quality of technical assistance provided is assessed through annual customer surveys carried out by FINACOOP. Poor performance will result in ending the partnership agreement with the co-operatives and not providing further credit to the co-operative members. This is a strong incentive for the co-operatives to maintain good technical advisory services. Other risk-mitigating techniques of FINACOOP comprise obligatory insurance of collateral against loss and a life insurance of the borrower.

Concerning semiformal financial institutions, in several countries credit unions seem to be an interesting option for target-group-oriented lending due to their localised focus, membership basis and intelligent credit enforcement techniques. The latter include mandatory savings before getting a credit and blocked savings until credit is repaid combined with peer pressure among members to ensure repayment. As credit unions often serve middle class and low-income members at the same time, they are used to provide credit for a large array of uses, ranging from emergency credits to housing credits. This is reflected by different credit sizes and a more varied term structure than semiformal financial intermediaries or financial NGOs normally offer.

As a result, credit unions might be interesting partners in delivering SHS credits as they work with more varied credit products and customers. However, due to their lack of access to apex facilities and the capital market, credit unions often suffer from limited funds. In addition, many credit unions struggle to find an appropriate balance between local involvement and professionalism of operations. Some credit unions are conservative as they do stay in their traditional market segments and do not try to develop new products or attract new customers. However, as the example from FINACOOP shows, credit unions can become quite innovative and even deliver specialised services to a sector considered to be a high credit risk, such as agriculture. In some countries, direct government intervention in the credit unions resulting from using them as a channel for a broader policy agenda largely discredited the co-operative movement.

[28] Example taken from Johnson/Rogaly (1997)

Multipurpose Co-operatives: The case of Joseph Credit Union - Philippines

The Development Bank of the Philippines (DBP) offered credit to newly established NGOs to cover the complete costs for a SHS. After technical and repayment problems emerged, the DBP decided to provide further credits only for the solar generator, and to onlend only to NGOs with good credit records.
In 1992 a credit application for the *St. Joseph Credit Union* , a Philippine NGO was appraised by DBP to finance Solar Home Systems in the village of Belance. The co-operative had shown a good credit record over the past thirteen years, and in addition, the proposed project was being prepared in co-ordination with a Dutch supplier and the *Department of the Interior*. The installation of 100 SHS was completed in 1994. 14 technicians were trained in maintenance work as well as in financial matters for the co-operative staff. It was to become a model for furthering SHS through a NGO instead of a governmental guided scheme.
After 4 years serious performance problems with the SHS developed. End-users complained and refused payment, leaving the co-operative unable to meet its credit obligations to the DBP. The DBP and DOE jointly investigated the case and came to the conclusion that technical problems (defect BCUs, damaged batteries and lamps) were not solved due mainly to management problems of the co-operative.
Although spare parts were available, the only remaining technician of the group of 14 technicians initially trained was obviously unable to repair the systems. Tampering with the equipment by the technician and the end-users in attempts to get SHS back in service (and bypassing the BCU) made the situation even worse.
The co-operative's mismanagement created ever more financial difficulties: overloaded with credits from different institutions, the co-operative was seeking new credits only to cover old obligations. Currently, a rehabilitation program is being discussed between the DBP, DOE and the co-operative, with the aim of stimulating end-users to resume their payments.
In this case, two problems caused the collapse of this project: SHS with low quality components were implemented by a weak organisation without a functioning after sales service. This example confirms the experience of other projects, that both technically reliable system components and functioning after sales services are key factors for any successful implementation of SHS projects and a precondition for their sustainable financing.

New types of financial institutions promoted in West Africa by several donor agencies, intending to combine strong participation of the villagers in financial management with access to the formal financial sector have also adopted the co-operative principles. Well-known examples of these self-reliant village banks are the Caisses Villageoises de’Epargne et de Crédit Autogérées (CVECA) in Mali, Burkina Faso, Madagascar, Gambia, Sao Tome, Cameroon, Benin and the Gambia.

These village banks or savings and credit associations are established and managed by the rural village communities. The villagers determine the organisation and rules of their bank and elect a management and credit committee. After a year or two, the village banks build an association that links the village banks up to the banking sector that provides refunding. In addition, the association helps to create better internal control and auditing mechanisms. Due to the specific credit product design, self-reliant village banks do not seem to be the best option for delivering SHS credits. As these institutions largely depend on members’ savings, it cannot be expected that the credit size will increase and the term structure will be expanded to include medium-term and long-term credits.

In general, most successful micro-finance-NGOs have started in urban areas and grown into suburban and rural areas as they gain experience. There might be very few NGOs that operate in a sustained manner in those remote rural areas where SHS programmes are concentrated. In addition, most of them have developed a standard financial product that suits traders and microentrepreneurs. In general, two

Caisses Villageoise (CVECA) Mali [29]

The CVECA provide current accounts, term deposits and working capital credit for less than one year. No direct link exists between credit amounts and member’s savings that distinguishes them from „classic“ credit unions. Interest rates are between 36-40% per year and are set by each village bank according to its experience with the lending business. Credit is repaid in one instalment. Collateral is obligatory, though village trust and social pressure are more important. At December 1996, the average credit size of all 52 CVECA in Mali was US$147 considering that the new village banks start with credits ranging from US$20-40. In 1996, 83% of the credits went to the commercial and service sector. The average amount on a current account was US$37 and of a term deposit US$121.

[29] Chao-Beroff (1998)

different approaches can be distinguished: (I) group-based lending following the joint liability approach and (ii) individual character- and cash-flow based lending.

The first approach is based on solidarity groups that are comprised of four to seven members who mutually guarantee each other. Initial credits are generally between 100-200 US$ and will then increase according to repayment performance. Solidarity groups will only be effective when groups are small and homogeneous. Normally, the groups fall apart after 3-5 years as some members will grow out of the groups because they progress more quickly in economic terms. Other risks associated with using solidarity groups are: potential for corruption, correlation of risks due to similar production patterns, risks of generalised repayment problems (domino effect), high up-front costs of forming viable groups, departure of group leader may undermine group stability, and increased transaction costs.[30] Solidarity group-based lending might be an interesting option to incorporate very poor households into the financial system. However, it might not easily work with SHS finance as solidarity groups have a shorter life-cycle than SHS credit would require. In addition, solidarity groups start with very low amounts of credit that are gradually increased. A SHS borrower would need to show a long credit record to gain access to a credit that is high enough to purchase a SHS.

The second approach provides credit to individuals on a case-by-case basis. Individual lending requires more information and a more detailed financial analysis than group-based lending as there exists a direct relationship between the financial institution and the client and no previous screening is done through a group. Instalments are normally paid on a weekly or monthly basis in order to facilitate credit monitoring and to instil repayment discipline among new borrowers. However, this policy can be relaxed with old clients who have a good repayment record. Collateral is generally substituted through „artificial“ guarantees such as household goods whose economic value is not large enough to cover the credit amount, but whose loss would considerably hurt the borrower. This approach might be interesting for SHS finance as it employs a larger variety of credit products in terms of credit size and term structures when the NGO gains more experience. However, some NGOs that engage in individual lending might still be in a stage on the institutional learning curve where credits for working capital for a maximum term of 12 months prevail.

Ademi – Dominican Republic

ADEMI provides credit and non-compulsory direct technical assistance to microentrepreneurs. It does not give consumption credits. The average credit size is US$1,110 and the majority of credits are for working capital with maximum credit terms of one year. ADEMI has started to provide investment credit for well-known clients with a maximum credit term of 60 months for fixed assets. A combination of collateral and guarantors is used to secure the credits. However, if first-time borrowers are not able to provide security, the credit officer will rely on information as collateral and investigate the applicant as an informal moneylender would do. Repayment is monthly and interest rates range from 2.2-3% per month.

ADEMI, whose experience is described in the box, started in 1983 and needed more than ten years of operations to introduce medium-term credits (up to 60 months) for small and medium enterprises. Most of the experienced NGOs test medium-term credits with well-known clients before delivering similar terms to new market segments. Therefore, potential SHS-borrowers would need a credit history with the institution to qualify for a medium-term credit. In addition, though none of the well-performing NGOs work with direct credit in order to promote a specific economic activity, most of them focus on „productive credit“. However, there are some NGOs like the former ProCrédito (Bolivia) that do not distinguish between a productive and a consumer credit. As long as the client shows sufficient capacity to pay, the credit will be approved. In chapter 6, the case study of Lesotho is presented, where a hire purchase model is practised for SHS financing.

30 World Bank (1997 (3))

Hatton Bank - Sri Lanka[31]

Hatton Bank has established the „Village Awakening Program“, using credit officers as „barefoot bankers“. Credit is largely provided for non-farm businesses as they seem to be less risky and produce a more stable income. The bank has experimented with credit groups and has tested different types of collateralised lending. The current credit size is US$550, which is much larger than the average credit size of the NGO sector.

In the formal financial sector, traditional commercial banks rarely show interest in serving the low-income population in rural areas, given their perceptions about the credit risk of low-income people, expected high operating costs, lack of collateral and the insecure legal status of this new market segment. Due to their bureaucratic procedures and collateral-based lending techniques they are unlikely to become important stakeholders in target-group-oriented lending. However, there have already been several examples where banks see micro-finance as a means of identifying future clients for larger credits. These examples include Centenary Rural Development Bank (CERUDEB - Uganda), Hatton Bank (Sri Lanka), Banco Caja Social (Colombia), Barclays Bank (Zimbabwe) and Banco del Pacífico (Ecuador). Other commercial banks such as Citibank have established foundations to experiment with micro-finance. Downscaling commercial banking operations is often achieved by copying lending techniques tested by NGOs and, hence, shows similar advantages and shortcomings.

Today, BancoSol (Bolivia) and Grameen Bank (Bangladesh) are probably the only formal banks that do not only provide a window for low-income people but exclusively focus on delivering financial services to the poor. An outstanding feature in both banks is the predominance of female clients. Women have a much better repayment record than men and are considered „first-class clients“. SHS finance should take this experience into consideration. Though the lending programmes of both banks are based on the solidarity group approach, the financial technologies BancoSol and Grameen Bank apply are quite different. Grameen Bank applies a rigid credit scheme that leaves little margin for individual credit solutions. Grameen Bank does not offer a simple credit programme but an integral development philosophy for the poor, tackling poverty in the areas of health, education, community development and income-generating activities as an integral approach. SHS finance cannot be easily accommodated within the Grameen Bank so that a separate institution was established for promoting renewable energy systems such as SHS, wind and biogas systems. The approach of Grameen Shakti Bank will be described in more detail further down. Compared to the Grameen Bank approach, BancoSol has already provided the first individual credits to borrowers with an excellent payment record. As BancoSol’s credit products are diversified, it could also address the financial needs of SHS borrowers. Target-group-oriented minibanks such as the private financial funds in Bolivia show similar characteristics to micro-finance NGOs or banks specialised in micro-finance. They face the same possibilities and constraints for SHS finance and will therefore not be treated separately in this study.

Grameen Bank – Bangladesh

The Grameen Bank of Bangladesh serves the landless women to improve their income-generating activities. Peer groups of 5 members are self-formed and incorporated into centres that are comprised of up to 8 groups. According to the solidarity principles, group members mutually guarantee each other and no new credits are paid if the credit of one member is still in arrears. Meetings of centres , which all groups and their members must attend, take place on a weekly basis. Weekly obligatory savings contribute to a group fund and an insurance mechanism. They must be contributed prior to the credit and will continue over the credit cycle. Credit appraisal is performed by group members and centre leaders. Grameen Bank officers only provide pre-credit orientation and minimal technical assistance. The largest portion of credits are provided from 6 months to one year. However, Grameen Bank also offers seasonal and leasing credits of 1-3 years and housing credits for 10 years. Credit amounts are usually US$100 to US$300 for the short-term credits. The group fund is completely self-managed by the group and is normally used for additional credits to members. Apart from financial transactions, the mandatory weekly meetings include self-esteem building activities and discipline enforcement.

31 Gallardo et.al. (1997)

Most commercial banks have not become effective target-group-oriented retail financial institutions due to political interference, subsidised interest rates and bureaucratic procedures. There is one remarkable exception from this: the rural Unit Desa system of the Bank Rakyat Indonesia (BRI). BRI has become the trademark for profitable, large-scale financial intermediation with the rural poor. Development banks such as BRI can become important partners in providing SHS finance as they offer different credit products, have a large outlet system so that they get close to the clients and work with professional staff. Though the BRI model was copied in several countries, few development banks exist that show such a remarkable outreach and profitability as BRI. Therefore, in many countries it is expected to be difficult to work with development banks as reliable partners in SHS finance.

Bank Rakyat Indonesia - Indonesia[32]

Credits can be used for any purpose, including consumption with an average size of US$570. The smallest credits are US$55 and the largest can exceed US%10,000. The interest rate was more than 30% p.a. in 1996. Borrowers must provide collateral, usually land titles, although occasionally pledging of buildings, motorcycles or other property is accepted.

5.5 Potential of micro-finance institutions

Most micro-finance institutions and programmes that deliver financial services to the low-income population do not fit the requirements of SHS finance. The reasons for this situation are closely related to the fact that micro-finance institutions are still at an early stage on the institutional learning curve and show the following characteristics:

- Micro-finance institutions still operate mainly in easily addressable market segments. These market segments often are comprised of the urban informal sectors, including petty traders and micro-entrepreneurs. The most remote areas that represent the most attractive potential markets for SHS are therefore least attractive for micro-finance institutions from a cost accounting point of view. Some micro-finance institutions have already proven that it is possible to deliver financial services in rural areas and to scattered customers. However, it is a question of speeding up institutional learning to further improve rural market penetration.

- Micro-finance institutions provide few standard credit products. In most countries, they are not tailor-made to respond to the economic characteristics of the individual borrower.

- These standard credit products in most countries consist of a small credit size (usually below US$500; in some countries even below US$100) and short maturities (below one year) that do not respond to the needs for SHS credits. Though some institutions eventually provide larger credits, they only do this for well-known customers that have graduated within the institutions over three or four credit cycles. New borrowers could not start at once with a higher credit amount even if his/her capacity to repay would allow him/her to do so.

- Credit unions and self-reliant village banks in particular can only grow according to the savings they are mobilising. Therefore, liquidity shortages might restrict the lending business and induce small credit amounts below the size that is necessary for SHS finance.

- In many micro-finance - institutions, frequent repayments such as weekly or biweekly instalments are a common screening device in order to prove the borrower's willingness to pay. This repayment schedule might be too rigid for SHS borrowers.

- Several micro-finance institutions work with group-based lending methods that rely on the solidarity principle. The solidarity groups whose members guarantee each other's credit in general show a short life-cycle of less than 5 years. They are not the most suitable option to

32 Maurer (1997)

guarantee a SHS credit since the necessary credit term might exceed the regular life-time of a solidarity group.

- Some micro-finance institutions only provide „productive“ credit and do not engage in consumer finance. This may also turn out to be a serious restriction for SHS.

Micro-finance institutions expand the variety of financial products over time and as they gain experience. As the example of ADEMI (see above) shows, it took this institution several years to include medium-term credits with maturities between one and five years. Very few institutions offer medium-term finance as the micro-finance sector only started in the late eighties and early nineties so their track records are short and their experience is limited. Most micro-finance institutions nowadays strictly separate the credit business from technical assistance. Even if they maintain financial and non-financial services under a common roof in one organisation, they generally separate both service areas in terms of staff, accounting and organisational structure. In case of SHS finance, it is important to rely on technical assistance and maintenance services to ensure that the SHS work satisfactorily.

One example where SHS credits and technical assistance are closely linked but managed separately in institutional terms is the **Grameen Shakti** whose design is summarised below. Results in terms of outreach and financial viability of the Grameen Shakti credit program are not yet known. However, it is evident that this innovative system to deal with SHS credits close to a micro-finance program faces major challenges:

The SHS customer is outside the traditional customer base of the Grameen Bank. Therefore, it might induce institutional stress as (i) SHS credits might lead to a deviation from the original institutional philosophy to serve the poorest women in Bangladesh, (ii) it might require other lending techniques, resulting in other operational requirements and staff capabilities and (iii) it may not distinguish between financing services and technical assistance. The operation of Grameen Shakti, however, does not foster the SHS market development with private sector involvement and is not finance sector compatible.

Grameen Shakti - Bangladesh[33]

Grameen Shakti is a sister organisation of the Grameen Bank specialised in selling, financing and providing technical assistance to renewable energy products (SHS, wind, biogas). The basic differences compared to the Grameen Bank are:

- While Grameen Bank credits vary from US$25 to US$500, a SHS costs US$300 to US$600. Therefore, Grameen Shakti works with more wealthy customers than those of the Grameen Bank.
- At the core of the Grameen Bank system is the solidarity group and the centre. However, as the number of solar customers is quite small, there are not enough to establish groups. In consequence, most SHS credits are individual. Only few borrowers of the traditional Grameen Bank groups and centres get a SHS credit and manage this credit within their traditional group arrangement.
- Grameen Shakti works with solar technicians who assist the borrowers in using and maintaining the system. In regular Grameen Bank operations, support to the borrowers is provided in the weekly centre meetings but not in the form of technical assistance as Grameen Shakti provides. Weekly meetings do not exist with SHS individual borrowers so that frequent visits of solar technicians to the borrowers become even more important.

The above-mentioned examples demonstrate that under current conditions micro-finance programmes will probably not be capable of delivering SHS credits effectively. However, they show a remarkable potential to become sustainable financial institutions that provide a large variety of financial services and to expand to the rural areas. SHS finance will possibly come into the picture with larger size lending and with the extension from the urban and peri- urban into rural areas.

33 Allderdice (1998)

6. The Way Ahead: Towards Higher Sustainability

6.1 Summary of the case studies[34]

The evaluation of SHS programmes concentrates on GTZ activities and projects in the portfolio of other organisations. Details of the evaluated SHS programmes like underlying financial schemes and related experience are given in Volume II (Case Studies) of this study.

The evaluated countries are:

- ***Tunisia***
- ***Philippines***
- ***Bolivia***
- ***Brazil***
- ***Morocco***
- ***Namibia***
- ***Lesotho***

Some comments to the country case studies seem to be appropriate:

- **Morocco** has by far the best SHS sales record of the evaluated countries. It has a well-established SHS market with a relatively small subsidy content. Morocco's SHS performance has been achieved on the basis of cash purchases, without the help of financing arrangements. This result might suggest that financing is of secondary importance or even irrelevant. It should be noted, however, that of the 80.000 PV systems sold about 60.000 are very small scale PV systems of only 11 or 20 Wp, and there is no evidence how many of these systems are operational.

- In some countries, e.g. **Brazil, Bolivia and Morocco** electric utilities increasingly offer to rural customers the installation of SHS as "pre-electrification". The applied service models are mainly on a leasing basis, where the customers own the BOS (battery, luminaries, accessories) while the utilities remain the owner of the solar panel and BCU ("Solar Generator") and charge a fee for electricity supply. Utilities more and more recognise the necessity for high quality components resulting in longer lifetime, and an overall higher customer satisfaction and willingness-to-pay. The advantages for the utilities are obvious: pre-electrification based on SHS helps fulfilling their obligation to supply electricity in their franchise area without the need for the costly grid extension. Once the users are accustomed to the electricity supply service, their willingness-to-pay is usually high and if electricity demand increases, the utility can then consider to extend the grid, recovere the no longer used PV systems and re-install them in other locations. For the customer this electricity supply service has some advantages as well: as long as the utility is the owner of the main components of the SHS, repair and maintenance services seem to work better compared to the situation where PV suppliers sell SHS only and do not care much about after sale service.

Probably, the most important policy conclusion to be drawn from the case studies is a lesson also shared by other organisations involved in SHS dissemination. As GEF (2000) put it: "By project completion, the number of systems installed is less significant than whether the business, delivery, and credit models are sustainable and whether replication mechanisms are effective".

[34] Detailed case studies are presented in Volume II of the study.

The following table gives an overview of the selected country programmes and their main parameters regarding the financing schemes applied. The attempt is made to quantify the degree of subsidies as far as possible. This quantification, however, is difficult due to existing indirect, and sometimes concealed subsidies. Therefore, the given figures are more a trend indication than exact figures.

Table 3: Summary of the case studies and main parameters of SHS programmes

Country / PARA-METER	Tunisia	Philippines	Morocco PERG-ONE	Bolivia	Namibia	Brazil	Lesotho	Morocco SEP
SUBSI-DIES[35] (TREND)	High			degree of subsidy			low	
[%] aprox.	> 90	> 75[36]	> 50	N.A[37].	> 35	> 30	0 - 30	0 - 30
N° of SHS[38]	4.000	965	2,000	1.300	171	500	sev. 100	15.000[39]
Total N° of SHS in the country	28,000	> 1,500	80,000	20,000	>250	>1,000	4,000	80,000
Financing scheme	Grant with single user contribu-tion	Credit based on revolving fund & rental scheme	Rental Scheme	Rental Scheme	Credit based on revolving fund	Rental Scheme	Hire Purchase Scheme	Cash purchase
Financial Intermed-iation	Govern-ment/ Energy Authority	Govern-ment Energy Authority & Electric Co-ope-rative	Utility	Utility	Develop-ment institution	Utility	PV dealers	PV dealers
Implement-ing agency	Local represent. of energy authority	Electricity Co-ope-rative	ONE	Utility	Local develop-ment insti-tution	Utility	PV dealers	Mainly cash sold SHS
Other projects in pipeline	1.000	15.000	7.000	10.000	N.A.	4.700	N.A.	N.A.

35 The percentage rates give only a rough indication where programmes can be localised according to known subsidies in the programme. Often, hidden subsidies exist which are at first glance not related to PV and are therefore difficult to identify and quantify.
36 Maybe even higher, considering the intention to reduce the interest rate to 0% over 20 years
37 Exact terms of rental schemes not available.
38 Aprox. number of SHS installed under the analysed programmes.
39 For Morocco, no number is available for SHS installed under international programmes; the given numbers are related to SHS in the range of 50 to 100 Wp mainly sold on cash basis to rural households.

6.2 Main Findings and Lessons Learned

The objective of the study was to verify the thesis that target-group-oriented financial services support the dissemination of SHS as long as they fit into existing financial structures and do not distort the local financial systems.

To recall, essential conditions for a sound financial market were identified as:

- **Government interference should be cut back.** Indicators: degree of interest rate ceilings, degree of targeted credits and degree of limitation by credit quota systems.
- **Existence of a regulatory and supervisory framework which instils customer orientation and sound financial management in financial institutions.** Indicators: subsidy dependence and level of financial self sufficiency

Looking at typical frame conditions for any SHS dissemination activities there are the following facts to be considered:

Basic frame conditions for any SHS dissemination activities

1.The potential SHS user is usually faced with a purchase price which is often a multiple of his yearly income and which, therefore, is hardly affordable. (First Cost barrier).

2. The typical potential user of a SHS in Developing Countries (remote rural area, no access to grid electricity in the longer run, low income and no regular cash flow) has usually no access to commercial credits.

3. So far, both formal and semi-formal financial institutions hesitate to enter voluntarily into SHS lending for this low-income sector of the rural population since this business is not compatible with the criteria for financial sustainability of a financial institution (see also Chapter 4.1).

4. A commercial credit according to the criteria of institutional sustainability would hardly be affordable for rural SHS-customers for two main reasons. First, the desirable short payback period requires high regular payment rates (amortisation, market interest rates and administration fees) and, second, rural customers can usually not offer suitable guarantees (collateral).

5. If the user can afford to pay cash, other problems related to the SHS technology do apply for him as well. Both cash payers and local implementing organisations go often for the cheapest PV systems and components on the local market with often poor quality resulting in higher maintenance and operational costs than expected.

6. The lack of information regarding the capacity limitations of even high quality SHS as well as the consequences of using low-quality systems is another barrier for SHS dissemination.

The majority of findings and lessons to be learned from SHS projects in numerous countries indicate similar experience and problems.[40] These problems seem to be typical for the majority of donor and/or government assisted programmes during the last decade and are mostly interrelated. They cannot be solved independently from each other.

The analysis of findings revealed barriers in the following areas, which need to be removed for the wider dissemination of SHS:

1. ***Policy issues***
2. ***Technology issues***
3. ***Financial issues***
4. ***Awareness issues***

The following table presents detailed issues, comments/lessons learned and respective recommendations according to these barriers.

[40] Additionally to the presented case studies, SHS activities in Dominican Republic, India, Indonesia, Kenya, Mexico, Senegal and Zimbabwe have also been looked at.

Findings	COMMENTS AND LESSONS LEARNED	RECOMMENDATIONS
1. Political aspects		
1.1 Allocation/ placement of subsi-dies	Direct or indirect subsidies were found in all government and donor assisted SHS programmes and on all levels. These programmes can be distinguished by their degree of subsidies (see Table 3) and the way the user of a SHS can benefit from it, be it as subsidy directly passed on to the end-user (e.g. Tunisia) or indirectly through 'zero-interest rate financing' like in the Philippines[41] or, to a lesser extent, utility based approaches with soft loans from international financial co-operation (Morocco)[42]. In some cases, subsidies are deliberately concealed.[43] There seems to be a common understanding that subsidies are not indispensable, but are a more or less accepted instrument of Governments and Donor Agencies used to remove barriers and to facilitate the widespread introduction of SHS provided certain preconditions are met.	- **Well targeted subsidies can reduce transaction costs for dealers/ banks. They should not be spent for partial equipment purchases but rather for institution-building measures, providing incentives for profitable business in rural areas.** - **Subsidies on recurring costs result in market distortions and should therefore not be approved.** - **Whenever possible, subsidies should be avoided, reduc-ed and/or made self-destructive after the fulfilment of theirs tasks.**
1.2 Lack of transpa-rency	The lack of transparency of subsidies, fees and tariffs results in 'hazy' cost structures. Often, the subsidy component is not clearly identified and is therefore not transparent either to the implementing or the financing institution or to the end-user. Sometimes, even credit and subsidies are mixed up, leading to disincentives for both credit recovery on the financial institution side and credit repayment on the customer side. Financial services are seldom delivered in a transparent way. They have not been separated at institutional level from sales and maintenance service, resulting in undefined responsibilities. In fact, while information on the number of SHS user households and regional distribution of SHS is relatively easily available, little can be said about the performance and	- **Establishment of transparent documentation on cost, tariffs and subsidy components throughout a project** - **Implementation of continuous monitoring & evaluation procedures from the beginning**

41 The 'zero-interest rate' applies only for the credit offered by NEA to the eligible Co-operatives. The Co-operative may pass the subsidies on to the customer by subsidising the rental fee for the Solar Generator.
42 SHS programme PERG of ONE/ KfW.
43 Like in the case of LADB-concept Lesotho; see case study Lesotho in volume II

	sustainability of the SHS financing schemes that are currently employed to promote SHS dissemination. This suggests that the financial sustainability of SHS financial programmes has received lower priority than the outreach of SHS dissemination. The results are lack of information on the side of the user/ customer, sometimes also the intermediary about the different types of costs to be borne. It also leads to a low credit recovery rate, since fees are not differentiated according to debt service (interests and amortisation), rental fees, or operational and maintenance fees. If these costs are not separated, the temptation exists for the implementing institution to cross-subsidise losses from unexpected expenditures for early replacement of components or to compensate low recovery rates. Thus, funds are reduced and cannot be recovered, which may result in the collapse of the financial scheme. Commercial financial institutions/ banks are well aware of that risk and are critical when it comes to financing SHS.	Sustainability can only be evaluated if carefully monitored over years of operation. This task requires the continuos application of a capable and easy-to-handle monitoring & evaluation system. Beside the 'classic' task of M&E to monitor operating problems, the financial performance of the applied financing scheme must be monitored and the results be fed back to the parties involved.
1.3 Lack of private sec-tor involve-ment	Although nearly all SHS programmes claim to support the private sector, the results are mixed at best. Due to the lack of incentives for private entrepreneurs and high risks perceived by financial intermediaries, international agencies get often directly involved in financing of SHS programmes. Many SHS programmes financed by international agencies are aimed at the installation of as many SHS as possible in rural areas, giving more importance to the number of disseminated systems than to sustainability. In some programmes presently in the pipeline, the focus is on systems provided by the industry of the donor country, thus not allowing for real competitive bidding in the private sector.[44]	- **Redefine the role of Technical Assistance** Technical Assistance Agencies should not be involved in financing rural PV electrification projects. Neither should they play a universal role in procurement of equipment, installation, training, maintenance etc. Instead, technical assistance projects should focus on improving the framework conditions through capacity building measures such as management training, demonstration of viable business models, quality assurance, monitoring and evaluation, thus helping national agencies and local intermediaries to better fulfil their mandates. TA could also contribute to developing regulatory models for energy-service concessions.

[44] Two programmes are known to be in the pipeline for the Philippines (EIES) and Bolivia with SHS equipment provided by the donor agency, in both cases the Dutch Government.

[45] Complains are known from Morocco (see Kublank et.al., 1997), but also from other countries.

[46] See Miller (1998).

	With a dissemination approach like this, the local private industry can not develop its own market structure and continues to depend on donor projects. The often used term "commercialisation" related to involvement of the private PV sector is misleading, if only selected activities are carried out under commercial conditions, while the main activities and costs of project implementation are often subsidised (e.g. overhead-costs, hardware). At best the private sector was not affected by these subsidised projects. However, there are reports of private PV dealers complaining that donor supported projects do jeopardise the development of the PV market with market distortions caused by subsidies.[45] The recent strategies of World Bank, GTZ, KfW and other agencies now indicate a shift from that approach and concentrate more on creating favourable market conditions for the private PV sector rather than on high numbers of SHS installed irrespective of the underlying dissemination approach.[46]	An example for the focus on increased private sector involvement is the German PPP (Public Private Partnership) programme, which aims to promote the dialogue and co-operation between the public development co-operation and private entrepreneurs in developing countries.[47] - **Redefine the role of Financial Assistance** Financial assistance agencies should restrict their role to that of a wholesale banker, e.g. the refinancing of working capital needed by private entrepreneurs to sustain their business of SHS dissemination.
1.4 Lack of responsive service structures/ after sales service	The lack of responsive after-sales service structures leaves end-users and implementing agencies alone with technical and operational problems. This lack is caused by insufficient private sector involvement or incomplete regulation and control of ESCos. Either private dealers under the sales model address this problem or effectively regulated ESCos with a clear mandate to provide after-sales services.	- **Emphasis on responsive after-sales services from the very beginning.** Considering the mixed experiences with local NGOs acting as implementers, it is a key factor for success that after sales service structures are offered on market-based principles, even after expiry of the warranty period. In principle, this can be achieved by sales or service models, with the recent trend going towards the latter approach, however. For regulated energy service concessions, a government agency at an appropriate level must learn to serve as an effective regulator.

[47] The PPP programme is financed by the German Ministry of Economic Co-operation and Development (BMZ) and implemented by GTZ, KfW and DEG since January 1999.

2. Technical issues		
2.1 Operational problems, technology transfer and quality manage-ment	PV Technology is commonly regarded as being technically mature and operationally reliable. However, this is only true for the application in industrialised countries with high quality products and an efficient after sales service in place. The study shows that SHS as implemented in developing countries often lacks reliability of certain components, mainly batteries and fluorescent lamps, and especially so if locally produced. [48] Malfunctioning systems, however, lead to higher operational costs, reduce the confidence of end-users in the PV technology and finally, their willingness to pay. It is crucial to get project designers and implementing organisations to understand that the lowest initial investment cost may be a worse option in the long-run. Technology transfer is often regarded as a key factor for lowering the investment costs of SHS through easy access to local products. It has the advantage of being independent of fluctuations in foreign currency exchange rates, not to mention the expected savings in foreign currencies. Experience with technology transfer measures e.g. in the Philippines, Tunisia and Bolivia reveal that any technology transfer measures can only be successful if based on a long term strategy combined with a strong quality assurance and control component. Without an efficient quality management and certification system in place, a sustainable market penetration of SHS is not achievable.	- **Increased technical reliability of SHS requires strict quality control measures and application of international standards and certification mechanisms.** - **Application of high quality PV-systems and components instead of going for the cheapest bid.** - **Training of national institutions/organisations to enable them to enforce internationally recognised technical standards for testing and certification on their own. [49]** - **The transfer of proven technologies must be designed and implemented as a long term commitment to the local private sector.**

[48] Respective reports exist among others from Morocco, Kenya, Bolivia, Philippines Lesotho and South Africa.
[49] International standards and conventions, which are already widely common and accepted e.g. for computers, TV and cars; international donors increasingly support the enforcement of technical standards initiated by international initiatives and projects like PV-GAP and PVMTI.

3. Financial issues		
3.1 Financial schemes often not cost covering	The underlying financing models for SHS dissemination projects are often not sustainable. The initial investment cost barrier being high, different ways of removing it were tried, mostly by some sort of subsidised financial schemes. In almost all the evaluated projects the service fees are fixed at a narrow range between 5 - 10 US$/month, although the real costs of the systems would require higher instalments. It is certainly not coincidental that this amount is almost exactly in the range of the expenditures of the rural population for traditional energy sources like kerosene, candles etc. Interestingly, the case of Namibia shows a significant number of people paying voluntarily a higher instalment than agreed on only to repay the credit as soon as possible. [50] Otherwise, experience in other countries with newly created village associations showed that service fees not fixed at a cost-covering level caused their early collapse, either in the first implementation phase or after external assistance expired. Heading for sustainability in a SHS introduction programme clearly requires cost-covering financial schemes. This, again, requires the careful design and allocation of subsidies, if allowed at all.	- **The financial scheme should be designed in such a way that financing institutions or any other financial intermediaries can recover their costs.** An appropriate financing scheme which is attractive for a financial institution should be calculated based on cost coverage principles irrespective of what people usually spend for traditional energy sources. If the user's capability-to-pay does not allow cost coverage, it should be carefully evaluated whether the target group is the right one to absorb a SHS dissemination programme, otherwise the selection of the target group should be reviewed and if necessary changed. The evaluation of SHS programmes shows a clear correlation between the sustainability of a SHS programme and the socio-economic situation of the target group: so poorer the target group so higher is the probability for a programme to fail.[51] This reflects the finding that SHS has low priority for the poorest part of the rural population.
3.2 The issue of under-stating recurrent costs	With the concentration on debt service payments only, recurrent costs are often underestimated. Operating costs for maintenance and repair which are usually not included in financial schemes may constitute a critical success factor for a SHS programme. Either the end-user, in case of a credit scheme, or the lessor in a leasing or rental scheme, has to assume the operational costs, at least for the duration of the leasing/rental contract.	- **Project planning should assess all costs occurring during the total lifetime of a SHS using the Life-Cycle-Costing (LCC) formula.** - **Since cost recovery is intended, the overall financial design of SHS project must appraise the following costs (even BOS and O&M being covered by the user):**

50 Müller, Siepker (1998).
51 Although strong evidence for this statement were found in the evaluated projects, more investigation and fundamental research is required.

	The issue can prove difficult: as long as technical problems do not occur, it remains non-critical. As soon as an unexpected (or too early) replacement of a component is required, additional and, frequently not anticipated costs have to be covered. In case of the end-user repaying a credit, he has to take over these costs additionally to the instalments. In case of a leasing or rental scheme implemented by institutions like co-operatives or utilities, the costs have to be borne by them, sometimes leading to the collapse of a revolving fund or to inability to repay a credit. Quite often, neither the end-user nor the implementing institution is aware of this issue.	⇒ **Initial investment cost (capital costs)** (Solar Generator, design overhead costs, administration fees and installation service) ⇒ **Costs of BOS components and spare parts** (mainly spare batteries, fluorescent tubes and electronic ballasts) ⇒ **Operation and Maintenance costs** (collection of service fees, cost for service personnel, pre-financing of spare parts)
3.3 No clear picture on the ideal mechanism for SHS financing	Projects have not yet produced sufficient experience for drawing a definite conclusion on the viability of the sales vis-à-vis the service model.	**More field research required on the preferred financing scheme for SHS dissemination** **Sales model:** - Attract other potential distribution channels into the Solar PV business (e.g. any firm with rural experience and/ or distribution infrastructure). - Demonstrate viable business models **Service model:** - Develop regulatory models for energy service concessions - Integrate rural electrification policy with SHS-delivery
3.4 Constraints of micro-finance organisa-tions	Despite the fact that micro-financial services are increasingly offered to rural populations, these financial services do not apply for SHS yet. Only few examples for involvement of the micro-finance institutions in SHS lending were found.	

[52] No evidence was found in the literature searched for the question of what is productive and what is consumptive: is the electricity light for children doing their homework consumptive or productive? Or does the light used by the women to do their homework at night help them to be more productive during the day?

Existing micro-finance service is often offered only for productive purposes or for short term lending, and usually in small amounts not high enough to cover the initial investment cost of a SHS.

'Productive use' still constitutes a selection criterion for credit appraisals, and may, therefore, facilitate the access to credit. There is, however, no final evidence of what is meant to be productive and pure consumptive use of PV electricity.[52] Productive use of PV-generated electricity, due to the technical characteristic of PV would be restricted anyway to selected low energy consuming applications.

The finally relevant question for micro-finance institutions is, whether SHS credits fit into their portfolio? It may well be that there exists no financial scheme so far being both profitable for the financial intermediary and affordable for the customer in the long run.

There is a multitude of reasons for this, ranging from lack of (perceived) creditworthiness of the target group to the low volumes of credit available. Even if the technical problems with SHS were solved, the ability-to-repay existed, interest rates were based on cost recovery, and the question of guarantee could satisfactorily be solved, the issues of high credit requirement and long payback period would still remain.

However, commercial lending for SHS or any other consumer good, where it exists, does provide benchmarks for sustainable lending conditions, like hire purchase schemes in Lesotho show, (although, the Lesotho experience needs further evaluation).

- **Instead of the distinction between consumptive and productive use, cost recovery and adjustment for positive/negative external effects should be put in the centre of attention.**
- **Design of risk mitigation measures adapted to the needs of both the financial institution and the customer, e.g. better information/ training in understanding the SHS technology.**

This issue is critical for any financial schemes since the portfolio at risk (< 10%) and credit losses (< 4%) are the two main indicators for a financial institution to measure its institutional sustainability.

- **Assessment of creditworthiness of the potential customer should be undertaken by a trained branch officer or experienced representative of the intermediary. The selection of target groups should be reconsidered; for the poorest of the poor a SHS ranks low in priority.**
- **Development and application of innovative guarantee models appropriate to and depending on the target group (e.g. collateral, involvement of community, PV dealer)**

Therefore, flexibility and willingness to look for and accept innovative ideas and new methods are essential on both sides. Chattel mortgage is only one possibility of securing a credit: another common practice although not quite innovative, is the reservation of proprietary rights e.g. for the Solar Generator.

- **Allocation of subsidies has to be done in a responsible way in order to avoid market distortions.**

[53] See respective discussions on 'good and bad subsidies' at World Bank Energy Roundtable Meeting, World Bank (1998). According to this discussion the 'good ones' refer mainly to well targeted subsidies on selected capital costs while the 'bad ones' are subsidies on operational costs and should definitely be avoided.

	Possibilities to get formal or semi-formal financial institutions interested in SHS dissemination projects are mostly limited to either governmental institutions such as development banks or public utilities (see, e.g. case studies Brazil, Morocco, Philippines, Tunisia), or non-profit co-operatives or village associations (e.g. Philippines, Senegal). As long as the term structure of a SHS financial scheme is not sufficiently attractive and does not seem to offer operational and financial self-sufficiency, and no real risk mitigation can be achieved, no commercial financial institution will engage in SHS financing without being forced to do so.	In order to minimise on capital costs, projects take advantage of different kinds of subsidies, the "good ones and the bad ones" [53], e.g. tax exemptions, bulk procurements as well as shifting administration and overhead-costs to other budget heads.
4. Awareness issues		
4.1 Low credit recovery rate as a result of lack of awareness and information	The frequently reported low credit recovery rate is closely related to the degree of awareness and information of the end-users of a SHS about the capabilities and limitations of 'their' system. Examples from Morocco, Lesotho, Kenya and others countries indicate that the ability-to-pay among some parts of the rural population is considerably higher than usually anticipated. People are willing to invest in getting electricity if the service is affordable and worthwhile. They appreciate the advantages that solar electricity offers in comparison to kerosene lamps, candles and dry cells and, especially, the operation of a TV. Although SHS offer the possibility of substituting expenses for traditional energy services, experience has shown that reducing expenses for traditional energy sources was seldom the driving force behind the purchase of a SHS. Instead, customers were willing to spend more for improved energy service. Energy related expenses of the household rather increased due to	- **Provide clear and comprehensive information about the performance of SHS and about operational costs in order to avoid disappointment, and as a consequence the collapse of the underlying financing scheme.** - **Any distribution of SHS free of charge must be avoided. Customers should be forced to contribute from the very beginning in order to raise their appreciation of the value of a SHS.** - **SHS customers should be carefully selected according to their economic capability bearing in mind that electricity supply is not always a priority, especially for the poorest part of rural population.**

[54] Like in the cases of the Philippines where in some cases the total amount to be collected from a remote island was lower than the transport cost for the service personnel to get there.

	changing consumer behaviour resulting generally in higher energy consumption. As this can be interpreted as a step towards improving the living conditions of the rural household, it implies also an increase in energy related expenses. Rural people are more creditworthy than usually expected, like the examples of successful hire-purchase schemes for household appliances e.g. in Southern Africa show. Regular payments for monthly service fees do not necessarily conflict with the seasonally determined income generation pattern of rural households as long as enough income is generated and stored to cover the frequent instalments. Low credit recovery rates as observed in some cases have different reasons which are either related to errors in the project design[54] or related to the disappointment of end-users with performance, reliability or unexpected high operational costs of the acquired SHS. In any case, the user's willingness-to-pay is affected. The same behaviour may be caused by donations and/or directly subsidised programmes when people received a SHS for free. There is a correlation between the degree of information and the user's willingness-to-pay, which however, is difficult to quantify and requires more research. Irrespective of the reasons, however, a low recovery rate has much to do with inadequate information of the potential customer for a SHS, be it about the operational costs and related risks or about the limitations of the PV system. A low recovery rate should be carefully monitored and avoided whenever possible, since it carries the danger of jeopardising the sustainability of any SHS dissemination programmes.	

4.2 SHS is no priority for the poorest of the poor	Implementing agencies, governments, financial intermediaries as well as donor agencies have to recognise that electricity supply and, particularly SHS is *not a priority* for the poorest part of the rural population. Only after the most urgent basic needs like food, health, housing, education are met, will electrification become an issue for this part of the population. The need to mobilise savings for down-payment and provision for the operational cost of a SHS requires a minimum income. If there is no constant and sufficient purchasing power and at least some minimum potential for savings, the basic requirements of commercial SHS dissemination are not met. There are examples of SHS programmes which were deliberately implemented for political and social reasons.[55] These programmes, however, are likely to fail from the very beginning due to the lack of economic commitment of the end-users and lack of continuing government subsidies necessary to keep these programmes going. These programmes jeopardise any approach to establish a sustainable and commercially viable SHS market.	- **Careful analysis and determination of the target group and its economic situation.** - **Governments, implementing agencies and donors must be well aware that politically motivated electrification programmes for the very poor part of the population cannot be sustainable as they depend on continued provision of subsidies.** - **If micro finance services were available for this group, there would be certainly more effective use for it, e.g. in the productive sector.**

[55] E.g. the so-called 'Presidential SHS- Flagship-Programme' in the Philippines.

7. Bibliography

1. **ADB-IT Power:** Solar PV Power Generation – Technology, Economics, Institutional Aspects (3 Volumes). Manila 1995.
2. **Adib; Hille:** Financing Solar Home Systems: The Case of Indonesia. Fraunhofer-Institut für Solare Energiesysteme ISE, 07/1998.
3. **Allderdice:** Challenges and Benefits of the Microlending Framework to Rural Renewable Energy Programmes. Paper presented on the workshop on "Institutional Co-operation for Solar Energy in the Mekong Riparian Countries". Hanoi 05/1998.
4. **AME/GTZ:** Solar Rural Electrification in Tunisia, Approach and practical experience; Volume 1 and 2. Tunis 1999
5. **Asian Development Bank:** Regional Workshop on Solar Power Generation Using Photovoltaic Technology, Proceedings, 02/1996 (1).
6. **Asian Development Bank:** Solar Photovoltaic Power Generation Using PV Technology, Volume I: The Technology, 02/1996 (2).
7. **Asian Development Bank:** Solar Photovoltaic Power Generation Using PV Technology, Volume II: The Economics of PV Systems, 02/1996 (3).
8. **Asian Development Bank:** Solar Photovoltaic Power Generation Using PV Technology, Volume III: The Institutional Aspects, 02/1996 (4).
9. **Berdai; Butin:** Electrification Décentralisée. Hypothèses, Options, Méthodes. Direction de la Planification et de l'Equipement, Cellule Projet, Morocco, 07/1994.
10. **Böhnke:** PV Electrification – an Option to improve the Living Conditions of Rural Households. NEA, Philippines 1997.
11. **BTG-Netherlands:** Market Development Plan, 1996.
12. **Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ):** Förderung erneuerbarer Energie in Entwicklungsländern. Referat Presse und Öffentlichkeitsarbeit, Entwicklungspolitik BMZ aktuell, 12/1992.
13. **CEMIG:** Pré-Electrifição Rural Através da Geração Descentralizada com Sistemas Fotovoltaicos. Belo Horizonte, Brazil, 1997.
14. **CGAP Working Group:** Financial Instruments and Savings Mobilization: Comparative Analysis of Savings Mobilization Strategies – Case Study Bank Rakyat Indonesia (BRI), Indonesia, Draft. GTZ, Division 405, Financial Systems and Small Enterprise Development, 1997.
15. **Chao-Beroff:** Analyse Comparative des Stratégies de la Mobilisation de l'Epargne, Etude de Case Caisses Villageoises du Pays Dogon, Mali. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn 1998.
16. **Corvinus; Halatanu; Matakiviti; Sefana; Toumoua:** Participatory Rural Energy Appraisal Fiji, Tonga. Pacific Regional Energy Programme (PREP) in collaboration with Ministry of Lands, Mining and Energy, Department of Energy and Ministry of Lands, Fiji, Survey and Natural Resources, Tonga, 1997.
17. **Diniz et. al.:** PV Energy Program in the State of Minas Gerais – Brazil. CEMIG, 1997.
18. **Eckhard:** Solar Bank: Progress in India and South Africa. Paper presented at the 2nd World Conference and Exhibition on PV Solar Energy Conservation, Vienna 1998.
19. **Fahlenbock:** Qualitätsstandards und Ausschreibungsunterlagen für Solar Home Systems (SHS) und PV-Systeme zur Versorgung von Krankenstationen in Entwicklungsländern. GTZ, Eschborn 03/1998.
20. **Finck; Oehlert:** A Giude to the Financial Evaluation of Investment Projects in Energy Supply, GTZ, 1985
21. **Flavin; O'Meara:** World Watch May/June 1997
22. **Gallardo; Randhawa; Sacay:** A Commercial Bank's Micro-finance Program: The Case of Hatton National Bank in Sri Lanka. World Bank Discussion Paper No. 369. Washington/DC, 1997
23. **GEF**: The GEF Solar PV Portfolio - Emerging Experience and Lessons, Monitoring and Evaluation Working Paper 2, August 2000

24. **Gregory; Silveira; Derrick; Cowley; Allinson; Paish:** Financing Renewable Energy Projects. A guide for development workers. Intermediate Technology Publications in association with The Stockholm Environment Institute, 1997.
25. **GTZ:** Evaluation of credit programmes of GTZ. Eschborn w/o year
26. **GTZ:** Sector paper on Financing. Eschborn 1994
27. **GTZ:** Basic Electrification for Rural Households. Eschborn 1995
28. **GTZ:** L'Electrification Rurale de Base Solaire en Tunisie. Eschborn 1997 (1)
29. **GTZ:** Orientierungsrahmen für die finanzsystemgerechte Gestaltung und Handhabung von Kredifonds. Eschborn 1997 (2)
30. **Haars:** Bericht zum DFS – GTZ Informationsgespräch: Verbreitungschancen für Solartechnik in Entwicklungsländern. GTZ, Eschborn 1997.
31. **Hankins:** Solar Rural Electrification in the Developing World. Four Country Case Studies: Dominican Republic, Kenya, Sri Lanka and Zimbabwe. Solar Electric Light Fund, 11/1992.
32. **IDAE, Instituto para la Diversificación y Ahorro de la Energía:** Third Party Financing for Energy Saving Projects. European Commission, Directorate-General for Energy (DG XVII), 10/1995.
33. **Japan Fuji Technosurvey Co. Ltd., The Institute of Energy Economics:** Study on the Promotion of Photovoltaic Rural Electrification in the Republic of Zimbabwe, Interim Report. Japan International Cooperation Agency, The Republic of Zimbabwe, Ministry of Transport & Energy, 01/1998.
34. **Jiménez:** Microenterprise and SME Lending. The ADEMI Experience in the Dominican Republic. Informal report presented to the World Bank, 1998.
35. **Johnson; Rogaly:** Micro-finance and Poverty Reduction. Oxfam Development Guides, Oxford, 1997
36. **Kölling:** PROPER-Bolivia, Final Report. CRE, Bolivia 1998.
37. **Kublank; Bloos; Scheutzlich:** Studie über den Wettbewerb zwischen konventionellen und regenerativen Energiesystemen am Beispiel der Photovoltaik in Marokko. GTZ, Eschborn 03/1997.
38. **Madon; Müller-Klinghammer:** Royaume du Maroc. Projet d'Electrification Solaire Perg-One-KfW, KfW, Frankfurt 1997
39. **Mason:** Rural Electrification. A Review of World Bank and USAID Financed Projects. Background Paper, 1990.
40. **Maurer:** Comparative Analysis of Savings Mobilisation Strategies. Case Study Bank Rakyat Indonesia (BRI), CGAP Focus Note # 10. GTZ, Eschborn 1997.
41. **Mendis; Gowen:** Financing Rural Energy Services, w/o year
42. **Miller:** Entrepreneurial Support as a Strategy for the Diffusion of PV Technology. The Case of World Bank Lending for Solar Home Systems in Rural India and Indonesia. University of Cambridge, Judge Institute of Management Studies, 1998
43. **Müller-Klinghammer:** The SHS project of CRE and the Technology Transfer, Frankfurt/M. 1994.

    Northrop; Riggs; Raymond: Selling Solar – Financing Household Solar Energy in the developing world. Pocantico paper No. 2, New York 1996.
44. **Office of Energy Affairs, Non-Conventional Resources Division, Republic of the Philippines in Cooperation with Asia Pacific and Development Centre, Kuala Lumpur, Malaysia; World Bank, Energy Sector Management Assistance Program:** Renewable Energy and Energy Conservation for Small-Scale Energy Users: Market Opportunities in the Philippines. Finesse Country Market Study Philippines.
45. **Pertz:** Philippines: Financial Aspects of Rural Household Electrification with Solar Home Systems. GTZ, Eschborn 10/1994.
46. **Pertz:** Rural PV-Electrification. Case Study Philippines. Final Report. GTZ, Eschborn 06/1993.
47. **Pertz:** The Role of Financing – Rural Household Electrification with SHS. Philippines 1998.
48. **Posorski, Fahlenbock:** Technical Standards and Tender Specifications for Solar Home Systems and PV Supply of Rural Health Stations in Developing Countries. Paper presented at the 2nd World Conference and Exhibition on PV Solar Energy Conservation, Vienna 1998.

49. **Ramani; Reddy; Islam:** Rural Energy Planning. A Government-Enabled Market-Based Approach. Asian and Pacific Development Centre (APDC) and GTZ, Kuala Lumpur 1995.
50. **Solar Development Corporation:** A New Approach for Photovoltaics, 1997.
51. **Ullerich et al.:** L'Electrification Rurale de Base 'Solaire' en Tunisie. AME, Tunisia 1998.
52. **UNDP:** Zimbabwe. GEF-Solar Project. Annual Report 1997.
53. **UNDP:** Report of the Secretary-General on Financial Mechanisms and Economic Instruments to Speed up the Investment in Sustainable Energy Development, 1999
54. **United Nations Development Programme:** Project of the Government of Philippines.
55. **Wisniwski:** Micro-finance-Multinationals: Micro-finance-Netzwerke und Geberinitiativen im Überblick. GTZ, 1998.
56. **World Bank:** Photovoltaic Applications in Rural Areas of the Developing World, 1995
57. **World Bank/GEF:** Photovoltaic Market Transformation Initiative, 1996 (1).
58. **World Bank:** Best Practices for PV Household Electrification Programmes, 1996 (2).
59. **World Bank:** The Case for Solar Energy Investments, 1996 (3).
60. **World Bank:** Rural Energy and Development: Improving Energy Supplies for 2 billion People, 1996 (4)
61. **World Bank:** Staff Appraisal Report Indonesia. Solar Home Systems Project. 1996 (5).
62. **World Bank**: Rural Energy and Development Roundtable, 1997 (1)
63. **World Bank:** Project Appraisal Document on a Proposed Credit to the Democratic Socialist Republic of Sri Lanka for an Energy Services Delivery Project, 1997 (2).
64. **World Bank:** SBP Micro-finance Handbook. Draft, Washington/DC, 1997 (3)
65. **World Bank:** PVMTI – an initiative of the World Bank Group, 1998
66. **World Bank:** World Bank/GEF Solar Home Systems Projects – Experiences and Lessons Learned 1993-2000, Washington/DC, 2000

8. Glossary

Apex institution Second-tier financial institution that does not engage in direct lending to individual borrowers but rather provides funds to first-tier financial institutions that onlend these funds to individual borrowers.

Blocked savings Savings that are blocked and cannot be withdrawn. They are often used as collateral substitutes in order to enforce credit repayment. These savings can only be withdrawn when the credit is fully repaid. Blocked savings generally represent 20-25% of the credit amount.

BOS Balance Of System: The parts of a photovoltaic system apart from the solar generator. Generally it is referred to the in-house components of a SHS (battery, fluorescent lamps, wiring etc.). Depending on the financing scheme the Battery Control Unit (BCU) is included or excluded from the BOS.

Capital Cost All costs of the total initial investment consisting of hardware cost, overhead cost for design/ engineering and cost of installation

Collateral Physical asset that serves as guarantee or security (real estate/land titles; prawn such as cars, household goods etc.) that backs the credit in case of credit default.

ESCO Energy Service Company. This can be a small co-operative as well as a big commercial utility.

Financial self-sufficiency Income from financial operations covers inflation costs, administrative costs, provisions for credit losses and financial costs plus opportunity costs for equity.

Life-cycle cost (LCC) A form of economical analysis where the initial costs and all future costs for the entire operational life of a system are considered. The period for the analysis is normally the lifetime of the longest lived system being compared, i.e. in a SHS the photovoltaic module.

Fluorescent lamps Lighting device used in photovoltaic applications. A fluorescent lamps contains generally a conventional fluorescent lamp (FL or CFL), an electronic ballast and the lighting fixture (carcasse, sockets, wiring). In SHS the fluorescent lamps is generally a 12 Volt-DC-powered device.

Micro-finance Micro-finance has evolved as an economic development approach to benefit low-income women and men. Micro-finance activities are generally distinguished from regular banking operations by the following characteristics: (i) small credits, typically for working capital (in general, below GDP per capita in the respective countries); (ii) informal credit appraisal; (iii) collateral substitutes such as solidarity groups and blocked savings (see Glossary); (iv) access to repeat and larger credits based on repayment performance; (v) streamlined credit disbursement and monitoring.